



# SAE AS50881™ REV. H Updates

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*Presented by:*

**Tracy Denmark**

Design & Installation Committee

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# Outline

- **AS50881TM Scope**
- **Revised Updates (2023-01)**
- **Discussion**

# MIL-W-5088L

- **Notice of Validation dated 07-Nov-2023 via Assist website**
- **Wiring, Aerospace Vehicle (Future Design Should Refer to SAE-AS50881)**
- **MIL-W-5088L, dated 30-Sep-1998, remains inactive for new design; however, the document is valid for use.**

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# AS50881™ Scope from Current “REV. H”

## “1. SCOPE

### 1.1 Purpose

This specification covers all aspects in electrical wire interconnection systems (EWIS) from the selection through installation of wiring and wiring devices and optical cabling and termination devices used in aerospace vehicles. Aerospace vehicles include manned and unmanned airplanes, helicopters, lighter-than-air vehicles, missiles and external pods.

#### 1.1.1 Application

This specification establishes design requirements guidance for wiring and optical cable installation in aerospace vehicles. Although many of the requirements are written as mandatory and shall be considered as such, there is also considerable material which is intended to denote optional, preferential or guidance type requirements. In interpreting the material contained herein, it is intended that the philosophy of the entire document be considered for the wiring of each new type of vehicle. This philosophy is safety of the personnel, safety of the vehicle, satisfactory performance and reliability of the vehicle and ease of maintenance, and service life all at the least cost to the operator. The intent of this document will be fulfilled by tailoring the requirements in each new type or class of aerospace vehicle designed, to the proper application. ARP/AIR documents listed in this specification are for reference only. Any reference in this document to Military, Air Force, Navy, Army or Coast Guard refers to systems managed or procured by the U.S. Department of Defense (DOD) or the U.S. Department of Homeland Security (DHS).

- 1.1.1.1 This document does not apply to wiring inside of airborne electronic equipment but shall apply to wiring externally attached to such equipment.”

# Para 2.1.1 SAE Publications

- **AIR 5919 – Alternatives for Cadmium Plating**
- **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**
- **ARP1987 – Clamp Selection and Installation Guide**
- **ARP7987 – Development, Verification and Validation of a Thermal Model for Determining Current Derating Design Limits of Aerospace Wires and Wire Bundles**
- **AS4372- Performance Requirements for Wire, Electric, Insulated Copper, or Copper Alloy**
- **AS60491 – Sleeve, Protection, for Cable and Harness Protection**

# Para 2.1.3.5 Military Specifications & Para 2.1.3.3.1 Military Handbooks

- **MIL-DTL-32554 – Straps, Tie-Downs, Adjustable, Non-Metallic, Cable Bundling, General Specification for**
- **MIL-HDBK-534 – Aircraft Fuel System Service Life Extension**
- **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 thru 5)**

# Para 2.1.3.5 Commercial Item Descriptions (CID) & Para 2.1.5 AIA Publications

- **A-A-59125 – Terminal Boards, Molded, Barrier Screw and Stud Types and Associated Accessories**
- **A-A-59877 – Insulating Compound, Electrical, Embedding**
- **NASM22529 – Grommet, Edging**



# Updates for REV H

## 3.6.4 Epoxy Adhesives

*Replaced existing paragraph with the following:*

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.**

*REASON: Provided inherent resistance requirements for epoxies.*

# Updates for REV H

## 3.8. Wiring Selection

*Replaced existing paragraph with the following:*

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.**

*REASON: Added Table A2 and referenced AIR6540.*

# Updates for REV H

## 3.9.2 High Voltage (600VAC/600VDC or Greater)

*Added the following paragraph:*

For U.S. Military applications, wire used in high voltage applications (600 VAC/600 VDC or greater) shall be distinguished from other wire/cables by using an orange (preferred International Orange 12197) color as the preferred primary insulation/jacket color. The wire shall be identified with a mark or marker sleeve with HIGH VOLTAGE preceding the existing wire ID marking, at intervals or 6 to 60 inches.

*REASON: Provided identification applications for high voltage.*

## 3.9.6 EWIS Components Identification

*Added the following paragraph:*

EWIS components installed on the aircraft shall be assigned a unique reference designator identification (RDI) number. Components are divided into three major categories: electrical equipment (i.e., WRAs/LRUs, terminal boards, relays, etc.), splice areas, and ground points. Each RDI will have a label or stencil visible on the aircraft structure adjacent to the assigned component. For U.S. Military applications, refer to the RDI format in MIL-HDBK-863 for guidance in identification of EWIS components.

*REASON: Provided RDI requirement for EWIS components.*

# Updates for REV H

## 3.11.2.3 Insulation Tape

*Revised the following sentence:*

Insulation tape shall be in accordance with 3.11.3.9 or 3.11.6.1 and may be used for additional protective covering for a protected harness (see 2.3.20).

*REASON: Provided additional use.*

## 3.11.2.4 Deleted

*REASON: No purpose for “Protective outer covering for a protected harness.”*

# Updates for REV H

## 3.11.2.5 Cable Lacing Fastener (CLF) System Usage

*Added the following sentences:*

Cable lacing fastener (CLF) shall be in accordance with MIL-DTL-32554. The physical properties of the tapes must be compatible with the installation environment (see 6.13).

3.11.2.5.1 CLF shall be installed with MIL-DTL-32555 tools.

3.11.2.5.2 Use of CLF is for general EWIS applications and same environment as A-A-52084.

3.11.2.5.3 When installed with three wraps, CLF may be used as secondary support in fuel exposure areas.

3.11.2.5.4 CLF shall be placed as secondary support in panels and junction boxes at a spacing no greater than 1-1/2 inches.

3.11.2.5.5 CLF shall not be placed within 1 inch of the back of connector as secondary support in panel and junction boxes. This is to prevent undue stress on the contact crimp terminations.

3.11.2.5.6 When installed with three wraps, CLF may be used for tying bundles containing RF cables with solid dielectric and optical cables (see 3.11.3.10.3), so long as the provision of 3.11.5 are met.

*Reason: Provided guidance for CLF System Usage.*

# Updates for REV H

## 3.11.3.10 Cable Lacing Fastener (CLF) System Usage Restriction

*Added the following sentences:*

CLF shall not be used in areas when the restriction of 3.11.3.10.1 through 3.11.3.10.3 apply:

3.11.3.10.1 Where failure would permit the strap to fall into moving mechanical parts.

3.11.3.10.2 To provide secondary support to wire, electrical cables, groups, or harnesses within bundles where CLF fastener may impose damage to adjacent wires or cables where supported would be on top of another fastener.

3.11.3.10.3 Where the bundle contains a fiber optics cable unless approved by the procuring activity and the cable is conducive to its usage.

*REASON: Addresses CLF Usage Restrictions.*

# Updates for REV H

## 3.11.4 Anti-Chafing Provisions

*Revised the following paragraph:*

Chafing shall be prevented by routing and clamping bundles to prevent contact with equipment and structure. Spiral wrap and other chafe guard materials shall not be used in lieu of primary supports for separation from equipment and structure. **Wiring inside slip on, loose braid sock, or otherwise metal braided shielded harnesses shall be protected from chafing on the braid sock (EMI backshell) or shield. Protection shall be accomplished by using AS60491, AS23053 material or a 25% overlap of A-A59474 tape.** Any protection must extend the full length of slip on or braid sock. Metal braided or shielded harnesses shall have a protective external nonmetallic covering, except for fire zone areas where it is optional.

*REASON: Addressed metal braided shielded harnesses and added AS60491, AS23053 and A-A59474 references.*

# Updates for REV H

## 3.11.4.2 Metallic Shielded/Braided Protected Harnesses

*Added the following paragraph:*

Where a separator/binder layer is used, the tape must be of a fungus resistant material with a temperature rating equivalent to, or higher than, the cable rating down the entire length of the harness. Non adhesive backed tapes shall be installed using a minimum 50% overlap to increase harness flexibility and reduce weight. A 25% overlap may be employed when using an adhesive backed tape such as A-A-59474.

*REASON: Addressed medal braided shielded harnesses and added AS60491, AS23053 and A-A59474 references.*



# Updates for REV H

## 3.11.5 Special Cable Support

*Revised the following paragraph:*

d. **Lacing** tape as specified in 3.11.2.1 (see 3.11.2.5.6 for CLF usage) shall be used for tying bundles containing RF cables. Selection of the tape and installation shall meet the requirements of 3.11.5 (a), (b), and (c), except that **AS23190** plastic straps may be used when approved (see 3.11.2.2) for tying bundles containing RF cables with solid dielectrics. **Straps shall be installed with tools in accordance with AS90387.** The tension adjustment on the AS90387 tool shall be set so that the requirement of 3.11.5 (a) is met (see 3.11.3.8.8 for optical cables).

*REASON: Addressed lacing tape, added references, and provided guidance on straps.*

# Updates for REV H

## 3.11.6.3 Terminal Nipples

*Revised the following sentence:*

A-A-59178 terminal nipples shall be used to provide overall insulation and protection on terminal lugs and studs *where termination covers or potting is not employed.*

*REASON: Addresses covers or potting.*

# Updates for REV H

## 3.11.13 Wiring Inside Fuel Tanks

Revised the following paragraph:

Wiring that is essential to the operation of fuel management or control system, may be routed inside fuel tanks only if there is no alternative and **requires the approval of the procuring activity**. Wiring that is used in circuits that are capable of generating energy levels greater than 0.02 mJ **must be isolated from fuel**. Isolation may be achieved by using grounded metal conduit having a fluorocarbon liner, approved components, approved materials for sealing, potting (3.14.8); routing through conduit or use a fuel-resistant Fluoropolymer molded harness, etc. (refer to MIL-HDBK-534). Wiring that comes in contact with fuel must have an insulation system which is compatible with the fuel and fuel vapor. Clamps and hardware used to attach wiring inside fuel tanks must also be compatible with the fuel and fuel vapor. **Environmentally sealed connectors and terminations used to attach wiring inside fuel tanks must also be compatible with the fuel and fuel vapor**. Tie tape, string, mechanical straps, or other items that could become loose and clog fuel filters shall not be used inside fuel tanks. Fiber optic cables and silver plated conductors (see 6.11) shall not be used inside fuel tanks. **Refer to AIR6820 for extended fuel performance characteristics of common wire types and wire selection guidance.**

*REASON: Added approval, isolation, compatibility and AIR6820.*

# Updates for REV H

## 3.14.5 Connector Installation

*Revised the following paragraph:*

Connectors shall be used to join harnesses to equipment or other harnesses when frequent disconnection is required to remove or service equipment, components, or wiring. Connectors shall be located and installed so that they will not provide hand holds or footrests to operating and maintenance personnel, or be damaged by cargo and stored material. Receptacles in pressurized structure shall preferably be installed with the flange to the high-pressure side. Fasteners shall be used in all holes of flange mounted connectors. Cadmium plated connectors or accessories **shall not be used inside fuel tanks** or anywhere that connectors can come in direct contact with titanium or carbon fiber composite components or structure. For recommended fastening hardware, tightening methods, and torque values, refer to AIR6151 and ARP1350.

*REASON: Fuel tank prohibition.*

# Updates for REV H

## 3.14.9 Fuel Exposure

*Added the following paragraph:*

For connectors subjected to extended fuel exposure, or inside fuel tank, A-A-59877 130° C (266° F) epoxy based molding compound may be used. User must verify the acceptability of A-A-59877 to their specific application. MIL-PRF-8516 (fuel resistant) sealant for operating temperatures not exceeding 93 ° C (200 ° F) may also be used with procuring activity approval.

*REASON: Added fuel exposure guidance.*

# Updates for REV H

## 3.20 Terminal Lugs

*Revised the following paragraph:*

**AS7928 copper** terminal lugs (see 3.20.1) shall be used to connect wiring to terminal board studs, equipment terminal studs, and ground studs. ARP6807 provides a method for **AS7928** terminal lug part number identification. No more than four terminal lugs or three terminal lugs and a bus bar shall be connected to any one stud (total number of terminal lugs per stud includes a common bus bar joining adjacent studs; four terminal lugs plus a common bus bar thus are not permitted on one stud). When the terminal lugs attached to a stud vary in diameter, the greatest diameter shall be placed on the bottom and smallest diameter on top. Terminal lugs shall be selected with a stud hole diameter which matches the diameter of the stud. For recommended fastening hardware, tightening methods, and torque values, refer to AIR6151. Tightening terminal hardware shall not deform the terminal lugs or the studs. The terminal tongue of a straight lug may be bent up to 90 degrees maximum away from the barrel, provided the bend radius is not less than twice the thickness of the lug tongue, and the distance from the tip of the tongue to the beginning of the bend is not less than the diameter across the lug. **Terminal lugs may be bent one time during installation, only. Any additional deformation/unbending of the lug requires terminal lug replacement.** Bending shall not be required to remove the fastening screw or nut. The position of the terminal lug shall be such that movement of the lug will tend to tighten the fastening screw or nut. Terminal lugs shall be installed to ensure no terminal lug or attached wiring comes into contact with other stud lugs, hardware, components, or structure. There shall be no more than two terminal lugs on the studs used to mount the terminal board cover.

**Copper** terminal lugs shall be used to connect wiring to circuit breakers terminals. No more than two terminal lugs, or one terminal lug and a bus bar or a bus bar shall be connected to any one **breaker** terminal. **provided the attaching screw has thread protrusion (minimum of two visible threads).** Multiple wire terminations in terminal lugs for secondary power distribution circuits shall not be permitted unless all the following conditions are met:

*REASON: Added AS7958, 3.20.1, and provided additional guidance.*

# Updates for REV H

## 3.21.1 Terminal Boards

*Revised the following paragraph:*

Terminal boards shall be in accordance with AS27212 and shall be installed with AS18029 covers. Terminal board mounting screw insulators shall be installed in accordance with AS33731. Ammeter shunts shall not be used as terminal boards. **The A-A-59125 terminal boards are not approved for aerospace applications.**

*REASON: Aerospace application prohibition.*

# Updates for REV H

## 4.6 Flight Test Wire Installation

*Revised the following paragraph:*

The flight test harnesses required for the test and certification phase of the air vehicle are temporary in nature and shall be removed once testing is complete. All test wire and harnesses shall be distinguished by color marking orange and for the U.S. Military applications shall be identified with “Flight Test” followed by voltage level (e.g., 28 VDC, or 115 VAC) on the wire ID label. If orange/test wire is routed in an existing harness it shall comply with all existing harness installation and routing requirements. For test wire harness installed in line/parallel with an existing flight control harness, it shall be installed, routed/separated, and supported, meeting the same requirements as the existing flight control harness. Components shall not be supported and secured to the aircraft existing harness. If attached to a flight test harness, the components shall meet existing mounting, security, and performance requirements and must be approved by procuring activity cognizant engineering.

*REASON: Addressed U.S. Military applications and orange/test wire routing.*



# Updates for REV H

## 6.7 Wire Current Ratings.

*Added the following sentence:*

ARP7987 can be used as guidance in developing wire and wire bundle current rating requirements given in this document.

*REASON: Added ARP7987.*

*Revised the following sentence:*

f. The total bundle capacity at sea level and 25 ° C ambient is 29.2 A x 12 wires = 350.4 A and the same bundle at 20000 feet at 60 ° C ambient is 23.8 A x 12 wires = 285.6 A. for the total bundle capacity. Each size 12 wire can carry 29.2 A at sea level, at 25 ° C ambient or 23.8 A at 20000 feet, at 60 ° C ambient.

*REASON: Added free air ratings (A).*

# Updates for REV H

## 6.12 Vibration

*Added the following sentence:*

When referenced within this document, vibration—including level, zone, and any specific component—is defined by the procurement or design authority. High or severe vibration levels are also defined by the procurement or design authority.

*REASON: Adds definition authority.*

## 6.13 Cable Lacing System Usage

*Added the following sentence:*

Due to the possibility of snagging of the buckle/catching on structure such as cutouts and conduit caution must be used when the MIL-DTL-32554 or AS23190 plastic strap is installed on those harnesses which must pass through these types of structure while being installed into the aircraft.

*REASON: Provides caution for use of plastic straps.*

# Updates for REV H

## 7.1 Revision Indicator

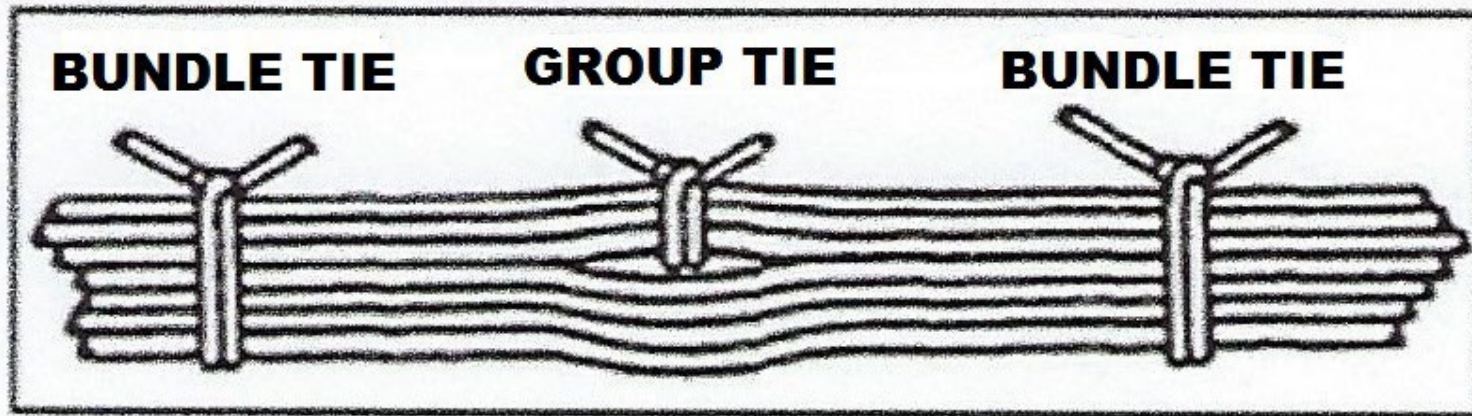
*Added the following sentence:*

Equation for calculating current derating factor:

$$Y = -1 \cdot 10^{-7} \cdot (X)^3 + 3 \cdot 10^{-5} \cdot (X)^2 - 0.0049 \cdot (X) + 0.9977$$

*REASON: Added equation for derating factor.*

*Added Figure 6:*



*REASON: Provided figure for group tie..*

# Discussion / Direction

