THE ADVANTAGES OF SAE AE-2 LIGHTNING COMMITTEE MEMBERSHIP

YOUR NAME
MEMBERSHIP ACROSS INDUSTRY

The SAE AE-2 Committee has a broad membership across the aviation industry

- FAA - TAD, HQ, SAD, Chief Scientist
- International Regulatory Authorities – TCCA, JCAB, ANAC
- US Military
- OEMs - Boeing, Airbus, Textron Aviation, Embraer, Mitsubishi, Bell, BAE Systems, Gulfstream, Dassault, Subaru
- Manufacturers - Rockwell Collins, Honeywell, Garmin, L-3, Pratt & Whitney, United Technologies, Dayton Granger, Parker Hannifin, Woodward, 3M, LDS, Adel Wiggins
- Test Facilities - DNB, LTI, Element, DLS, Elite, NIAR
- Test Equipment – EMC Partner, Thermo Fisher Scientific
- Software – EMA
- Consultants
MEMBERSHIP BENEFITS

Membership brings knowledge of:
• Proper design used to protect aircraft and associated equipment
• How to conduct the testing to verify proper designs

Membership brings additional benefits:
• A voice in the development of the standards and therefore how to show compliance for certification
• Networking with the experts in the field and recognition
It is the duty of the AE-2 committee to produce advisory materials for the aerospace community in the following areas:

1. The natural lightning environment and related environment standards

2. Protection of aerospace vehicles from the effects of lightning and other atmospheric electrical environments

3. Means of verifying the adequacy of protection measures

4. Standardized and other atmospheric electrical environments for lightning simulation and test methods
The SAE AE-2 Committee works closely with EUROCAE Working Group 31 to “Harmonize” all guidance material to ensure that all standards meet both US and European requirements.

AE-2 collaborates with other SAE Aerospace Council committees (e.g. fuel systems, mechanical systems, structures, etc.) as needed on lightning protection issues.

Intellectual interfaces with other committees and organization (RTCA, ARAC, EEHWG, IEEC, research institutions, universities, etc.)
Completed Review of FAA NPRM for Electrical/Electronic System Protection from the Indirect Effects of Lightning
   - Rule has been released and is applicable to 14 CFR 23, 25, 27, and 29

Development of AC 20-136B to align with new rules

Guidance for “default” test levels and installations for Part 23 FADEC
   - FAA has included within AC 33-28 and released
   - Advantages to industry:
     - Default levels have standardized the approach to installation compliance
     - Allows for STC Installations without requirements to run vehicle tests
     - Improves the safety/performance of the fleet by allowing for economical update of older aircraft
Development of Document for 25.981(a)(3), Fuel Tank Ignition Prevention Guidance

- Completed document outline
- Have section owners identified
- Drafted sections on testing, compliance, introduction, and background
- Coordination with WG-31 has resulted in an additional approach to compliance which may be included in the document
The committee has been in existence for in excess of 45 Years

- Founded as an AE4 Special Task Group F in 1972 in response to a Military request for assistance, designated AE4L in 1977

- Early Accomplishments
  - Determined external lightning environment from
    - Tower strike measurements
    - In-flight measurements
  - Determined internal lightning environment
  - Followed the Space Shuttle lightning criteria committee and NASA 07636
  - Developed MIL-STD-1757, “Lightning Qualification Techniques for Aerospace Vehicles and Hardware”
  - Developed MIL-STD-1795, “Lightning Protection of Aerospace Vehicles and Hardware”
  - Published Committee Reports, predecessors to ARPs – Red Book, Blue Book, Yellow Book, Orange Book, Purple Book
HISTORY

• Chartered as AE-2 in 2000

• Involved in the development of all lightning related materials currently being used in the commercial and military aviation industry
  • FAA NPRM and rules
  • FAA Advisory Circulars
    • AC 20-136B
    • AC 20-155
  • SAE Aerospace Recommended Practice documents
  • Test methods in industry standards for equipment and systems
    • DO-160
    • MIL-STD-461
    • MIL-STD-464
Since 2000, the SAE AE-2 and the EUROCAE WG-31 Committees have produced a number of documents which have had a positive impact on certification requirements

- ARP 5412/ ED 84 – Aircraft Lightning Environment and Related Test Waveforms
- ARP 5413/ ED 81 – Certification of Aircraft Electrical/Electronic Systems for the Indirect Effects of Lightning
- ARP 5414/ ED91 – Aircraft Lightning Zoning
- ARP 5416/ ED105 – Aircraft Lightning Test Methods
- ARP 5577/ ED113 – Aircraft Lightning Direct Effects Certification
- ARP 5672/ ED152 – Aircraft Precipitation Static Certification
- DO-160/ED14, Section 22 (Indirect Effects) and Section 23 (Direct Effects)
- DO-357 – User Guide Supplement to DO-160, Section 22 and Section 23
- MIL-STD-461G, CS117 (Cable Bundle Indirect Effects)
Aircraft Lightning Environment and Related Test Waveforms

- The environment and test waveforms defined in this SAE Aerospace Recommended Practice (ARP) account for the best lightning data and analysis currently available.

Advantage to Using Community

- Limits the requirements to current data base
- Provides default levels for testing
- Ensures that environment will be reviewed before revision

ARP5412B - this document was revised in 2013, with primary focus on environment definition update and historical background on environment and idealized test waveforms
Certification of Aircraft Electrical/Electronic Systems for the Indirect Effects of Lightning

• This SAE Aerospace Recommended Practice (ARP) provides guidance for a means of showing compliance with the regulations for hazards caused by the lightning environment to electrical/electronic systems installed either on or within aircraft

Advantage to Using Community

• Establishes clear path to compliance for all levels of criticalities
• Allows for default levels to be used for all systems except for Critical Control, making it much easier to establish standard method of compliance

ARP5413A - this document has now been cancelled due to the release of AC 20-136B, which has taken the technical content and converted it into an Advisory Circular; however, EUROCAE has not cancelled ED 81
Aircraft Lightning Zoning

- This SAE Aerospace Recommended Practice (ARP) defines lightning strike zones and provides guidelines for locating them on particular aircraft, together with examples

Advantage to Using Community

- Allows for Default Zoning using standard aircraft models
- Establishes clear swept stroke boundaries
- Defines the requirements for New/Novel Zone 3 Designs

ARP5414A - this document is currently under revision and in the balloting process with the goal of updating the “database” and possible relaxation of certain zone 2A areas, addition of winglet zoning, as well as other areas that need updating
User’s Manual for Certification of Aircraft Electrical/Electronic Systems for the Indirect Effects of Lightning

- This SAE Aerospace Recommended Practice (ARP) provides detailed guidance in support of AC20-136A for addressing effects of lightning to electrical and electronic systems

Advantage to Using Community

- Provides examples for determining test levels based on airplane tests
- Provides guidance on maintenance

ARP5415A - this document is currently under revision with the goal of updating material and expanding the certification guidance coverage based upon substantial industry learning since the original content was developed as well as aligning with the current revision B of AC20-136
Aircraft Lightning Test Methods

• This document is intended to describe how to conduct lightning direct effects tests and indirect system upset effects tests
• Guidance is provided on how to select the appropriate test or series of tests and how the test results can be assessed

Advantage to Using Community

• Establishes a standard method of test so there is a much greater consistency in results between test houses and therefore between vendors
• New standard test methods for high voltage attachment, high current, fuel system, complex electronic systems and full vehicle

ARP5416A – this document is planned for revision, with a task group already established for development of guidance in the following areas:

• Published White Paper Recommended Camera Calibration and Image Evaluation Methods for Detection of Ignition Sources, Rev. NEW, January 2018
• Fuel System Testing
• Flame Arrestor Testing
• High Voltage Testing
Aircraft Lightning Direct Effects Certification

- Provides guidance for a means of showing compliance with regulations for protection against lightning direct effects for aircraft of conventional design as well as for those involving advanced composite structures or other new technologies

Advantage to Using Community

- First document to provide certification guidance on composite structures
- Provides guidance on “damage tolerance”
- Provides guidance on “lightning certification plan”

ARP5577 – It is possible this document will be “stabilized” or possibly revised to update to current references
Aircraft Precipitation Static Certification

• Provides guidance on aircraft P-Static design as well as detailed guidance on showing compliance to P-Static rule, 25.899

Advantage to Using Community

• First document to provide guidance for design
• First document to provide guidance for a clear path for showing compliance

ARP5562 – Reaffirmed in 2016
Environmental Conditions and Test Procedures for Airborne Equipment

- **Section 22, Lightning Induced Transient Susceptibility**
  - Includes Pin Injection damage assessment and Cable Bundle MS/MB functional upset test procedures and default levels
  - Standardizes waveform sets & relationship between Voltage/Current waveforms
- **Section 23, Lightning Direct Effects**
  - High Voltage strike attachment test waveforms and procedures
  - High Current physical damage test waveforms and procedures

**Advantage to Using Community**

- DO-160 lightning sections provide test procedures and categories for equipment qualification to Indirect Effects (Section 22) and Direct Effects (Section 23) requirements
- Sec. 22 basic IEL test procedures are used in more rigorous Level A integrated system tests

RTCA DO-160G - RTCA has requested this document be revised and has begun on the both the main document (Rev H) and User’s Guide, DO-357 for both Section 22 and 23. DO-357 will also be updated to stay aligned with changes.
Conducted Susceptibility, Lightning Induced Transients, Cables & Power Leads
• Used to verify the ability of equipment to withstand coupled lightning transients
• Includes Cable Bundle MS/MB functional upset test procedures, waveforms, and test levels

Advantage to Using Community
• Highly similar to DO-160 Section 22 Cable Bundle test procedures, utilizing the same waveforms and a simplified subset of procedures and test levels
  • DO-160 Level 3 = CS117 Internal Equipment Levels
  • DO-160 Level 4 = CS117 External Equipment Levels
• Compatible with other MIL-STD-461G procedures, familiar for the MIL community
• Uses same test equipment as Section 22, controlling cost of qualification

MIL-STD-461G CS117 – AE-2 supported development of this test procedure upon request by and in collaboration with the US Air Force and the DoD Tri-Services Working Group (TSWG) with the goal of compatibility between the commercial and MIL procedures.
Lightning Protection for Large Transport Fuel System

- Based upon committee recommendations to the NPRM and consistent with ARC recommendation
- Coordination with WG-31 has begun, as they have launched their own task group for this effort

Advantage to Using Community

- Will provide guidance for the application of the new rule
- Development of standard approach
  - FAA has indicated that this ARP will be accepted as Advisory Material

ARP6205 – schedule is dependent upon FAA releasing a new Rule
Equivalence of Equipment Environmental Qualification Standards for Civil and Military Aircraft Equipment


Advantage to Using Community

- Will address application of these qualification standards for civil aircraft certification intended for military use, and for military aircraft equipment installed on civil aircraft
- Will identify where the equipment environmental qualification standards meet the intent of the civil or military aircraft certification requirements

AIR6811 – SAE AE-2 working group; work will be coordinated with SAE AE-4 EMC committee and RTCA SC-135 committee
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