

**Aging Transport Systems
Rulemaking Advisory Committee**

**ATSRAC Task 6:
Wire Systems
Certification Requirements
Harmonization Working Group
Final Report to ATSRAC**

WSHWG Document No. WS-50-04
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of the ATSRAC WSHWG and ARAC ESHWG
October 29, 2002

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Abbreviations

This is a list of abbreviations used in the report:

AC	Advisory Circular (FAA)
ACJ	Advisory Circular Joint (JAA)
AECMA	European Association of Aerospace Industries
AIR	Aerospace Information Report
AMJ	Advisory Material Joint (JAA)
ARAC	Aviation Rulemaking Advisory Committee
ARP	Aerospace Recommended Practice
ATC	Amended type certificate
ATSRAC	Aging Transport Systems Rulemaking Advisory Committee
CTA	Centro Técnico Aeroespacial (Brazilian airworthiness authorities)
EN	European Norm
ESHWG	Electrical Systems Harmonization Working Group
EWIS	Electrical wiring interconnection system
FAA	Federal Aviation Administration
FAR	Federal Aviation Requirements
HWG	Harmonization Working Group
IIR	Intrusive Inspection Report
IIWG	Intrusive Inspection Working Group
ISO	International Standards Organization
JAA	Joint Aviation Authorities
JAR	Joint Aviation Requirements
LRU	Line Replaceable Unit
NPA	Notice of Proposed Amendment (JAA)
OAM	Original Aircraft Manufacturer
SAE	Society of Automotive Engineers
STC	Supplemental type certificate
TCCA	Transport Canada Civil Aviation
TC	Type certificate
WSHWG	Wire Systems Harmonization Working Group

Foreword

This report contains the recommendations of the Aging Transport Systems Rulemaking Advisory Committee (ATSRAC) Wire Systems Harmonization Working Group (WSHWG) and the Aviation Rulemaking Advisory Committee (ARAC) Electrical Systems Harmonization Working Group (ESHWG). The WSHWG was formed by ATSRAC to address Task 6 which deals with the certification of wiring systems on transport category airplanes. This report is submitted to ATSRAC at its meeting, October 23, 2002.

Section 1: Background

Based on the tasking of ATSRAC by the Federal Aviation Authority (FAA), ATSRAC assigned nine tasks to the WSHWG dealing with the certification of wiring systems on transport category aircraft. The first three tasks, 6.1, 6.2, and 6.3 were administrative in nature and therefore are not discussed in this report except for brief mention of Task 6.2, coordination with ARAC, as follows. Some of the existing Federal Aviation Regulations and Joint Aviation Requirements (FAR/JAR's) being addressed by the WSHWG were already recommended for revision by the ESHWG. Some of these FAR/JAR's are recommended for further change by the WSHWG. Therefore, there was a need to establish a working relation with the ESHWG. In order not to undo each working groups effort it was mutually decided to work together by holding concurrent meetings.

Tasks 6.4, 6.5, 6.6, 6.7, 6.8, and 6.9 are summarized below. Full details of each of the Tasks and the Federal Register tasking are provided in Appendix H of this report.

TASK 6.4: Combine Current Wire System Regulations into One Section

ATSRAC is tasked to review all 14 CFR part 25 and JAR-25 paragraphs related to wiring systems, as well as all ATSRAC and ARAC recommendations related to wiring systems. Following this review, ATSRAC is tasked to submit recommendations for combining the existing paragraphs and creating a new section dedicated specifically to wire systems.

TASK 6.5: Identify Design Requirements to Mitigate Problems of Aging in Wire Systems

ATSRAC is tasked to identify requirements for a new wire systems rule on how to account for aging effects in the certification of wire systems. These new requirements must consider the conclusions and recommendations contained in the ATSRAC recommendations of Chapter 7 of the Intrusive Inspection Report, as well as other ATSRAC recommendations.

TASK 6.6: Identify Requirements for Wire System Safety Assessments

ATSRAC is tasked to review § 25.1309, AC 25.1309-1A (or latest revision), corresponding JAR-25 material, and related ARAC recommendations. ATSRAC is then to submit a recommendation on whether particular methods of compliance with § 25.1309 should be mandated in the new wire systems rule. Particular methods include, but are not limited to:

- common mode analysis,
- safety zonal analysis, and
- particular risk analysis.

The recommendation should consider how to address potential wiring failures and in-service conditions as contained in the ATSRAC recommendations from the Intrusive Inspection Report, as well as aging effects, as part of system safety assessments performed in compliance with § 25.1309.

TASK 6.7: Identify Requirements for Wire Separation

ATSRAC is tasked to determine if a comprehensive wire separation regulation, in addition to § 25.1353, should be included in the new wire system rule. If so, the recommendations obtained from this task should include general requirements for all wire systems regarding wire separation. In responding to this task, ATSRAC should review:

- existing FAA/JAA guidance;
- ATSRAC and ARAC recommendations; and
- industry documentation for wire separation requirements and associated guidance.

TASK 6.8: Identify Requirements for Wire Identification

ATSRAC is tasked to provide recommendations on the need for the special identification of wire and/or wire bundles based on the airplane-level effect of failures of systems contained in a given wire bundle.

TASK 6.9: Recommend Advisory Material for the New Wire Systems Rule

ATSRAC is tasked to provide recommended methods of compliance with the requirements established from TASKS 6.4 through 6.8, described above. Existing advisory material may already provide acceptable means of compliance. If so, ATSRAC is tasked to identify where this guidance exists.

ATSRAC is also tasked to review the existing advisory material, guidelines, and policies regarding the design and installation of wiring systems, as well as related ARAC recommendations. ATSRAC will then recommend necessary changes, considering the aging effects on wiring as noted in the previous recommendations submitted by ATSRAC and, in particular, in the Intrusive Inspection Report.

Task Products

The product for Tasks 6.4 through 6.9 are incorporated throughout the content of this report. The product for Task 6.4 is the proposed new FAR/JAR Part 25 subpart and revisions to some existing regulations. The proposed new subpart is contained in Appendix A (new subpart) and Appendix C (changes to existing regulations) of this report.

Task 6.5 resulted in the creation of proposed new and revised regulations. They are incorporated into the new subpart. Advisory material was developed to support the new/revised regulations. A table listing the items covered by Task 6.5 and their disposition is contained in Appendix D. The results of this task are incorporated into the new subpart and new advisory material of Appendices A and B, respectively

The product of Task 6.6, 6.7, and 6.8 are new/revised requirements and supporting advisory material. The results of these tasks are incorporated into the new subpart and new advisory material of Appendices A and B, respectively.

New advisory material is the product for Task 6.9. The advisory material was developed to support the new/revised requirements of the proposed subpart. The advisory material is contained in Appendix B.

Acknowledgement

To facilitate the completion of the above tasks, it was suggested by the US Co-chair and accepted by the WSHWG to call for volunteers to act as focal points for each of the above tasks. The following WSHWG members volunteered:

- Task 6.4 – Stephen Slotte, Federal Aviation Administration
- Task 6.5 – Ashok Bhattacharya, The Boeing Company
- Task 6.6 – Stephen Slotte, Federal Aviation Administration
- Task 6.7 – Issa Ghoreishi, The Boeing Company
- Task 6.8 – Jean-Luc Ballenghien, Airbus S.A.S
- Task 6.9 – Dave Tudor, JAA/CAA-United Kingdom

These persons put in extra work and effort to organize each task, coordinate it, and lead the working group discussions. To them the US Co-chair expresses his warmest thank you.

(A) Safety Issue Addressed/Statement of the Problem

(1) What prompted this rulemaking activity? (e.g., accident, accident investigation, NTSB recommendation, new technology, service history, etc.)?

In response to the White House Commission on Aviation Safety and Security, the FAA formed the Aging Non-Structural Systems Study Team, which developed the FAA's approach to

improving the management of aging wire systems. To assist in fulfilling the actions specified in the Aging Non-Structural Systems Plan, the FAA established an Aging Transport Systems Rulemaking Advisory Committee (ATSRAC) to provide advice and recommendations to the FAA Administrator, through the Associate Administrator for Regulation and Certification, on airplane system safety issues like aging wire systems. The ATSRAC was initially tasked in 1998 with five tasks, which encompassed collecting data on aging wiring systems through airplane inspections, reviewing airplane manufacturer's service information, reviewing operators' maintenance programs, and providing the FAA with recommendations to enhance the safety of these systems.

Based on the results and recommendations from the first five ATSRAC tasks, the FAA tasked ATSRAC with four new tasks. These new tasks are intended to facilitate implementation of earlier recommendations of ATSRAC tasks one through five. The ATSRAC made the decision to establish harmonization working groups (HWG) to provide technical support in developing its recommendations to the FAA for tasks six through nine. A Working Group activity was also proposed within JAA to consolidate the various existing requirements and guidance material into JAR Requirements and Advisory Material and supplement them with additional information. This activity was merged with the Wiring Systems Harmonization Working Group.

Specifically, task six was formed to address wire related certification issues as discussed in the preceding Background section of this report.

(2) What focused our attention on these issues?

Aircraft systems, including the electrical wiring interconnections are becoming more and more complex and electrical wires, cables and their associated components are becoming increasingly important with respect to airplane systems that are necessary for safe flight.

There has been and continue to be many events associated with wire failures. In 2000 the FAA issued 78 airworthiness directives related to electrical wiring. Wire failures are also known to be contributory factors in many incidents and some aircraft accidents. There is concern that existing procedures, directives, and inspections are not sufficient to prevent unsafe situations associated with the degradation of aircraft wire.

The Intrusive Inspection Working Group (IIWG) under assignment and direction from ATSRAC conducted an intensive detailed visual inspection of wiring system components on six decommissioned airplanes. This was followed by on airplane non-destructive testing and laboratory analysis. The results of these detailed visual inspections, non-destructive testing and laboratory analysis were used to determine the state of wiring system on aged aircraft. The results of the IIWG are recorded in the *Transport Aircraft Intrusive Inspection Project, Final Report*, dated December 29, 2000 (referred to as the Intrusive Inspection Report - IIR). The results of the IIR indicate that wire related failures can be attributed to multiple factors. These include, but are not limited to: localized heat damage, breaches in wire insulation, embrittled, charred or missing insulation, chaffing, arcing, arc tracking, reduced insulation resistance in certain wet wires, defective or broken connectors, and damage to connector backshells. It should be noted that problems associated with systems on aging airplanes are not completely related to

the degradation of wire over time. Inadequate design, installation, maintenance, and modifications practices can lead to what is commonly referred to as an “aging system” problem.

Additionally, the JAA had made a proposal for a working group activity to consolidate the various existing wire related requirements and guidance material into JAR Requirements and Advisory Material. The JAA group was also going to address other safety related wiring issues. However, since the ATSRAC activity was under way it was decided to combine the effort. A preliminary list of twenty wiring issues was prepared by the JAA and brought forth to the Task 6 Working Group. While some of the items were the same as in the IIR, the new items (e.g. “Red Plague” corrosion, Glycol Fires, Smoke and Toxicity By-Products) were merged into WSHWG Task 6.5 effort. The safety issues identified by the JAA and in Table 7.5 of the IIR along with the WSHWG’s disposition of them are listed in Appendix D.

(3) What are the underlying safety issues to be addressed in this proposal?

The following safety issues are being addressed with the proposed new FAR/JAR Part 25 airworthiness certification requirements and the accompanying advisory material:

- (a) Insufficient mitigation strategies to account for and help prevent wire related hazards due to aging
- (b) Lack of clear certification requirements for the wire system, including
 - (i) Wire system design
 - (ii) Wire system installation
 - (iii) Separation between airplane systems wiring
 - (iv) Insufficient wire system safety assessment requirements
 - (v) Insufficient wire systems identification requirements
 - (vi) Insufficient advisory material relating to the design and installation of wire system
 - (vii) Insufficient instructions for continued airworthiness of wire systems
 - (viii) Insufficient guidance to the designer, installer, maintainer, and modifier of airplane wire system

(4) What is the underlying safety rationale for the requirements?

Traditionally wire has not been looked upon at the same “level” as the rest of the systems for which it provides the electrical interconnection. Whereas a particular line replaceable unit (LRU) may be the focus of intense scrutiny regarding its design, installation, and maintenance, the wires that provide the electrical interconnection have not received the same level of attention. Additionally, in the past system safety assessments tended to include only the effect of a wire failure on the system itself. The safety assessments have not always clearly identified the effect a particular wire failure (functional and physical failure) has on other systems or at the airplane level.

(5) Why should the requirements exist?

The recommended FAR/JAR Part 25 requirements and accompanying advisory material provide solutions to the concerns expressed in the IIR. Adoption of the proposed new and revised requirements and advisory material will enhance the safety of the transport airplane fleet. This will be accomplished by shifting the paradigm of those in the aerospace industry in how design, installation, and maintenance of wire systems should be accomplished and by providing them the regulatory tools they need to do so. The requirements and advisory material brings focus to the importance of viewing wiring systems with the same importance as the rest of the systems for which they provide the electrical interconnection. The creation of a new FAR/JAR Part 25 subpart that is devoted to wire systems and contains existing, revised, and new wire system certification requirements will not only highlight the importance of properly designed, installed, and maintained wire systems in increasing safety of flight, but will also provide the regulatory tools to help ensure this outcome.

Wire system degradation resulting from inadequate design, installation, maintenance and field modifications (e.g., via supplemental type certificate - STC) will be mitigated. The results and recommendations from the IIR indicate that problems associated with the wiring systems on aging airplanes are not completely related to the degradation over time of wire systems. Age is not the sole cause of the wire degradation we call "aging". The probability that inadequate maintenance, contamination, improper repair, or mechanical damage has occurred to a particular wiring system or component will increase over time. Therefore, "age" includes the breakdown of inherent characteristics of wire as a function of time and the effect of maintenance, contamination, improper repair, modification, and mechanical damage.

(B) Current Standards or Means to Address

(1) If regulations currently exist:

(a) What are the current regulations relative to this subject? (Include both the FAR's and JAR's.)

The proposed regulations being proposed by the WSHWG are based in part on existing FAR and JAR Part 25 regulations.

Table 1 shows the correlation between the new regulations and the existing Part 25 regulations used as the basis for the new proposed regulations. There may not be a one-to-one correlation between the base regulation and the new proposed regulation because of the evolution of the new regulations over the past year. Appendix C contains the necessary changes to the current regulation to support the new requirements proposed in Appendix A.

Of the 24 regulations listed, 8 require revisions to accommodate the new proposed regulations. These are identified in Table 2.

Note: The existing regulations used for the new proposed requirements are based on FAR Part 25, revised as of January 1, 2001 and JAR Part 25, Change 15 both as modified by the recommendations of the ARAC Electrical Systems Harmonization Working Group (ESHWG). The current standards that are the subject of an ESHWG recommendation are marked with an asterisk (*). Therefore, for the purposes of this report it is assumed that the recommendations made by the ESHWG have been, or will concurrently be, accepted by the FAA and JAA. None of the ESHWG recommendations have been codified by the FAA. However, the JAA recently released a Notice of Proposed Amendment (NPA) based on the ESHWG recommendations. A copy of the NPA is contained in Appendix G for reference.

Table 1: Correlation Between Existing Regulations and Proposed New Regulations

Existing Regulations	Proposed New Regulations	Existing Regulations	Proposed New Regulation	Existing Regulations	Proposed New Regulation
§ 25.611	§ 25.1729	§ 25.1189	§ 25.1741	§ 25.1353*	§ 25.1723
§ 25.773	§ 25.1731	§ 25.1203	§ 25.1745	§ 25.1355*	§ 25.1725
§ 25.855	§ 25.1733	§ 25.1301	§ 25.1703	§ 25.1357*	§ 25.1719
§ 25.863	§ 25.1735	§ 25.1309	§ 25.1705	§ 25.1360*	§ 25.1747
§ 25.869*	§ 25.1713	§ 25.1310*	§ 25.1707	§ 25.1362*	§ 25.1749
§ 25.899*	§ 25.1717	§ 25.1316	§ 25.1715	§ 25.1365*	§ 25.1751
§ 25.903	§ 25.1737	§ 25.1331	§ 25.1727	§ 25.1431*	§ 25.1753
§ 25.1165	§ 25.1739	§ 25.1351*	§ 25.1721	§ 25.1529	§ 25.1755

Table 2: Existing FAR and JAR Part 25 Requirements That Require Revision to Support the New Proposed Regulations

Existing Regulations	Revision To Existing Regulation Required?	Existing Regulations	Revision To Existing Regulation Required?	Existing Regulations	Revision To Existing Regulation Required?
§ 25.611	Yes	§ 25.1189	No	§ 25.1353*	Yes
§ 25.773	No	§ 25.1203	Yes	§ 25.1355*	No
§ 25.855	Yes	§ 25.1301	Yes	§ 25.1357*	Yes
§ 25.863	No	§ 25.1309	Yes	§ 25.1360*	No
§ 25.869*	Yes	§ 25.1310*	No	§ 25.1362*	No
§ 25.899*	No	§ 25.1316	No	§ 25.1365*	No
§ 25.903	No	§ 25.1331	No	§ 25.1431*	No
§ 25.1165	No	§ 25.1351*	No	§ 25.1529	No

(b) How have the regulations been applied? (What are the current means of compliance?) If there are differences between the FAR and JAR, what are they and how has each been applied? (Include a discussion of any advisory material that currently exists.)

With the assumption that all current FAR and JAR Part 25 electrical system regulations have been harmonized there are no differences between FAR Part 25 and JAR Part 25. Therefore, the means of compliance are the same. Table 3 lists the currently existing AC/ACJ's

Table 3: FAA and JAA Advisory Circulars That Currently Exist For FAR and JAR Part 25 Requirements

FAR/JAR	AC?	ACJ?	Relative Regulations	AC?	ACJ?	Relative Regulations	AC?	ACJ?
§ 25.611	No	No	§ 25.1189	No	No	§ 25.1353	No	Yes
§ 25.773	Yes	Yes	§ 25.1203	No	No	§ 25.1355	No	Yes
§ 25.855	No	No	§ 25.1301	No	Yes	§ 25.1357	Yes	Yes
§ 25.863	No	Yes	§ 25.1309	Yes	Yes	§ 25.1360	Yes	Yes
§ 25.869	Yes	Yes	§ 25.1310	No	No	§ 25.1362	Yes	Yes
§ 25.899	Yes	Yes	§ 25.1316	No	No	§ 25.1365	No	No
§ 25.903	No	Yes	§ 25.1331	No	Yes	§ 25.1431	No	No
§ 25.1165	No	No	§ 25.1351	No	No	§ 25.1529	No	No

(c) What has occurred since those regulations were adopted that has caused us to conclude that additional or revised regulations are necessary? Why are those regulations now inadequate?

Refer to the Background section and the section immediately preceding this section for why ATSRAC was tasked with new tasks and the reason why the existing regulations require enhancement.

(2) If no regulations currently exist:

(a) What means, if any, have been used in the past to ensure that this safety issue is addressed? Has the FAA relied on issue papers? Special Conditions? Policy statements? Certification action items? If so, reproduce the applicable text from these items that is relative to this issue.

Safety for the current fleet of Part 25 airplanes has been ensured through the application of the existing regulations. However, due to recent incidents, accidents, other investigations, and the recommendations contained in the IIR, the FAA, JAA, and industry recognize that the current regulations fall short of providing necessary specific requirements for wire certification. This is

particularly true in the case of the important role that wiring plays in the development of system and airplane level safety assessments, system separation, and in wire and its associated components identification.

The FAA recently issued a new policy statement addressing the certification of wiring on Part 25 airplanes: FAA Policy Statement ANM-01-04, *Systems Wiring Policy for Certification of Part 25 Airplanes*, effective July 2, 2001 (finalized policy was published in the Federal Register on February 5, 2002, Volume 67, Number 27, page 5357). The statement provides the FAA's policy with respect to the type design data needed for the certification of wiring installed on transport category airplanes. The FAA issued the policy to correct deficiencies associated with the submittal of design data and instructions for continuing airworthiness involving airplane system wiring for type design, amended design, and supplemental design changes. It advises applicants for type certificates, amended type certificates, supplemental type certificates, or type design changes, of the range and quality of type design data that the FAA expects applicants to submit as part of any certification project.

The existing minimum standards will be enhanced by the adoption of the new proposed regulations and thus will help increase safety.

(b) Why are those means inadequate? Why is rulemaking considered necessary (i.e., do we need a general standard instead of addressing the issue on a case-by-case basis?)

The current regulations fall short of providing specific requirements that the FAA, JAA, and industry now recognize should be provided through the Part 25 regulations. As examples, the current regulations do not adequately address requirements for wires in system separation, safety assessments, protection of wires in fire zones, protection of wires in cargo and baggage compartments, and accessibility of wires for inspection, maintenance, and repair, etc. Current requirements also do not clearly define the necessity and method for wire identification. Identifying wires and its components associated with systems necessary for safe flight and landing will aid those performing maintenance, repair, and modifications by helping to ensure that these systems are not compromised by the work being performed.

A quote from the FAA Wiring Policy ANM-01-04 also supports this: "The FAA expects the applicant to provide engineering drawings instead of merely statements such as "install in accordance with industry standard practices," or "install in accordance with AC 43.13." The FAA considers such statements inadequate because the standard practices cannot define the location or routing of the wiring."

The proposed regulations and associated advisory material are considered necessary to address these specific concerns and more. The new regulations are necessary to enhance the minimum safety standards that are currently required by the Part 25 regulations and increase the level of safety that already exists.

Section 2: DISCUSSION

- *This section explains:*
 - *what the proposal would require,*
 - *what effect we intend the requirement to have, and*
 - *how the proposal addresses the problems identified in Background.*
- *Discuss each requirement separately. Where two or more requirements are very closely related, discuss them together.*
- *This section also should discuss alternatives considered and why each was rejected.*

(A) Section-by-Section Description of Proposed Action

(1) What is the proposed action? Is the proposed action to introduce a new regulation, revise the existing regulation, or to take some other action?

Following are the titles of the ATSRAC tasking of Task Group 6, *Wire Systems Harmonization Working Group* (WSHWG), complete details of each task are can be found in Appendix H:

- Task 6.4: Combine Current Wire System Regulations into One Section
- Task 6.5: Identify Design Requirements to Mitigate Problems of Aging in Wire Systems
- Task 6.6: Identify Requirements for Wire System Safety Assessments
- Task 6.7: Identify Requirements for Wire Separation
- Task 6.8: Identify Requirements for Wire Identification
- Task 6.9: Recommend Advisory Material for the New Wire Systems Rule

Based on these tasks, the following actions were accomplished by the WSHWG:

- (a) Creation of a new FAR/JAR Part 25 subpart (Subpart H) that contains all existing Part 25 requirements, or provides a reference to existing requirements, that are directly or indirectly applicable to electrical wiring interconnection systems (EWIS), (refer to Appendix A),
- (b) Creation of new FAR/JAR Part 25 EWIS requirements to be included in Subpart H taking into account Tasks 6.5, 6.6, 6.7, and 6.8, (refer to Appendix A),
- (c) Creation of a new advisory circular/advisory circular joint (AC/ACJs) using existing advisory and new advisory material developed during WSHWG meetings for each of the new proposed Subpart H EWIS regulations. The AC/ACJ is proposed to be a single document (as opposed to separate AC/ACJs for each regulation) that provides acceptable means of complying with the new proposed requirements, (refer to Appendix B),
- (d) Revision of existing FAR/JAR Part 25 Subparts D, E, F, and G regulations to account for the creation of Subpart H, taking into account Tasks 6.4, 6.5, 6.6, 6.7, and 6.8 (refer to Appendix C),
- (e) Revision of FAR/JAR Part 1 to add the definition of the acronym EWIS. (refer to Appendix A),

- (f) Incorporation of the applicable portions of FAA Policy Statement Number ANM-01-04; *System Wiring Policy for Certification of Part 25 Airplanes FAA* into the new advisory material, and
- (g) Creation of recommendations for various actions that the members of the WSHWG believe are necessary but are outside the scope of the ATSRAC tasking, (refer to Appendix F).

(2) If regulatory action is proposed, what is the text of the proposed regulations?

The complete text of the proposed requirements is contained in Appendix A of this report. Following are the numbers and title of the Subpart H requirements.

[Note: The style and numbering system for federal regulations for any federal agency, including the FAA, are controlled by the U.S. National Archives and Records Administration. Therefore, it is understood that the FAA does not have the authority to deviate from these style and numbering requirements.]

FAR/JAR Part 1:

§ 1.2 Abbreviations and symbols

FAR/JAR Part 25:

- § 25.1701 Electrical Wiring Interconnection System Definition
- § 25.1703 Electrical Wiring Interconnection System Function and Installation
- § 25.1705 Electrical Wiring Interconnection System Safety
- § 25.1707 Power Source Capacity and Distribution - EWIS
- § 25.1709 System Separation - EWIS
- § 25.1711 Electrical Wiring Interconnection System Component Identification
- § 25.1713 Fire protection: EWIS
- § 25.1715 System Lightning Protection - EWIS
- § 25.1717 Electrical Bonding and Protection Against Lightning and Static Electricity - EWIS
- § 25.1719 Circuit Protective Devices - EWIS
- § 25.1720 System Power Removal
- § 25.1721 Electrical Power Generation - General - EWIS
- § 25.1723 Electrical Equipment and Installations - EWIS
- § 25.1725 Distribution System - EWIS
- § 25.1727 Instruments Using a Power Supply - EWIS
- § 25.1729 Accessibility Provisions for EWIS
- § 25.1731 Pilot Compartment View - EWIS
- § 25.1733 Protection of EWIS in Cargo or Baggage Compartments
- § 25.1735 Flammable Fluid Fire Protection - EWIS
- § 25.1737 Powerplants - EWIS

- § 25.1739 Engine Ignition Systems - EWIS
- § 25.1741 Flammable Fluid Shutoff means - EWIS
- § 25.1743 Fire detector systems – General - EWIS
- § 25.1745 Powerplant and APU Fire detector system – EWIS
- § 25.1747 Electrical Shock and Burn - EWIS
- § 25.1749 Electrical Supplies for Emergency Conditions - EWIS
- § 25.1751 Electrical Appliances, Motors, and Transformers - EWIS
- § 25.1753 Electronic equipment - EWIS
- § 25.1755 EWIS Instructions for Continued Airworthiness - EWIS

(3) If this text changes current regulations, what change does it make?

The proposed new Part 25 Subpart H affects existing regulations. Therefore changes to the current regulations are required to support the addition of Subpart H. These changes are defined in detail in Appendix C. The following paragraphs provide the reason and the effect of these changes.

25.611 Accessibility Provisions

Reason for change: EWIS accessibility requirements have not previously existed in Part 25. The change to this regulation adds a reference to § 25.1729 (EWIS accessibility)

Effect of change: This change provides enhanced visibility for EWIS accessibility requirement and cross-referencing the new EWIS regulation in existing § 25.611 also effectively closes the loop on requirements.

§ 25.855 Cargo or Baggage Compartments

Reason for change: The present rule does contains a requirement for wire protection in cargo and baggage compartments. However, in order to provide enhanced visibility of the related EWIS requirement a new rule devoted specifically to EWIS located in cargo or baggage compartments is proposed. The change to this regulation adds a reference to the new proposed regulation § 25.1733, (Cargo and Baggage Compartments: EWIS)

Effect of change: Moves the requirement for preventing damage to wires from the existing requirement and moving it to Subpart H to provide enhanced visibility of the need to protect EWIS from damage by baggage or cargo. Cross-referencing the new EWIS regulation in existing §25.855 also effectively closes the loop on requirements.

§ 25.869 Fire Protection: Systems

Reason for change: The present rule does contains requirements for fire protection of wires. However, in order to provide enhanced visibility of the related EWIS requirements and gather them in one central place a new rule devoted specifically to EWIS fire protection requirements is

proposed. The change to this regulation adds a reference to the new proposed regulation § 25.1713, (Fire Protection : EWIS)

Effect of change: Moves the requirements of fire protection of wires from the existing requirement to Subpart H to provide enhanced visibility of EWIS fire protection requirements. Cross-referencing the new EWIS regulation in existing §25.869 also effectively closes the loop on requirements.

§ 25.1203 Fire Detector System

Reason for change: The present rule does contains requirement for wire used in the fire detection system. However, in order to provide enhanced visibility of the related EWIS requirements and gather them in one central place a new rule devoted specifically to fire detector system EWIS is proposed. The change to this regulation adds a reference to the new proposed regulation § 25.1745, (Powerplant and APU Fire Detector System: EWIS).

Effect of change: Moves the requirements of wires used in the fire detection system from the existing requirement to Sub-part H to provide enhanced visibility of the need protection of EWIS. Cross-referencing the new EWIS regulation in existing §25.1203 also effectively closes the loop on requirements.

§ 25.1301 Function and Installation

Reason for change: New EWIS requirements for wire selection, identification, general installation to minimize the mechanical strain, and protection from damage by personnel/passengers brings to the attention of the designer and the installer the need to be careful in wire type choices, system design, and installation design. The new rule also allows the regulatory agencies more control over later modifications of the airplane wiring by requiring applicants use the same standards used by the original airplane manufacturer or other approved standards. Therefore, in order to provide enhanced visibility of the EWIS requirements and gather them in one central place, the change to this regulation adds a reference to a new proposed regulation § 25.1703, (EWIS Function and Installation).

Effect of change: The new sub-section H § 25.1703 combines some requirements from existing current regulation of §25.1301, Function and installation. The existing §25.1301 needs to be amended by cross-referencing the new EWIS requirement of §25.1703 in existing §25.1301 thus effectively closing the loop on requirements.

§ 25.1309 Equipment, Systems, and Installations

Reason for change: To provide enhanced visibility of the EWIS safety assessment requirements and gather them in one central place, the change to this regulation adds a reference to a new proposed regulation § 25.1705, (EWIS Failures).

Effect of change: Guides the designer or modifier to the new sub-part H by cross-referencing the new EWIS requirement of §25.1705 in existing §25.1309, thus effectively closing the loop on requirements.

§ 25.1353 Electrical Equipment and Installations

Reason for change: To provide enhanced visibility of the EWIS requirements related to electrical equipment and installations and gather them in one central place, the change to this regulation adds a references to new proposed regulations § 25.1709, §25.1711, §25.1719, and § 25.1723.

Effect of change: Guides the designer or modifier to the new sub-part H by cross-referencing the new EWIS requirements in existing §25.1353, thus effectively closing the loop on requirements.

§ 25.1357 Circuit Protective Devices

Reason for change: To provide enhanced visibility of the EWIS requirements related to thermal circuit breakers and fuses and gather them in one central place, the change to this rule transfers the requirements for thermal circuit breakers and fuses to § 25.1719, and makes a reference to this proposed new regulation.

Effect of change: Modifies as required existing rule words to delete references to thermal circuit breakers, fuses and in-flight replacement thereof. Guides the designer or modifier to the new sub-part H by cross-referencing the new EWIS requirements in existing §25.1357, thus effectively closing the loop on requirements.

(4) If not answered already, how will the proposed action address (i.e., correct, eliminate) the underlying safety issue (identified previously)?

The proposed changes to the existing requirements support the new EWIS requirements of proposed Subpart H. These changes allow the wiring related requirements of the existing requirements to be moved to the proposed subpart. Additionally, by adding references to the proposed new requirements where applicable provides enhanced visibility of EWIS requirements.

(5) Why is the proposed action superior to the current regulations?

Refer to Section 1, (B)(2)(b) for an explanation of why the current regulations need enhancing.

(B) Alternatives Considered

(1) What actions did the working group consider other than the action proposed? Explain alternative ideas and dissenting opinions.

Prior to the decision to place all EWIS related requirements in a new FAR/JAR Part 25 subpart and placing all the supporting advisory material in a single AC/ACJ (as opposed to a separate

AC/ACJ for each new regulation), the WSHWG discussed several alternatives. These alternate courses of action considered include revising the existing EWIS related FAR/JAR Part 25 regulations to include the new requirements developed for Task 6.5, 6.6, 6.7, and 6.8. Another alternative discussed was to place all the new requirements for the before mentioned tasks into an advisory circular. However, the group decided on the means proposed in this report because it provided the best way to clearly communicate the new EWIS based requirements and provide the enhanced visibility of EWIS requirements (which is one of the goals of the WSHWG as tasked by ATSRAC.)

In addition, the working group recommended the following text for paragraph (a) for the proposed § 25.1713:

§ 25.1713 Fire protection –EWIS

(a) EWIS components must meet the applicable fire and smoke protection requirements of 25.831(c) and 25.1735. EWIS components must be constructed and installed so that in the event of failure, no hazardous quantities of smoke, toxic, or noxious products will be distributed in the crew and passenger compartment.

This text was modified by the ATSRAC by deleting the last sentence of paragraph (a), thus deleting the references to “smoke, toxic, or noxious products”. The change was made because of ATSRAC’s concern over the lack of agreed upon standards, test methods and test equipment for “hazardous quantities of smoke, toxic or noxious products”. The WSHWG agrees that ATSRAC has the authority to make the revision, however, the WSHWG members do not endorse this change. The proposed text for § 25.1713, as modified by ATSRAC, is contained in Appendix A of this report. Additionally, refer to Appendix F of this report for a recommendation by the WSHWG to develop testing and measurement standards for smoke, toxic, or noxious products emanating from EWIS components.

(2) Why was each action rejected (e.g., cost/benefit? unacceptable decrease in the level of safety? lack of consensus? etc.)? Include the pros and cons associated with each alternative.

The idea to revise the existing EWIS related FAR/JAR Part 25 regulations was rejected because of the complexity of integrating the new requirements identified by Tasks 6.4 through 6.8 into them. Additionally, it would have failed to enhance the visibility of EWIS related certification requirements. The idea to include the requirements into an advisory circular was dismissed because our tasking instructed us to develop new “regulations” as we deem necessary. Since ACs and ACJs do not constitute regulations we could not use advisory circulars except to communicate the new advisory material that support the new requirements. The decision to use a single AC/ACJ was made because producing a separate AC/ACJ for each new regulation would be an unnecessarily complex task and a single document makes for a simple and handy reference for compliance options to the new subpart.

Section 3: COSTS AND OTHER ISSUES THAT MUST BE CONSIDERED

(A) Costs Associated with the Proposal

(1) Who would be affected by the proposed change? How? (Identify the parties that would be materially affected by the rule change – airplane manufacturers, airplane operators, etc.)

Airplane manufacturers, airplane operators, Designated Alteration Stations, modification shops, repair stations will be affected by these changes. Design, installation, and documentation practices would be impacted because the proposed rules modify existing requirements and add additional certification requirements above those that exist today.

(2) What is the cost impact of complying with the proposed regulation? Provide any information that will assist in estimating the costs (either positive or negative) of the proposed rule.

(i) What are the differences (in general terms) between current practice and the actions required by the new rule?

Due to the proposed rules internal design practices, certification documentation, EWIS identification methods, and electrical analysis practices will be impacted. For example new EWIS safety analysis requirements will require applicants to perform analysis that is not required today. Additionally new EWIS identification requirements may cause applicants to modify their identification practices and documentation. Installation practices and their documentation may change due to new EWIS separation requirements. Post-TC modifiers will be required to have greater knowledge of the airplane manufacturers design and installation standards.

(ii) If new tests or designs are required, how much time and costs would be associated with them?

Detailed cost information has not been provided to the WSHWG from all affected parties. However, one airplane manufacturer estimated that for a new TC program an additional 15,000 work hours will be required to comply with the proposed rules (this figure does not include the time necessary for documentation). Another airplane manufacturer estimates that the proposed rules will add 2,000 work hours for documentation work, but did not provide a figure for design and certification work hours. One Part 121 operator who performs modifications on its fleet estimates that the cost of modifications will increase 3% to 7% depending on the modification complexity.

(iii) If new equipment is required, what can be reported relative to purchase, installation, and maintenance costs?

No new equipment will be required to comply with the proposed rules.

(iv) In contrast, if the proposed rule relieves industry of testing or other costs, please provide any known estimate of costs.

While the new rules will not provide relief to the industry, the new requirements will be harmonized with the JAA requirements. Therefore, applicants will need to demonstrate compliance to a single set of rules rather than multiple sets. This harmonization will help reduce both design and documentation costs.

(v) What more-- or what less -- will affected parties have to do if this rule is issued?

Refer to the first answer for question (2) above.

(B) Other Issues

(1) Will small businesses be affected? (In general terms, "small businesses" are those employing 1,500 people or less. This question relates to the Regulatory Flexibility Act of 1980 and the Small Business Regulatory Enforcement Fairness Act of 1996.)

Yes, the proposed rules will be applicable to any business no matter the size.

(2) Will the proposed rule require affected parties to do any new or additional recordkeeping? If so, explain. [This question relates to the Paperwork Reduction Act of 1995.]

Yes, the proposed rules will require new or revised documentation on the part of an applicant. The new or revised documentation will consist of engineering, installation, and certification documentation.

(3) Will the proposed rule create any unnecessary obstacles to the foreign commerce of the United States? -- i.e., create barriers to international trade? [This question relates to the Trade Agreement Act of 1979.]

No, because the JAA, TCCA and most likely CTA will adopt the same set of revised and new requirements. Therefore, US and foreign companies will have to comply to the same set of rules.

(4) Will the proposed rule result in spending by State, local, or tribal governments, or by the private sector, that will be \$100 million or more in one year? [This question relates to the Unfunded Mandates Reform Act of 1995.]

No, based on the cost estimates provided by manufacturers and operators (refer to the answer for the cost portion of Question (2) above).

Section 4: ADVISORY MATERIAL

(A) Is existing FAA advisory material adequate?

No, the existing advisory material is not adequate because of the numerous revisions made to existing Part 25 EWIS related electrical requirements and the addition of new requirements.

(B) If not, what advisory material should be adopted? Should the existing material be revised, or should new material be provided?

The decision was made to develop a single AC/ACJ that contains all of the advisory material applicable to Subpart H. The AC/ACJ is a combination of existing advisory material currently contain in multiple AC/ACJs, revisions to the existing material and new advisory material develop by the WSHWG.

(C) Insert the text of the proposed advisory material here (or attach), or summarize the information it will contain, and indicate what form it will be in (e.g., Advisory Circular, policy statement, FAA Order, etc.)

Appendix B contains the text of the proposed advisory material and therefore is not reproduced herein.

APPENDICES

Appendix A: Proposed Subpart H

Part 1 – Definitions and Abbreviations

Add the following abbreviation to 14 CFR Part 1:

§ 1.2 Abbreviations and symbols

EWIS means electrical wiring interconnection system

Part 25 – Subpart H – Electrical Wiring Interconnection Systems

§ 25.1701 Electrical Wiring Interconnection System Definition

(a) For the purposes of this part, an electrical wiring interconnection system is defined as an electrical connection between two or more points including the associated termination devices and the necessary means for its installation and identification. This includes:

- (1) Wires and cables
- (2) Bus bars
- (3) Connection to electrical devices
- (4) Circuit breakers or other circuit protection devices
- (5) Connectors and accessories
- (6) Electrical grounding and bonding devices
- (7) Electrical splices
- (8) Materials used to provide additional protection for wires
- (9) Shield or braids
- (10) Conduits that have electrical termination for the purpose of bonding
- (11) Clamps and other devices used to route and support the wire bundle
- (12) Cable tie devices
- (13) Labels or other means of identification
- (14) Pressure seals associated with EWIS

(b) Electrical wiring interconnection system components inside shelves, panels, racks, junction boxes, distribution panels, back-planes of equipment racks including circuit board back-planes, wire integration units, etc. answering to the upper definition, is included.

(c) The mating connection at the termination point of the wire on those devices that are excluded from this definition is not included as part of the Electrical Wiring Interconnection System

(d) The following is excluded:

- (1) Wiring inside avionics equipment,
- (2) Equipment including non-required miscellaneous equipment qualified to environmental conditions and testing procedures approved by the Administrator other than those specifically included in this definition,
- (3) Equipment qualified to a technical standard order
- (4) Portable, carry on, or otherwise non-permanently mounted electrical equipment.
- (5) Fiber optics

§ 25.1703 Electrical Wiring Interconnection System Function and Installation

(a) Each EWIS component installed in any area of the aircraft must:

- (1) Be of a kind and design appropriate to its intended function;
- (2) Be labeled and identified in accordance with the requirements of § 25.1711.
- (3) Be installed according to limitations specified for the EWIS components.
- (4) Be installed in accordance with the separation requirements of § 25.1709.
- (5) Function properly when installed.
- (6) Be designed and installed such that:
 - (i) Mechanical strain is minimized,
 - (ii) Damage and risk of damage by personnel movement in the airplane during all phases of flight, maintenance, and servicing is minimized, and
 - (iii) Damage and risk of damage by items carried onto the aircraft by passengers, cabin crew, and flightcrew is minimized.

(b) The selection of wires must take into account known characteristics in relation to particular installation and application so as to minimize the risk of wire damage including any arc tracking phenomena.

(c) The design and installation of the main power cables, including generator cables allow for a reasonable degree of deformation and stretching without failure.

(d) Electrical wiring interconnection system components located in areas of known moisture accumulation must be adequately protected to minimize any hazardous effect due to moisture.

(e) Electrical wiring interconnection system modifications to the original type design must be designed and installed to the same standards used by the original aircraft manufacturer or other equivalent standards acceptable to the Administrator (for FAR)/authorities (for JAR).

§ 25.1705 Electrical Wiring Interconnection System Safety

Electrical wiring interconnection systems must be designed and installed so that:

- (1) Each catastrophic failure condition
 - (i) is extremely improbable; and
 - (ii) does not result from a single failure; and
- (2) Each hazardous failure condition is extremely remote.

§ 25.1707 Power source capacity and distribution - EWIS

Electrical wiring interconnection systems associated with “essential loads” on a power supply must meet the requirements of § 25.1310.

§ 25.1709 System Separation - EWIS

(a) Each EWIS must be designed and installed so that under normal or failure condition as defined by 25.1309, it will not adversely affect the simultaneous operation of any other systems necessary for continued safe flight, landing and egress.

(b) Each EWIS must be designed and installed such that any electrical interference likely to be present in the airplane will not result in hazardous effects upon the airplane or its systems except under extremely remote conditions.

(c) Wires and Cables carrying heavy current and their associated EWIS components must be designed and installed to ensure adequate physical separation and electrical isolation, so that damage to essential circuits will be minimized under fault conditions. The physical separation must be achieved by separation distance, barrier, or other means shown to be at least equivalent.

(d) Each EWIS associated with independent airplane power sources must be designed and installed to ensure adequate physical separation and electrical isolation so that a fault in any one airplane power source EWIS will not adversely affect any other independent power sources. The physical separation must be achieved by separation distance, barrier, or other means shown to be at least equivalent.

(1) In addition, airplane independent electrical power sources must not share a common ground terminating location, and

(2) Airplane system’s static grounds must not have a common ground terminating location with any of the airplane independent electrical power sources.

(e) Except to the extent necessary to provide electrical connection to the fuel systems components the EWIS must be designed and installed with adequate separation distance or barrier from fuel lines and other fuel system components, such that

(1) Any EWIS component failure will not create a hazardous condition, and

(2) Any fuel leakage onto EWIS components will not create a hazardous condition.

(f) Except to the extent necessary to provide electrical connection to the hydraulic systems components the EWIS must be designed and installed with adequate separation distance or barrier from hydraulic lines and other hydraulic system components, such that

(1) Any EWIS component failure will not create a hazardous condition, and

(2) Any hydraulic fluid leakage onto EWIS components will not create a hazardous condition.

(g) Except to the extent necessary to provide electrical connection to the oxygen systems components the EWIS must be designed and installed with adequate separation distance or barrier from oxygen lines and other oxygen system components, such that any EWIS component failure will not create a hazardous condition.

- (h) Except to the extent necessary to provide electrical connection to the water/waste systems components the EWIS must be designed and installed with adequate separation distance or barrier from water/waste lines and other water/waste system components, such that
- (1) Any EWIS component failure will not create a hazardous condition, and
 - (2) Any water/waste leakage onto EWIS components will not create a hazardous condition.
- (i) Electrical wiring interconnection systems must be designed and installed with adequate separation distance or barrier between the EWIS and flight or other mechanical control systems cables, and associated system components such that,
- (1) Chafing, jamming, or other interference are prevented, and
 - (2) Any EWIS component failure will not create a hazardous condition, and
 - (3) Failure of any flight or other mechanical control systems cables or systems components will not damage EWIS and create hazardous condition.
- (j) Electrical wiring interconnection systems must be designed and installed with adequate separation distance or barrier between the EWIS components and heated equipment, hot air ducts, and lines such that;
- (1) Any EWIS component failure will not create a hazardous condition, and
 - (2) Any hot air leakage or generated heat onto EWIS components will not create a hazardous condition.
- (k) When specific system certification requirements are achieved by redundancy, each applicable EWIS must be designed and installed with adequate separation distance or barrier.
- (l) Each EWIS must be designed and installed such that it is adequately separated from the aircraft structure, protected from sharp edges and corners, and to minimize potential for abrasion/chafing, vibration damage, and other types of mechanical damage.

§ 25.1711 Electrical Wiring Interconnection System Component Identification

- (a) Electrical wiring interconnection system components must be labeled or otherwise identified so as to facilitate its identification, function, or operating limitations, or any applicable combination of these factors.
- (b) In addition to the requirement of (a) above, when assessed in accordance with § 25.1705 as required for the safe flight, landing, egress, or having the potential to impact the ability of the flight crew to cope with adverse operating conditions, concerned EWIS components must be particularly identified with its component part number, function, and separation requirement for bundles;
- (1) The identification must be placed along the wire, cable or wire bundles at appropriate intervals and in areas of the airplane so they are readily visible to maintenance, repair, or alteration personnel.
 - (2) As all components cannot physically be marked , others means of identification must be provided.

- (c) The identifying markings required by paragraphs (a) and (b) must remain legible throughout the design life of the EWIS component.
- (d) The means used for identifying EWIS components required by this chapter must not have an adverse affect on the components performance throughout the design life of the EWIS component.
- (e) Electrical wiring interconnection system modifications to the original type design must be identified to the same standards used by the original aircraft manufacturer or other equivalent standards acceptable to the authorities.

§ 25.1713 Fire protection - EWIS

- (a) EWIS components must meet the applicable fire and smoke protection requirements of 25.831(c) and 25.1735.
- (b) Electrical wiring interconnection system components located in designated fire zones, that are necessary during emergency procedures, must be at least fire resistant.
- (c) Insulation on electrical wire and electrical cable, including materials used to provide additional protection for the wire and cable installed in any area of the airplane must be self-extinguishing when tested in accordance with the applicable portions of part I, appendix F of this part.

§ 25.1715 System Lightning Protection - EWIS

For the effects of a lightning strike on EWIS components associated with systems whose failure could effect the continued safe flight and landing of the airplane compliance with the requirements of § 25.1316 must be shown.

§ 25.1717 Electrical Bonding and Protection Against Lightning and Static Electricity - EWIS

Electrical wiring interconnection system components used for electrical bonding and protection against lightning and static electricity must meet the requirements of § 25.899.

§ 25.1719 Circuit Protective Devices - EWIS

- (a) If thermal circuit breakers or fuses are used for the protection of EWIS components the following requirements apply, otherwise the requirements of § 25.1357 apply:
 - (1) Automatic protective devices must be used to minimize distress to the electrical system and hazard to the airplane in the event of EWIS faults or serious malfunction of the system or connected equipment.
 - (2) If the ability to reset a circuit breaker or replace a fuse is essential to safety in flight, that circuit breaker or fuse must be located and identified so that it can be readily reset or replaced

in flight. Where fuses are used, there must be spare fuses for use in flight equal to at least 50 percent of the number of fuses of each rating required for complete circuit protection.

(3) Each circuit for essential loads must have individual circuit protection. However, individual protection for each circuit in an essential load system (such as each position light circuit in a system) is not required.

§ 25.1720 System Power Removal

For airplane systems that require the ability to remove or reset power during normal operations the system must be designed such that circuit breakers are not the primary means to remove or reset system power.

§ 25.1721 Electrical Power Generation – General - EWIS

Components of an EWIS must meet the applicable requirements of § 25.1351

§ 25.1723 Electrical Equipment and Installations - EWIS

(a) Electrical wires and cables must be designed and installed so they are compatible with the circuit protection devices required by § 25.1719 such that a fire or smoke hazard cannot be created under temporary or continuous fault conditions.

(b) Electrical bonding provided by EWIS components must provide an adequate electrical return path under both normal and fault conditions, on airplanes having grounded electrical systems.

§ 25.1725 Distribution System - EWIS

Electrical wiring interconnection system components associated with the electrical distribution system must meet the requirements of § 25.1355.

§ 25.1727 Instruments Using A Power Supply - EWIS

Electrical wiring interconnection system components associated with instruments required by 25.1303(b) that use a power supply must be designed and installed such that compliance with 25.1331(a)(2) is ensured.

§ 25.1729 EWIS Accessibility Provisions for EWIS

Means must be provided to allow for inspection of EWIS and the replacement of its components as necessary for continued airworthiness

§ 25.1731 Pilot Compartment View - EWIS

Electrical wiring interconnection system components of the window de-ice system must meet the requirements of 25.773(b)(2).

§ 25.1733 Protection of EWIS in Cargo or Baggage Compartments

Electrical wiring interconnection systems located in cargo or baggage compartments must be designed and installed so;

- (a) They cannot be damaged by the movement of cargo and personnel in the compartment, and
- (b) Their breakage or failure will not create a fire hazard.

§ 25.1735 Flammable fluid fire protection - EWIS

Electrical wiring interconnection system components must be considered to be a potential ignition source in each area where flammable fluid or vapors might escape by leakage of a fluid system and must meet the requirements of § 25.863.

§ 25.1737 Powerplants - EWIS

(a) Electrical wiring interconnection systems associated with any powerplant must be designed and installed so that the failure of an EWIS components will not prevent the continued safe operation of the remaining powerplants; or require immediate action by any crew member for continued safe operation in accordance with the requirements of 25.903(b).

(b) Design precautions must be taken to minimize the hazards to the aircraft due to EWIS damage in the event of a powerplant rotor failure or of a fire originating within the powerplant which burns through the powerplant case in accordance with the requirements of 25.903(d)(1).

§ 25.1739 Engine ignition systems - EWIS

Electrical wiring interconnection system components associated with engine ignition systems must meet the applicable requirements of § 25.1165

§ 25.1741 Flammable Fluid Shutoff Means - EWIS

Electrical wiring interconnection systems associated with each flammable fluid shutoff means and control must be fireproof or must be located and protected so that any fire in a fire zone will not affect operation of the flammable fluid shutoff means in accordance with the requirements of § 25.1189

§ 25.1743 Fire Detector Systems – General - EWIS

For any installed fire protection systems the EWIS associated with that system must meet the applicable requirements for that particular system, and must be shown to be effective for all operating configurations and conditions.

§ 25.1745 Powerplant and APU Fire detector system – Electrical Wiring Interconnection System - EWIS

(a) Electrical wiring interconnection systems that are part of each fire or overheat detector system in a fire zone must be at least fire-resistant.

(b) No EWIS component of any fire or overheat detector system for any fire zone may pass through another fire zone, unless --

(1) It is protected against the possibility of false warnings resulting from fires in zones through which it passes; or

(2) Each zone involved is simultaneously protected by the same detector and extinguishing system.

(c) Compliance with the requirements of § 25.1203 must be shown.

§ 25.1747 Electrical Shock and Burn - EWIS

Electrical wiring interconnection system components must be designed and installed to minimize the risk of electric shock and burns in accordance with the requirements of § 25.1360.

§ 25.1749 Electrical Supplies for Emergency Conditions - EWIS

Electrical wiring interconnection system components for the electrical services required for emergency conditions must meet the requirements of § 25.1362.

§ 25.1751 Electrical Appliances, Motors, and Transformers - EWIS

Electrical wiring interconnection system components associated with electrical appliances, motors and transformers must meet the requirements of § 25.1365

25.1753 Electronic equipment - EWIS

Electrical wiring interconnection system components associated with radio and electronic equipment and controls must meet the requirements of § 25.1431(c) and (d).

§ 25.1755 Instructions for Continued Airworthiness - EWIS

The applicant must prepare Instructions for Continued Airworthiness applicable to EWIS in accordance with the requirements of § 25.1529 and Appendix H to this part that are acceptable to the Administrator.

Appendix B: Proposed Subpart H Advisory Material



U.S. Department
of Transportation
**Federal Aviation
Administration**

Advisory Circular

Subject: ELECTRICAL WIRING
INTERCONNECTION SYSTEM

Date: 10/29/02
Initiated By:
ATSRAC WSWHG

AC No: 25H17XX

Change: DRAFT

PURPOSE.

This Advisory Circular (AC) provides guidance for certification of Electrical Wiring Interconnection System (EWIS) on transport category airplanes. The guidance in this AC is based on recommendations submitted to the FAA from the Aging Transport Systems Rulemaking Advisory Committee (ATSRAC). The guidance and recommendations in this AC are derived from the best practices developed through extensive research by ATSRAC Industry Working Group 6. While this is the primary focus of this AC, the guidance also supplements similar guidance provided in other AC's concerning EWIS requirements for other parts of the airplane systems. To fully realize the objectives of this AC, type certificate holders, STC holders, maintenance providers, repair stations and persons performing field approval modifications or repairs, will need to rethink their current approach to designing and modifying aircraft wiring and systems. Design and modification personnel need to be aware that aircraft EWIS should be designed and installed with the same level of diligence as any other essential or critical system in the aircraft.

APPLICABILITY.

The guidance provided herein applies to the approval of the installation of EWIS as defined in 14 CFR Part 25 Section H.

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25HAC/ACJ1701 EWIS Definition

(a) Electrical Wiring Interconnection System (EWIS) is defined as an electrical connection between two or more points including the associated termination (e.g., connectors, terminal block, splice, etc) devices and the necessary means for its installation and identification. This includes:

- | | |
|---|---|
| (1) Wires and cables (e.g., wire, cable, coax, databus, feeders, ribbon cable, etc.) | (7) Electrical splices |
| (2) Bus bars | (9) Shield or braids |
| (3) Connection to electrical devices (e.g., relays, interrupters, switches, contactors, terminal blocks, feed-through connectors, etc.) | (10) Conduits that have electrical termination for the purpose of bonding |
| (4) Circuit Breakers or other circuit protection devices (not performance) | (11) Clamps and other devices used to route and support the wire bundle |
| (8) Material used to provide additional protection for wires | (12) Cable tie devices |
| (5) Connector and accessories (e.g., backshell, sealing boot grommet sealing plugs,) | (13) Labels or other means of identification |
| (6) Electrical grounding and bonding devices (e.g., modules, straps, studs, etc.) | (14) Pressure seals associated with wiring systems |

(b) Electrical wiring interconnection system components inside shelves, panels, racks, junction boxes, distribution panels, back-planes of equipment racks including circuit board back-planes, wire integration units, etc. answering to the upper definition, is included.

(c) The mating connection at the termination point of the wire on those devices that are excluded from this definition is not included as part of the Electrical Wiring Interconnection System

(d) The following is excluded:

1. Wiring inside avionics equipment (e.g., flight management system computer, flight data recorder, VHF radio, primary flight display, etc.),
2. Equipment including non required miscellaneous equipment qualified to the standards of RTCA Document DO-160 or shown to be equivalent (other than those specifically included in this definition),
3. Equipment qualified to a technical standard order (TSO),
4. Portable, carry on, or otherwise non-permanently mounted (not part of the certification basis) electrical equipment.

5. Fiber optics

(e) For the purposes of this AC/ACJ the use of the term separation or segregation is a measure of distance, barrier or other means shown to be at least equivalent and addresses physical hazards resulting from potential electrical failure modes

25HAC/ACJ1703 Function and Installation

(a) EWIS Components

(1) EWIS components should be designed and installed so that they:

- (i)** Have sufficient mechanical strength to allow for service conditions, and
- (ii)** Do not exceed allowable voltage drop levels, and be appropriate for the environment to which they are installed.
- (iii)** Are selected with due consideration to their design service objective. This should not normally be less than the design service objective of the aircraft structure. If the design requires that EWIS components must be replaced at certain intervals, these intervals should be specified in the ICAW as required by § 25.1529.

(2) EWIS components should be qualified for airborne use or specifically assessed as acceptable for the intended use.

Note: The Original Aircraft Manufacturer (OAM) lists approved components in their Manuals. Components, or their approved substitutes, listed in the applicable Manual should ideally be used for maintenance, repair or modification of the aircraft. EWIS modifications to the original type design shall be designed and installed to the same standards used by the original aircraft manufacturer or other equivalent standards acceptable to the authorities. The use of same or equivalent standards is justified by the fact that the OAM technical choice of an EWIS component is not always driven by the regulation requirements but in some cases could exceed the minimum level required by the regulation due to specific technical constraints.

(i) The EWIS should be installed with sufficient slack so that bundles and individual wires are not under undue tension. Wires connected to movable or shock-mounted equipment should have sufficient length to allow full travel without tension on the bundle. Wiring at terminal lugs or connectors should have sufficient slack to allow two re-terminations without replacement of wires, unless other design considerations apply. This slack should be in addition to the drip loop and the allowance for movable equipment.

(ii) In order to prevent mechanical damage wires should be supported by suitable clamps, or other devices at suitable intervals, except when contained in troughs, ducts, or conduits. The supporting devices should be of a suitable size and type, with the wires and cables held securely in place without damage to the insulation as per SAE AS50881 or equivalent standard.

(iii) To avoid damage to the wire insulation the minimum radius of bends in wire groups or bundles should be in accordance with the wire manufacturers specification, OAM recommendations or industry standards such as AECMA EN3197 or SAE AS50881. The minimum bend radii for bends in wire groups or bundles should not be less than 10 times the out-side diameter of their largest wire; or they may be bent at 6 times their outside-diameter at breakouts or where they must reverse direction in a bundle, provided that they are suitably supported unless authorized by wiring product specification.

(iv) Damage to Coaxial cable can occur when clamped too tightly, or when they are bent sharply (normally at or near connectors). Damage can also be incurred during unrelated maintenance actions around the coaxial cable. Coaxial cable can be severely damaged on the inside without any evidence of damage on the outside. The installation design should therefore minimize the possibility of such damage.

(v) Wire bundle adhesive clamp selection.

Certain designs that employ adhesive means to affix the bundle support to the aircraft structure are known to work loose during aircraft in service operation, either as a result of improper choice of design or surface preparation. Particular attention should therefore be given to the selection and methods used for affixing this type of wire bundle support.

(vi) 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 in 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. Wiring 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, etc., should be provided. Protective grommets should be used, wherever wires cannot be clamped, in a way that ensures clearance from structure at penetrations. Wire should not have a preload against the corners or edges of chafing strips or grommets. Wiring should be routed away from high-temperature equipment and lines to prevent deterioration of insulation. Wiring that is routed across hinged panels, should be routed and clamped so that the bundle will twist, rather than bend, when the panel is moved. Conduits should be designed and manufactured such that the potential for chafing between the wiring and the conduit internal walls is eliminated.

(vii) Conduit: Wiring inside conduit may be subjected to damage. Where the failure of wiring inside a conduit can lead to a hazardous condition a means should be provided to allow inspection or protection of the cables. This inspection may be by testing or other means acceptable to the Administrator. Refer to 25HAC/ACJ1729 Accessibility Provisions.

Non-Metallic Conduit: Insulating tubing is sometimes used to provide additional electrical protection and limited additional mechanical protection or to increase the external wire dimension, however insulating tubing should not be considered as mechanical protection against external abrasion of wire; since at best, it provides only

a delaying action. Conduit or ducting should be used when additional mechanical or environmental protection is needed.

Metallic Conduit: The ends of metallic conduits should be flared and the interior surface treated to reduce the possibility of abrasion.

(viii) Connector Selection: The connector used for each application should be selected only after a careful determination of the electrical and environmental requirements. Particular attention should be taken of the use of components with dissimilar metals, which may cause electrolytic corrosion.

Environment-resistant connectors should be used in applications where they will be subjected to fluids, vibration, temperature extremes, mechanical shock, corrosive elements, etc. The use of sealing plugs and contacts in unused connector cavities should be used where necessary. Firewall class connectors incorporating these same features should, in addition, be able to prevent the penetration of the fire through the aircraft firewall connector opening and continue to function without failure for a specified period of time when exposed to fire. When EMI/RFI protection is required, special attention should be given to the termination of individual and overall shields. Back shell adapters designed for shield termination, connectors with conductive finishes, and EMI grounding fingers are available for this purpose.

(ix) Splice Selection: Environmentally sealed splices should be used in accordance with the requirements of the airframe manufacturers standard practices or SAE AS81824/1, or equivalent specification, particularly in un-pressurized and severe wind and moisture problem (SWAMP) areas.

In pressurized areas, pre-insulated splices conforming to SAE AS7928, or equivalent specification, may be used if approved by the OAM or Design Authority as long as the possibility of fluid contamination can be shown to be remote.

For a mechanically protected splice a post insulated splice may be used provided the splice is covered with a suitable plastic sleeve, such as a dual wall shrink sleeve, that is permanently secured in position at both ends.

Note: Environmental splices generally available use heat shrink material that needs application of heat. Generally, these heat sources cannot be used in flammable vapour areas aircraft without proper precautions.

Aluminum wire splice: Splices for aluminum wires shall be in accordance with the requirements of the airframe manufacturers standard practices or SAE AS70991, MS25439 or equivalent specification. Special attention shall be given to aluminum wire and cable splice installation to guard against conditions that would result in excessive voltage drop and high resistance at junctions that may ultimately lead to failure of the junction. Preferable location for aluminum splice should be in pressurized areas.

Note: To avoid contamination (foreign particles) the crimp tool (dies) should be dedicated to aluminum wire crimping.

b) Wire Selection.

(i) Environment: An important consideration in the selection of aircraft wire is properly matching the wire's construction to the application environment. Wire construction that is suitable for the most severe environment likely to be encountered in service should be selected. Particular attention should be applied to the type of wire needed for the application. E.g. Flexible wire for installations involving movement, airframe wire or interconnect wire, higher temperature installations etc.

In considering the acceptability of wire, reference should be made to industry standards that define acceptable test methods for aircraft wire, including arc tracking test methods. E.g. EN3475, SAE AS4373

Note: Alternative OAM standards may also be used.

Insulation of wires should be appropriately chosen in accordance with the environmental characteristics of wire routing areas.

(ii) Wires shall be sufficiently robust to withstand, without risk of failure, all movement, flexing, vibration, abrasion and other mechanical hazards to which they may be reasonably subjected to when installed in the airplane. Generally, conductor wire should be stranded to minimize fatigue breakage. Refer to AS50881 and AECMA EN3197 for accepted standards.

(iii) Wire shall also be sufficiently robust to withstand the mechanical hazards to which they may reasonable subjected to during the installation of the wires into the aircraft.

(iv) Wire installed in the same bundle shall be able to withstand the wire-to-wire abrasion. The Routing of wires with dissimilar insulation, within the same bundle, is not generally recommended, particularly when relative motion and abrasion between wires having dissimilar insulation could occur.

(v) For wire sizes smaller than #22, particular attention should be given to the mechanical strength and installation handling of these wires, e.g., vibration, flexing, and termination. Consideration should be given to the use of high-strength alloy conductors in small gauge wires to increase mechanical strength.

(vi) To select the correct size of electrical wire, the following requirements should be met:

- The wire size should be matched with the circuit protective device with regard to the required current.
- The wire size should be sufficient to prevent overheating of the wire carrying the required current.

- The wire size should be sufficient to prevent an excessive voltage drop while carrying the required current over the required distance.

Refer to the appropriate industry standards for the detailed method of selecting wire rating. E.g. SAE AS50881 and AECMA EN2853.

(vii) The temperature rating of a wire should be selected taking into consideration the worst-case requirements of the application. Caution should be used in locating wires in areas where heat is generated – for example oxygen generators, lighting ballast units, etc.

Wires have a specified maximum continuous operating temperature, and for many types, this may be achieved by any combination of maximum ambient temperature plus temperature rise due to electrical heating.

In general, it is undesirable to contribute more than 40°C rise to the operating temperature by electrical heating.

Other factors to be considered are altitude de-rating, bundle size de-rating, and use of conduits.

Particular reference should be made to the specified voltage of any wire where higher than normal potentials may be used, examples being discharge lamp circuits and windscreen heating.

(viii) For EWIS Identification refer to AC/ACJ25.1711.

c) Reserved

d) EWIS components in moisture areas.

(i) Areas designated as severe wind and moisture problem (SWAMP) areas differ from aircraft to aircraft but generally are considered to be areas such as wheel wells, near wing flaps, wing folds, pylons, and other exterior areas that may have a harsh environment. Wires for these applications should have design features incorporated into their construction that address these severe environments. Refer to paragraph a) 2) ix) for splice selection.

Note: Reference to the original aircraft manufacturers wire selection should be made prior to the selection of other alternative wire.

(ii) Silver plated conductors. Many high strength copper alloy conductors and Coaxial cables use silver plating. An electrical fire can result if silver-plated conductors are contaminated by glycol (de-icing fluid). Accordingly, silver plated conductors should not be used in areas where de-icing fluid can be present unless suitable protection features are employed. (E.g. High quality silver plating).

Note also that silver plated conductors and shields can exhibit a corrosive condition (also known as 'Red Plague') if the plating has been damaged or is of poor quality and then exposed to moisture. Designers should therefore be aware of these conditions.

(iii) Tin plated conductors. If not treated properly tin plated conductors may be difficult to solder properly.

(iv) Fluid contamination of EWIS components should be avoided, as far as practicable. However, EWIS components should be designed and installed assuming that contamination with any fluids present in the particular area, due to either to the normal environment or accidental leaks or spillage will occur. Industry standards, such as RTCA DO-160/EUROCAE ED-14 contain information regarding typical aircraft fluids. It is particularly important to appreciate that certain contaminants, notably that from toilet waste systems, galleys and fluids which contain sugar, such as sweetened drinks, can induce electrical tracking of degraded electrical wires and unsealed electrical components.

Only cleaning fluids recommended in the standards practices manual by the airframe constructor should be used and his recommendations and safety practices should be followed. In the absence of specific instructions Isopropyl Alcohol (IPA) and a lint free cloth may be used.

e) Reserved

25HAC/ACJ1705 Electrical Wiring Interconnection System Safety

Introduction:

The analysis described in this advisory material is based on a qualitative approach to assessing EWIS safety as opposed to a numerical, probability based quantitative analysis. The intent is not to examine each individual wire and its relation to other wires but rather to ensure that there are no hazardous combinations. However, in case the “top down” analysis process described in the AC identifies that a failure in a given bundle may lead to a Catastrophic Failure Condition, the mitigation process may lead to performing a complete analysis of each wire in the relevant bundle.

The analysis described in this AC/ACJ may be accomplished in conjunction with the required aircraft system safety assessments of §§ 25.1309, 25.671, etc.

The classification of failure conditions is given in Table 1.

There are two flowcharts contained in this AC/ACJ:

- Flowchart 1 applies to applicants for pre-TC work and for amended TC's, and STC's when the applicant is in possession of all data necessary to perform the analysis per Flowchart 1. If Flowchart 1 is used for post-TC modifications the available data must include the identification of the systems in the EWIS under consideration for modification and the system functions associated with that EWIS.
- Flowchart 2 applies to applicants for post-TC modifications where the applicant cannot identify the systems or systems function contained in EWIS under consideration for modification

The analysis processes is initiated by a Functional Hazard Analysis performed at aircraft level identifying catastrophic and hazardous failure events.

The processes of both Flowcharts 1 and 2 identifies two aspects; physical and functional failures.

NOTE: For the purposes of this AC the following definitions apply:

Validation: The determination that the requirements for a product are sufficiently correct and complete.

Verification: The evaluation of an implementation of requirements to determine that they have been met.

Physical Failure Analysis

Only single common cause events or failures need to be addressed during the physical failure analysis as described in this AC and shown on the left hand sides of Charts 1, and 2. The objective of the physical analysis is to protect against single common cause events or failures that may involve single or multiple physical failures. Multiple common cause events or failures need not be addressed.

In relation to physical effects it should be considered that wires are carrying electrical energy and in the case of a EWIS failure, as defined in the preceding paragraph, this energy may result in hazardous or catastrophic effects directly or when combined with other conditions (e.g., fuel, oxygen, hydraulic, damage by passengers, etc.) These failures, for example, may result in fire, smoke, emission of toxic gases, damage to co-located systems, structural elements or injury to personnel. This analysis takes into account all EWIS from all systems regardless of criticality, (E.g., autopilot, auto throttle, PA system, IFE system, etc....).

Functional Failure Analysis

The function aspects considers that electrical wires are carrying power, signal, or information data.. Failure of the EWIS under these considerations may lead to aircraft system degradation effects.

Descriptive Text for Flowchart 1

BOX A

The FHA referred to in this box is the aircraft level FHA that has been developed to help demonstrate the acceptability of a design concept, to identify potential problem areas or desirable design changes, or to determine the need for and scope of any additional analyses (refer to AC/ACJ 25.1309-1B). This is not a stand-alone separate document specifically created to show compliance with § 25.1705.

Physical Failures

BOX B

EWIS Characteristics:

The results of the FHA (Box A) are utilized for identification of EWIS installation criteria and definition of component characteristics. The results of Box B are fed into the PSSA's/SSA's of Box J.

BOXES C, D and E

Validation and verification of installation criteria:

Ensure that the EWIS component qualification satisfies the design requirements and that components are selected, used and installed according to their qualification characteristics and the aircraft constraints linked to their location.

Using available information (e.g., digital mockup, physical mockup, aircraft, historical data), inspections and analyses (e.g. 1st article inspection, design review, particular risks, zonal safety assessments, zonal inspections, common mode analysis, as applicable) should be performed to validate that design and installation criteria are adequate to the zone/function, including multi-systems impact. Also, the inspections and analyses should be used to assess that design and installation criteria were correctly applied. Special consideration should be given to those areas of the airplane that are known problem areas based on service history and historical data (e.g., arcing, smoke, loose clamps, chafing, arc tracking, interference with other systems, etc.). Special considerations should also be given to cases where new (previously unused) material or other technologies are utilized.

Deviations from installation and component selection criteria identified by these activities should be evaluated and a determination made as to their acceptability. Alternative mitigation strategies should be developed as necessary.

BOXES F & G

Development & validation of mitigation strategy:

This activity is to identify & to develop a mitigation strategy for the physical failures and their adverse effects identified in Boxes D and E.

Validation and verification of the mitigation solution should ensure that the hazardous failure conditions are extremely remote and catastrophic failure conditions don't result from a single common cause event or failure and this mitigation solution does not introduce any new potential failure conditions.

BOX H

Newly developed mitigation strategies (Box F) should be incorporated into guidelines (Box B) for further design and inspection and analysis process.

BOX I

The EWIS Physical Failure Analysis documents the physical failures that were addressed, their effects, and the mitigation strategies that were developed. This information supports the final analysis documentation (Box P).

Functional Failures

BOX J

System safety Assessment:

The results of the aircraft level FHA (Box A) guide the system level FHA (Box J).

EWIS failures identified by 25.1705 are to be incorporated into the FHAs/PSSAs/CCAs/SSAs. These analyses are performed to satisfy the requirements of 25.1309.

The results of these analyses are used to update the EWIS definition (Box B).

BOXES K, L, and M

Hazardous and Catastrophic failure conditions:

This analysis should identify if the EWIS associated with the system under analysis can contribute (in whole or in part) to the failure condition under study. A determination needs to be made if the EWIS failure needs to be mitigated. If yes, a mitigation strategy needs to be developed, validated, and verified. If no, the appropriate safety assessment should be completed (e.g., per 25.1309, 25.671, etc.)

BOXES N and O

Development & validation of mitigation strategy:

This activity is to identify & to develop a mitigation strategy for the functional failures and their adverse effects identified in Box J

Validation and verification of the mitigation solution should assess that initial objective is fully reached and assess that this mitigation solution is compatible with existing installations and installation criteria. If the EWIS was the failure cause, the subsequent mitigation strategy developed may introduce new adverse effects not previously identified by the analysis. A check for any new adverse effects should be accomplished and the aircraft level FHA and other system safety assessments should be updated as necessary.

BOX P

After the mitigation strategies have been validated and verified, the results of the § 25.1705 analysis should be documented and the Aircraft FHA (Box A) should be updated as necessary.

Descriptive Text for Flow chart 2:

The main objectives are to ensure that the proposed modification will be correctly designed and installed and will not adversely affect existing systems.

As far as EWIS is concerned, correct incorporation of the modification should be ensured by both good knowledge of OAM installation practices and their correct implementation or by adequate separation of the added EWIS from existing EWIS. In either case, physical analyses should be performed (similar to physical part of the flow chart 1).

BOX A

Aircraft level effects must be considered for modified or added systems to the aircraft. If the applicant has the Aircraft FHA it should be examined to determine the airplane level effect of the proposed modification. If the applicant doesn't have the Aircraft FHA then the applicant must generate a Aircraft FHA based on the proposed modification, This Aircraft FHA would be limited to just those aircraft systems that are affected by the proposed modification. If it is determined that no aircraft level functional effects are impacted or introduced, a statement to this effect and the supporting data is sufficient to satisfy BOX A.

Physical Failures

BOX B

EWIS Characteristics:

The results of the FHA (Box A) are utilized for identification of EWIS installation criteria and definition of component characteristics. The results of Box B are fed into the PSSAs/SSAs of Box J.

BOX C

The EWIS to be added should be separated from other existing airplane EWIS since it cannot be determined what systems or system functions are contained in the existing EWIS. Physical separation between the new and existing EWIS must be achieved through separation distance or an appropriate barrier or other means shown to be at least equivalent when allowed by § 25.1709.

The methods given in AC/ACJ 25.1709 provide an acceptable way to determine adequate separation.

In cases where the separation cannot be maintained due to physical constraints (i.e., terminal strips and connectors etc), the applicant should accomplish the appropriate analysis to show that no adverse failure conditions exists because of sharing the common device. This requires that the applicant have knowledge of the systems or system functions that also use the common device (i.e., terminal strips and connectors etc).

Boxes D and E

Validation and verification of installation criteria:

Ensure that the EWIS component qualification satisfies the design requirements and that components are selected, used and installed according to their qualification characteristics and the aircraft constraints linked to their location.

Using available information (e.g., digital mockup, physical mockup, aircraft, historical data), inspections and analyses (e.g. 1st article inspection, design review, particular risks, zonal safety assessments, zonal inspections, common mode analysis, as applicable) should be performed to validate that design and installation criteria are adequate to the zone/function, including multi-systems impact. Also, the inspections and analyses should be used to assess that design and installation criteria were correctly applied. Special consideration should be given to those areas of the airplane that are known problem areas based on service history and historical data (e.g., arcing, smoke, loose clamps, chafing, arc tracking, interference with other systems, etc.). Special considerations should also be given to cases where new (previously unused) material or other technologies are utilized.

Deviations from installation and component selection criteria identified by these activities should be evaluated and a determination made as to their acceptability. Alternative mitigation strategies should be developed as necessary.

BOXES F and G

Development & validation of mitigation strategy:

This activity it to identify & to develop a mitigation strategy for the physical failures and their adverse effects identified in Boxes D and E.

Validation and verification of the mitigation solution should ensure that the hazardous failure conditions are extremely remote and catastrophic failure conditions don't result from a single common cause event or failure and this mitigation solution does not introduce any new potential failure conditions.

BOX H

Newly developed mitigation strategies (Box F) should be incorporated into guidelines (Box B) for further design and inspection and analysis process.

BOX I

The EWIS Physical Failure Analysis documents the physical failures that were addressed, their effects, and the mitigation strategies that were developed. This information supports the final analysis documentation (Box P).

Functional Failures

BOX J

System safety Assessment:

The results of the aircraft level FHA (Box A) guide the system level FHA (Box J).

EWIS failures identified by 25.1705 are to be incorporated into the FHAs/PSSAs/CCAs/SSAs. These analyses are performed to satisfy the requirements of 25.1309.

The results of these analyses are used to update the EWIS definition (Box B).

BOXES K, L, and M

Hazardous and Catastrophic failure conditions:

This analysis should identify if the EWIS associated with the system under analysis can contribute (in whole or in part) to the failure condition under study. A determination needs to be made if the EWIS failure needs to be mitigated. If yes, a mitigation strategy needs to be developed, validated, and verified. If no, the appropriate safety assessment should be completed (e.g., per 25.1309, 25.671, etc.)

BOXES N and O

Development & validation of mitigation strategy:

This activity it to identify & to develop a mitigation strategy for the functional failures and their adverse effects identified in Box J.

Validation and verification of the mitigation solution should assess that initial objective is fully reached and assess that this mitigation solution is compatible with existing installations and installation criteria. If the EWIS was the failure cause, the subsequent mitigation strategy

developed may introduce new adverse effects not previously identified by the analysis. A check for any new adverse effects should be accomplished and the aircraft level FHA and other system safety assessments should be updated as necessary.

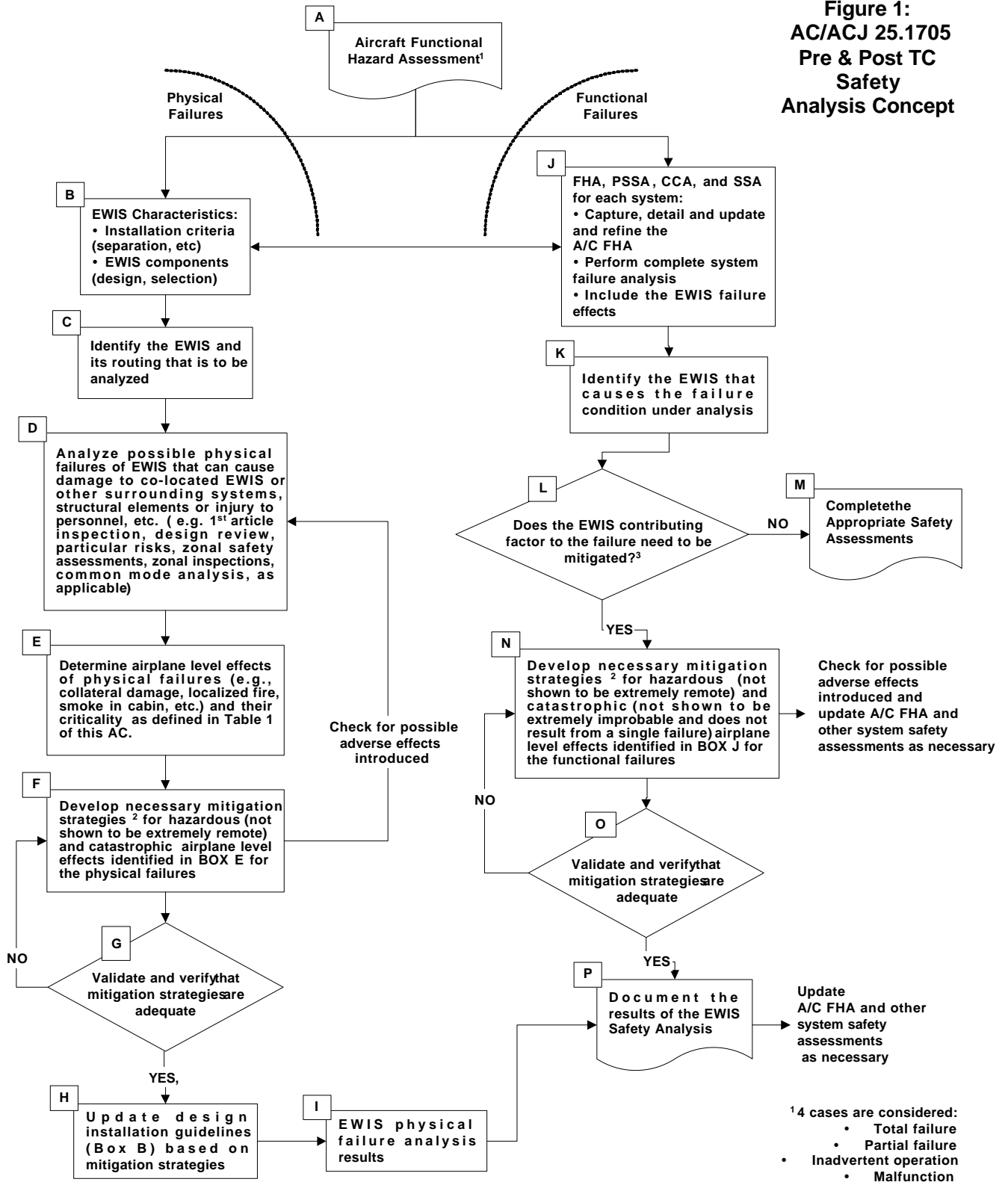
BOX F

After the mitigation strategies have been validated and verified, the results of the § 25.1705 analysis should be documented and the Aircraft FHA (Box A) should be updated as necessary.

Table 1: Classification of Failure Conditions

Term	Explanation
No Safety Effect	Failure conditions that would have no effect on safety; for example, failure conditions that would not affect the operational capability of the airplane or increase flightcrew workload.
Minor	Failure conditions that would not significantly reduce airplane safety, and involve flightcrew actions that are well within their capabilities. Minor failure conditions may include, for example: <ul style="list-style-type: none"> • a slight reduction in safety margins or functional capabilities; • a slight increase in flightcrew workload, such as routine flight plan changes; or • some physical discomfort to passengers or cabin crew.
Major	Failure conditions that would reduce the capability of the airplane or the ability of the flightcrew to cope with adverse operating conditions to the extent that there would be, for example: <ul style="list-style-type: none"> • a significant reduction in safety margins or functional capabilities; • a significant increase in flightcrew workload or in conditions impairing flightcrew efficiency; • discomfort to the flightcrew; or • physical distress to passengers or cabin crew, possibly including injuries.
Hazardous	Failure conditions that would reduce the capability of the airplane or the ability of the flightcrew to cope with adverse operating conditions to the extent that there would be, for example: <ul style="list-style-type: none"> • a large reduction in safety margins or functional capabilities; or • physical distress or excessive workload such that the flightcrew cannot be relied upon to perform their tasks accurately or completely; or • serious or fatal injuries to a relatively small number of persons other than the flightcrew.
Catastrophic	Failure conditions that would result in multiple fatalities, usually with the loss of the airplane. (NOTE: A catastrophic failure condition was defined differently in previous versions of § 25.1309 and in accompanying advisory material as “a failure condition that would prevent continued safe flight and landing.”)

**Figure 1:
 AC/ACJ 25.1705
 Pre & Post TC
 Safety
 Analysis Concept**

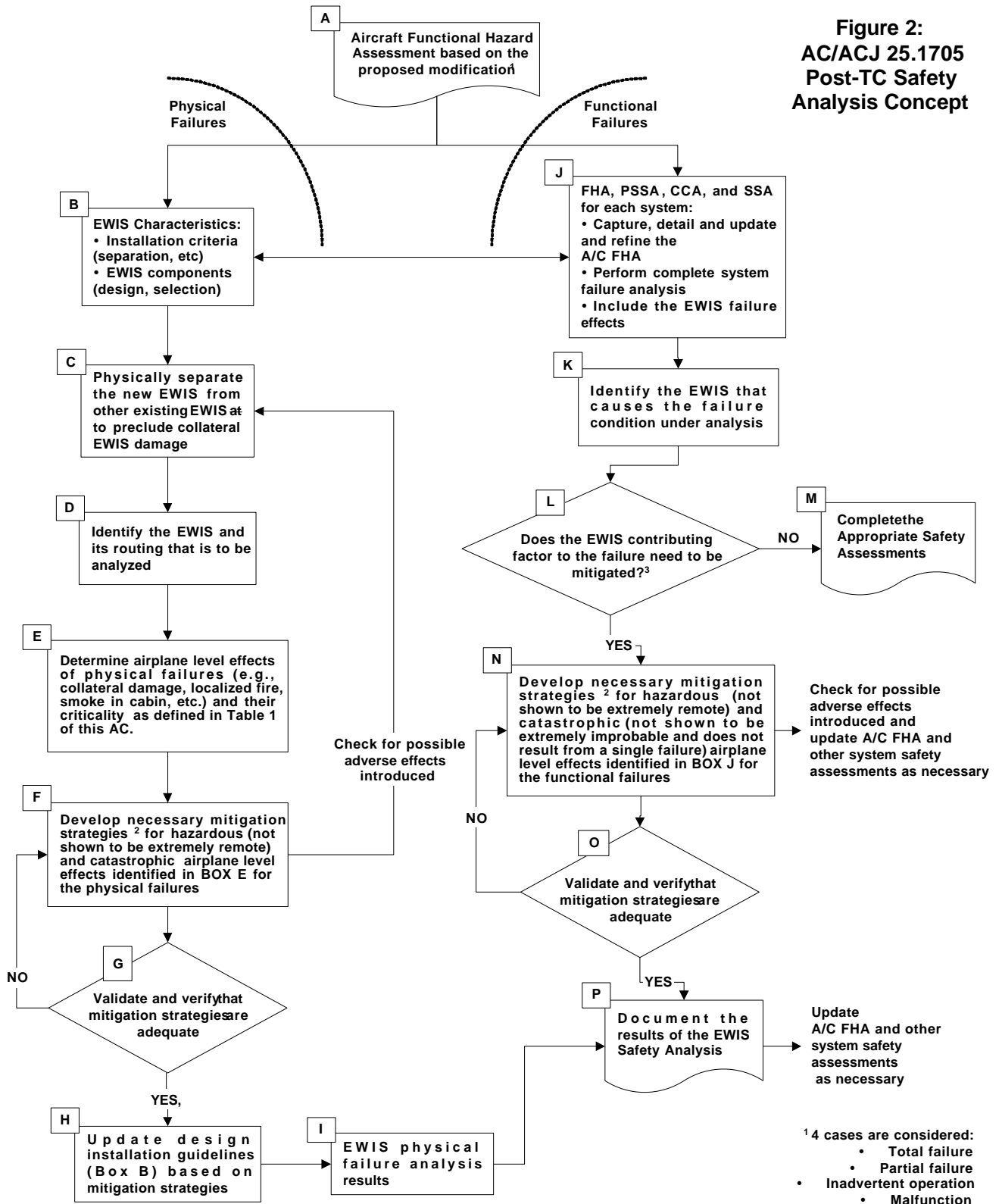


²e.g., re-route, different clamping, add sleeving, add barrier, etc

³ Contributing means the EWIS causes the failure in whole or in part

- ⁴ 4 cases are considered:
- Total failure
 - Partial failure
 - Inadvertent operation
 - Malfunction

**Figure 2:
 AC/ACJ 25.1705
 Post-TC Safety
 Analysis Concept**



² e.g., re-route, different clamping, add sleeving, add barrier, etc

³ Contributing means the EWIS causes the failure in whole or in part

25H AC/ACJ1709 EWIS Separation

(a). General Wiring designs used on transport airplanes vary significantly between manufacturers and models. The continuing safe operation of aircraft during their expected service life depends on the safe transfer of electrical energy by the EWIS. If an EWIS failure occurs, the separation plays an important role in assuring the hazardous effects of the failure are mitigated to an acceptable level. Separation is a measure of physical distance, barrier or other means shown to be at least equivalent that mitigates hazards resulting from potential failures that may occur in a single bundle or may span two or more bundles, or may occur between an electrical bundle and a surrounding non-electrical system.

Wires not protected from wiring faults by a circuit-protective device, such as thermal circuit breakers, arc fault protection devices, ground fault interrupters, other proven protection devices, or combination of such device as needed, whose failure can cause a hazard to the aircraft, should be routed separately from all other wiring.

When physical separation of system wiring from other wiring or mechanical structure and systems is used, then the minimum physical separation (or equivalent barriers) of these wires should be established based upon analysis of design and installation of specific features including:

- (1) The electrical characteristics, amount of power and failure condition severity of the system functions performed by the signals in the EWIS and adjacent EWIS, and
- (2) Installation design features including the number, type, and location of support devices along the wire path, and
- (3) The maximum amount of slack wire resulting from wire bundle build tolerances and other wire bundle manufacturing variability's, and
- (4) Probable variations in the installation of the wiring and adjacent wiring, including position of wire support devices and the amount of slack wire that is possible, and
- (5) The intended operating environment including the amount of deflection or relative movement that can occur and the effect of a failure of a wire support device, or a broken wire, or other methods used to maintain separation, and
- (6) Maintenance practices as defined by the airplanes manufacturer's standard wiring practices manual and the instructions for continuing airworthiness required by § 25.1529, and

(7) The maximum temperature generated by adjacent wire/wire bundle during normal and fault conditions

Physical separation must be achieved through separation distance or an appropriate barrier or other means shown to be at least equivalent when allowed by the rule. Adequate distance separation is the preferred method. The separation distance must not contain equipment or materials that could aid in the propagation of fire/failure that could disable a redundant system EWIS component. Other means of physical separation may be used if it is shown to be at least equivalent in all characteristics to separation achieved through the use of separation distance (e.g., fire resistant barrier).

Some airplane types may have localized areas where maintaining the minimum physical separation distance is not feasible. When the applicant justifies the need to go below the established minimum physical separation distance, other means to ensure the equivalence of the minimum physical separation may be acceptable, if demonstrated by testing or analysis. This testing or analysis program must be conservative and envelope the worst possible condition and must provide reasonable interpretation of test results

Note: Separation From Personnel and Cargo

EWIS in general and wiring in particular must be installed so the structure affords protection against its use as a handhold and damage from cargo. Wires and wire bundles should be routed or otherwise protected to minimize the potential for maintenance personnel to step, walk, or climb on them. Where the structure does not afford adequate protection, other protection means should be used, or a suitable mechanical guard should be provided. The wire bundles should be routed along heavier structural members whenever possible. Sharp metal edges must be protected by grommets to prevent chafing. Wires should not be routed between aircraft skin and fuel lines. Avoid running wires along the bottom of the fuselage, over the landing gear, in areas of the leading edge of the wing where fuel spillage is anticipated, or adjacent to flammable fluid lines or tanks. EWIS components in the passenger cabin should be protected from possible damage by passengers. Wiring routed to, and on, seats, should be protected so passenger luggage, feet, or other possible contact by the passenger does not damage the wire. Separation distances (or equivalent barriers) should be determined considering the factors listed above.

(b) Electromagnetic Interference (EMI)

EWIS and wiring of sensitive circuits that may be affected by EMI must be routed away from other wiring interference, or provided with sufficient shielding to avoid system malfunctions under operating conditions. EMI between susceptible wiring and wiring which is a source of EMI increases in proportion to the length of parallel runs and decreases with greater separation. EMI should be limited to negligible levels in wiring related to systems necessary for continued safe flight, landing and egress. Function of systems should not be affected by the EMI generated by the adjacent wire. Separation distances (or equivalent barriers) should be determined considering the factors listed in General paragraph (a) above.

(c) Reserved

(d) Reserved

(e) Separation From Flammable Fluids

An arcing fault between an EWIS in general and electrical wire in particular and flammable fluid line may puncture the line and result in a fire. Every effort must be made to avoid this hazard by physical separation of the EWIS from lines and equipment containing oxygen, fuel, hydraulic fluid, and other flammable fluids. Separation distances (or equivalent barriers) should be determined considering the factors listed in General paragraph (a) above. EWIS should be routed and installed with a maximum achievable separation as determined considering the factors listed in General paragraph (a) above whenever possible. Further, other means of protection (e. g. drip shield) must be provided to prevent potential leaking fluids on EWIS.

(f) Reserved

(g) Reserved

(h) Separation From Water Waste

Leakage from these systems can cause damage to EWIS components and adversely affect their integrity. Every effort should be made to design and install EWIS so that leaking fluid does not contact the wiring or electrical connectors. Wiring and other EWIS components should be routed with a maximum achievable separation as determined in General paragraph (a) above. Further, EWIS should be designed and installed so that some means of protection from potential leaking fluids is provided (e.g., drip shields).

(i) Separation From Flight Controls

In order to prevent chafing jamming or other types of interference that may lead to loss of control of the airplane EWIS in general and wiring in particular must be physically separated. Clamping of wires routed near moveable flight controls should be attached and should be spaced so that failure of a single attachment point can not result in interference with flight controls cables, components or other moveable flight control surfaces or moveable equipments. Separation distances (or equivalent barriers) should be determined considering the factors listed in General paragraph (a) above.

(j) Separation from High Temperature Equipment

EWIS in general and wiring in particular must be routed away from high-temperature equipment and lines to prevent deterioration of the EWIS and wire insulation. Wires must be rated so that the conductor temperature remains within the wire specification maximum when the ambient temperature, and heat rise, related to current carrying capacity are taken into account. The residual heating effects caused by environmental operating condition, exposure to sunlight, or proximate artificial light sources where radiant heat is a factor should also be taken into account.

Wires in fire detection, fire extinguishing, fuel shutoff, and fly-by-wire flight control systems that must operate during and after a fire, must be selected from types that are qualified to provide circuit integrity after exposure to fire for a specified period. Separation distances (or equivalent barriers) should be determined considering the factors listed in General paragraph (a) above.

(k) Redundant System Separation

Separation and electrical isolation shall be provided to maintain the independence of all redundant systems and equipment so that safety functions required for flight, landing, and egress are maintained.

EWIS of redundant aircraft systems should be routed in separate bundles and through separate connectors to prevent a single fault from disabling multiple redundant systems. Segregation of functional similar, EWIS components is necessary to prevent the degradation of their ability to perform their required functions.

Power feeders from separate power sources should be routed in separate bundles from each other and from other aircraft wiring, in order to prevent a single fault from disabling more than one power source. The ground wires from aircraft independent power sources should be grounded individually to the airframe at separate points so that a single ground failure will not disable multiple power sources. Wiring that is part of electro-explosive subsystems, such as cartridge-actuated fire extinguishers, and emergency jettison devices, should be routed in shielded and jacketed twisted-pair cables, shielded without discontinuities, and kept separate from other wiring at connectors. Separation distances (or equivalent barriers) should be determined considering the factors listed in General paragraph (a) above.

(l) Reserved

25HAC/ACJ1711 EWIS Component Identification

(a) General

To ensure that systems remain safe and operate as intended throughout the service life of the airplane it is necessary that their components are properly labeled, or otherwise identified, so as to facilitate determination of the function of the allied system, together with any associated separation requirements and operating limitations. Clear labeling of EWIS allows installers, inspectors, and maintainers to readily identify that the correct system components are installed as designed, and allows modifiers to add systems with due regard to the existing protection and separation requirements.

Specific system identification principles are part of the general identification principles. There are at least four types of EWIS Component Identification, which are performed at different stages. The types of identification are: Component Manufacturer Part Number, Airframer Component Function Identification Number, Airframer Routing Identification and

Modification or Repair-Operators Identification. Methods of identification for each type can be different and are described in paragraphs (a)(i), (ii), (iii) and (e).

(1) Identification Of EWIS Components – Component Manufacturer Marking – Part Number

(i) In order to facilitate

- The identification and traceability of EWIS components
- Verification of compliance with the aircraft certification basis
- Manufacture, maintenance, quality control, storage and delivery
- Verification of the use of approved/qualified sourcing
- The monitoring of the aircraft configuration during the aircraft life

The EWIS components should be identified in accordance with the following:

EWIS components used on aircraft should be identified according to ISO2574 or similar requirements. This identification comprise product part number, manufacturer identification and when possible or specifically required batch identification or year of manufacture.

(ii) EWIS Components concerned by (1) above shall at least include: wires, connectors, terminal blocks, bus bars, circuit breakers, clamps

(iii) For manufacturer identification: it is also common practice to use the five-digit/letter C.A.G.E. code, particularly for wires. Alternatively, for small components, a logo may be used, since their size may be such that it can be difficult to use other forms of clear identification

(iv) Ensure that all wires and cables are identified properly at intervals of not more than 380mm (15 inches).

(v) Types of wire manufacturer markings: the marking must be generally of green color to differ from the OAM black marking, others contrasting colors are also acceptable. The preferred process used are “ink transfer” or “ink jet” process with post curing to increase their resistance to mechanical or chemical aggression. Hot stamp may not be used.

(vi) Means used for identification and legibility during the design life must be covered by the component technical specification.

(2) Identification Of EWIS Components – Airframer Component Function Marking – Function Identification Number

(i) In order to facilitate:

- the identification and inspection of cable runs
- manufacture, maintenance, quality control, storage and delivery

- verification of the system to which the component belongs
- the identification of components related to systems that are required for the safe flight, landing, egress, or have the potential to impact the ability of the flight crew to cope with adverse operating conditions, functions identification should be provided in accordance with the following:

Functions of EWIS components used on aircraft must be identified through adequate means, such as markings, labels, tags, placards, etc...

EWIS Components concerned by such request shall at least include: wires, connectors, terminal blocks, bus bars, circuit breakers, electrical conduits, feed-through, pressure seals, splices

In addition to the type identification imprinted by the original wire manufacturer, aircraft wire also contains its unique circuit identification coding that is put on at the time of harness assembly.

Existing installed wire that needs replacement can thereby be identified as to its performance capabilities, and the inadvertent use of a lower performance and unsuitable replacement wire avoided.

(ii) Ensure that all wires and cables are identified properly at intervals of preferably not more than 460mm (18 inches). Coaxial cables are identified at both equipment ends, at least.

(iii) Types of wire airframer markings: Hot stamp printing is not recommended. Alternative identification methods to mark directly on the wire are: "Laser Printing" preferably, "Dot Matrix" or "Ink Jet Printing" when there is no strong need for chemical or mechanical resistance of the ink. If such methods are not available the use of special sleeves to carry identification marks is possible.

Means used for such identification should be appropriate for the component type. During the design life the marking should be visible and the color should contrast with the wire insulation or sleeve or support material.

All wires, terminal blocks, and individual studs are clearly identified to correspond to aircraft wiring manuals.

(3) Identification Of EWIS Bundles – Airframer Identification – Routing

(i) In order to facilitate:

- the identification and inspection of bundles
- manufacture, maintenance, quality control, storage and delivery
- the determination of the type of route, or route function, (feeder power, radio etc.)

- clear identification of systems that require physical segregation (i.e. to detect the possible mix of different routes/bundles, the misrouting of a system in an area etc)
- the identification of routes taken by systems that are required for safe flight, landing, egress, or have the potential to impact the ability of the flight crew to cope with adverse operating conditions

Identification coding should be available on each bundle with the following:

Routes or bundles identification coding used on aircraft must be identified by adequate means such as labels, tags, placards, colored ties, or bar-codes.

In order to ensure awareness of modification designers and maintenance personnel on the defined physical segregation of the different routes of the aircraft model they are working on, electrical drawings should describe wire routings through the entire airplane (for example: incompatibility between routes, minimum distance between routes, absolute ban of combining bundles) and shall be available in the maintenance documentation.

Means used for such identification should be appropriate for the component type. During the design life the marking should be visible and the color should contrast with the wire insulation or sleeve or support material.

The characteristics of all wire cables in each harness shall not be downgraded by the identification process used.

Ensure that all routes or bundles are identified properly at sufficient intervals for installation and maintenance visibility.

Visible Identification of Critical Design Configuration Limitations.

(ii) Section 25.981(b) states that "...visible means must be placed in areas of the airplane where maintenance, repairs, or alterations may violate the critical design configuration limitations." The design approval holder should define a method of ensuring that this essential information will be communicated by statements in appropriate manuals, such as Wiring Diagram Manuals, and be evident to those that may perform and approve such repairs and alterations.

(iii) An example of a critical design configuration control limitation that would result in a requirement for visible means would be maintaining wire separation between FQIS wiring and other high power electrical circuits where separation of the wiring was determined to be a critical design configuration control limitation. Acceptable means of providing visible means would include color-coding of the wiring or, for retrofit, placement of identification tabs at specific intervals along the wiring.

(b) Reserved

(c) Reserved

(d) Reserved

(e) Identification Of User EWIS Modification Or Repair—Operators Identification - Coding

(1) Preliminaries:

- Operators should repair & STC applicants should design wiring modification with respect to OAM wiring philosophy and instructions or other equivalent standards acceptable to the administrator.
- Modifiers and maintainers of aeronautical products should use practices that reflect the certification criteria applicable to the original airplane manufacturer (OAM). (Ref. ANM-01-04)

(2) In order to facilitate inspection/monitoring/replacement/repair/modification, eventually implementation, and finally approval:

(i) Repair data package should comprise: configuration, material and production process necessary to repair the wiring installation, including parts identification, location, installation and routing as appropriate, and the temporary or permanent nature of the repair, in accordance with OAM's standard practices instructions or equivalent.

(ii) Type design data package should comprise: configuration, material and production process necessary to produce each part in accordance with the certification basis of the product, any specification referenced by the required drawings, drawings that completely define location, installation and routing of all equipment etc.,(Ref. FAA Policy Statement Number ANM-01-04, System Wiring policy for Certification of Part 25 Airplanes).

Modifications and repairs shall be identified in accordance with the approved OAM's identification process standard or recorded according to efficient and acceptable methods.

(3) All EWIS components shall be identified.

(i) When replacing wiring or coaxial cables, identify them adequately at both equipment power source ends at least.

(ii) All wires, terminal blocks, and individual studs are clearly identified to correspond to aircraft wiring manuals.

(iii) Identification should be available all along the wire (preferably at not less than 460mm, 18 inches maximum) at the defined pattern as defined by the OAM. Identification means at each wire extremity is only acceptable when the physical

identification on the wire cable cannot be achieved at [OAM] defined pattern due to e.g. wire length restriction.

(4) Types of wire markings:

(i) The use of Hot Stamp printing of wire in aerospace applications is not recommended. Good Industry practices and Standards such as AS50881 do not support the use of hot stamp printing. Suitable non-impact marking methods are readily available as an alternative. These methods include: laser printing, dot matrix printing, or ink jet printing when there is no strong need for chemical or mechanical resistance of the ink. If such methods are not available the use of sleeves to carry identification marks should be used instead of marking the wire insulation directly. If hot stamp printing of the wire insulation is to be used then the best possible process controls should be employed. Refer to SAE AIR 5575, ARP 5369 and AECMA EN3197.

(ii) Means used for such identification should be appropriate for the component type. As long as it is installed on the aircraft the marking should be visible and the color should contrast with the wire insulation or sleeve or support material, e.g. a temporary repair/identification mean using a non-hydraulic resistant material in an hydraulic bay could remain on the aircraft for some days, knowing that the material is not suitable on the long term.

(iii) The characteristics of all EWIS components shall not be degraded by the identification process used.

(iv) Replace worn stencils and missing placards in the concerned area

25H AC/ACJ1713 Fire Protection: EWIS

The intent of this requirement is to help ensure that the EWIS does not propagate fire and produce hazardous quantities of smoke and toxic fumes

(a) Reserved

NOTE: Fiber Optics are not exempt from fire, smoke, and toxicity requirements.

(b) To protect against propagation of a fire, EWIS components other than wire and cable (which must be tested per part 1, appendix F) should be designed using non-flammable and self-extinguishing materials as tested to the spirit of Part 1, appendix F or equivalent. Maximum physical or spatial separation is especially important above the component, or downstream of any consistent, known airflow. See paragraph 25.1705 for the separation requirements

25HAC/ACJ1719 Circuit Protective Devices

The primary function of mechanical (thermal) circuit breakers, (arc fault circuit breakers are considered to be thermal breakers also), is to protect the wiring of an electrical circuit from the effects of an over current condition. Frequent actuation of this circuit breaker may reduce its reliability to perform the function of protecting the wire.

25HAC/ACJ1720 System Power Removal

Circuit breakers should not be used to perform the function of a switch unless specifically designed and qualified to do so. For systems where it would be desirable to have capability to switch power ON or OFF during normal operation of the aircraft, a switch must be installed to perform that function. Miscellaneous non required systems should have their own means to remove electrical power that does not rely on the circuit breaker to perform this function. It would be acceptable, however, that maintenance, test or checkout procedures performed infrequently on the ground may specify the use of appropriate circuit breakers for the purpose of accomplishing the procedure.

25HAC/ACJ1729 Accessibility Provisions.

EWIS components should be installed such that, as far as practicable, inspections, tests, repair and replacements can be undertaken without undue disturbance to the installation. Consideration, during the design phase, should be given to minimize the amount of aircraft disassembly required to inspect or replace EWIS components.

25HAC/ACJ1733 Cargo or Baggage Compartments.

When EWIS is installed in cargo or baggage compartments there should be protection against its use as a handhold or stepping, damage from cargo, and protection from moisture and spills. If structure does not afford adequate protection, a suitable mechanical guard may be provided.

25HAC/ACJ1735 Flammable Fluid Fire Protection.

See paragraph 25.1705 for the separation requirements between electrical wiring interconnection systems and flammable fluids.

Electrical components located in fuel vapor zones should be qualified as explosion proof in accordance with Section 9 of RTCA/EUROCAE Document DO160/ED-14, "Environmental Conditions and Test Procedures for Airborne Equipment," latest approved revision or other equivalent approved industry standard. The airplane manufacturer defines fuel vapor zones. The possibility of contamination with flammable fluids due to spillage during maintenance action should also be considered.

25HAC/ACJ1743 Fire Detector System – General

The environmental qualification of the system components should be such to ensure that the system will detect the fire during the exposure to the threat by the use of fire resistant EWIS components and/or design.

25HAC/ACJ1745 Power plant and APU Fire Detector Systems – EWIS.

To minimize the occurrences of nuisance fire warnings consideration should be given to separately routing fire detection system wiring within the fire zone to allow more optimum routing and ease of replacement. Particular care should also be exercised with regards to the environmental qualification of the system connectors (e.g. Fire resistant, resistance to moisture and fluids etc.).

Appendix C: Changes to Existing FAR/JAR Part 25 Requirements

Document Summary

This document proposes changes to existing FAR/JAR 25 requirements that are necessary due to the addition of Subpart H. For those requirements that are currently in ARAC, both the new and existing version of the requirement is given.

The requirement is given as it exist today (along with the ARAC proposal if applicable), with the proposed changes immediately following. The proposed changes are given in the legal style used for FAA rulemaking. Note: * * * * * means all that precede or all that follow remain unchanged. * * * means that all that precede or all that follow within that sentence/paragraph remain unchanged.

Revisions

§ 25.611

Existing

§ 25.611 Accessibility provisions.

Means must be provided to allow inspection (including inspection of principal structural elements and control systems), replacement of parts normally requiring replacement, adjustment, and lubrication as necessary for continued airworthiness. The inspection means for each item must be practicable for the inspection interval for the item. Nondestructive inspection aids may be used to inspect structural elements where it is impracticable to provide means for direct visual inspection if it is shown that the inspection is effective and the inspection procedures are specified in the maintenance manual required by §25.1529.

[Amdt. 25-23, 35 FR 5674, Apr. 8, 1970]

Proposed WSHWG Revision

Amend § 25.611 by identifying the first paragraph as (a) and adding new paragraph (b), as follows:

§ 25.611 Accessibility provisions.

(a) * * *

(b) Electrical wiring interconnection systems must meet the accessibility requirements of §25.1729

§ 25.855

Existing

§ 25.855 Cargo or baggage compartments.

For each cargo and baggage compartment not occupied by crew or passengers, the following apply:

- (a) The compartment must meet one of the class requirements of §25.857.
- (b) Class B through Class E cargo or baggage compartments, as defined in §25.857, must have a liner, and the liner must be separate from (but may be attached to) the airplane structure.
- (c) Ceiling and sidewall liner panels of Class C compartments must meet the test requirements of part III of appendix F of this part or other approved equivalent methods.
- (d) All other materials used in the construction of the cargo or baggage compartment must meet the applicable test criteria prescribed in part I of appendix F of this part or other approved equivalent methods.
- (e) No compartment may contain any controls, wiring, lines, equipment, or accessories whose damage or failure would affect safe operation, unless those items are protected so that --
 - (1) They cannot be damaged by the movement of cargo in the compartment, and
 - (2) Their breakage or failure will not create a fire hazard.
- (f) There must be means to prevent cargo or baggage from interfering with the functioning of the fire protective features of the compartment.
- (g) Sources of heat within the compartment must be shielded and insulated to prevent igniting the cargo or baggage.
- (h) Flight tests must be conducted to show compliance with the provisions of §25.857 concerning --
 - (1) Compartment accessibility,
 - (2) The entries of hazardous quantities of smoke or extinguishing agent into compartments occupied by the crew or passengers, and
 - (3) The dissipation of the extinguishing agent in Class C compartments.
- (i) During the above tests, it must be shown that no inadvertent operation of smoke or fire detectors in any compartment would occur as a result of fire contained in any other compartment, either during or after extinguishment, unless the extinguishing system floods each such compartment simultaneously.

Proposed WSHWG Revision

Amend § 25.855 by removing the word “wiring” from paragraph (e) and adding new paragraph (j) as follow:

§ 25.855 Cargo or baggage compartments.

* * * * *

(e) No compartment may contain any controls, lines, equipment, or accessories whose * * *

* * * * *

(j) Cargo or baggage compartment electrical wiring interconnection system components must meet the requirements of § 25.1733.

§ 25.869

Existing

§ 25.869 Fire protection: systems

(a) Electrical system components:

(1) Components of the electrical system must meet the applicable fire and smoke protection requirements of §§25.831(c) and 25.863.

(2) Electrical cables, terminals, and equipment in designated fire zones that are used during emergency procedures must be at least fire resistant.

(3) Main power cables (including generator cables) in the fuselage must be designed to allow a reasonable degree of deformation and stretching without failure and must be --

(i) Isolated from flammable fluid lines; or

(ii) Shrouded by means of electrically insulated, flexible conduit, or equivalent, which is in addition to the normal cable insulation.

(4) Insulation on electrical wire and electrical cable installed in any area of the fuselage must be self-extinguishing when tested in accordance with the applicable portions of part I, appendix F of this part.

(b) Each vacuum air system line and fitting on the discharge side of the pump that might contain flammable vapors or fluids must meet the requirements of §25.1183 if the line or fitting is in a designated fire zone. Other vacuum air systems components in designated fire zones must be at least fire resistant.

(c) Oxygen equipment and lines must --

(1) Not be located in any designated fire zone,

(2) Be protected from heat that may be generated in, or escape from, any designated fire zone, and

(3) Be installed so that escaping oxygen cannot cause ignition of grease, fluid, or vapor accumulations that are present in normal operation or as a result of failure or malfunction of any system.

[Amdt. 25-72, 55 FR 29784, July 20, 1990]

Proposed ESHWG Harmonized Revision

Per Federal Register Docket Number FAA-2001-9637, Notice No. 01-06, dated May 15, 2001 (FR reference 66FR26964), amend 25.869 by revising paragraph (a)(4) as follows:

§ 25.869 Fire protection: systems

(a) * * *

(4) Insulation on electrical wire and electrical cable installed in any area of the airplane must be self-extinguishing when tested in accordance with the applicable portions of part I, appendix F of this part.

* * * * *

Proposed WSHWG Revision

Amend § 25.869 by revising paragraph (a)(2) and (a)(3) and reserving paragraphs (a)(3)(i), (a)(3)(ii) and (a)(4) as follows:

§ 25.869 Fire protection: systems

* * * * *

(a)(2) Equipment in designated fire zones, that are used during emergency procedures, must be at least fire resistant

(a)(3) Electrical Wiring Interconnection System components must meet the requirements of § 25.1713.

(a)(4) [Reserved]

* * * * *

§ 25.1203

Existing

§25.1203 Fire detector system.

(a) There must be approved, quick acting fire or overheat detectors in each designated fire zone, and in the combustion, turbine, and tailpipe sections of turbine engine installations, in numbers and locations ensuring prompt detection of fire in those zones.

(b) Each fire detector system must be constructed and installed so that --

- (1) It will withstand the vibration, inertia, and other loads to which it may be subjected in operation;
 - (2) There is a means to warn the crew in the event that the sensor or associated wiring within a designated fire zone is severed at one point, unless the system continues to function as a satisfactory detection system after the severing; and
 - (3) There is a means to warn the crew in the event of a short circuit in the sensor or associated wiring within a designated fire zone, unless the system continues to function as a satisfactory detection system after the short circuit.
- (c) No fire or overheat detector may be affected by any oil, water, other fluids or fumes that might be present.
- (d) There must be means to allow the crew to check, in flight, the functioning of each fire or overheat detector electric circuit.
- (e) Wiring and other components of each fire or overheat detector system in a fire zone must be at least fire-resistant.
- (f) No fire or overheat detector system component for any fire zone may pass through another fire zone, unless --
- (1) It is protected against the possibility of false warnings resulting from fires in zones through which it passes; or
 - (2) Each zone involved is simultaneously protected by the same detector and extinguishing system.
- (g) Each fire detector system must be constructed so that when it is in the configuration for installation it will not exceed the alarm activation time approved for the detectors using the response time criteria specified in the appropriate Technical Standard Order for the detector.

[Doc. No. 5066, 29 FR 18291, Dec. 24, 1964, as amended by Amdt. 25-23, 35 FR 5678, Apr. 8, 1970; Amdt. 25-26, 36 FR 5493, Mar. 24, 1971]

Proposed WSHWG Revision

Amend § 25.1203 by revising paragraph (e) and adding a new paragraph (h) as follows:

§ 25.1203 Fire detector system.

* * * * *

(e) Components of each fire or overheat detector system in a fire zone must be at least fire-resistant.

* * * * *

(h) Electrical wiring interconnection systems for each fire or overheat detector system in a fire zone must meet the requirements of § 25.1745.

§ 25.1301

Existing

§ 25.1301 Function and installation.
Each item of installed equipment must --

- (a) Be of a kind and design appropriate to its intended function;
- (b) Be labeled as to its identification, function, or operating limitations, or any applicable combination of these factors;
- (c) Be installed according to limitations specified for that equipment; and
- (d) Function properly when installed.

Proposed WSHWG Revision

Amend § 25.1301 by renumbering the existing paragraphs and adding a new paragraph (b) as follows:

§ 25.1301 Function and installation.

(a) Each item of installed equipment must --

- (1) * * *
- (2) * * *
- (3) * * *
- (4) * * *

(b) Electrical Wiring Interconnection Systems must meet the requirements of § 25.1703

§ 25.1309

Existing

§ 25.1309 Equipment, systems, and installations.

(a) The equipment, systems, and installations whose functioning is required by this subchapter, must be designed to ensure that they perform their intended functions under any foreseeable operating condition.

(b) The airplane systems and associated components, considered separately and in relation to other systems, must be designed so that --

- (1) The occurrence of any failure condition which would prevent the continued safe flight and landing of the airplane is extremely improbable, and
- (2) The occurrence of any other failure conditions which would reduce the capability of the airplane or the ability of the crew to cope with adverse operating conditions is improbable.

(c) Warning information must be provided to alert the crew to unsafe system operating conditions, and to enable them to take appropriate corrective action. Systems, controls, and associated monitoring and warning means must be designed to minimize crew errors which could create additional hazards.

(d) Compliance with the requirements of paragraph (b) of this section must be shown by analysis, and where necessary, by appropriate ground, flight, or simulator tests. The analysis must consider:

- (1) Possible modes of failure, including malfunctions and damage from external sources.
- (2) The probability of multiple failures and undetected failures.
- (3) The resulting effects on the airplane and occupants, considering the stage of flight and operating conditions, and
- (4) The crew warning cues, corrective action required, and the capability of detecting faults.

(e) Each installation whose functioning is required by this subchapter, and that requires a power supply, is an "essential load" on the power supply. The power sources and the system must be able to supply the following power loads in probable operating combinations and for probable durations:

- (1) Loads connected to the system with the system functioning normally.
- (2) Essential loads, after failure of any one prime mover, power converter, or energy storage device.
- (3) Essential loads after failure of --
 - (i) Any one engine on two-engine airplanes; and
 - (ii) Any two engines on three-or-more-engine airplanes.
- (4) Essential loads for which an alternate source of power is required by this chapter, after any failure or malfunction in any one power supply system, distribution system, or other utilization system.

(f) In determining compliance with paragraphs (e)(2) and (3) of this section, the power loads may be assumed to be reduced under a monitoring procedure consistent with safety in the kinds of operation authorized. Loads not required in controlled flight need not be considered for the two-engine-inoperative condition on airplanes with three or more engines.

(g) In showing compliance with paragraphs (a) and (b) of this section with regard to the electrical system and equipment design and installation, critical environmental conditions must be considered. For electrical generation, distribution, and utilization equipment required by or used in complying with this chapter, except equipment covered by Technical Standard Orders containing environmental test procedures, the ability to provide continuous, safe service under foreseeable environmental conditions may be shown by environmental tests, design analysis, or reference to previous comparable service experience on other aircraft.

[Amdt. 25-23, 35 FR 5679, Apr. 8, 1970, as amended by Amdt. 25-38, 41 FR 55467, Dec. 20, 1976; Amdt. 25-41, 42 FR 36970, July 18, 1977]

Proposed WSHWG Revision

Amend § 25.1309 by adding a new paragraph (h) as follows:

§ 25.1309 Equipment, systems, and installations.

* * * * *

(h) Electrical wiring interconnection systems must be assessed in accordance with the requirements of § 25.1705.

§ 25.1353

Existing

§ 25.1353 Electrical equipment and installations

(a) Electrical equipment, controls, and wiring must be installed so that operation of any one unit or system of units will not adversely affect the simultaneous operation of any other electrical unit or system essential to the safe operation.

(b) Cables must be grouped, routed, and spaced so that damage to essential circuits will be minimized if there are faults in heavy current-carrying cables.

(c) Storage batteries must be designed and installed as follows:

(1) Safe cell temperatures and pressures must be maintained during any probable charging or discharging condition. No uncontrolled increase in cell temperature may result when the battery is recharged (after previous complete discharge)

(i) At maximum regulated voltage or power;

(ii) During a flight of maximum duration; and

(iii) Under the most adverse cooling condition likely to occur in service.

(2) Compliance with paragraph (c)(1) of this section must be shown by test unless experience with similar batteries and installations has shown that maintaining safe cell temperatures and pressures presents no problem.

(3) No explosive or toxic gases emitted by any battery in normal operation, or as the result of any probable malfunction in the charging system or battery installation, may accumulate in hazardous quantities within the airplane.

(4) No corrosive fluids or gases that may escape from the battery may damage surrounding airplane structures or adjacent essential equipment.

(5) Each nickel cadmium battery installation capable of being used to start an engine or auxiliary

power unit must have provisions to prevent any hazardous effect on structure or essential systems that may be caused by the maximum amount of heat the battery can generate during a short circuit of the battery or its individual cells.

(6) Nickel cadmium battery installations capable of being used to start an engine or auxiliary power unit must have --

- (i) A system to control the charging rate of the battery automatically so as to prevent battery overheating;
- (ii) A battery temperature sensing and over-temperature warning system with a means for disconnecting the battery from its charging source in the event of an over-temperature condition; or
- (iii) A battery failure sensing and warning system with a means for disconnecting the battery from its charging source in the event of battery failure.

[Doc. No. 5066, 29 FR 18291, Dec. 24, 1964, as amended by Amdt. 25-41, 42 FR 36970, July 18, 1977; Amdt. 25-42, 43 FR 2323, Jan. 16, 1978]

Proposed ESHWG Harmonized Revision

Per Federal Register Docket Number FAA-2001-9634, Notice No. 01-04, dated May 17, 2001 (FR reference 66FR27582), amend 25.1353 by revising paragraphs (a), (c)(5), and (c)(6) to read as follows:

-AND-

Per Federal Register Docket Number FAA-2001-9633, Notice No. 01-03, dated May 15, 2001 (FR reference 66FR26942), amend 25.1353 by adding paragraph (d) to read as follows:

§ 25.1353 Electrical equipment and installations

(a) Electrical equipment, controls, and wiring must be installed so that operations of any one unit or system of units will not adversely affect the simultaneous operation of any other electrical unit or system essential to the safe operation. Any electrical interference likely to be present in the airplane must not result in hazardous effect upon the airplane or its systems except under extremely remote conditions.

* * * * *

(c) * * *

(5) Each nickel cadmium battery installation must have provisions to prevent any hazardous effect on structure or essential systems that may be caused by the maximum amount of heat the battery can generate during a short circuit of the battery or its individual cells.

(6) Nickel cadmium battery installations must have --

- (i) A system to control the charging rate of the battery automatically so as to prevent battery overheating; or
- (ii) A battery temperature sensing and over-temperature warning system with a means for disconnecting the battery from its charging source in the event of an over-temperature condition; or
- (iii) A battery failure sensing and warning system with a means for disconnecting the battery from its charging source in the event of battery failure.

- (d) Electrical cables and cable installation must be designed and installed as follows:
- (1) Electrical cables used must be compatible with the circuit protection devices required by § 25.1357 such that a fire or smoke hazard cannot be created under temporary or continuous fault conditions.
 - (2) Means of permanent identification must be provided for electrical cables, connectors and terminals.
 - (3) Electrical cables must be installed such that the risk of mechanical damage and/or damage caused by fluids, vapors, or sources of heat, is minimized.

Proposed WSHWG Revision

Amend § 25.1353 by revising paragraphs (a) and (b) and deleting paragraph (d) as follows:

§ 25.1353 Electrical equipment and installations

- (a) Electrical equipment and controls must be installed so that operation * * *
- (b) Electrical Wiring Interconnection System components must meet the requirements of § 25.1709, § 25.1711, §25.1719, and § 25.1723.

* * * * *

(d) Reserved

§ 25.1357

Existing

§ 25.1357 Circuit protective devices

- (a) Automatic protective devices must be used to minimize distress to the electrical system and hazard to the airplane in the event of wiring faults or serious malfunction of the system or connected equipment.
- (b) The protective and control devices in the generating system must be designed to de-energize and disconnect faulty power sources and power transmission equipment from their associated busses with sufficient rapidity to provide protection from hazardous over-voltage and other malfunctioning.
- (c) Each resettable circuit protective device must be designed so that, when an overload or circuit fault exists, it will open the circuit irrespective of the position of the operating control.
- (d) If the ability to reset a circuit breaker or replace a fuse is essential to safety in flight, that circuit breaker or fuse must be located and identified so that it can be readily reset or replaced in flight.

(e) Each circuit for essential loads must have individual circuit protection. However, individual protection for each circuit in an essential load system (such as each position light circuit in a system) is not required.

(f) If fuses are used, there must be spare fuses for use in flight equal to at least 50 percent of the number of fuses of each rating required for complete circuit protection.

(g) Automatic reset circuit breakers may be used as integral protectors for electrical equipment (such as thermal cut-outs) if there is circuit protection to protect the cable to the equipment.

Proposed ESHWG Harmonized Revision

§ 25.1357 Circuit protective devices

* * * * *

(d) * * * Where fuses are used, there must be spare fuses for use in flight equal to at least 50 percent of the number of fuses of each rating required for complete circuit protection.

* * * * *

(f) [Reserved]

* * * * *

Proposed WSHWG Revision

Amend § 25.1357 by adding the lead-in statement and revising paragraph (d) as follows:

§ 25.1357 Circuit protective devices

The following requirements apply to circuit protective devices other than thermal circuit breakers or fuses. If thermal circuit breakers or fuses are used as circuit protective devices the requirements of § 25.1719 apply.

* * * * *

(d) If the ability to reset a circuit protective device is essential to safety in flight, that circuit protective device must be located and identified so that it can be readily reset in flight.

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* * * * *

Appendix D: WSHWG Disposition of IIR Table 7.5 Recommendations

NOTE: Items 1 – 8 are from IIR Table 7.5. Items 9-27 are additional addressed by Task Group 6 in addition to the IIR items.

Item No.	Situation/Criteria	Remarks	Covered by Existing Rule	Covered by Existing Design/Advisory Circular	Need New Design/Rule	Need Advisory Materials	Other Groups Involved	Recommendations
1	Degraded Repair or Splice (Section 7.5.1)	How many splices should be allowed in a wire?	No	OEM Requirements & AC43.13-1B Section 11-167 exists	No	Yes	Task Group 8	<p>The following information is included in the new AC/ACJ for EWIS</p> <ol style="list-style-type: none"> 1. The environmental splicing is the preferred method for repair and or maintenance. 2. Only environmental splice now available uses heat shrink material that need application of heat but this heat gun should not be used on a fueled aircraft without proper precautions. 3. Maximum number of splices allowed per wire segment is three excluding any production splices. No permanent splice will be allowed on those system wires/ wire gages that are specifically prohibited by OEMs

Item No.	Situation/Criteria	Remarks	Covered by Existing Rule	Covered by Existing Design/Advisory Circular	Need New Design/Rule	Need Advisory Materials	Other Groups Involved	Recommendations
2	Degraded Repair or Splice (Section 7.5.1a)	This section is for "Potential heating condition due to degraded splice"	No	AC43.13-1B Section 11-167 exists	Yes	Yes	Task 8	A new rule is drafted under sub-part 25.1709 to protect EWIS from heat damage. Corresponding Advisory Materials is included in the new wire AC/ACJ for EWIS Task Group 8 has already been informed regarding the recommendation of Task
3 7.5.2. b, c,d,e, f	Heat Damage or Burnt Wire	Relatively common finding by AAIIIG Heat damage may cause wiring failure.	No	OEM Requirements exists AC43.13-1B Section 11-124	Yes	Yes	Task Group 9	A new rule is drafted under sub-part 25.1709 to protect EWIS from heat damage. Corresponding Advisory Materials is included in the new wire AC/ACJ for EWIS

Item No.	Situation/Criteria	Remarks	Covered by Existing Rule	Covered by Existing Design/Advisory Circular	Need New Design/Rule	Need Advisory Materials	Other Groups Involved	Recommendations
4	Vibration Damage/Chafing (Section 7.5.3a) and Vibration Damage/Chafing (Section 7.5.3e)	Relatively common finding by AAIIIG. Special consideration for the High Vibration areas	No	OEM Requirements exists (also covered in SWPM). AC43.13-1B Section 11-96q, 11-97a	Yes	Yes	None	<p>The following statement is currently in FAR 25.1709 "...be designed and installed such that it is adequately separated from the aircraft structure, protected from sharp edges and corners, and to minimize potential for abrasion/chafing, and vibration damage, and other types of mechanical damage."</p> <p>Advisory Materials for this is now included in the new AC/ACJ for EWIS</p>
5	Cracked Insulation (Section 7.5.4d) and Cracked Insulation (Section 7.5.4e)	Relatively common finding by AAIIIG. Under certain conditions may cause multiple system failure.	No	There are some wire damage information on OEM manuals	Yes	Yes	Group 9	<p>This item is covered under 25.1703 as follows "...EWIS components located in areas of known moisture accumulation shall be adequately protected to minimize any hazardous affect due to the moisture. ..."</p> <p>Corresponding material is included in the new AC/ACJ for EWIS</p>

Item No.	Situation/Criteria	Remarks	Covered by Existing Rule	Covered by Existing Design/Advisory Circular	Need New Design/Rule	Need Advisory Materials	Other Groups Involved	Recommendations
6	Delamination (Section 7.5.5)	AAIIG finding was relatively infrequent	No	No	No	Yes	Group 9	<p>The following statement is added to the new EWIS AC/ACJ “The battery installation must provide protection for EWIS components from corrosive effects of Battery fluid.”</p> <p>In addition, revise FAR/JAR 25.1353(c)(4) to include EWIS as part of the section as follows “...No corrosive fluid or adjacent essential equipment including EWIS components.</p>
7	Arcing (Section 7.5.6c) Arcing (Section 7.5.6d) and Arcing (Section 7.5.6e)	AAIIG finding was relatively infrequent. Possibly beyond the scope of the Task Group 6	No	Some OEM Requirements exists related to arc tracking properties of wire insulation	Yes	Yes	Task Groups 8 and Task Group 9. R&D work is being done on Arc Fault Circuit breakers by FAA Tech Center and OEMs	<p>The following is now covered in the new sub-part 25.1703 “Ensure the selection of wires accountincluding any arc tracking phenomena”</p> <p>Appropriate information is included in the new AC/ACJ for EWIS</p>

Item No.	Situation/Criteria	Remarks	Covered by Existing Rule	Covered by Existing Design/Advisory Circular	Need New Design/Rule	Need Advisory Materials	Other Groups Involved	Recommendations
8	Current Rating	Wire property. Covered in wire specification (s)	No	AC 43.13-1B Section 5 and OEM specifications	No	Yes	No	Appropriate information for wire current rating is now included in the new AC/ACJ for EWIS.
9	Robustness	Much of this is covered by insulation type and installation practices	No	No	Yes	Yes	Task Group 8	Information such as damage resistance & wire-to-wire abrasion is now covered by the proposed 25.1703 & 25.1709
10	Circuit Protection		FAR/JAR 25.1357	Yes	Yes	Yes	R&D work is being done on Arc Fault Circuit breakers by FAA Tech	FAR/JAR 25.1357 information is moved to the new subpart H. 25.1719. Appropriate compliance method(s) is included in the new AC/ACJ for EWIS.

Item No.	Situation/Criteria	Remarks	Covered by Existing Rule	Covered by Existing Design/Advisory Circular	Need New Design/Rule	Need Advisory Materials	Other Groups Involved	Recommendations
11	Fire Protection/Self Extinguishing Insulation	Wire property. Covered in wire specification(s)	FAR/JAR 25.869(a)(4)	OEM specifications	No	No	FAA Tech Center	A recommendation to ATSRAC is included in our final report indicating that Appendix F and 25.869(a)(4) should be revised to reflect present industry standards.
12	Fire Resistance (fire zones)	Wire property. Covered in wire specification(s)	FAR/JAR 25.869(a)(2)	OEM specifications	Yes	Yes		Information regarding Fire Resistance as defined in 25.869(a)(2) is now included in new subpart H 25.1713. Appropriate information is included in the new AC/ACJ for EWIS.
13	Identification	Wire vendor identification is provided.	FAR/JAR 25.1301	Mostly covered by OEMs and in the SWPM. AC 43.13-1B Section 16 Cautionary Note: Some Identification methods may damage the wire insulation	Yes	Yes	No	Identification requirements developed by the group is now defined in the FAR/JAR new Sub part H Section 25.1711 In addition, advisory materials are included in the AC/ACJ for EWIS.

Item No.	Situation/Criteria	Remarks	Covered by Existing Rule	Covered by Existing Design/Advisory Circular	Need New Design/Rule	Need Advisory Materials	Other Groups Involved	Recommendations
14	Accessibility	Wiring need to be accessible for easy inspection	No	No	Yes	Yes	None	Wire accessibility requirement is covered under the new proposed FAR/JAR 25.1729. New AC/ACJ material for this item is included in the new AC/ACJ for EWIS
15	Risk of Damage	Protection from damage due to failure of other devices (e.g. Control Cables) or by Maintenance / Repair personnel	FAR/JAR 25.1353	AC 43.13-1B 11-123, 11-124, 11-125 and OEM installation design requirements	Yes	Yes	None	Risk of damage is covered in the rule FAR/JAR 25.1709. Advisory materials is included in the new wiring AC/ACJ for EWIS

Item No.	Situation/Criteria	Remarks	Covered by Existing Rule	Covered by Existing Design/Advisory Circular	Need New Design/Rule	Need Advisory Materials	Other Groups Involved	Recommendations
16	Cable Temperature	Wire property. Covered in wire specification (s) – OEMs and Industry	FAR/JAR 25.1301	Indirectly covered in AC43.13-1B Section 5	No	Yes	None	Information regarding wire temperature rating and criteria to be used for selection of the correctly rated wire (150c etc.) is included in the new AC/ACJ for EWIS
17	Installation & Termination	Mostly process related and covered by OEMs in their process and SPWM manuals	No	OEM Specification Requirements and AC 43.13-1B Section 8 and other sections	No	Yes	Task Group 8	The intent of this item is covered in the new FAR/JAR 25.1703 New advisory material is included in the AC/ACJ for EWIS. The advisory material is based on the FAA wire policy that was released earlier this year.
18	Segregation	This issue is being worked and addressed by various working groups	FAR/JAR 25.1353, 25.1309, 25.1333(a)(c) 25.1431(C) &	OEM Specification Requirements and AC 43.13-1B Sections 8, 10 and 11	Yes	Yes	Task Group 8	Wire separation requirements are covered in detail in the new FAR/JAR 25.1709 Compliance and guidance material is included in the new AC/ACJ for EWIS.

Item No.	Situation/Criteria	Remarks	Covered by Existing Rule	Covered by Existing Design/Advisory Circular	Need New Design/Rule	Need Advisory Materials	Other Groups Involved	Recommendations
19	Voltage Rating	Wire property. Covered in wire specification (s)	No	Indirectly covered in AC 43.13-1B sections 5, 6 and 7	No	Yes	None	Information regarding wire voltage rating and criteria to be used for selection of the correct voltage rating for the application (600V AC etc.) is included in the new AC/ACJ for EWIS
20	Smoke	Wire property. Covered in some of the OEM's wire specifications	Indirectly covered by FAR/JAR 25.831	Some OEM specifications	Yes	Yes	None	<p>The following requirement with respect to wire and cable only (not the other EWIS components) is included in the new FAR/JAR subpart 25H 25.1713</p> <p>“EWIS components must meet the applicable fire and smoke protection requirements of 25.831(c) and 25.1735. EWIS components must be constructed and installed so that in the event of failure, no hazardous quantities of smoke, toxic, or noxious products will be distributed in the crew and passenger compartment”*</p> <p>Advisory material for this item is included in the new AC/ACJ for EWIS.</p> <p>*Deleted at the direction of the ATSRAC committee – the WSHWG members do not support this deletion. See recommendation F3 in Appendix F of this report.</p>

Item No.	Situation/Criteria	Remarks	Covered by Existing Rule	Covered by Existing Design/Advisory Circular	Need New Design/Rule	Need Advisory Materials	Other Groups Involved	Recommendations
21	Toxicity By-Products	Wire property. Covered in wire specification (s)	No	Some OEM specifications	Yes	Yes	None	Information is included in the new FAR/JAR sub-part H. Please See recommendation in item 20 above.
22	Arc Tracking	Wire property. Covered in some of the wire specification (s)	No	Some OEM specifications	Yes	Yes	FAA Tech Center and OEMs	Information is included in the new FAR/JAR sub-part H. Please See recommendation in item 7 above. Appropriate information is included in the new AC/ACJ for EWIS

Item No.	Situation/Criteria	Remarks	Covered by Existing Rule	Covered by Existing Design/Advisory Circular	Need New Design/Rule	Need Advisory Materials	Other Groups Involved	Recommendations
23	CB Reset	Part of Aircraft Flight Manuals	FAR/JAR 25.1357 and possibly FAR 121	OEM/ ALPA requirements and Partially covered in AC 43.13-1B Section 4	No	Yes	Task Group 8	<p>This is an operational issue. FSDO has release a bulletin on circuit breaker resetting. (Reference: Flight Standards Bulletin: FSAW 00-08A, FSAT 00-07A, and FSGA 00-04A (Amended))</p> <p>This bulletin has expired, so the WSHWG included a recommendation in this report that the bulletin be renewed (Ref Appendix F, F7).</p>
24	Modification and Repair	By airlines, repair stations, alteration stations and STC	In general needs to comply with FAR and JAR requirements	OEM Standard Wiring Practices Manuals and AC25-16, AC 43-13	No	Yes	Task Groups 8	<p>All new FAR/JARs developed by Task group 6 are equally applicable to modifications. Appropriate information is included in new AC/ACJ for EWIS.</p>

Item No.	Situation/Criteria	Remarks	Covered by Existing Rule	Covered by Existing Design/Advisory Circular	Need New Design/Rule	Need Advisory Materials	Other Groups Involved	Recommendations
25	Cable to Cable Abrasion	Wire Insulation property	No	OEM wire specifications	No	Yes	Task Groups 8 and Task Group 9	The proposed FAR/JAR Sub-part 25.1703 covers the intent of this item Compliance method(s) are included in the new AC/ACJ for EWIS.
26	“Red Plague” Corrosion	Specific to a particular wire conductor and insulation	No	No	Yes	Yes		The new FAR/JAR, 25.1703 includes the following requirement “EWIS components located in areas of known moisture accumulation must be adequately protected to minimize any hazardous affect due to moisture” Compliance methods are included in the new wire AC/ACJ for EWIS.
27	Glycol Fires	Specific to a particular wire conductor and insulation	No	No	No	Yes		The new wire AC/ACJ for EWIS includes words that address the potential for combustion when glycol/water combinations come into contact with sliver plated wires.

Appendix E: Electrical Systems Harmonization Working Group Rules Status

Requirement	Title	Status	Change Necessary due to WSHWG?	Next Action
§ 25.581	Lightning Protection	NPRM Review by ESHWG, comments provided	No	Incorporate comments and prepare NRPM for publication
§ 25.869(a)(4)	Fire protection: systems	NPRM issued – comments received	Yes	Revise rule and issue new NPRM to add reference to 25.1713
§ 25.899	Electrical Bonding and Protection Against Lightning and Static Electricity	NPR NMM accepted by HWG - minor comments (Document ESH-95)	No Yes	Finalize NPRM for Federal Register publication Montreal Note: AC material for 25.1717 advisory material that the WSHWG/ESHWG has developed but agreed that it should go into the proposed AC25.899
§ 25.1310	Power Supply – Essential Load	RPR to Inter-directorate and JAA coordination – comments received Montreal NOTE: ESHWG has not seen RPR for this proposal.	No	Need to dispose of ACO comments and verify that ESHWG has provided comments on the RPR Next action is to send RPR to ESHWG for comment
§ 25.1351(b)	Electrical Generating System	NPRM in drafting Montreal Note: Not been reviewed by ESHWG	No	Next action is to prepare NPRM draft and send to ESHWG for review
§ 25.1351(c)	External Power	NPRM accepted by HWG - minor comments (Document ESH-95)	No	Finalize NPRM for Federal Register publication

Requirement	Title	Status	Change Necessary due to WSHWG?	Next Action
§ 25.1351(d)	Operation Without Normal Electrical Power	RPR dispose of comments from ACOs	No	Dispose of ACO comments and draft NPRM Next action: dispose of ACO comments and send RPR to ESHWG for review.
§ 25.1353(a),(c)(5), (c)(6)	Electrical Equipment Installation and Battery Installation	NPRM issued – comments received	Yes	Revise proposed rule to remove from paragraph (a) the mention of wire, delete paragraph (b) add a reference to Subpart H: 25.1709 Note: (b) is not part of ESHWG Terms of Reference
§ 25.1353(d)	Electrical Cables	NPRM issued– comment received	Yes	Withdraw proposed rule. Requirements are in Subpart H:25.1709, 25.1711, and 25.1723(a) Note: Need to consider ESHWG comments on (d) to determine relevance to the Subpart H rule(s)
25.1353(e)	Electrical Bonding	NPRM reviewed by ESHWG – comments provided	Yes	Note: this is part of the 25.899 rule package. [Take 25X899(d) and make a new 25.1353(e)] May need to add a reference to Subpart H stating that if wire is used for bonding it must meet the requirements of 25.1717
§ 25.1355(c)	Distribution System	NPRM accepted by HWG - minor comments (Document ESH-95) ESHWG wants new AC to reflect current ACJ	No	Finalize NPRM for Federal Register publication
§ 25.1360	Electrical Shock and Burn Protection	NPRM accepted by HWG - minor comments (Document ESH-95) ESHWG wants new AC to reflect current ACJ	No	Finalize NPRM for Federal Register publication

Requirement	Title	Status	Change Necessary due to WSHWG?	Next Action
§ 25.1362	Electrical Supply for Emergency Services	NPRM in drafting – dispose of ACO comments	No	Prepare NPRM for review by ESHWG
§25.1357	Circuit Protective Devices	NPRM is being drafting	Yes	Need to include in the proposed revision a reference to Subpart H: 25.1719
§ 25.1363	Electrical System Tests	NPRM in drafting	No	Finalize NPRM for ESHWG review and publication
§ 25.1365	Electrical Appliances (Domestic)	NRPM in drafting	No	Finalize NPRM for ESHWG review and publication
§ 25.1431(d)	Electronic Equipment	NPRM issued, comment received (ESH-91)	No	Prepare final rule

Appendix F: Other Recommendations Outside WSHWG Tasking

ATSRAC Task Group 6 make the following additional recommendations:

(F1) Update the definition for “Electrical Wiring Interconnection Systems” in the EZAP AC (ASTRAC Task Group 9) to be the same as the proposed § 25.1701 *Electrical Wiring Interconnection Systems Definition*.

(F2) Revise the proposed Training AC from ATSRAC Task Group 8 to include the term “Electrical Wiring Interconnection Systems” in place of “Wiring Systems” and update the definition for “Electrical Wiring Interconnection Systems” in the AC to be the same as the proposed § 25.1701 *Electrical Wiring Interconnection Systems Definition*.

(F3) ATSRAC should recommend to the FAA that:

- a. Standards be developed to define what constitutes “hazardous quantities of smoke, toxic, or noxious products” produced by burning EWIS components.
- b. Test methods and equipment be developed in order that hazardous quantities of smoke, toxic, or noxious products from burning EWIS components can be measured.

(F4) ATSRAC should recommend to the FAA that 14 CFR Part 25, Appendix F, Part (1)(a)(3), and § 25.869 (a)(4) should be revised to reflect present industry standards.

(F5) The WSHWG recommends the following revisions to the EZAP AC produced by ATSRAC Task Group 9:

Section (9)(b)(1) *Guidance for Zonal Inspections*

Revise: Wire bundle/wire bundle or wire bundle/structure contact/chafing

To: Wire bundle/wire bundle or wire bundle/structure contact/chafing and still protected from sharp edges and corners and other item that may cause physical damage"

This compliments 25HAC/ACJ1703 paragraph (a) (2)vi (refer to Appendix B of this report).

Revise: Inappropriate attachments to or separation from fluid lines.

To: Inappropriate attachments to or separation from fluid lines, separation from fluid lines, moveable flight controls, and high temperature equipment"

This compliments 25HAC/ACJ1709 (refer to Appendix B of this report).

Add: "Wire bundle not under undue tension or reduced length (incorrect bending radius, missing drip loop)"

This compliments 25HAC/ACJ1703 paragraph (2)(i) and (2)(iii) (refer to Appendix B of this report).

Section (9)(c)(1) *Wiring Installations – Terminations*

Task Group 6 agrees with this paragraph and recommends that OAM's provide for some type of visual means to verify the correct attachment torque for heavy current carrying cable terminations (e.g., red mark between screw head and a fixed point).

(F6) The WSHWG recognizes that safety assessments are complex in nature and that applicants and regulatory personnel may lack the required knowledge to perform adequate assessments. This is especially true for applicants whose resources do not allow them to have dedicated safety assessment specialists on their staff. Fair and consistent application of acceptable means of compliance is an issue with industry. Both regulatory aircraft certification engineers and field personnel need to have the required knowledge to ensure fair and standardized application of safety assessment requirements. Therefore, the WSHWG recommends that training be developed and made available to regulatory and industry personnel in the § 25.1705 safety assessment processes in addition to existing § 25.1309 training.

(F7) The WSHWG Recommends that the Flight Standards Bulletins (FSAW 00-08A, FSAT 00-07A and FSGA 00-04A) be renewed.

Appendix G: Better Plan For Harmonisation - "Category 1" Items Jar D&F Sg Items - Electrical Systems; npa 25df-317 Draft 3 Dated 30/10/01

I. INTRODUCTION :

- The "Better Plan for Harmonisation", agreed between JAA and FAA at the Annual Meeting in June 1999, identifies some requirements, known as "Category 1", where the intention is that the final harmonised standard should reflect the more severe position of the JAR-25 and FAR 25 requirements. The rationale for this approach is that, as industry is generally already designing to the more severe standard to ease certification to both JAR-25 and FAR 25, the overall cost of certification should be reduced without compromising safety. The harmonisation process for "Category 1" also requires that the advisory material associated with the more severe standard is adopted for both codes.
- This NPA is sponsored by the JAR D&F SG. It provides both the requirement and advisory material changes for JAR-25 paragraphs addressing electrical systems issues. These proposals are based on reports prepared by the Electrical Systems Harmonisation Working Group. Inputs from the Electromagnetic Effects Harmonisation Working Group for JAR 25.581 and JAR 25.899 have also been taken into account.
- The standards of requirements used for this harmonisation are JAR-25 Change 15 and FAR 25 Amendment 98. The proposals in the attached draft NPA take account of the standard JAR-25 editorial differences and differing applicability (large aeroplanes, turbine engines, etc.).
- From an editorial point of view, it must also be noted that the proposals and final text are based on the assumption that the FAR 25 equivalent text will be modified as well, as a result of the harmonisation effort (i.e., underlining, suppression of X for JAR 25X... requirements). This may need to be revisited at the time of final publication, if JAR/FAR 25 texts are not published concurrently.

II. PARAGRAPHS REVIEWED :

JAR 25.581 and ACJ 25.581
JAR 25X799 and ACJ 25X799
JAR 25.869(a) and ACJ 25.869(a)
JAR 25X899 and ACJ 25X899
lightning and static electricity

Lightning protection
Water systems
Fire protection electrical systems
Electrical bonding and protection against

AMJ 25.1309(b)	Equipment, systems and installations
JAR 25.1310 and ACJs 25.1310(a) & (a)(3)	Power source capacity and distribution
JAR 25.1351(b)(5), (c) & (d) and ACJs	Electrical systems - General
JAR 25.1353 and ACJs	Electrical equipment and installations
JAR 25.1355(c) and ACJ 25.1355(c)	Distribution system
JAR 25.1357 and ACJ 25.1357(a)	Circuit protective devices
JAR 25X1360 and ACJs	Precautions against injury
JAR 25X1362 and ACJ 25X1362	Electrical supplies for emergency conditions
JAR 25.1363 and ACJ 25.1363	Electrical system tests
JAR 25.1431(d)	Electronic equipment
JAR 25X1499 and ACJs 25X1499(a) & (b)	Domestic services and appliances

III. PARAGRAPHS AFFECTED :

JAR 25.581(a) and ACJ 25.581	Lightning protection
JAR 25X799 and ACJ 25X799	Water systems
ACJ 25.603	Composite aircraft structure
JAR 25.869(a) and ACJ 25.869(a)	Fire protection electrical systems
JAR 25X899 and ACJ 25X899	Electrical bonding and protection against
lightning and static electricity	
JAR 25.954	Fuel system lightning protection
AMJ 25.1309(b)	Equipment, systems and installations
JAR 25.1310 and ACJ 25.1310(a)(3)	Power source capacity and distribution
JAR 25.1351(c)	Electrical systems - General
JAR 25.1353	Electrical equipment and installations
JAR 25.1355(c)	Distribution system
JAR 25X1360 and ACJs	Precautions against injury
JAR 25X1362 and ACJ 25X1362	Electrical supplies for emergency conditions
JAR 25.1363	Electrical system tests
JAR 25.1365 (new)	Electrical appliances and motors
JAR 25.1431(d)	Electronic equipment
JAR 25X1499 and ACJs 25X1499(a) & (b)	Domestic services and appliances

IV. PROPOSED NEW REQUIREMENTS AND ADVISORY MATERIAL

JAR-25 SECTION 1 SUBPART D

I. Delete existing JAR 25X799.

2. *Modify JAR 25.869(a)(4) (suppression of underlining for aeroplane) to read :*

JAR 25.869 Fire protection: systems

(a) Electrical system components:

(4) Insulation on electrical wire and electrical cable installed in any area of the aeroplane must be self-extinguishing when tested in accordance with the applicable portions of Part I, Appendix F.

3. *Revise JAR 25X899 to read :*

JAR 25.899 Electrical bonding and protection against static electricity
(See ACJ 25.899)

(a) Electrical bonding and protection against static electricity must be designed to minimise accumulation of electrostatic charge, which would cause:

- (1) Human injury from electrical shock,
- (2) Ignition of flammable vapours, or
- (3) Interference with installed electrical/electronic equipment.

(b) Compliance with sub-paragraph (a) of this paragraph may be shown by

- (1) Bonding the components properly to the airframe or
- (2) Incorporating other acceptable means to dissipate the static charge so as not to endanger the aeroplane, personnel or operation of the installed electrical/electronic systems.

4. *In JAR 25.581(a), change reference to JAR 25X899 by reference to JAR 25.899.*

5. *In JAR 25.954, change reference to ACJ 25X899 by reference to ACJ 25.899.*

JAR-25 SECTION 1 SUBPART F

6. *Modify JAR 25.1310 coming from NPA 25F-281 to read :*

JAR 25.1310 Power source capacity and distribution

(a) Each installation whose functioning is required for type certification or by operating rules and that requires a power supply is an "essential load" on the power supply. The power sources and the system must be able to supply the following power loads in probable operating combinations and for probable durations (see ACJ 25.1310(a)):

- (1) Loads connected to the system with the system functioning normally.
 - (2) Essential loads, after failure of any one prime mover, power converter, or energy storage device.
 - (3) Essential loads after failure of -
 - (i) Any one engine on two-engined aeroplanes; and
 - (ii) Any two engines on three-or-more engined aeroplanes.
 - (4) Essential loads for which an alternate source of power is required, after any failure or malfunction in any one power supply system, distribution system, or other utilisation system.
- (b) In determining compliance with sub-paragraphs (a)(2) and (3) of this paragraph, the power loads may be assumed to be reduced under a monitoring procedure consistent with safety in the kinds of operation authorised. Loads not required in controlled flight need not be considered for the two-engine-inoperative condition on aeroplanes with three or more engines.

7. *Modify JAR 25.1351(b)(5) (suppression of underlining) to read :*

JAR 25.1351 General

(b)(5) There are means accessible where necessary, in flight, to appropriate crew members for the individual and rapid disconnection of each electrical power source (see ACJ 25.1351(b)(5)); and
.....

8. *Modify JAR 25.1351(c) to read :*

JAR 25.1351 General

(c) *External power.* If provisions are made for connecting external power to the aeroplane, and that external power can be electrically connected to equipment other than that used for engine starting, means must be provided to ensure that no external power supply having a reverse polarity, a reverse phase sequence (including crossed phase and neutral), open circuit line, incorrect frequency or voltage, can supply power to the aeroplane's electrical system.

9. *Modify JAR 25.1351(d) (suppression of underlining) to read :*

JAR 25.1351 General

(d) *Operation without normal electrical power.*

(See ACJ 25.1351(d).) The following apply:

- (1) Unless it can be shown that the loss of the normal electrical power generating system(s) is Extremely Improbable, alternate high integrity electrical power system(s), independent of the normal electrical power generating system(s), must be provided to power those services necessary to complete a flight and make a safe landing.
- (2) The services to be powered must include --
 - (i) Those required for immediate safety and which must continue to operate following the loss of the normal electrical power generating system(s), without the need for flight crew action;
 - (ii) Those required for continued controlled flight; and
 - (iii) Those required for descent, approach and landing.
- (3) Failures, including junction box, control panel or wire bundle fires, which would result in the loss of the normal and alternate systems must be shown to be Extremely Improbable.

10. Modify JAR 25.1353(a) (suppression of underlining) to read :

JAR 25.1353 Electrical equipment and installations

(a) Electrical equipment, controls, and wiring must be installed so that operation of any one unit or system of units will not adversely affect the simultaneous operation of any other electrical unit or system essential to the safe operation. Any electrical interference likely to be present in the aeroplane must not result in hazardous effects upon the aeroplane or its systems except under extremely remote conditions. (See ACJ 25.1353 (a).)

11. Modify JAR 25.1353(c)(5) & (c)(6) to read :

JAR 25.1353 Electrical equipment and installations

(c)(5) Each nickel cadmium battery installation must have provisions to prevent any hazardous effect on structure or essential systems that may be caused by the maximum amount of heat the battery can generate during a short circuit of the battery or of individual cells.

(c)(6) Nickel cadmium battery installations must have --

- (i) A system to control the charging rate of the battery automatically so as to prevent battery overheating; or
- (ii) A battery temperature sensing and over-temperature warning system with a means for disconnecting the battery from its charging source in the event of an over-temperature condition;
or
- (iii) A battery failure sensing and warning system with a means for disconnecting the battery from its charging source in the event of battery failure. (See ACJ 25.1353 (c)(6)(ii) and (iii).)

12. Modify JAR 25.1353(d) (suppression of underlining) to read :

JAR 25.1353 Electrical equipment and installations

(d) Electrical cables and cable installations must be designed and installed as follows:

- (1) The electrical cables used must be compatible with the circuit protection devices required by JAR 25.1357, such that a fire or smoke hazard cannot be created under temporary or continuous fault conditions.
- (2) Means of permanent identification must be provided for electrical cables, connectors and terminals.
- (3) Electrical cables must be installed such that the risk of mechanical damage and/or damage caused by fluids, vapours or sources of heat, is minimised.

13. Revise JAR 25.1353 by adding a new sub-paragraph (e) to read :

JAR 25.1353 Electrical equipment and installations

(e) Electrical bonding must provide an adequate electrical return path under both normal and fault conditions, on aeroplanes having earthed electrical systems (see JAR 25.899).

14. Modify JAR 25.1355(c) to read :

JAR 25.1355 Distribution system

(c) If two independent sources of electrical power for particular equipment or systems are required for certification or by operating rules, in the event of the failure of one power source for such equipment or system, another power source (including its separate feeder) must be automatically provided or be manually selectable to maintain equipment or system operation. (See ACJ 25.1355(c) and ACJ 25.1310(a).)

Note : Reference to ACJ No. 6 to JAR 25.1309 changed to ACJ 25.1310(a) assuming NPA 25F-281 final text is published before this NPA.

15. Modify JAR 25.1357(d) (suppression of underlining) to read :

JAR 25.1357 Circuit protective devices

(d) If the ability to reset a circuit breaker or replace a fuse is essential to safety in flight, that circuit breaker or fuse must be located and identified so that it can be readily reset or replaced in flight. Where fuses are used, there must be spare fuses for use in-flight equal to at least 50% of the number of fuses of each rating required for complete circuit protection.

16. Modify JAR 25X1360 (change JAR/ACJ 25X1360 to 25.1360, suppression of underlining, add reference to JAR 25.899) to read :

JAR 25.1360 Precautions against injury

(a) *Shock.* The electrical system must be designed so as to minimise the risk of electric shock to crew, passengers and servicing personnel and also to maintenance personnel using normal precautions. (See ACJ 25.1360(a) and JAR 25.899.)

(b) *Burns.* The temperature of any part, which has to be handled during normal operation by the flight crew, must not be such as to cause dangerous inadvertent movement, or injury to the crew member. (See ACJ 25.1360(b).)

17. Modify JAR 25X1362 to read :

JAR 25.1362 Electrical supplies for emergency conditions

(See ACJ 25.1362)

A suitable supply must be provided to those services which are required, in order that emergency procedures may be carried out, after an emergency landing or ditching. The circuits for these services must be so designed, protected and installed such that the risk of their causing a fire, under these conditions, is minimised.

18. Modify JAR 25.1363 (change JAR/ACJ 25X1363 to 25.1363, suppression of underlining) to read :

JAR 25.1363 Electrical system tests

(See ACJ 25.1363)

(a) Tests must be made to determine that the performance of the electrical supply systems meets the requirements of this JAR-25 under all the appropriate normal and failure conditions. When laboratory tests of the electrical system are conducted –

(1) The tests must be performed on a mock-up using the same generating equipment used in the aeroplane;

(2) The equipment must simulate the electrical characteristics of the distribution wiring and connected loads to the extent necessary for valid test results; and

(3) Laboratory generator drives must simulate the actual prime movers on the aeroplane with respect to their reaction to generator loading, including loading due to faults.

(b) For each flight condition that cannot be simulated adequately in the laboratory or by ground tests on the aeroplane, flight tests must be made.

19. Add a new JAR 25.1365 to read :

JAR 25.1365 Electrical appliances, motors and transformers

(See ACJ 25.1365)

(a) Domestic appliances must be so designed and installed that in the event of failures of the electrical supply or control system, the requirements of JAR 25.1309(b), (c) and (d) will be satisfied.

(b) The installation of galleys and cooking appliances must be such as to minimise the risk of overheat or fire.

(c) Domestic appliances, particularly those in galley areas, must be so installed or protected as to prevent damage or contamination of other equipment or systems from fluids or vapours which may be present during normal operation or as a result of spillage, where such damage or contamination may hazard the aeroplane.

(d) Unless it can be shown that compliance with JAR 25.1309(b) is provided by the circuit protective device required by JAR 25.1357(a), electric motors and transformers etc. (including those installed in domestic systems, such as galleys and toilet flush systems) must be provided with a suitable thermal protection device if necessary to prevent them overheating such as to create a smoke or fire hazard under normal operation and failure conditions.

20. Modify JAR 25.1431(d) (suppression of underlining) to read :

JAR 25.1431 Electronic equipment

(d) Electronic equipment must be designed and installed such that it does not cause essential loads to become inoperative, as a result of electrical power supply transients or transients from other causes.

21. Delete existing JAR 25X1499.

**JAR-25 SECTION 2
ACJ - SUBPART C**

22. Modify ACJ 25.581 sub-paragraph 2.1a. to read :

ACJ 25.581
Lightning Protection (Acceptable Means of Compliance and Interpretative Material)
See JAR 25.581

2.1 External non-metallic parts should be so designed and installed that --

a. They are provided with effective lightning diverters which will safely carry the lightning discharges described in EUROCAE document ED-84 (including Amendment N°1 dated 06/09/99) titled : Aircraft Lightning Environment and Related Test Waveforms, or equivalent SAE ARP5412 document.

23. In ACJ 25.603, change reference to JAR 25.899 and ACJ 25X899 by reference to JAR 25.899 and ACJ 25.899, so that TABLE 1 - 8.3 reads :

ACJ 25.603
Composite Aircraft Structure (Acceptable Means Of Compliance)
See JAR 25.603

TABLE 1

ACJ paragraphs	JAR-25 paragraphs
..... 8.3 Lightning Protection 25.581 (see ACJ 25.899 Paragraph 6) 25.609 25.899 (see ACJ 25.899 Paragraph 6) 25.954 (see ACJ 25.899 Paragraph 6)

JAR-25 SECTION 2
ACJ - SUBPART D

24. Delete existing ACJ 25X799.

25. Modify ACJ 25.869(a) title and paragraph 3 to read :

ACJ 25.869(a)(1)
Electrical System Fire and Smoke Protection (Interpretative Material and Acceptable Means of Compliance)
See JAR 25.869(a)(1)

3 Electrical equipment, which may come into contact with flammable vapours should be so designed and installed as to minimise the risk of the vapours exploding under both normal and

fault conditions. This can be satisfied by meeting the Explosion Proofness Standards of RTCA DO-160/EUROCAE ED-14.

26. Modify ACJ 25X899 title and paragraphs 1, 2, 3 and 4 to read :

ACJ 25.899
Electrical Bonding and Protection Against Static Electricity
See JAR 25.899

Replace whole paragraph 1 by the following :

1 *Protection against Lightning Discharges.*

Refer to JAR 25.581; 25.954; 25.1316 and associated Advisory Material.

Replace whole paragraph 2 by the following :

2 *Characteristics of Lightning Discharges.*

Refer to EUROCAE document ED-84 (including Amendment N°1 dated 06/09/99) titled : Aircraft Lightning Environment and Related Test Waveforms; or equivalent SAE ARP5412 document.

Paragraph 3 unchanged apart from revised sub-paragraph 3.3.1 to read :

3 *Protection against the Accumulation of Static Charges.*

3.3.1 With standard refuelling equipment and standard aircraft turbine fuels, voltages high enough to cause sparking may be induced between the surface of the fuel and the metal parts of the tank at refuelling flow velocities above approximately 7 meters/second (23 feet/second). These induced voltages may be increased by the presence of additives and contaminants (e.g. anti-corrosion inhibitors, lubricating oil, free water), and by splashing or spraying of the fuel in the tank.

Modify introduction of paragraph 4 as follows :

4 *Primary and Secondary Bonding Paths.*
(Reference : JAR 25.581; 25.899, 25.954; 25.1316; 25.1353; 25.1360.)

.....
(*Rest of sub-paragraph 4 unchanged*)

5 *Resistance and Continuity Measurement.*
(*unchanged*)

6 *Electrical Properties of Composite Structure.*
(unchanged)

JAR-25 SECTION 2
ACJ - SUBPART F

27. Delete ACJ 25.1310(a)(3) coming from NPA 25F-281 (was ACJ N° 7 to JAR 25.1309).

28. Rename ACJ 25X1360(a) and ACJ 25X1360(b) respectively as ACJ 25.1360(a) and ACJ 25.1360(b). Make also reference to JAR 25.1360(a) and JAR 25.1360(b) instead of JAR 25X1360(a) and JAR 25X1360(b). Suppress example in ACJ 25.1360(a)2, so that they read :

ACJ 25.1360(a)
Protection Against Injury (Acceptable Means of Compliance)
See JAR 25.1360(a)

1 Where there may be a hazard during maintenance or servicing, aeroplane panels, etc., carrying voltages of above 50V RMS, should be marked with the voltage.

2 Where socket outlets are provided, these should be labelled as to use and with the output voltage or voltages. Where the output voltage exceeds 100 volts d.c. and/or 50 volts a.c. RMS either the output should be electrically isolated from the aeroplane structure, or means shall be provided to prevent inadvertent contact with live parts.

ACJ 25.1360(b)
Protection Against Injury (Acceptable Means of Compliance)
See JAR 25.1360(b)

1 For equipment which has to be handled during normal operation by the flight or cabin crew, a temperature rise of the order of 25°C, for metal parts, should not be exceeded. For other equipment, mounted in parts of the aeroplane normally accessible to passengers or crew, or which may come into contact with objects such as clothing or paper, the surface temperature should not exceed 100°C, in an ambient temperature of 20°C.

2 The heating surfaces of properly installed cooking apparatus are excluded from these requirements.

3 The provision of guards around hot surfaces is an acceptable method of complying with these requirements.

29. Modify ACJ 25X1362 to read :

AC/ACJ 25.1362

Electrical Supplies for Emergency Conditions (Interpretative Material)

See JAR 25.1362

1 The emergency services which may require a supply include fuel shut-off valves, hydraulic shut-off valves and engine / APU fire extinguisher systems.

2 An appropriate design and/or unambiguous AFM procedures should be provided in order to prevent disconnection of the electrical supply to the required services before the emergency procedures are fully completed.

30. Add a new ACJ 25.1365 to read :

ACJ 25.1365

Electrical appliances, motors and transformers (Interpretative Material and Acceptable Means of Compliance)

See JAR 25.1365

1. Heated Domestic Appliances (Galley Equipment)

In showing compliance with JAR 25.1365(a), the following should be taken into consideration:

1.1 The design and installation of heated domestic appliances should be such that no single failure (e.g. welded thermostat or contactor, loss of water supply) can result in dangerous overheating and consequent risk of fire or smoke or injury to occupants.

An acceptable method of achieving this is by the provision of a means independent of the normal temperature control system, which will automatically interrupt the electrical power supply to the unit in the event of an overheat condition occurring. The means adopted should be such that it cannot be reset in flight.

1.2 The design and installation of microwave ovens should be such that no hazard could be caused to the occupants or the equipment of the aeroplane under either normal operation or single failure conditions.

1.3 Heated liquid containers, e.g. water boilers, coffee makers should, in addition to overheat protection, be provided with an effective means to relieve overpressure, either in the equipment itself or in its installations.

1.4 When considering failures of domestic appliances, the effect of the loss of the water supply to a water heater, with the electrical supply maintained, should be taken into account.

NOTES:

Due account should be taken of the possible effects of lime scale deposit both in the design and maintenance procedures of water heating equipment.

The design of galley and cooking appliance installations should be such as to facilitate cleaning to limit the accumulation of extraneous substances which may constitute a fire risk.

2. Electric Overheat Protection Equipment

In showing compliance with JAR 25.1365(d), the following should be taken into consideration:

- a. Failures of any automatic control systems, e.g. automatic timer systems, which may cause the motor to run continuously;
- b. Short circuit failures of motor windings or transformer windings to each other or to the motor or transformer frame;
- c. Open circuit of one or more phases on multi-phase motors;
- d. Motor seizures;
- e. The proximity of flammable materials or fluids;
- f. The proximity of other aeroplane installations;
- g. Spillage of fluids, such as toilet waste;
- h. Accumulation of combustible material; and
- i. Cooling air discharge under normal operating or failure conditions.

3. Water Systems

3.1 Where water is provided in the aeroplane for consumption or use by the occupant, the associated system should be designed so as to ensure that no hazard to the aeroplane can result from water coming into contact with electrical or other systems.

3.2 Service connections (filling points) should be of a different type from those used for other services, such that water could not inadvertently be introduced into the systems for other services.

31. Delete existing ACJs 25X1499(a) and 25X1499(b).

JAR-25 SECTION 3

32. Delete existing AMJ 25.1309(b).

V. TECHNICAL JUSTIFICATION :

The following can be seen as the traditional justification section of an NPA, and is for comments and explanation for the changes. It covers all the JAR-25 paragraphs to be reviewed as defined under paragraph II above, with a justification for the changes, and also where applicable for JAR-25 paragraphs where no action is taken.

JAR 25.869(a) Fire protection electrical systems

(Proposals 2, 25)

FAR/JAR 25.869(a) addresses fire protection of electrical system components and provides specific standards to be met depending on location and type of cables.

The regulatory difference is within 25.869(a)(4) where JAR refers to “aeroplane” and FAR refers to “fuselage”. The technical need and accepted industry practice and Regulatory Authority application is that all wiring installed in the airframe and engines, (i.e. not just those in the fuselage), is self-extinguishing. The JAR text introduced by NPA 25DF-191 is such that the requirement reflects this standard.

JAR has a specific ACJ related to 25.869(a)(1).

According to the better plan for harmonisation, JAR/FAR 25.869(a) is to be enveloped to the most stringent requirement, which is JAR 25.869(a). This is also in line with current design practices.

The JAR ACJ is also proposed to be kept, but within its paragraph 3 reference to the Explosion Proofness Standards of draft ISO document TC20/SC5/N.43, dated 1974 should be updated to RTCA DO-160/EUROCAE ED-14.

That means that no change is introduced by this specific NPA on the JAR text itself apart from deletion of underlining.

JAR 25.899 Electrical Bonding and protection against static electricity

(Proposals 3, 4, 5, 13, 16, 22, 23, 26)

Differences between JAR and FAR text are as follows :

The JAR 25X899 requirement for electrical bonding and protection from the effects of lightning and static electricity are stated explicitly in the JAR text, with specific Interpretative Material and Acceptable Means of Compliance given in ACJ 25X899.

The FAR provides some equivalent requirements in FAR paragraphs 25.581, 25.954 and 25.1316 for protection from lightning discharges. However, JAR 25X899 and its related ACJ 25X899 have additional requirements relating to protection from electrical shock, fuel vapour ignition or electromagnetic interference caused by accumulation of electrostatic charge and for aircraft having a ground return path through structure. Electrical bonding must be adequate for both normal and fault conditions.

JAR 25X899 and its associated ACJ, as it is currently written, duplicates some of the requirements found in other JAR paragraphs and specifications given for use in assessing adequacy of protection from lightning discharges are out of date.

The differences in the standards of the FAR and JAR result in inconsistency and confusion because compliance for features relating to bonding and protection from effects of lightning discharges and accumulation of static electricity must be shown using different paragraphs in each standard.

For JAR 25X899, compliance requirements are given by ACJ 25X899 and interim policies. In the FAR, there are other paragraphs that are applicable to much of this subject matter but there are no specific guidelines given to show compliance.

The proposed action is to highlight the requirement of electrical bonding and static electricity as a full aircraft requirement, suppress the duplication for the lightning aspects, and place cross-references within the specific section which deals with electrical systems and lightning protection.

It is then proposed that the JAR 25X899 should be revised as follows:

- Delete JAR 25X899(a) because it is addressed in JAR paragraphs 25.581, 25.954 and 25.1316.
- The intent of JAR 25X899(b) should be retained to address protection from the accumulation of static electricity, but it should be rewritten to clearly state the requirement.
- Delete JAR 25X899(c) because it is addressed in JAR 25X1360(a), which will also be adopted into the FAR as part of this harmonisation project.
- Move the requirement of JAR 25X899(d) to a new JAR sub-paragraph 25.1353(e). This will place this requirement with related requirements and provide for improved consistency and co-ordination of both FAR and JAR.
- Delete JAR 25X899(e) because it is addressed in JAR 25.1353(a) and JAR 25.1431(d). JAR 25.1431(d) should also be adopted into the FAR as part of this harmonisation project.
- Modify ACJ 25X899 to provide specific Interpretative Material and Acceptable Means of Compliance for the new harmonised JAR 25.899, which will address bonding and static electricity. This new ACJ should also reference and be applicable to the other paragraphs that relate to bonding and static electricity.
- The modification to JAR 25X899 into JAR 25.899 leads to a number of changes where this paragraph is referred to. There is a reference to JAR 25X899 in JAR 25.581(a), which should be revised to refer to the new JAR 25.899. Similar modifications are proposed for JAR 25.954, ACJ 25.581 and ACJ 25.603.

In addition, FAA and JAA should request SAE and EUROCAE committees to prepare updated technical guidance on bonding and static electricity, which may be considered for a future revision to AC/ACJ 25.899.

JAR 25.1310 Power source capacity and distribution

(Proposals 6, 27)

Proposed JAR/FAR 25.1310 come from NPA 25F-281 and were formerly covered by JAR/FAR 25.1309(e) and (f). They define what is an ‘essential load’ on the power supply and the conditions under which those loads must be supplied. They are not directly related to the other safety and analysis requirements of JAR 25.1309 and are stated separately for the purpose of clarity through JAA NPA 25F-281. JAR 25.1310 and FAR 25.1310 are not completely harmonised in that JAR 25.1310 contains requirements for maintenance of airworthiness essential services after failure of any two engines on a three-engined aeroplane and makes reference to two ACJs.

According to the better plan for harmonisation, JAR/FAR 25.1310 is to be enveloped to the most stringent requirement, which is FAR 25.1310. JAR text can be considered as an alleviation of the services to be maintained after the failure of any two-engines on a three-engined aeroplane. This should be also applicable on a four (or more) engined aircraft.

It is proposed to suppress the last paragraph of JAR 25.1310(a)(3) (After the failure of any two engines on a three-engined aeroplane, those services essential to airworthiness must continue to function and perform adequately within the limits of operation implied by the emergency conditions. (See ACJ 25.1310(a)(3).)) and also to suppress the relevant ACJ 25.1310(a)(3). On the other side, there is no current published FAA Advisory Material. It is recommended that the JAR ACJ to 25.1310(a) be kept. It should be adopted as FAA advisory material as it provides useful acceptable means of compliance.

JAR 25.1351(b) Electrical systems - General

Sub-paragraph (b)(5) Disconnection of power sources (Proposal 7)

JAR 25.1351(b)(5), with its related ACJ 25.1351(b)(5), provide different accessibility requirements for means to disconnect power sources from the electrical system. FAR 25.1351(b)(5) requires means that are accessible in flight for individual and collective disconnection of all power sources. JAR 25.1351(b)(5) specifies “individual and rapid disconnection” instead of “individual and collective disconnection” and allows for flexibility by use of the words “where necessary”.

The JAR has a specific ACJ to cover the means for disconnecting power sources from the electrical system.

The proposed action is to adopt JAR 25.1351(b)(5) and associated ACJ. This allows for a greater flexibility for appropriate action to be taken, and removes the implication that a single means for disconnection of all electrical power sources is required. This is also in line with current design practices. That means that no change is introduced by this specific NPA on the JAR text apart from deletion of underlining.

JAR 25.1351(c) Electrical systems - General

Sub-paragraph (c) External power protection (Proposal 8)

JAR and FAR 25.1351(c) define minimum requirements for connecting external power to the aeroplane electrical power system, with the objective to protect the aeroplane/systems from possible malfunctions from the external power.

JAR 25.1351(c) refines the FAR requirements by requiring additional parameters to be monitored for the external power. This was introduced with NPA 25DF-191 due to an increasing number of incidents being reported of damage being caused to aircraft installed equipment, by malfunctioning external power supply equipment. Modern aircraft do already incorporate comprehensive external power protection systems.

It is proposed to envelope JAR 25.1351(c) with a minor revision to replace “incorrect frequency or over-voltage” by “incorrect frequency or voltage”. This ensures that all incorrect voltage conditions are addressed.

JAR 25.1351(d) Electrical systems - General

Sub-paragraph (d) Operation without normal electrical power (Proposal 9)

JAR and FAR 25.1351(d) address alternate/standby power systems. FAR 25.1351(d) defines minimum requirements for an alternate/standby power system that can enable safe operation in VFR conditions for period of not less than five minutes to enable attempted engine re-lights. JAR 25.1351(d), with it's related ACJ, requires provision for a high integrity alternate/standby power system with a duration for time limited system compatible with JAR-OPS and ICAO Annex 8. This ACJ also provides Interpretative Material for non-time limited alternate/standby power sources and specifies services that must remain powered following loss of normal electrical power.

The rules between the JAR and FAR are significantly different therefore the means of compliance are also significantly different.

Since the JAR is considered to be more stringent and more closely related to the current industry and regulatory practices, it is recommended to adopt the current JAR 25.1351(d) and the associated ACJ 25.1351(d).

The proposed standard will ensure adequate electrical power is supplied to those services which are necessary to complete the flight and make a safe landing in the event of a failure of all normal generated electrical power. With the growing dependence on electrically powered systems for safe aircraft operation, this section of the FAR has become out of date.

With this approach, that means that no change is introduced by this specific NPA on the JAR text or ACJ apart from deletion of underlining.

It should be noted that on the FAR side ,there is a draft AC 25.1351-1 as advisory material for FAR 25.1351(d). However this draft does not adequately address the new proposed requirement.

It has several provisions that are felt appropriate. It is envisaged that this draft AC along with the current ACJ 25.1351(d) be used in the future to create a more up to date harmonised AC/ACJ.

JAR 25.1353(a) Electrical equipment and installations

Sub-paragraph (a) Electrical interference (Proposal 10)

JAR/FAR 25.1353(a) give requirements relating to electrical installation including equipment, controls and wiring.

Both texts require that operation of any one unit or system will not adversely affect the simultaneous operation of any other electrical unit or system essential to safe operation under normal operating conditions. The JAR text also considers failure effects on the aeroplane or its systems and is therefore considered to be more stringent. JAR 25 1353(a) with its related ACJ 25.1353(a) provides a clarification in the intent of the requirement.

No specific means of compliance is furnished in the FAR. JAR has a specific ACJ to establish a list of possible sources of interference and reference to JAR 25.1309 to be considered and used for means of compliance.

The proposed action is adoption of JAR 25.1353(a) and associated ACJ. That means that no change is introduced by this specific NPA on the JAR text apart from deletion of underlining.

JAR 25.1353(c) Electrical equipment and installations

Sub-paragraphs (c)(5) & (6) Nickel-Cadmium batteries (Proposal 11)

The JAR/FAR 25.1353(c)(5) gives requirements relating to the design and installation of nickel cadmium storage batteries.

JAR 25.1353(c)(5) requires provisions to prevent any hazardous effect on structure or essential systems by all nickel cadmium batteries regardless of their capabilities; whereas FAR 25.1353(c)(5) requires provisions only for the batteries capable of being used to start an engine or auxiliary power unit.

The proposed action is to adopt JAR 25.1353(c)(5). This allows for coverage of the greater range of battery sizes and capabilities. There is then no change to existing JAR text except from deletion of underlining.

The JAR/FAR 25.1353(c)(6) give requirements relating to nickel cadmium battery installations with regard to protection against battery overheating.

JAR 25.1353(c)(6), with its related ACJ 25.1353(c)(6), provides requirements for all nickel cadmium battery installations (not provided with a low energy charging means) in addition to those provided for engine or APU starting. FAR equivalent text is specific to batteries capable of being used to start an engine or auxiliary power unit.

JAR has a specific ACJ to address the maintenance requirements of temperature sensing and over-temperature warning devices installed to cover the requirements of 25.1353(c)(6) sub-paragraphs (ii) or (iii). There is no published FAA advisory material for this requirement.

The proposed action is to adopt a modified JAR 25.1353(c)(6) and associated ACJ. The modification is to remove the wording “that are not provided with low energy charging means” as felt redundant with provisions of JAR 25.1353(c)(6)(i). This proposed action provides for greater coverage by including all nickel cadmium battery installations, irrespective of whether provided for engine or APU starting. Service experience has shown that any battery installation can, if not carefully controlled, result in an overheat or fire condition. This is also in line with current design practices.

Another modification is the introduction of text of JAA TGM/25/03 which can then be deleted when this amendment is adopted.

According to JAA Temporary Guidance Material TGM/25/03, the correct interpretation between JAR 25.1353(c)(6)(i) and JAR 25.1353(c)(6)(ii) is that an 'OR' is to be placed between the two sub-paragraphs.

JAR 25.1353(d) Electrical equipment and installations

Sub-paragraph (d) Electrical cables (Proposal 12)

JAR 25.1353(d) gives design requirements relating to the installation of aircraft electrical wiring. All wire and equipment installations must provide for continuous fault protection against fire and smoke hazards, there must be permanent cable, connector and terminal identification and the risk of mechanical, fluid, heat or vapour damage must be minimised.

There is no current FAR rules text.

JAR 25.1353(d) provides very explicit aircraft installation design requirements for electrical cables. FAR 25.1353(a), (b) and (c) does not address these design features.

The JAR states specific requirements for cable installations that must be met. Installation designs approved by the FAR's typically meet the JAR requirement. Installation designers through experience have adopted the practice of permanent identification, protection and installation routing to minimise the risk of damage to electrical cables.

Adoption of JAR 25.1353(d) in its entirety is recommended. This requires an appropriate design action to be taken, removes the possibility that a designer may not consider a critical installation design condition and is in line with current best design practices. That means that no change is introduced by this specific NPA on the JAR text apart from deletion of underlining.

JAR 25.1355(c) Distribution system

(Proposal 14)

The JAR/FAR 25.1355(c) gives requirements relating to the arrangement, protection and control of the electrical feeders from the busbars to the distribution points.

The divisions of loads among the feeders shall be such that no single fault occurring in any feeder or associated control circuit will hazard the aeroplane.

Differences in the standards is that the FAR refers to “chapter” while the JAR refers to “JAR 25” in the rule text. The FAR reference to “chapter” implies broader coverage. The JAR also refers to advisory material.

There are no differences in the means of compliance, however the JAR has specific ACJ’s as follows:

The ACJ to JAR 25.1355(c) introduced Interpretative Material concerning the segregation of electrical feeders to minimise the possibility of cascade or multiple failures. In addition, ACJ No. 6 to JAR 25.1309 refers to the same objective but in relation to the installation of the equipment and systems rather than the electrical feeders only. Segregation of electrical cable bundles or groups of hydraulic pipes being examples that are explicitly quoted.

The proposed action is in line with the fast track harmonisation process, to adopt the FAR text but change reference to “chapter” by “for certification or by operating rules”.

Reference to the two ACJs is kept, but reference to ACJ No. 6 to JAR 25.1309 is changed to ACJ 25.1310(a) assuming NPA 25F-281 final text is published before this NPA.

JAR 25.1357 Circuit protective devices

(Proposal 15)

The safety issue addressed by JAR/FAR 25.1357 is the use, functional requirements and installation requirements of electrical circuit protective devices.

The JAR references ACJ 25.1357(a), which adds interpretative material stating that effects of variations in ambient temperatures on either the protective device or the equipment it protects must not result in hazards. This is in line with current industry practice.

The JAR also has the text formerly located in sub-paragraph (f) moved to be included in sub-paragraph (d). This change was made to avoid any confusion that may be created regarding whether the spare fuse requirement also applied to fuses that are inaccessible in flight. This change has not been done in the FAR, but there is no difference in interpretation.

Since the JAR standard is in line with current industry practice, the means of compliance is the same, with the addition of showing what effect temperature variations have on the circuit protection and the equipment it protects.

The proposed action is to adopt JAR 25.1357 into FAR and to incorporate its related ACJ 25.1357(a) into FAA advisory material. That means that no change is introduced by this specific NPA on the JAR text apart from deletion of underlining.

JAR 25.1360 Precautions against injury
(Proposals 16, 28)

JAR 25X1360 provides requirements for protection of the crew, passengers, maintenance and servicing personnel from electrical shock and burns while performing their normal activities. There is no current FAR standard.

JAR 25X1360(a) & (b) with its related ACJ, require electrical system and equipment be designed so as to minimise the risk of electric shock and burns to crew and passengers. The ACJ provides interpretative material for high voltages and high temperatures and a means of compliance to the requirements.

Since the JAR increases the level of safety for the crew and passengers, it is recommended to adopt of the current JAR 25X1360(a) & (b) and the associated ACJ. A small modification is made for ACJ 25.1360(a) (suppression of example).

That means that no change is introduced by this specific NPA on the JAR text apart from deletion of underlining (see also addition of reference to JAR 25.899 under 25.1360(a) as discussed earlier).

JAR 25.1362 Electrical supplies for emergency conditions
(Proposals 17, 29)

JAR 25X1362 addresses electrical supplies for emergency conditions. This JAR and associated ACJ was created to ensure that electrical supplies are maintained to emergency services (such as fuel and hydraulic shut-off valves) so that these may be closed after the main power sources have been switched off by the flight crew.

JAR 25X1362 was introduced at JAR-25 Change 3 (effective 31.12.76). This requirement was considered necessary concerning the provision of an adequate electrical supply after an emergency landing or ditching.

JAR 25X1362 was further modified at JAR-25 Change 14 (effective 27.05.94) as a result of NPA 25DF-191 by introducing new ACJ material to clarify the intent of requirement for the provision of electrical supplies for such emergency conditions.

No equivalent standard exists in FAR 25. It can be noted that application of JAA standards has sometimes resulted in different designs for the powering of appropriate emergency services.

The following points can be noted from JAA experience with application of JAR 25X1362 :

- JAR 25X1362 by itself has no structural implications. JAR 25X1362 is requesting the provision of electrical power, after an emergency landing, ditching or crash, to those services which may be required after such an event.

- The solution implied by the ACJ 25X1362 paragraph 2 is to power the emergency services from a 'hot' battery bus. This means that the aeroplane battery (batteries) can be used for that purpose. A specific dedicated battery is not required, nor it is forbidden. Use of appropriate AFM procedures has sometimes been accepted in order to make sure that all electrical power sources are not disconnected or isolated by the flight crew just prior to, or during, an emergency landing,
- Aeroplane battery (batteries) would have to meet 25.561(b) loads, if they are likely to cause injury to occupants or create an additional hazard to the aeroplane if they break loose.
- The circuits to the emergency services should be designed and installed such that the risk of damaging them during the emergency landing is minimised.

Due to the fact there is no existing FAR 25.1362 and as there has been inconsistent application of the JAR, it is recommended that the JAR 25X1362 be revised and a new JAR/FAR 25.1362 be created. The ACJ will also be revised and adopted as an ACJ/AC by the JAA/FAA. The proposed rule is similar to the existing JAA text, and covers the underlying safety issue which is to provide appropriate electrical power supplies for emergency conditions. The advisory material will provide flexibility by allowing either an appropriate AFM procedure and/or design implementation to achieve compliance.

JAR 25.1363 Electrical system tests
(Proposal 18)

The underlying safety issue addressed by JAR/FAR 25.1363 is to provide assurance that tests of the electrical system are performed using mock-ups and equipment that are as close to the aeroplane characteristics as possible. This means that generator drives must simulate the actual aeroplane prime mover (mechanical equivalence), generating equipment must be the same as the aircraft and the distribution system must be simulated to the extent required to give valid test results. For any condition that cannot be simulated adequately in a laboratory or ground test, flight testing must be done.

JAA and FAA standards and policies are generally equivalent. However, the JAR adds requirements for testing to demonstrate performance of the electrical supply system under all appropriate normal and failure conditions. The related ACJ 25.1363 specifies Acceptable Means of Compliance, which requires testing to account for load switching and flight crew operation of the system. This ACJ also gives more specific guidance for electrical parameters that should be simulated in laboratory tests to demonstrate system performance. Testing must demonstrate system performance throughout the temperature range and other environmental extremes for all ground and flight conditions. There must be written test procedures to document the conditions of each ground or flight test.

The differences in the means of compliance are related to the additional testing and reports that must be prepared and submitted. Even though the JAR contains additional specific test conditions

and requirements, they are normally addressed in the design phase of the project regardless of whether it is for JAA or FAA certification.

The proposed action is for the FAA to adopt the JAR text for 25.1363 and to adopt ACJ 25.1363 as FAA advisory material. That means that no change is introduced by this specific NPA on the JAR text apart from deletion of underlining.

JAR 25.1365 Electrical appliances and motors / AMJ 25.1309(b)

(Proposals 1, 19, 21, 24, 30, 31, 32)

JAR specific AMJ 25.1309(b) was introduced to cover two basic issues:

- Faulty galley heating equipment has been the cause of many incidents which have resulted in smoke or fire in the cabin and of incidents involving injuries to cabin crew, etc. Improvements in the safety of aircraft domestic equipment design and installations should reduce the probability of such incidents and improve safety standards.
- Recorded incidents have shown that the circuit protection devices used in motor power supplies, particularly those used in domestic systems, have not always provided adequate protection against failures which cause a motor overheat condition.

The advisory material provided in AMJ 25.1309(b) gives guidance on some acceptable methods of reducing the probability of failures which could cause airworthiness hazards. FAR does not provide standards for domestic services and appliances. JAA has a specific AMJ. Also, there is no published FAA Advisory Material equivalent to AMJ 25.1309(b) on the subject, apart from AC 25-10, which is less specific.

According to the better plan for harmonisation, FAR/JAR 25.1309(b) is to be enveloped to the most stringent requirement. As there is no direct equivalent FAA AC text, the initial plan was to adopt AMJ 25.1309(b) as FAA advisory material.

It has been established that the AMJ 25.1309(b) is not the best place to add substantial material that is specific for domestic services and appliances only, since this could give the suggestion that 25.1309(b) is not applicable to other systems.

Furthermore it is proposed to have a lead in paragraph specific to domestic appliances which would contain the parts of the AMJ that are more appropriate to a rule text and also contain some parts of JAR25X799 and JAR 25X1499 that are relevant to the subject.

To accomplish this, the proposal is to:

- Introduce a new FAR/JAR 25.1365 within the “Miscellaneous Equipment” section of subpart F, that is specific to domestic appliances.
- Introduce a new AC/ACJ 25.1365 that is based on existing AMJ 25.1309(b) and ACJs to 25X799 and 25X1499, but with those elements that have been transferred to the rule removed.
- Delete existing AMJ 25.1309(b).

- Delete existing JAR 25X799 and JAR 25X1499 with their associated ACJs.

JAR 25.1431(d) Electronic equipment
(Proposal 20)

JAR 25.1431(d) specifies requirements relating to the design and installation of electronic equipment such that these may not cause essential loads to malfunction.

There is no equivalent FAR text. JAR requires additional verification that any electronic equipment will not cause essential loads to become inoperative as a result of electrical power supply transients or transients from other causes.

It is felt that this is in line with current industry practices, and could be considered included by implication in paragraphs 25.1309(e), 25.1351(b) and 25.1353(a). However, for the benefit of harmonisation, the proposed action is to adopt JAR 25.1431(d). That means that no change is introduced by this specific NPA on the JAR text apart from deletion of underlining

Appendix H: Tasking Statement for the WSHWG

TASK 6.1: Establish a Harmonization Working Group (HWG)

ATSRAC is tasked to establish a *Wire System Harmonization Working Group* (HWG) to provide a report to the FAA that will include response and recommendations to the following tasking statements. The FAA will use this report as the basis to develop a new part 25 regulation addressing the certification requirements for wire systems and any associated guidance. The Wire System HWG, should be established as a part 25 / JAR-25 Harmonization Working Group, and be comprised of, as a minimum, representatives from:

- type certificate and supplemental type certificate holders,
- operators, and
- Regulatory authorities.

TASK 6.2: Develop a Coordination Process with ARAC

The Wire System HWG should establish working methods to ensure proper coordination with the ARAC Electrical Systems HWG and the Systems Design & Analysis HWG, who are addressing related subjects. Methods of coordination may include:

- cross-membership,
- joint meetings,
- systematic exchange of documents, or
- ARAC review of recommendations.

TASK 6.3: Develop a Coordination Process with other ATSRAC Working Groups

In developing the report for wire system certification requirements, the Wire System HWG must coordinate with:

- Standard Wire Practices Manual HWG (addressing TASK 7), and
- Enhanced Maintenance Practices for Systems HWG (addressing TASK 9).

Therefore, ATSRAC is tasked to develop a process for coordination between these working groups.

TASK 6.4: Combine Current Wire System Regulations into One Section

Current requirements for the certification of wire systems from connector to connector (including other terminating devices, such as terminal blocks, terminal lugs, modules, etc.) are contained in various paragraphs throughout part 25. (Circuit Protection Devices will not be addressed) This reduces the visibility of the requirements and does not facilitate a comprehensive process for the design and certification of wire systems. Therefore, to raise the awareness of wire system certification, ATSRAC is tasked to review all 14 CFR part 25 and JAR-25 paragraphs related to

wiring systems, as well as all ATSRAC and ARAC recommendations related to wiring systems. Following this review, ATSRAC is tasked to submit recommendations for combining the existing paragraphs and creating a new section dedicated specifically to wire systems.

TASK 6.5: Identify Design Requirements to Mitigate Problems of Aging in Wire Systems

ATSRAC recommendations have identified aging characteristics of wire systems and methods to mitigate the effects of aging. Certain design practices have been recognized as a means to mitigate potential problems due to “aging.” Consideration should be given to enhance certification by requiring that new wire system designs include these means of mitigation. Therefore, ATSRAC is tasked to identify requirements for a new wire systems rule on how to account for aging effects in the certification of wire systems. These new requirements must consider the conclusions and recommendations contained in the ATSRAC recommendations of Chapter 7 of the Intrusive Inspection Report, as well as other ATSRAC recommendations.

TASK 6.6: Identify Requirements for Wire System Safety Assessments

Historically, the wiring associated with a certain system has been included in the safety assessment of that system. Failures of the wiring and components were typically considered solely on the end effect to that system. However, the failure of the wire system at an airplane level has not been given consistent consideration.

Service history and the recommendations from ATSRAC have shown that wire systems failures often affect multiple systems within a particular zone. Current safety assessment practices, as identified in Advisory Circular (AC) 25.1309-1A, “System Design Analysis,” provide methods to address these types of failures. Performing these safety assessments to show compliance with § 25.1309 (“Equipment, systems, and installations”) may be necessary to adequately certify wire systems.

Therefore, ATSRAC is tasked to review § 25.1309, AC 25.1309-1A (or latest revision), corresponding JAR-25 material, and related ARAC recommendations. ATSRAC is then to submit a recommendation on whether particular methods of compliance with § 25.1309 should be mandated in the new wire systems rule. Particular methods include, but are not limited to:

- common mode analysis,
- safety zonal analysis, and
- particular risk analysis.

The recommendation should consider how to address potential wiring failures and in-service conditions as contained in the ATSRAC recommendations from the Intrusive Inspection Report, as well as aging effects, as part of system safety assessments performed in compliance with § 25.1309.

TASK 6.7: Identify Requirements for Wire Separation

ATSRAC recommendations, as defined in the Intrusive Inspection Report, identified the enhancement of wire separation requirements as a mitigating factor against certain failure modes

and conditions. Current FAA/JAA requirements for wire separation are contained in § 25.1353 (“Electrical equipment and installations”), and implied in § 25.1309. Therefore, ATSRAC is tasked to determine if a comprehensive wire separation regulation, in addition to § 25.1353, should be included in the new wire system rule. If so, the recommendations obtained from this task should include general requirements for all wire systems regarding wire separation. In responding to this task, ATSRAC should review:

- existing FAA/JAA guidance;
- ATSRAC and ARAC recommendations; and
- industry documentation for wire separation requirements and associated guidance.

TASK 6.8: Identify Requirements for Wire Identification

Maintaining proper wire separation requires the need to adequately define the airplane-level effect of failure of the functions contained in any given wire bundle. In addition, it may be prudent to allow more detailed inspections of wire bundles that

- contain wires associated with those systems required for continued safe flight and landing, or
- contain wires, the failure of which would affect the ability of the flightcrew to cope with adverse operating conditions.

Therefore, ATSRAC is tasked to provide recommendations on the need for the special identification of wire and/or wire bundles based on the airplane-level effect of failures of systems contained in a given wire bundle.

TASK 6.9: Recommend Advisory Material for the New Wire Systems Rule

Providing acceptable guidance with the new wire systems rule will facilitate compliance with the rule. Therefore, ATSRAC is tasked to provide recommended methods of compliance with the requirements established from TASKS 6.4 through 6.8, described above. Existing advisory material may already provide acceptable means of compliance. If so, ATSRAC is tasked to identify where this guidance exists.

In preparation for fulfilling this task, ATSRAC is also tasked to review the existing advisory material, guidelines, and policies regarding the design and installation of wiring systems, as well as related ARAC recommendations. ATSRAC will then recommend necessary changes, considering the aging effects on wiring as noted in the previous recommendations submitted by ATSRAC and, in particular, in the Intrusive Inspection Report.

The following is the Federal Register tasking statement for the Wire System Certification Requirements Harmonization Working Group (volume 66, No. 103, Tuesday, May 29, 2001, page 29203):

“Wire System Certification Requirements Harmonization Working Group

This group should be comprised of representatives and experts from type certificate and supplemental type certificate holders, operators, and regulatory authorities

- Review all 14 CFR part 25 and JAR 25 requirements and ATSRAC and ARAC recommendations related to wiring systems
- Submit recommendations consolidating existing paragraphs and creating a new section dedicated to wire system requirements.
- Identify design and certification requirements to conduct wire system safety assessments. Review § 25.1309, AC 251309-1A (or latest revision), corresponding JAR-25 material, and related ARAC recommendations and recommend, if appropriate, particular methods of compliance with § 25.139 that should be mandated in a new wire system rule.
- Review existing FAA and JAA guidance, related ATSRAC and ARAC recommendations, and industry documentation and guidance for wire separation requirements.
- Recommend, if appropriate, a comprehensive wire separation regulation (in addition to § 25.1353).
- Recommend requirements for special identification of wire and/or wire bundles based on the airplane level of effect of failures of systems contained in a wire bundle.
- Review and revise, as appropriate, existing advisory material, guidance and policies and related ARAC recommendation on design and installation of wiring systems, in consideration of aging effects on wiring noted in previous recommendation submitted by ATSRAC.”

Appendix I: Minority Position Letters to WSHWG

1. Letter from Boeing:

October 15, 2002

Vidmantas Variakojs
Boeing Long Beach Division
3855 Lakewood Blvd.
Long beach CA. 90846
Mail code: D800-0030

Dear Mr. Variakojs,

The purpose of this letter is to transmit The Boeing Company's Commercial Airplanes Group written recommendations regarding the ATSRAC WSHWG Task 6 Report, dated August 29, 2002 as updated in the Montreal WSHWG meeting held October 7-10, 2002. Boeing requests these recommendations be considered for inclusion within the final Task 6 Working Group Report submittal to ATSRAC.

Boeing recognizes the hard work and dedication reflected in the assembly of information contained within the Task 6 Working Group Report. After thoughtful review and consideration however, Boeing has identified some major concerns with the report and has enclosed the following suggestions for WSHWG and ATSRAC consideration.

Of the 29 new, revised, or consolidated 1700 series group of rules, two new rules, 25.1709, addressing wire separation, and 25.1711 addressing marking, stand out as providing increased value as FAR/JAR rulemaking which Boeing supports. Boeing suggests the remaining 27 duplicate draft rules and advisory material not be considered for rule making. The duplicate rules detract from existing FAR/JAR rules covering the same subjects, further complicating and expanding the existing rule system. Though it may appear to help by consolidating wire related rules, inappropriate dilution of existing rules and unnecessary interdependence will result causing diverging requirements, duplicate efforts, and potential gaps in future rule coverage.

The report identifies areas which do not appear to indicate deficiencies in existing rules, as can be seen by the number of references to existing FAR sub-paragraphs, but rather identifies problems we believe result from less than adequate application of existing rules, as reflected in the reports advisory material emphasis on wire.

Boeing suggests the desired increase in attention to wire during the compliance process would be more timely and efficiently addressed through proper training and policy

deployment. Knowledge in how to perform proper compliance activity to existing rules as well as consistent and fair enforcement is recommended when addressing these tasks identified by ATSRAC.

The advisory information within the report contains some valuable insight, providing additional wiring emphasis and perspective aimed at improving compliance practices of some applicants. Boeing suggests this added emphasis on wire is a valuable reminder when properly performing wire related compliance activities to existing regulations and should be considered for future advisory and policy revision and reinforcement.

Boeing therefore recommends the following change:

1. The 25.1709 and 25.1711 proposed rule making proceed forward as recommended in the Task 6 Working Group.
2. The remaining draft rules which duplicate or refer to existing part 25 paragraphs be addressed by policy deployment, identifying all existing part 25 rules applicable to wire. Policy deployment would be preferred in providing a timely and efficient method of instituting positive change of increased wire awareness without compromises associated with duplicating rules.
3. 25.1705 advisory material should be provided for consideration andly inclusion within AC 25.1309, which provides guidance on acceptable means for performing systems design and analysis compliance activities, as well as SAE ARP 4761, which contains methods for conducting safety assessment processes. This would result in proper wire emphasis and harmonization within the appropriate existing material consulted when performing FAR/JAR 25.1309 assessments.

Boeing also recommendations industry and regulators focus on the importance of thorough and consistent application and compliance to existing rules achieved through proper training and policy enforcement.

Sincerely,

Steve Atkins
Vice President
Boeing Commercial Airplane
Aviation Safety, Certification and Regulatory Affairs

2. Letter from Bombardier:

Bombardier reviewed the “Oct 10th 2002” version of the proposed 25.1705 and AC/ACJ25.1705, while the updates to the rule and advisory material have addressed several of the concerns that we previously expressed, Bombardier still have a concern over the application of ‘hazardous’ within the ‘Physical failures’ path of flowchart 2 and 3.

The application of this new rule may cause prejudice to the aerospace industry. Particularly considering that the wording requires that all common hazardous physical effects must be mitigated. In some instances it may not be practical or even possible to mitigate.

Bombardier proposal is to change in the body of the AC/ACJ 25.1705, the explanatory text for box F:

FROM:

BOXES F & G

Development & validation of mitigation strategy:

This activity it to identify & to develop a mitigation strategy for the physical failures and their adverse effects identified in Boxes D and E.

Validation and verification of the mitigation solution should ensure that the hazardous failure conditions are extremely remote and catastrophic failure conditions don’t result from a single common cause event or failure and this mitigation solution does not introduce any new potential failure conditions.

TO:

BOXES F & G

Development & validation of mitigation strategy:

This activity it to identify & to develop a mitigation strategy for the physical failures **leading to catastrophic failure conditions** and their adverse effects **and also to address the physical failures leading to hazardous failure conditions and their adverse effects**, identified in Boxes D and E.

Validation and verification of the mitigation solution should **ensure that catastrophic failure conditions don’t result from a single common cause event or failure. The hazardous failure conditions should be adressed to ensure that the risk is to a level shown to be acceptable. It must also be verified that the** mitigation solution does not introduce any new potential failure conditions.

Regards,

Jomar Rocha
Bombardier Aerospace -
Electrical Systems Section Chief