NOTICE OF PROPOSED AMENDMENT (NPA) No 2007-01

DRAFT OPINION OF THE EXECUTIVE DIRECTOR OF THE AGENCY

AMENDING
COMMISSION REGULATION (EC) NO 2042/2003 OF 20 NOVEMBER 2003
on the continuing airworthiness of aircraft and aeronautical products, parts and appliances, and on the approval of organisations and personnel involved in these tasks

And

DRAFT DECISION OF THE EXECUTIVE DIRECTOR OF THE AGENCY,

AMENDING
DECISION NO 2005/06/R OF THE EXECUTIVE DIRECTOR OF THE AGENCY OF 12 DECEMBER 2005
on certification specifications, including airworthiness code and acceptable means of compliance, for large aeroplanes (« CS-25 »)

And

DRAFT DECISION OF THE EXECUTIVE DIRECTOR OF THE AGENCY,

AMENDING
DECISION NO 2003/19/RM OF THE EXECUTIVE DIRECTOR OF THE AGENCY OF 28 NOVEMBER 2003
on acceptable means of compliance and guidance material to Commission Regulation (EC) No 2042/2003 of 20 November 2003 on the continuing airworthiness of aircraft and aeronautical products, parts and appliances, and on the approval of organisations and personnel involved in these tasks.

And

DRAFT DECISION OF THE EXECUTIVE DIRECTOR OF THE AGENCY,

AMENDING

DECISION NO. 2003/12/RM OF THE EXECUTIVE DIRECTOR OF THE AGENCY OF 5 NOVEMBER 2003
on general acceptable means of compliance for airworthiness of products, parts and appliances (« AMC-20 »)

And

INTENDED AIRWORTHINESS DIRECTIVES

Electrical Wiring Interconnection System

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Acronyms used in this NPA

AAIB	Air Accident Investigation Branch
AC	Advisory Circular
ACJ	Advisory Circular Joint
AD	Airworthiness Directive
AEA	Association of European Airlines
AMC	Acceptable Means of Compliance
ARAC	Aviation Rulemaking Advisory Committee
ASTF	Ageing Systems Task Force
ATA	Air Transport Association
ATSRAC	Ageing Transport Systems Rulemaking Advisory Committee
CAA	Civil Aviation Authority
CAST	Commercial Aviation Safety Team
CS	Certification Specification
DGAC	Direction Générale de l'Aviation Civile
EAPAS/FTS	Enhanced Airworthiness Programme for Airplane Systems/Fuel Tank Safety
EASA	European Aviation Safety Agency
EASCG	European Ageing Systems Coordination Group
ESHWG	Electrical Systems Harmonisation Working Group
ESWPM	Electrical Standard Wiring Practices Manual
EWIS	Electrical Wiring Interconnection Systems
EZAP	Enhanced Zonal Analysis Procedure
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
ICA	Instructions for Continued Airworthiness
IIWG	Intrusive Inspection Working Group
INT/POL	Interim Policy
JAA	Joint Aviation Authorities
JAR	Joint Aviation Requirements
MDM	Multi Disciplinary Measures
NPA	Notice of Proposed Amendment
NPRM	Notice of Proposed Rulemaking
OEM	Original Equipment Manufacturer
RIA	Regulatory Impact Assessment
STC	Supplemental Type Certificate
TC	Type Certificate
ToR	Terms of Reference
WSHWG	Wire Systems Harmonisation Working Group

A. EXPLANATORY NOTE

I. General

1. The purpose of this Notice of Proposed Amendment (NPA) is to envisage amending Regulation No 2042/2003[1], ED Decision No 2005/06/R[2], ED Decision No 2003/19/RM[3] and ED Decision No 2003/12/RM[4] as well as to envisage the use of Part 21A.3B(c) requiring type certificate holders to produce instructions for continuing airworthiness derived from applying an Enhanced Zonal Analysis Procedure. The scope of this rulemaking activity is outlined in ToR MDM.002 and is described in more details below.

2. The Agency is directly involved in the rule-shaping process. It assists the Commission in its executive tasks by preparing draft regulations, and amendments thereof, for the implementation of the Basic Regulation[5], which are adopted as “Opinions” (Article 14.1). It also adopts Certification Specifications, including Airworthiness Codes and Acceptable Means of Compliance and Guidance Material to be used in the certification process (Article 14.2).

3. When developing rules, the Agency is bound to follow a structured process as required by article 43.1 of the Basic Regulation. Such process has been adopted by the Agency’s Management Board and is referred to as “The Rulemaking Procedure”[6].

4. This rulemaking activity is included in the Agency’s rulemaking programme for 2007. It implements the rulemaking task MDM.002.

5. This NPA is based on a draft produced by the EASA rulemaking group also known as the European Ageing Systems Coordination Group (EASCG) according to EASA terms of reference MDM.002. It contains the recommendations of the Ageing Transport Systems Rulemaking Advisory Committee (ATSRAC), Wire Systems Harmonisation Working Group (WSHWG), Aviation Rulemaking Advisory Committee (ARAC) and the Electrical Systems Harmonisation Working Group (ESHWG). The WSHWG was formed by ATSRAC to address the certification aspects of wiring systems on large transport category aeroplanes. The NPA is submitted for consultation of all interested parties in accordance with Article 43 of the Basic Regulation and Articles 5.3 and 6 of the EASA rulemaking procedure.

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[1] Commission Regulation (EC) No 2042/2003 of 20 November 2003 on the continuing airworthiness of aircraft and aeronautical products, parts and appliances, and on the approval of organisations and personnel involved in these tasks, *OJ L 315, 28.11.2003, p. 1*. Regulation as amended by Regulation (EC) 707/2006 (*OJ L 122, 09.5.2006, p. 17*).

[2] Decision N° 2005/06/R of the Executive Director of the Agency of 12 December 2005 on certification specifications, including airworthiness code and acceptable means of compliance, for large aeroplanes (« CS-25 »).

[3] Decision No 2003/19/RM of the Executive Director of the Agency of 28 November 2003 on acceptable means of compliance and guidance material to Commission Regulation (EC) No 2042/2003 of 20 November 2003 on the continuing airworthiness of aircraft and aeronautical products, parts and appliances, and on the approval of organisations and personnel involved in these tasks.

[4] Decision No. 2003/12/RM of the Executive Director of the Agency of 5 November 2003 on general acceptable means of compliance for airworthiness of products, parts and appliances (« AMC-20 »).

[5] Regulation (EC) No 1592/2002 of the European Parliament and of the Council of 15 July 2002 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency, *OJ L 240, 7.9.2002, p.1*. Regulation as last amended by Regulation (EC) No 1701/2003 (*OJ L 243, 27.9.2003, p. 5*).

[6] Management Board decision concerning the procedure to be applied by the Agency for the issuing of opinions, certification specifications and guidance material (“Rulemaking procedure”), EASA MB/7/03, 27.6.2003.

II. Consultation

6. To achieve optimal consultation, the Agency is publishing the draft decision of the Executive Director on its internet site. Comments should be provided within 3 months in accordance with Article 6.4 of the EASA rulemaking procedure. Comments on this proposal may be forwarded *(preferably by e-mail)*, using the attached comment form, to:

By e-mail: NPA@easa.europa.eu

By correspondence: Process Support
Rulemaking Directorate
EASA
Ref: NPA 2007-01
Postfach 10 12 53
D-50452 Cologne
Germany

Comments should be received by the Agency before **13-06-2007**. If received after this deadline they might not be treated. Comments may not be considered if the form provided for this purpose is not used.

III. Comment response document

7. All comments received in time will be responded to and incorporated in a comment response document (CRD). This may contain a list of all persons and/or organisations that have provided comments. The CRD will be widely available on the Agency's website.

IV. Content of the draft opinion and decision

8. Summary

Safety concerns about wiring systems in aeroplanes were brought to the forefront of public and governmental attention by a mid-air explosion in 1996 involving a 747 aeroplane. Ignition of flammable vapours in the fuel tank was the probable cause of that fatal accident and the most likely source was determined to be a wiring failure causing a spark to enter the fuel tank. All 230 people aboard were killed. Two years later, an MD–11 aeroplane crashed into the Atlantic Ocean, killing all 229 people aboard. Although an exact cause could not be determined, a region of resolidified copper on a wire of the inflight-entertainment system cable indicated that wire arcing had occurred in the area where the fire most likely originated.

Investigations of those accidents and subsequent examinations of other aeroplanes showed that deteriorated wiring, corrosion, improper wire installation and repairs, and contamination of wire bundles with metal shavings, dust, and fluids, which would provide fuel for fire, were common conditions in representative examples of the ''ageing fleet of transport aeroplanes.'' It was concluded that current maintenance practices do not adequately address wiring components, wiring inspection criteria are too general, and unacceptable conditions, such as improper repairs and installations, are not described enough in details in maintenance instructions. Wiring failures result in aeroplane delays, unscheduled landings, in-flight entertainment system problems, nonfatal accidents, and fatal accidents.

Up until this time, aeroplane wiring has never been singled out for special attention during maintenance inspections. Although close attention is paid to safe design within systems, it was assumed that for the wiring providing power to those systems, standard industry practice was appropriate, and modifications have often been performed without scrutiny for the effect their wiring additions may have on other systems in the aeroplane. Damaged wire and insulation can cause electrical arcing, providing the spark that can cause fire. Dust, dirt, lint, contamination, and vapours provide fuel for fire. Recent rules have established requirements for wiring connected to fuel tank systems. This proposal goes further; to address all the wiring contained in an aeroplane, as systems on their own, and provides scrutiny to the conditions that affect their safe functioning. It aligns with the requirements for fuel tank wiring. This NPA introduces requirements and associated guidance material as they relate to Electrical Wiring Interconnection System (EWIS). It is harmonised with the FAA.

Amendments to CS-25 are envisaged to enhance the design requirements related to wiring as well as improved provisions to assure the continuing airworthiness of EWIS.
However to address the safety issue at hand it is not sufficient to address future designs only, which is the result of an amendment to CS-25. In order to achieve the full safety benefit the Regulatory Impact Assessment (see chapter V) concludes that the Enhanced Zonal Analysis Procedure (EZAP) should also be performed on existing designs to improve the instructions for continuing airworthiness. Therefore at the end of this NPA a draft measure based on Part 21A.3B(c) requiring type certificate holders to produce instructions for continuing airworthiness derived from applying an Enhanced Zonal Analysis Procedure is included.

To complement the proposal, amenments to Part M and Part 66 are envisaged to emphasise EWIS in the maintenance programme and the importance of EWIS training for maintenance personnel.

Finally three general AMCs are envisaged to provide guidance for conducting EZAP, for EWIS maintenance training and to promote an Electrical Standard Wiring Practices Manual.

9. General

Electrical wiring systems perform functions essential to the safety of the entire aeroplane. They distribute power throughout the aeroplane, transmit signals for control, and send data. Over time, as more sophisticated computerized systems have been introduced into aeroplane controls, their electrical wires, cables, and associated components have become increasingly important to safe flight.

Historically, manufacturers have been required to provide maintenance-related information for aeroplane systems. However, there has never been a requirement for maintenance information specifically for wiring systems. Since the early 1980's, design approval holders have been required to provide Instructions for Continued Airworthiness (ICA) for the aeroplane. Currently, ICA must be prepared in accordance with Appendix H to CS-25. In developing ICA, the applicant must include certain information. This includes a description of the aeroplane and its systems, servicing information, and maintenance instructions, including the frequency and extent of inspections necessary to provide for the continued airworthiness of the aeroplane. Current Appendix H to CS 25.1529 includes a requirement for an approved Airworthiness Limitations section in the ICA. This section must list those mandatory inspections, inspection intervals, replacement times, and related procedures approved under CS 25.571, but there are no requirements for specific information related to wiring in CS 25.1529.

Aeroplanes must be continually maintained and inspected, and the information contained in the ICA is used as a basis for developing a maintenance programme. Yet the examinations of large aeroplanes revealed many anomalies in electrical wiring systems and their components, as well as contamination by dirt and debris.

Part M and Part 145 requires anyone performing maintenance or alteration to do the work in such a manner and use materials of such a quality that the condition of the aircraft, airframe, engine, propeller, or appliance worked on will be at least equal to its original or properly altered condition. Persons performing maintenance must use methods, techniques, and practices prescribed in the current manufacturer's maintenance manual or ICA prepared by the manufacturer, or methods, techniques, and practices referred to in Part M acceptable to the Agency. But current practice has shown that, when wiring is inspected as part of the maintenance programme or following alterations, it is not always cleaned appropriately for the inspection being performed. Generally, neither regulators nor airline maintenance workers have been fully aware of the vulnerability and criticality of electrical wiring. Less focus has been placed on the importance of cleaning electrical wiring during maintenance or alteration. The result has been to hasten the degradation of wiring.

Extensive research has shown that electrical wiring on large aeroplanes is subject to a breakdown of physical and functional properties, not just as a function of time, but also as a result of many stresses on the wiring. These stressors include chafing, vibration, contamination, and temperature variation, all of which can cause cumulative damage. Each aeroplane maintenance procedure or modification, whether performed on the wiring system itself or on surrounding components, introduce possibilities for inadvertent damage, changes to the previously approved wire design, or contamination of the wiring systems by fluids, foreign objects, and debris. As the aviation industry matures, the average age of aeroplanes in service is increasing, and the wiring in those aeroplanes has had more years of exposure to all these factors. Electrical wiring system malfunctions resulting from inadequate design, alteration, maintenance, inspection, and repair practices can cause incidents and accidents involving smoke, fire, and/or loss of function.

Another investigative group functioning within ATSRAC, was the Intrusive Inspection Working Group (IIWG). The IIWG was a separate but parallel group within the Ageing Systems Task Force (ASTF). The Air Transport Association (ATA) formed the ASTF in June 1998 to review the effectiveness of maintenance on electrical wiring systems and assess the condition of those systems on aircraft with type certificates older than 20 years.

When ATSRAC was formed in 1998, it continued the work started under the ASTF. The IIWG subjected selected wire installations on six decommissioned aeroplanes to an intensive, detailed visual inspection, followed by non-destructive testing and laboratory analysis. They analyzed the results to assess the state of wire on aged aeroplanes as a function of wire type and service history. In addition, the results from the visual inspections were compared with the non-destructive testing and laboratory analysis to determine the efficacy of visual inspections for the detection of age-related deterioration.

It should be noted that problems associated with systems on ageing aeroplanes are not only related to the degradation of wire over time. Inadequate design, installation, maintenance and modifications practices can also lead to what is commonly referred to as an "ageing systems" problem.

The findings from the IIWG were documented in the "Transport Aircraft Intrusive Inspection Project (An Analysis of the Wire Installations of Six Decommissioned Aircraft) Final Report," issued on December 29, 2000 (hereafter referred to as "Intrusive Inspection

Report"). The findings showed that wire-related failures have multiple causes. These include:

- Localized heat damage;
- Breaches in wire insulation;
- Wire embrittlement;
- Charred wire insulation;
- Missing insulation;
- Chafing;
- Arcing;
- Arc tracking;
- Reduced insulation resistance in certain wires;
- Defective and broken connectors;
- Damage to connector back-shells.

Both the non-intrusive and intrusive inspections found that most wiring discrepancies were in areas of frequent maintenance activity. In addition, fluid contamination and dust and dirt accumulations were found in those areas.

The Intrusive Inspection Report identified several areas that required special emphasis. Three areas – the cockpit, electrical power centres, and power feeder cables – were considered critical. This is because if chafing exists on wiring in these areas and flammable materials are in close proximity to the chafed wiring, severe outcomes, such as wire-to-structure or wire-to-wire shorting and arcing, can result. Since a fire in these areas could present a high risk to continued safe flight and landing, the IIWG recommended more detailed inspections for those three areas. The intent was to ensure that potential problems are identified and corrected.

This effort led to the development of an Enhanced Zonal Analysis Procedure (EZAP) to assess risk for fire to help ensure that maintenance programmes developed for wire systems in such critical areas would require more detailed inspections. An EZAP is a specifically wire-focused version of the zonal analysis procedure widely used to analyse an aeroplane in terms of each of its physical areas or zones. It is used for developing maintenance tasks. EZAP is discussed more fully in the discussion of proposed changes to CS-25 Appendix H, and one version of EZAP is described in AMC 20-21 "Programme to Enhance Aircraft Electrical Wiring Interconnection System Maintenance".

The NPA proposals are outlined as follows:

<u>Amendments to CS-25:</u>

- Amendments to existing CS-25 requirements that are necessary due to the creation of the new subpart H;
- Creating a new CS-25 Subpart H containing all wiring related regulations in one paragraph, entitled Electrical Wiring Interconnection System (EWIS). This new subpart is to contain new and revised wire related certification requirements (some taken from existing subparts of CS-25);
- Creation of new Acceptable Means of Compliance in CS-25 Book 2 to support the new Subpart H and 25.1357(f).

<u>Amendments to Commission regulation (EC) 2042/2003:</u>

- Amendment to Part M to amend M.A.706 (personnel requirements);

- Amendment to Part 66 syllabus module 7.7 to reflect EWIS training recommendations.

<u>Amendments to ED Decision No 2003/19/RM of 28.11.2003:</u>

- Amendments to AMC/GM to Part M.

<u>Amendments to AMC-20:</u>

- Introduction of new AMC to support conducting an EZAP;
- Introduction of new AMC to support training;
- Introduction of new AMC to support development of a new wiring standard practises manual.

<u>Intended airworthiness directives (ADs):</u>

- Draft Agency measure based on Part 21A.3B(c) that directs TC holders to review their existing designs in light of amended certification standards for an Enhanced Zonal Analysis Procedure (EZAP) for EWIS and produce new instructions for continuing airworthiness.

10. Detailed justification of amendments

<u>**Amendments to CS-25:**</u>

Changes to existing paragraphs

25.611 Accessibility provisions
Subparagraph (b) added to introduce EWIS and make a reference to CS 25.1719 in the new Subpart H.

25.855 Cargo or baggage compartments
Subparagraph (j) added to introduce EWIS and make reference to the new subpart H. The word wiring removed as it is considered redundant by the introduction of new subpara (j).

25.869 Fire protection: systems
The proposal is to move para (a)(3) on main power cables deformation to CS 25.1703 of the new Subpart H. Subparagraph (a)(4) on compliance with Appendix F is moved to CS 25.1713(c) of the new Subpart H.

25.1203 Fire detector system
Subparagraph (h) added to introduce EWIS and make reference to the new subpart H. The word wiring removed as it is considered redundant by the introduction of new subpara (h).

25.1301 Function and installation
Paragraph restructured and subparagraph (b) added to make reference to the new subpart H.

25.1309 Equipment, systems, and installations
A new subparagraph (d) has been added to refer to subpart H.

25.1353 Electrical equipment and installations
Subparagraph (a) has been revised as the word ‘wiring’ has been removed. By revising subparagraph (b) to refer to subpart H subpara (d) is considered to be redundant and is therefore deleted.

25.1357 Circuit protective devices

Subparagraph (f) added to clarify the requirement that circuit breakers should not be used as switches unless specifically designed for the purpose.

Appendix H Instructions for continued airworthiness
New paragraphs added to Appendix H to specifically address airworthiness limitations for EWIS. Proposed CS 25.1729 and Appendix H would apply the requirement for EWIS ICA to future applicants for TCs. EWIS ICA would be used by operators to prepare their maintenance programmes. This requirement would be necessary to ensure that wiring is properly maintained and inspected to avoid problems that could affect safety.

New Subpart H

General
The introduction of Subpart H to CS 25 would raise visibility of EWIS at the certification stage and enhance the safety of the transport aeroplane fleet. This would 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 would bring 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 CS 25 subpart H that is devoted to wire systems and contains existing, revised, and new wire system certification requirements would not only highlight the importance of properly designed, installed, and maintained wire systems in increasing safety of flight, but would 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) would be mitigated. The results and recommendations from the IIR indicate that problems associated with the wiring systems on ageing aeroplanes are not completely related to the degradation over time of wire systems. Age is not the sole cause of the wire degradation called “ageing”. 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.

25.1701 Definition
Proposed CS 25.1701 provides the definition of EWIS for the purposes of complying with the proposed subpart H requirements and other EWIS-related requirements.
Without this definition, the proposed rules could be inconsistently applied to various wire-related components. To completely address the safety issues associated with wiring systems, requirements must address not only the wiring itself, but also components and devices that are required to adequately install and identify each wire. Various components and devices needed to route and identify wires are critical in ensuring that a proper electrical interconnection is made and maintained.

25.1703 Function and Installation; EWIS
Proposed CS 25.1703 would require that applicants select EWIS components that are of a kind and design appropriate to their intended function. Factors such as the components’ design limitations, functionality, and susceptibility to arc tracking and moisture must be considered when selecting EWIS components.

CS 25.1301 requires that each item of installed equipment be of a kind and design appropriate to its intended function, be labelled (identified), be installed according to any limitations specified for it, and function properly when installed. This is a general "catch-all" regulation applicable to equipment and systems certified under subpart F. Because of its generality and the fact that the Agency has not published comprehensive advisory material for this requirement, CS 25.1301 has not been applied in a standardized way. Currently, CS 25.1301 is applicable to wire and its associated components but it does not provide sufficient wire-specific requirements to ensure proper function and installation of EWIS. Adoption of CS 25.1703 would ensure that the selection of EWIS components, and their installation, is carried out in a safe, consistent, and standardized manner.

25.1705 Systems and Functions; EWIS

Proposed CS 25.1705 requires that EWIS components be considered in showing compliance with the certification requirements of specific aeroplane systems. Many of the current CS 25 paragraphs contain system requirements that apply to EWIS in a non-specific way. The EWIS associated with such systems play an integral role in ensuring the safe operation of the system and of the aeroplane. The EWIS associated with any aeroplane system needs to be considered an integral part of that system and must be given the same design and installation attention as the rest of the system.

The current CS 25 requirements contain fire detection requirements for lavatories (CS 25.854) and cargo compartments (CS 25.858). The EWIS components must be considered an integral part of the fire detection system and meet the requirements of the applicable regulation. The proposal would apply to all required fire protection systems with the exception of powerplants and APUs.

25.1707 System Separation; EWIS

Proposed CS 25.1707 would require applicants to design EWIS with appropriate separation to minimize the possibility of hazardous effects upon the aeroplane or its systems.

Safe operation of aeroplanes depends in part on the safe transfer of electrical energy, a function provided by aeroplane EWIS. If an EWIS failure should occur, the separation between the failed EWIS and other EWIS and aeroplane systems plays an important role in ensuring that any hazardous effects of the failure are mitigated to an acceptable level. Thus, it is vital to design and install wiring systems with adequate separation from those systems whose interaction with the wire could create hazardous effects.

CS-25 does not adequately address wire system separation. The requirement currently used to require system separation are CS 25.1353(a), (b), and (c), but service experience has shown that compliance with these requirements with regard to wiring systems has not always been adequate. This is due in part to their lack of specific wording about which wiring systems are covered and which systems those wires are meant to be separated from. The proposed rule corrects these inadequacies by stating specifically that it applies to each EWIS on the aeroplane, and mandating specific separation requirements for certain aeroplane systems known to have potential for creating a hazardous condition.

The term "hazardous condition" in this proposed requirement is used in a different context than in the proposed CS 25.1709. Proposed CS 25.1709 uses the terms "hazardous" and "catastrophic" for failure conditions that could be associated with a numerical probability objective. The intent of the proposed CS 25.1707 is that the applicant must perform a qualitative design assessment of the installed EWIS and the physical separation to guard against hazardous conditions. This assessment would involve using reasonable engineering and manufacturing judgment and assessing relevant service history to decide whether an EWIS, any other type of system, or any structural component could fail in such a way that a condition affecting the aeroplane's ability to continue safe operation could result. A numerical probability assessment may still be required under the requirements of the proposed CS 25.1709 if the aeroplane level functional hazard assessment identifies failures that could affect safe operation of the aeroplane.

25.1709 System Safety; EWIS

Proposed CS 25.1709 would require applicants to perform a system safety assessment of the EWIS. The safety assessment must consider the effects that both physical and functional failures of EWIS would have on the aeroplane's safety. Based on that safety assessment, it must be shown that each EWIS failure considered to be hazardous is extremely remote. Each EWIS failure considered to be catastrophic must be shown to be extremely improbable and not result from a single failure.

The current requirement for system safety assessments is CS 25.1309. But current practice does not lead to the type of analysis that fully ensures all EWIS failure conditions affecting aeroplane level safety are considered. This is because the current CS 25.1309(a) only covers systems and equipment that are "required by this CS 25 or operating rules," and wiring for non-required systems is sometimes ignored. The current safety analysis requirements of CS 25.1309(b) have not always been applied to wire associated with the aeroplane systems that are covered by the same rule. When they are, there is evidence of inadequate and inconsistent application. This is especially true for miscellaneous electrical equipment that is not required, such as IFE systems. Traditional thinking about these non-required systems has been that, since they are not required, and the function they provide is not necessary for the safety of the aeroplane, their failure could not affect the safety of the aeroplane. This is not a valid assumption because failure of an electrical wire can have hazardous or even catastrophic results regardless of the system it is associated with.

25.1711 Component Identification; EWIS

Proposed CS 25.1711 requires applicants to identify EWIS components using consistent methods that facilitate easy identification of the component, its function, and its design limitations. For EWIS associated with flight-essential functions, identification of the EWIS separation requirement would also be required.

An important aspect of ensuring safe operation of aeroplanes is making sure that EWIS components are properly identified. This is necessary so that modification designers, maintenance personnel, and inspectors can easily determine the function of the associated system, together with any associated separation requirements and design limitations. Clear labeling of EWIS components and easy-to-understand identification aids allow installers, inspectors, and maintainers to readily ascertain that correct system components are installed as designed, and allow modifiers to add systems with due regard to the existing protection and separation requirements.

The current CS-25 for equipment identification is CS 25.1301(b) and it is applicable to "each item of installed equipment". This current requirement is inadequate for EWIS because it does not provide the specific requirements that have been determined necessary for identifying EWIS components. Specific EWIS component identification needs to be provided to prevent modifiers from unintentionally introducing unsafe design or installation features on previously certified aeroplanes when they install new or modified systems. Component identification would also make those performing maintenance and inspections more aware of what systems are associated with specific EWIS in the areas undergoing maintenance or inspection.

25.1713 Fire Protection; EWIS

Proposed CS 25.1713 requires that EWIS components meet the applicable fire and smoke protection requirements of CS 25.831(c) and CS 25.863. It would further require that EWIS located in designated fire zones be at least fire resistant. Insulation on electrical wires and cables would also be required to be self-extinguishing when tested in accordance with the applicable portions of Appendix F, Part I.

During an emergency situation it is important that aeroplane systems needed by the flightcrew to effectively deal with the emergency be operative. To help ensure this, CS 25.869 requires that electrical systems components meet certain flammability requirements and be designed and installed to minimize probability of ignition of flammable fluids and vapours. The proposal is to move the requirements of CS 25.869(a) related to protection of wiring from fire and put them into the proposed CS 25.1713. This will allow easy identification of the requirements for fire protection of EWIS, because they will be found in the proposed new subpart H, which is dedicated to EWIS. The provisions of CS 25.869 dealing with isolation from flammable fluid lines have been moved to the new CS 25.1707 and requirements for allowance for deformation and stretching have been moved to CS 25.1703.

25.1715 Electrical Bonding and Protection against Static Electricity; EWIS

Proposed CS 25.1715(a) requires that EWIS used for electrical bonding and protection against static electricity meet the requirements of CS 25.899.

The build-up and subsequent discharge of static electricity has the potential to create hazardous conditions for both aeroplane systems and people. Static electricity can injure people. It can also interfere with installed electrical/electronic equipment and cause ignition of flammable vapours. The proper design and installation of EWIS components used to accomplish such protection is critical to ensure the hazardous effects of static discharge are minimized. For example, the cross-sectional area of bonding paths used for primary bonding paths is important in ensuring that low electrical impedance is obtained, as is the method in which the bonding connection is made to the aeroplane structure. Thus, EWIS must be fully considered when designing and installing protection from the adverse effects of static electricity.

Proposed CS 25.1715(b) requires that EWIS components used for any electrical bonding purposes provide an adequate electrical return path under both normal and fault conditions.

25.1717 Circuit Protective Devices; EWIS

Proposed CS 25.1717 requires that electrical wires and cable be compatible with the circuit protective devices required by CS 25.1357.

This is based on existing CS 25.1353 (d)(1), which has been moved to the new subpart H as relevant to EWIS.

25.1719 Accessibility Provisions; EWIS

The proposed new CS 25.1719 requires that means be provided to allow for inspection of EWIS and replacement of their components as necessary for continued airworthiness.

Currently, CS 25.611 requires that means must be provided to allow inspection, replacement of parts, adjustment, and lubrication as necessary for principal structural elements and control systems. While EWIS is not specifically referred to in the existing requirements, the "accessibility" concept is easily applied to EWIS.

25.1721 Protection of EWIS

Proposed CS 25.1721 requires that cargo or baggage compartments do not contain any EWIS whose failure would adversely affect safe operation. It also requires that all EWIS be protected from damage by movement of people.

CS 25.855(e) currently requires that cargo or baggage compartments may not contain any controls, wiring, lines, equipment, or accessories whose damage or failure would affect safe operation of the aeroplane unless they are protected so that they cannot be damaged by movement of cargo in the compartment and their breakage or failure will not create a fire hazard.

25.1723 Flammable Fluid Protection; EWIS
The proposed CS 25.1723 requires that EWIS components be considered a potential ignition source in each area where flammable fluid or vapours might escape by leakage of a fluid system and must meet the requirements of CS 25.863. The current CS 25.863 mandates that, in each area where flammable fluids or vapours might escape by leakage of a fluid system, there must be means to minimize the probability of ignition, and resultant hazards if ignition does occur. Possible ignition sources, including overheating of equipment, malfunctioning of protective devices, and electrical faults must be considered in showing compliance with this requirement. Many types of electrical faults could cause ignition. Among them are sparks emitting from an avionics component, overheated electrical component surfaces, and arcing from electrical wiring.

25.1725 Powerplants; EWIS
The proposed CS 25.1725 specifies that EWIS associated with any powerplant must be designed and installed so that failure of an EWIS component will not prevent continued safe operation of the remaining powerplants or require immediate action by any crewmember for continued safe operation, in accordance with CS 25.903(b). It will also mandate that design precautions be taken to minimize hazards to the aeroplane because of EWIS damage in the event of a powerplant rotor failure or a fire originating in the powerplant that burns through the powerplant case, in accordance with CS 25.903(d)(1). The purpose of this paragraph is to ensure proper consideration of EWIS in evaluating powerplant installation designs.

25.1727 Flammable fluid shutoff means; EWIS
Proposed CS 25.1727 requires that EWIS associated with each flammable fluid shutoff means and control be "fireproof" as defined in CS-Definitions or located and protected so that any fire in a fire zone will not affect operation of the flammable fluid shutoff means, in accordance with CS 25.1189.

25.1729 Instructions for Continued Airworthiness; EWIS
New paragraph added to reference Appendix H to specifically address Instructions for Continued Airworthiness for EWIS

25.1731 Powerplant and APU fire detector system; EWIS
Proposed CS 25.1731 requires that EWIS that are part of a fire or overheat detector system located in a fire zone be at least fire-resistant, as defined CS-Definitions. It would also require that EWIS components of any fire or overheat detector system for any fire zone may not pass through another fire zone unless:

- they are protected against the possibility of false warning caused by fire in the zone through which they pass, or
- each zone involved is simultaneously protected by the same detector or extinguishing system.

The present rule does contain requirements for wire used in the fire detection systems. But to increase visibility of the related EWIS requirements and to gather them into one central place, a new rule devoted specifically to fire detector system EWIS is proposed.

Amendment to Commission Regulation (EC) No. 2042/2003 Part M

M.A.706 Personnel requirements

The new subpoaragraph (i) brings the requirements for competency in line with those of Part 21 and Part 145.

Amendments to Acceptable Means of Compliance to Part M:

AMC M.A.302(d) Maintenance programme – reliability programmes
Amended paragraph 5 of AMC M.A.302 wording highlights the need to take account of possible additional requirements for the existing fleet (as desribed in the possible Airworthiness Directive at the end of this NPA)

AMC M.A.706(e) Personnel Requirements
The new AMC M.A.706(e) brings the requirements for competency in line with those of Part 21 and Part 145.

Amendments to AMC-20; General Acceptable Means of Compliance

To support the implementation of the new and amended requirements related to EWIS.

Draft Agency measure based on Part 21A.3B(c)

In accordance with Part 21A.3B(c)1 the Agency intends to require that certain TC holders develop Instructions for Continued Airworthiness (ICA) for EWIS. These EWIS ICA will be imposed by the Agency through issuance of dedicated ADs on operators that would be required to implement them in their maintenance programmes. This requirement is necessary to ensure that wiring is properly maintained and inspected to avoid problems that could affect safety.

V. Regulatory Impact Assessment

1. Purpose and Intended Effect

a. Issue, which the NPA is intended to address and scale of the issue

Aeroplane 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 aeroplane 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 aeroplane accidents. There is concern that existing procedures, directive and inspections are not sufficient to prevent unsafe situations associated with the degradation of aeroplane wire.

A number of accident and incident reports in recent years have identified causal factors that include electrical arcing and damage to aircraft wiring. Significant accidents include a Boeing 747-131, N93119, near East Moriches, New York on July 17, 1996 (TWA 800 - NTSB/AAR-00/03), a Boeing 767-322ER N653UA at London Heathrow Airport on 9 January 1998 (AAIB/AAR 5/2000) and McDonnell Douglas MD-11 HB-IWF near Peggy's Cove, Nova Scotia on 2 September 1998 (Flight 111 - Canadian Report Number A98H0003).
Reports for the fatal accidents can be found via following links
Trans World Airlines Flight 800 NTSB Report (B747-131):
http://www.ntsb.gov/Publictn/2000/AAR0003.pdf

http://www.ntsb.gov/Publictn/2000/AAR0003_App.pdf
Swissair Flight 111 TSB Canada Report (MD-11):
http://www.bst.gc.ca/en/reports/air/1998/a98h0003/eReport/sr111_200303.pdf

Ageing and maintenance related wiring incidents continue to occur despite, generally, an enhanced awareness of the problems associated with aircraft wiring systems. Four such incidents are presented together in one issue of an UK AAIB Bulletin (Ref.: EW/C2002/11/02, see also http://www.aaib.gov.uk/cms_resources/dft_avsafety_pdf_029072.pdf); all feature damage to electrical wiring and identify similar causal factors. Although each incident may be read as a stand alone report, this overview document draws together the common issues and makes four additional Safety Recommendations. The four incidents are as follows:

EW/C2002/11/02	Boeing 737-436, G-DOCH	8 November 2002
EW/C2003/05/06	Boeing 737-436, G-DOCE	30 May 2003
EW/C2003/06/03	Concorde Type 1 V102, G-BOAC	13 June 2003
EW/C2003/07/07	Boeing 737-300, G-LGTI	30 July 2003

The visual inspections carried out by ATSRAC showed that aircraft wiring deteriorates with time and, particularly, in areas subject to high levels of maintenance activity. This is reflected in the incident to G-BOAC, where the airworthiness issues highlighted are not limited to Concorde, which is no longer in service, but reflect broader concerns on all aircraft types regarding wiring maintenance, particularly as aircraft age and modifications are introduced. The probable causal factor for a wire to chafe was introduced during a maintenance input two years prior to this incident, when the wiring was last disturbed. This ultimately led to a short duration in-flight fuel fire.

Similar factors were identified in the incident to a B737, G-DOCH, where a maintenance input led to the mis-routing of the water supply line. This resulted in abrasion between the wires and the hose, and in the shorting and severing of a number of the wires. The hose was too long for this application and the excess length had been looped through the overhead area and then secured by a tie-wrap to adjacent wire bundles. It was most likely that that this was simply a short-term expedient while systems were being disconnected and disassembled and that the 'temporary' tie-wrap was then missed during reassembly.

Loss of the pressurisation system on another B737, G-DOCE, resulted from the abrasion of the insulation of two or more wires in the affected loom. As in the other incidents, there was the possibility that the loom may have been damaged whilst maintenance was carried out in the area, and that this may have started the process which led to the conductors being exposed.

The incident to B737 G-LGTI occurred prior to flight, when the flight crew became aware of an electrical burning smell and smoke. The aircraft was shut down and the passengers evacuated. Pre-existing damage to the electrical galley feeder cables was identified which provided for the possibility of electrical arcing. It is probable that the damage to these cables occurred at an earlier time, during the replacement of the forward toilet service panel.

All these incidents show how prone electrical wiring is to damage, occurring over time or being introduced during maintenance or modification action. Periodic zonal inspections are carried out but damage and debris is often hidden within wiring bundles and is difficult to detect without disturbing the looms.

b. The objectives of the NPA

In order to effectively address the issues that have been identified as causal in the degradation of aeroplane wiring systems it is proposed that several certification specifications are to be amended and certain Agency continuing airworthiness measures are taken.
The JAA had made an earlier 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 also determined that wiring issues caused an unacceptably large proportion of electrical in flight incidents. However, since the ATSRAC activity was under way it was decided to combine the effort. An additional preliminary list of twenty wiring issues was prepared by the JAA and brought forth to the WSHWG.

Following a review of related wiring issues there was a consensus that current regulations fall short of providing specific requirements that the FAA, JAA (now EASA) and industry recognise that should be provided through the FAR 25 and CS 25 requirements. Examples include:

- System separation;
- Safety assessments;
- Protection of wires in fire zones and in cargo and baggage areas;
- Accessibility of wires for inspection, maintenance and repair;
- Wire identification.

Regulatory Authority studies also concluded that wiring system failures caused an unacceptably high number of in-service incidents and accidents. One study that looked at 'electrical systems' occurrence reports over a 15-year period found that approximately 60% were due to wiring failures and 13% were due to connector failures. The total number of occurrences over the 15-year period studied was 1388.

As a consequence it was decided to review all electrical wire related existing FAR/JAR 25 requirements and to create a new FAR 25 and JAR 25 (now CS 25) subpart H that would give wiring requirements a higher profile than currently exists and combine this with other new requirements to increase the level of safety and awareness that already exists. It was also agreed that comprehensive guidance material should also be proposed to complement the new subpart H Electrical Wiring Interconnection System (EWIS) requirements.

The proposed Advisory Material provides guidance for certification of Electrical Wiring Interconnection System (EWIS) on large aeroplanes. The guidance and recommendations are derived from the best practices developed through extensive research by ATSRAC Industry Working Group 6. While this is the primary focus, the guidance also supplements similar guidance provided in other AMC’s concerning EWIS requirements for other parts of the aeroplane systems. To fully realize the objectives of this material, type certificate holders, STC holders, maintenance providers, repair stations and persons performing modifications or repairs, will need to rethink their current approach to designing and modifying aeroplane wiring and systems. Design and modification personnel need to be aware that aeroplane EWIS should be designed and installed with the same level of attention as any other essential or critical system in the aeroplane.

2. Options

a. The options identified:
The following five regulatory options have been considered and are summarised below.
Option 1 – No new regulatory action.
Option 2 – Rely on voluntary compliance with the intent of the rule by affected parties.
Option 3 –Application of the new CS-25 standards without retro-active EZAP.
Option 4 – Application of the new CS-25 standards with retro-active EZAP applicable to TC holders only.
Option 5 – Application of the new CS-25 standards with retro-active EZAP applicable to TC and STC holders.
Other regulatory options were considered in the frame of the ATSRAC work in which many representatives from European Authorities participated. Those options were already covered by the work done by ATSRAC/FAA.

b. The preferred option selected:
See chapter 5 of this RIA.

3. Sectors concerned

It has been determined that the following sectors are potentially affected:

- TC and STC applicants and holders;
- Operators;
- Maintenance organisations;
- Training organisations;
- Regulatory authorities.

4. Impacts

4.1 Safety and Economic Impact

During the preparation of this NPA the rulemaking group in charge has made a considerable effort to obtain input from European sources for establishing quantified safety and economic impact data. Unfortunately the group was not successful in gathering the data from the European industry. Therefore, instead of presenting qualitative assessments of the European impacts, a copy of the FAA Cost Benefit Analysis which accompanied the FAA Notice of Proposed Rulemaking (NPRM 05-08[7]) on the same subject, is presented here for reference. This is regarded as a good indication of the costs and benefits in Europe, notably with regard to the relative amounts of the costs versus the benefits. This copy also includes the *Initial Regulatory Flexibility Determination* which gives an indication of the expected impact of the proposal on small businesses:

"Annual Burden Estimate
To provide estimates for the burden associated with this NPRM, the FAA developed categories corresponding to information collection impacts of requirements contained in the proposal. The summary table below contains the impacted entities, average annual hours and hardware costs, and the corresponding average annual cost. Details of the estimates are in the paragraphs below.

Entities impacted	Proposed requirement	Hardware cost	Average annual hours	Average annual cost
Airplane Manufacturers	Wire identification (30 seconds per label)		12,046	$430,524
Airplane Manufacturers	Label	5 cents per label		72,275
Airplane Modifiers	Wire identification (30 seconds per label)		18,417	658,224
Airplane Modifiers	Label	5 cents per label		110,500

[7] Federal Register / Vol. 70 No. 193 / Thursday, October 6, 2005 / Proposed Rules p. 58508

Existing TC Holders	Develop ICA		15,743	868,699
Future TC Applicants	Develop ICA		3,578	197,434
Future STC Applicants	Develop ICA		57,828	3,190,949
Airplane Manufacturers	Revise SWPM		1,035	57,111
Airplane Manufacturers	Develop Compliance Plan		132	7,284
Airplane Operators	Revise Maintenance Program		2,744	151,414
Airplane Operators	Develop Training Program		2,376	131,108
Total			113,899	5,875,522

Proposed § 25.1711 would affect airplane manufacturers by requiring additional labelling. Over the 25-year period of analysis, manufacturers would label on average 413 airplanes yearly. The FAA estimates that an additional 3,500 labels might be added to wires in each part 25 airplane, for 1,445,500 labels annually. The additional identification requirement would take roughly 30 seconds, requiring approximately 12,046 annual hours. Using the fully burdened hourly cost of a mechanic ($35.74), the average annual hourly burden for the wire identification requirement on manufacturers is $430,524. The estimated cost resulting from information collection from TC holders also considers the additional cost of labels. The additional manufacturer identification requirements would require roughly 1,445,500 labels annually. Industry representatives provided the FAA with cost estimates for each label of approximately 5 cents. The estimated annual corresponding cost is $72,275. Section 25.1711 would also affect airplane modifiers when electrical wiring supplemental type certificates (STC) are installed on airplanes. The FAA estimates there would be an additional 200 labels added each time an affected STC is installed on an airplane. Using 170 as the average annual affected number of STCs, and 65 as the number of installations per STC, the corresponding total annual number of labels for STCs is 2,210,000. The identification requirement would take about 30 seconds for each additional label, requiring an annual burden of roughly 18,417 hours. Using the fully burdened hourly cost of a mechanic ($35.74), the annual burden on airplane modifiers for the wire identification requirement is $658,224. Estimated costs resulting from information collection from STC applicants consider the additional cost of labels. The additional STC identification requirements would require roughly 2,210,000 labels annually. With the cost of each label approximately 5 cents, the estimated average annual corresponding cost is $110,500. The proposal would require that existing TC holders develop ICA for EWIS. Over the period of analysis, the FAA estimates the proposal would require 15,743 average annual engineering hours, resulting in an average annual cost of $868,699 (using the fully burdened hourly rate of $55.18 for an engineer). Proposed §25.1805 would also require future TC applicants to develop ICA for EWIS. The FAA estimates roughly .5 part 25 TCs yearly, with average annual estimated labour hours to perform the analysis of 3,578. This would result in average annual costs of $197,434. The proposal would require future applicants for STCs to develop ICA for EWIS as well. Over the period of analysis, the FAA estimates it would take 948 annual STC applicants 61 hours to perform the analysis. With engineering costs of $55.18 per hour, the average annual burden would be $3,190,949. Because of this proposal, manufacturers would change their Standard Wiring Practices Manual (SWPM). The FAA calculates 1,035 as the average annual hours required to update manuals, resulting in an average annual burden of roughly $57,111. Manufacturers would present a plan for approval describing how they intend to comply with the requirements. The FAA believes the data contained in this plan would be submitted electronically with no cost to submit the plan. We estimate 60 labour hours (per airplane model) to develop a plan and submit data to the FAA. We estimate 3,300 hours for roughly 55 models. The average annual hours are 132, with corresponding average annual costs of $7,284 (using the fully burdened hourly cost of $55.18). Operators would be required to revise their existing maintenance program to incorporate the maintenance and inspection tasks for EWIS contained in the EWIS ICA. Over the period of analysis, the FAA estimates 68,607 total hours, or 2,744 average annual hours required to revise existing maintenance programs. Using the fully burdened labour cost for an engineer, the average annual planning cost would be $151,414. The estimated cost to develop training considers the industry's standard training factor of 200 hours per one hour of prepared training material. 600 hours is the estimated training development time for the 3-hour training course for each operator. When combined with 99 operators, the total hours would be 59,400 or 2,376 annually. Combined with the burdened hourly cost of $55.18, the average annual cost for training development would be $131,108.

Cost Assumptions and Sources of Information
Discount rate—7%
Period of analysis—25 Years, 2005 through 2029
Burdened labour rate (as shown in key assumptions & labour rates in regulatory evaluation)—

- Aerospace engineers—$55.18/hour
- Maintenance personnel—$35.74/hour

Value of fatality avoided—$3.0 million (Source: ''Revised Departmental Guidance, Treatment of Value of Life and Injuries in Preparing Economic Evaluations,'' Office of the Secretary of Transportation Memorandum'', January 29, 2002)
Fleet—FAA Flight Standards (SPAS Database)
Fleet Growth (3.82% per year) & Passenger Occupancy Rates (75%)—FAA Aerospace Forecasts Years 2003–2014
Failures, Incidents and Accidents—The National Aviation Safety Data Analysis Center
Aircraft Value—Economic Values for Evaluation of Federal Aviation Administration Investment and Regulatory Programs 1998

Costs of This Rulemaking
The FAA estimates $474.3 million ($209.2 million present value) as the total cost of this proposal. In the table below, the left-hand column specifies the cost component by 14 CFR part, the middle column gives the nominal cost, and the right-hand column gives the total incremental present value costs by 14 CFR part.

Cost component	Nominal values (millions)	Present value (millions)
Part 25 Harmonization	0	0
Part 25 Subpart H	$131.9	$53.8
Part 25 Subpart I	23.3	20.3
Part 121 ICA	319.1	135.1
Parts 91/121/125—Fuel Tank	(*)	
Total	474.3	209.2

** De minimus.*

Benefits of This Rulemaking
The FAA estimates $755.3 million ($340.7 million present value) as the total benefits of this proposal. In the table below, categories of benefits are shown. The middle column gives the nominal values of quantified benefits, while the right-hand column gives the total incremental present value benefits broken down by category type.

Benefits	Nominal values (millions)	Present value (millions)
Non Fatal & Fatal Accidents:		
Non Fatal events	$56.0	$26.1
Fatal events	507.0	236.3
Total	563.0	262.4
EWIS Operational Improvements:		
Averted delays	21.2	8.3
Averted unscheduled landings	152.4	62.4
Averted IFE failures	18.7	7.6
Total	192.3	78.3
Total—All Benefits	755.3	340.7

The total estimated benefits of the proposal are comprised of efficiency benefits and safety benefits. The efficiency benefits are $192.3 million ($78.3 million present value). The safety benefits are $563 million ($262.4 million present value). From 1995– 2002, 397 wiring failures were reported. We used industry estimates to determine that 68% of those failures would be detectable. The 7 most common—burned, loose, damaged, shorted, failed, chafed, and broken wires—account for 84% of all wiring failures. Wiring failures cause 22.1 flight delays per year, with an average time of 3.5 hours and an estimated cost of approximately $35,639 each, and without this proposal, we believe that wiring delays will increase proportionately with the growth of the fleet. Wiring failures cause 27.5 unscheduled landings per year at an average cost of approximately $200,461 per unscheduled landing. We estimate that, based on expected fleet growth of 3.82% per year, there will be 1,118 unscheduled landings caused by wiring failures over a 25-year period, of which approximately 760 would be prevented by this proposal, resulting in a total benefit of averting unscheduled landings of $152.4 million. Delays and unscheduled landings contain safety risks for passengers and crew and increase the likelihood of a more serious event. We estimate 32.8 wiring-related incidents or accidents could be prevented by this proposal in the next 25 years, for a total safety benefit of $563 million ($262.4 million present value). This includes 1.2 fatal accidents that can be prevented.

Summary
The estimated total cost of this NPRM is $474.4 million ($209.2 million present value) over 25 years. The total estimated benefits are $755.3 million ($340.7 million present value) over the same period. This proposal is meant to proactively address wiring conditions existing in the transport airplane fleet that we now know affect safe flight and can be detected, corrected, or prevented.

Initial Regulatory Flexibility Determination
The Regulatory Flexibility Act of 1980 (RFA) establishes ‘‘as a principle of regulatory issuance that agencies shall endeavour, consistent with the objective of the rule and of applicable statutes, to fit regulatory and informational requirements to the scale of the business, organizations, and governmental jurisdictions subject to regulation.’’ To achieve that principle, the RFA requires agencies to solicit and consider flexible regulatory proposals and to explain the rationale for their actions. The RFA covers a wide-range of small entities, including small businesses, not-for-profit organizations, and small governmental jurisdictions. Agencies must perform a review to determine whether a proposed or final rule will have a significant economic impact on a substantial number of small entities. If the agency determines that it will, the agency must prepare a regulatory flexibility analysis as described in the Act. However, if an agency determines that a proposed or final rule is not expected to have a significant economic impact on a substantial number of small entities, section 605(b) of the 1980 RFA provides that the head of the agency may so certify and a regulatory flexibility analysis is not required. The certification must include a statement providing the factual basis for this determination, and the reasoning should be clear. This proposed rule would not have a significant economic impact on a substantial number of small entities for the following reasons. Entities potentially affected by this proposal include part 25 manufacturers, applicants for future amended and supplemental type certificates, and part 121 operators of large transport category airplanes. The FAA uses the size standards from the Small Business Administration for Air Transportation and Aircraft Manufacturing, which specify companies having less than 1,500 employees as small entities. The current United States part 25 airplane manufacturers include: Boeing, Cessna Aircraft, Gulfstream Aerospace, Learjet (owned by Bombardier), Lockheed Martin, McDonnell Douglas (a wholly-owned subsidiary of The Boeing Company), Raytheon Aircraft, and Sabreliner Corporation. These manufacturers would incur type certificate (TC) and amended TC costs. Because all U.S. transport-aircraft category manufacturers have more than 1,500 employees, none are considered small entities. Future supplemental type certificate (STC) applicants would incur additional compliance costs. These STC applicants would incur the cost only if the expected revenue from the STC would exceed the expected cost. While future STC costs would be passed on to airplane operators, it is not possible to determine when and which operator would purchase and install such a future STC. Because a future STC applicant would incur the additional compliance cost only if the STC would generate profits, the FAA believes there would not be a significant impact on a substantial number of STC applicants. The FAA calculated the economic impact on small-business part 121 operators by dividing the annual compliance cost by the firm’s annual revenue. The annual estimated average annual cost of the proposal would approach 1⁄2 of 1 percent for only two small entities. For the others, the cost impact would be a few hundredths of 1 percent of revenue. The FAA has determined that: No part 25 manufacturers are small entities, there would not be a significant impact on a substantial number of amended TC or STC applicants, the estimated operator compliance cost as a percent of annual revenue would not be significant. Accordingly, pursuant to the Regulatory Flexibility Act, 5 U.S.C. 605(b), the Federal Aviation Administration certifies that this proposed rule would not have a significant impact on a substantial number of small entities.”

4.2 Safety and Economic Impact for the various options

4.2.1 Option 1 - No new regulatory action

This option would not bring any safety benefit nor any implementation costs. However the negative economic impact due to accidents incidents and flight delays will be considerable.

4.2.2 Option 2 – Rely on voluntary compliance with the intent of the rule by affected parties.

To rely on voluntary industry change, as proposed in option 2, would show some safety benefits however these would be difficult to quantify and would ensure neither consistent results nor the achievement of the safety objectives of this proposal for the current and future fleet.

4.2.3 Option 3 –Application of the new CS-25 standards without retro-active EZAP.
Option 3 would have a safety benefit over the longer term but this will not address existing type certificated aircraft. This option would result in continued incidents and accidents resulting from wiring system failures on existing fleets. The rate of improvement would be directly proportional to operator fleet renewal.

4.2.4 Option 4 – Application of the new CS-25 standards with retro-active EZAP applicable to TC holders only.
Option 4 would give the safety and economic impacts as indicated in the FAA Cost Benefit Analysis. The additional benefit will be the full harmonisation of the EASA and the FAA rules.

Option 5 – Application of the new CS-25 standards with retro-active EZAP applicable to TC and STC holders.
Option 5 would give the greatest safety benefit. However the safety and economic impact cannot be quantified due to a lack of data. The costs for each individual STC holder may not be high but due to the large number of affected STC holders the total costs can be considerable.

4.3 Harmonisation with other authorities

It was a driving factor to harmonize with the FAA rulemaking initiative to the biggest degree possible.

As a lot of the work on the US side was initiated by the FAA and the FAA has indicated their intention to proceed with legislation, the implementation of this EASA NPA will ensure the harmonisation with the FAA.

TCCA (Transport Canada), and ANAC (formerly CTA Brazil) also have comparable harmonised rulemaking activities.

The proposal does not conflict with ICAO Annex 8 Part IIIB, Electrical systems.

4.4 Environmental Impact

The change of regulation will require more labelling effort for wiring. This will mostly be achieved via on laser marking machines which might produce ozone. But in the frame of the overall process of labelling this can be neglected.

Also some cleaning agents may be used for some procedures. But in the frame of the overall process of cleaning this can be neglected.

Other changes of material are not expected apart from changes that are already going on from other rulemaking activities.

Although it is not possible to quantify precisely the effect, the introduction of the NPA should not have any significant impacts on the environment.

4.5 Social Impact

Working conditions will not change significantly for workers in the aviation industry, it is not expected that workers will be dismissed if they are not trained according to this rulemaking.
In contrast it can be assumed that more people would be employed due to the constant need to perform EZAP.

4.6 Impact on other aviation requirements outside EASA scope

The Agency has not identified contradictions of the envisaged measures with other EU regulations.

5. Summary and Final Assessment

Five options have been considered to address the above safety issues and the safety and economic arguments made for each.

Option 1 – No new regulatory action.
The result of taking no action would be continued incidents and accidents resulting from wiring system failures. The Agency would continue to address these situations ‘‘reactively’’ on a case-by-case basis (as they occur) by issuing airworthiness directives. This is unacceptable from a safety standpoint.
Improved certification regulations, inspection and maintenance programs, and ICA for wiring systems are needed to address the potential for similar problems arising on existing and future designs, and to ensure their long-term safety.

Option 2 – Rely on voluntary compliance with the intent of the rule by affected parties.
Some in industry have suggested simply issuing AMCs to give guidance on the changes that need to be made. Issuing AMCs would depend on voluntary compliance, and would not be enforceable. While certain members of the industry would proceed with voluntary programs, others would not.
The use of AMCs alone would ensure neither consistent results nor the achievement of the safety objectives of this proposal for the current and future fleet. Previous voluntary safety assessments, such as those relating to the thrust reverser and cargo door reviews, have been difficult to complete in a timely manner because they lacked enforceability. The proposed rules provide an enforceable means to require timely completion of the actions identified as necessary to address ageing electrical wiring systems.

Option 3 –Application of the new CS-25 standards without retro-active EZAP.
The application of the NPA without retro-active EZAP would not address the current existing fleets and would only apply for new types of aeroplane or STCs. There would be continued incidents and accidents resulting from wiring system failures on existing fleets.

Option 4 – Application of the new CS-25 standards with retro-active EZAP applicable to TC holders only.
This option will address the basic aircraft design, however this option would not address EWIS changes introduced by previous STC action.
The above evaluation of the safety and economic impact indicate that the implementation costs associated with this option are commensurate with the expected safety benefit.

Option 5 – Application of the new CS-25 standards with retro-active EZAP applicable to TC and STC holders.
This option would enhance safety of current existing fleets and would improve the design for new types of aeroplane and STCs. It would achieve the biggest safety gain. However both the safety gain and the implementation costs for this option cannot be quantified.

The EASA rulemaking group responsible for drafting this NPA was in favour of option 5 because this would achieve the best safety enhancement.
However the Agency has concluded that Option 5 is not the preferred option for two principle reasons:

- The lack of data to quantify the additional safety and economic impact compared to option 4:
  Without this data the Agency cannot substantiate that the additional compliance costs are justified by the added safety gain.
- The expected difficulty to enforce the retroactive measure for STC holders:
  Currently the only available legal tool for the Agency to impose retroactive airworthiness measures is the airworthiness directive. Due to a number of legal constraints those airworthiness directives can only be issued by the Agency if they can be addressed to a known design approval holder. All national STCs or similar that were issued before the EASA rules became applicable (28 September 2003) are deemed to have been issued by the Agency but currently the Agency does not have an overview of all these “grandfathered” STCs. It will therefore be impossible to identify all the STCs that would be affected by the measure. This situation may improve in the future if this historical data would be gathered. At that moment in time the Agency might reconsider extending the retroactive measure. The Agency position can also be reconsidered if other legal tools would become available for mandating continuing airworthiness measures.

The Agency therefore concludes that option 4 is the preferred option.

B. DRAFT OPINION AND DECISIONS

The following explanation must be given before the actual draft text.

The text of the amendment is arranged to show deleted text, new text or new paragraph as shown below:

1. ~~Text to be deleted is shown with a line through it.~~
2. New text to be inserted is highlighted with grey shading.
3. New paragraph or parts are not highlighted with grey shading, but are accompanied by the following box text:

Insert new paragraph / part *(Include N° and title)*, ore replace existing paragraph/ part

4. ….
   Indicates that remaining text is unchanged in front of or following the reflected amendment.
   ….

I. Amendments to CS-25

<u>Amendments to existing CS-25 requirements, Book 1</u>

CS 25 Book 1 and Book 2 Table of Contents

a. Add the new Subpart H in the table of contents

SUBPART H - ELECTRICAL WIRING INTERCONNECTION SYSTEMS

CS-25 Book 1 Subparts D & F

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

25.611 Accessibility provisions

(a) 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. Non-destructive 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 CS 25.1529.

(b) Electrical wiring interconnection systems must meet the accessibility requirements of CS 25.1719

c. Amend CS 25.855 by removing the word "wiring" from paragraph (e) and adding new paragraph (j) as follows:

CS 25.855 Cargo or baggage compartments.

….

(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–

….

(j) Cargo or baggage compartment electrical wiring interconnection system components must meet the requirements of CS 25.1721

d. Amend CS 25.869 by revising subparagraph (a)(2),replacing subparagraph (a)(3) by a new text and deleting subparagraph (a)(4) as follows:

CS 25.869 Fire protection: systems

(a) Electrical system components:

….

(2) ~~Electrical cables, terminals, and e~~Equipment in designated fire zones, that ~~are~~ is used during emergency procedures, must be at least fire resistant

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

~~(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.~~

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

CS 25.1203 Fire detector system.

….

(e) ~~Wiring and other c~~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 CS 25.1713 and 1731.

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

CS 25.1301 Function and installation.

(a) Each item of installed equipment must –

(~~a~~1) Be of a kind and design appropriate to its intended function;

(~~b~~2) Be labelled as to its identification, function, or operating limitations, or any applicable combination of these factors (see AMC 25.1301(~~b~~a)(2)).

(~~c~~3) Be installed according to limitations specified for that equipment.

(b) Electrical wiring interconnection systems must meet the requirements of subpart H of this CS-25.

g. Amend CS 25.1309 by adding a new paragraph (d) as follows:

CS 25.1309 Equipment, systems and installations

….

(d) Electrical wiring interconnection systems must be assessed in accordance with the requirements of CS 25.1709.

h. Amend CS 25.1353 by revising sub-paragraphs (a) & (b) and deleting sub-paragraph (d) as follows:

CS 25.1353 Electrical equipment and installations

(a) Electrical equipment~~,~~ and 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 AMC 25.1353 (a).)

(b) ~~Cables must be grouped, routed and spaced so that damage to essential circuits will be minimised if there are faults in cables, particularly heavy current-carrying cables.~~ Electrical Wiring Interconnection System components must meet the requirements of 25.1357, 25.1703, 25.1707, 25.1711 and 25.1717.

….

(d) Reserved ~~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 CS 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.~~

….

i. Amend CS 25.1357 by adding a new paragraph (f) as follows:

CS 25.1357 Circuit protective devices

….

(f) ~~Reserved~~ For aeroplane systems for which the ability to remove or reset power during normal operations is necessary, the system must be designed so that circuit breakers are not the primary means to remove or reset system power, unless specifically designed for use as a switch. (see AMC 25.1357(f))

….

CS-25 Book 1 Appendix H

j. Add "and 25.1729" to the end of H 25.1 paragraph (a) as follows:

H25.1 General

(a) This Appendix specifies requirements for the preparation of Instructions for Continued Airworthiness as required by CS 25.1529 and CS 25.1729.

….

k. Amend H 25.4 Airworthiness Limitations Section to read:

H25.4 Airworthiness Limitations Section

(a) The Instructions for Continued Airworthiness must contain a section titled Airworthiness Limitations that is segregated and clearly distinguishable from the rest of the document. This section must set forth –

(1) Each mandatory replacement time, structural inspection interval, and related structural inspection procedure approved under CS 25.571; and

(2) *Reserved*

(3) Any mandatory replacement time of EWIS components as defined in CS 25.1701 (see AMC Appendix H 25.4(a)(3))

(b) If the Instructions for Continued Airworthiness consist of multiple documents, the section required by this paragraph must be included in the principal manual. This section must contain a legible statement in a prominent location that reads: 'The Airworthiness Limitations Section is approved and variations must also be approved'.

l. Add a new H 25.5 EWIS ICA as follows:

H25.5 Electrical Wiring Interconnection System Instructions for Continued Airworthiness

The applicant must prepare Instructions for Continued Airworthiness applicable to Electrical Wiring Interconnection System as defined in CS 25.1701. (see AMC Appendix H 25.5)

New CS-25 Subpart H Electrical Wiring Interconnection System, Book 1

m. Add a new subpart H to read as follows:

SUBPART H - ELECTRICAL WIRING INTERCONNECTION SYSTEM

25.1701 Definition (see AMC 25.1701)

(a) Electrical wiring interconnection system (EWIS) means any wire, wiring device, or combination of these, including termination devices, installed in any area of the aeroplane for the purpose of transmitting electrical energy between two or more intended termination points. Except as provided for in subparagraph (c) of this paragraph, this includes:

(1) Wires and cables.

(2) Bus bars.

(3) The termination point on electrical devices, including those on relays, interrupters, switches, contactors, terminal blocks, and circuit breakers and other circuit protection devices.

(4) Connectors, including feed-through connectors.

(5) Connector accessories.

(6) Electrical grounding and bonding devices and their associated connections.

(7) Electrical splices.

(8) Materials used to provide additional protection for wires, including wire insulation, wire sleeving, and conduits that have electrical termination for the purpose of bonding.

(9) Shields or braids.

(10) Clamps and other devices used to route and support the wire bundle.

(11) Cable tie devices.

(12) Labels or other means of identification.

(13) Pressure seals.

(b) The definition in subparagraph (a) of this paragraph covers EWIS components inside shelves, panels, racks, junction boxes, distribution panels, and back-planes of equipment racks, including, but not limited to, circuit board back-planes and wire integration units.

(c) Except for the equipment indicated in subparagraph (b) of this paragraph, EWIS components inside the following equipment, and the external connectors that are part of that equipment, are excluded from the definition in subparagraph (a) of this paragraph:

(1) Electrical equipment or avionics that is qualified to environmental conditions and testing procedures when those conditions and procedures are -

(i) Appropriate for the intended function and operating environment, and

(ii) Acceptable to the Agency.

(2) Portable electrical devices that are not part of the type design of the aeroplane. This includes personal entertainment devices and laptop computers.

(3) Fibre optics.

25.1703 Function and Installation; EWIS (see AMC 25.1703)

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

(1) Be of a kind and design appropriate to its intended function.

(2) Be installed according to limitations specified for the EWIS components.

(3) Function properly when installed.

(4) Be designed and installed in a way that will minimise mechanical strain.

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

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

(d) EWIS components located in areas of known moisture accumulation must be adequately protected to minimise any hazardous effect due to moisture.

(e) EWIS modifications to the original type design must be designed and installed to the same standards used by the original aeroplane manufacturer or other equivalent standards acceptable to the Agency.

25.1705 Systems and Functions; EWIS

(a) EWIS associated with systems required for type certification or by operating rules must be considered an integral part of that system and must be considered in showing compliance with the applicable requirements for that system.

(b) For systems to which the following rules apply, the components of EWIS associated with those systems must be considered an integral part of that system or systems and must be considered in showing compliance with the applicable requirements for that system.

(1) CS 25.773(b)(2) Pilot compartment view.

(2) CS 25.854 Lavatory fire protection

(3) CS 25.858 Cargo compartment fire detection systems

(4) CS 25.981 Fuel tank ignition prevention.

(5) CS 25.1165 Engine ignition systems.

(6) CS 25.1203 Fire-detector systems

(7) CS 25.1303(b) Flight and Navigation Instruments

(8) CS 25.1310 Power source Capacity and Distribution

(9) CS 25.1316 System lightning protection

(10) CS 25.1331(a)(2) Instruments using a power supply

(11) CS 25.1351 General.

(12) CS 25.1355 Distribution system.

(13) CS 25.1360 Precautions against injury.

(14) CS 25.1362 Electrical supplies for emergency conditions.

(15) CS 25.1365 Electrical appliances, motors, and transformers.

(16) CS 25.1431(c) and (d) Electronic equipment.

25.1707 System Separation; EWIS (see AMC 25.1707)

(a) Each EWIS must be designed and installed so that under normal or failure condition as defined by CS 25.1309, it will not adversely affect the simultaneous operation of any other systems necessary for continued safe flight, landing and egress. Unless otherwise stated, for the purposes of this paragraph, adequate physical separation must be achieved by separation distance or by a barrier that provides protection equivalent to that separation distance.

(b) Each EWIS must be designed and installed such that any electrical interference likely to be present in the aeroplane will not result in hazardous effects upon the aeroplane 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 minimised under fault conditions.

(d) Each EWIS associated with independent aeroplane power sources must be designed and installed to ensure adequate physical separation and electrical isolation so that a fault in any one aeroplane power source EWIS will not adversely affect any other independent power sources. In addition:

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

(2) Aeroplane system's static grounds must not share a common ground terminating location with any of the aeroplane 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 physical separation from fuel lines and other fuel system components, such that

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

(2) 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 physical separation from hydraulic lines and other hydraulic system components, such that

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

(2) 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 physical separation from oxygen lines and other oxygen system components, such that an 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 physical separation from water/waste lines and other water/waste system components, such that

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

(2) Water/waste leakage onto EWIS components will not create a hazardous condition.

(i) Electrical wiring interconnection systems must be designed and installed with adequate physical separation 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) An 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 a hazardous condition.

(j) Electrical wiring interconnection systems must be designed and installed with adequate physical separation between the EWIS components and heated equipment, hot air ducts, and lines such that;

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

(2) Hot air leakage or generated heat onto EWIS components will not create a hazardous condition.

(k) For systems for which redundancy is required either by specific certification requirements, operating rules or by CS 25.1709, each applicable EWIS must be designed and installed with adequate physical separation.

(l) Each EWIS must be designed and installed such that there is adequate physical separation between it and aeroplane structure and the EWIS is protected from sharp edges and corners, to minimise potential for abrasion/chafing, vibration damage, and other types of mechanical damage.

25.1709 System Safety; EWIS (see AMC 25.1709)

EWIS must be designed and installed so that:

(a) Each catastrophic failure condition

(1) is extremely improbable; and

(2) does not result from a single failure; and

(b) Each hazardous failure condition is extremely remote.

25.1711 Component identification; EWIS (see AMC 25.1711)

(a) EWIS components must be labelled or otherwise identified using a consistent method that facilitates identification of the wire, its function, and its design limitations, if any.

(b) For systems for which redundancy is required either by specific certification requirements, operating rules or by CS 25.1709, 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 aeroplane so they are readily visible to maintenance, repair, or alteration personnel.

(2) If an EWIS component cannot be marked physically, then others means of identification must be provided.

(c) The identifying markings required by sub-paragraphs (a) and (b) must remain legible throughout the expected service life of the EWIS component.

(d) The means used for identifying each EWIS component as required by this paragraph must not have an adverse effect on the performance of that component throughout its expected service life.

(e) Identification for EWIS modifications to the type design must be consistent with the identification scheme of the original type design.

25.1713 Fire Protection; EWIS (see AMC 25.1713)

(a) All EWIS components must meet the applicable fire and smoke protection requirements of CS 25.831(c) and CS 25.863.

(b) EWIS components that are located in designated fire zones and 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 aeroplane, must be self-extinguishing when tested in accordance with the applicable portions of Part I, Appendix F.

25.1715 Electrical bonding and protection against static electricity; EWIS (see AMC 25.1715)

(a) EWIS components used for electrical bonding and protection against static electricity must meet the requirements of CS 25.899.

(b) Electrical bonding provided by EWIS components must provide an adequate electrical return path under both normal and fault conditions, on aeroplanes having earthed electrical systems (see CS 25.1353(e)).

25.1717 Circuit protective devices; EWIS (see AMC 25.1717)

EWIS components must be designed and installed so they are compatible with the circuit protection devices required by CS 25.1357, so that a fire or smoke hazard cannot be created under temporary or continuous fault conditions.

25.1719 Accessibility Provisions; EWIS (see AMC 25.1719)

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

25.1721 Protection of EWIS (see AMC 25.1721)

(a) No cargo or baggage compartment may contain any EWIS whose damage or failure may affect safe operation, unless the EWIS is protected so that:

(1) It cannot be damaged by the movement of cargo or baggage in the compartment.

(2) Its breakage or failure will not create a fire hazard.

(b) EWIS must be designed and installed to minimise damage and risk of damage to EWIS by movement of people in the aeroplane during all phases of flight, maintenance, and servicing.

(c) EWIS must be designed and installed to minimise damage and risk of damage to EWIS by items carried onto the aeroplane by passengers or cabin crew.

25.1723 Flammable fluid protection; EWIS (see AMC 25.1723)

EWIS components must be considered to be a potential ignition source in each area where flammable fluid or vapours might escape by leakage of a fluid system and must meet the requirements of CS 25.863.

25.1725 Powerplants; EWIS

(a) EWIS associated with any powerplant must be designed and installed so that the failure of an EWIS component 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 CS 25.903(b).

(b) Design precautions must be taken to minimise hazards to the aeroplane 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 CS 25.903(d)(1).

25.1727 Flammable Fluid Shutoff Means; EWIS

EWIS 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 CS 25.1189.

25.1729 Instructions for Continued Airworthiness; EWIS

The applicant must prepare Instructions for Continued Airworthiness applicable to EWIS in accordance with the requirements of CS 25.1529 and Appendix H 25.4 and H 25.5.

25.1731 Powerplant and APU fire detector system; EWIS

(a) EWIS 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.

New and amended AMC to CS-25, Book 2

n. AMC 25.1301(b): Delete paragraph 1 and make paragraph 2 a stand-alone paragraph to be re-titled as:

AMC 25.1301(~~b~~a)(2)
Function and Installation

~~1. Adequate means of identification should be provided for all cables, connectors and terminals. The means employed should be such as to ensure that the identification does not deteriorate under service conditions.~~

~~2.~~ When pipelines are marked for the purpose of distinguishing their functions, the markings should be such that the risk of confusion by maintenance or servicing personnel will be minimised. Distinction by means of colour markings alone is not acceptable. The use of alphabetic or numerical symbols will be acceptable if recognition depends upon reference to a master key and any relation between symbol and function is carefully avoided. Specification ISO.12 version 2ED 1987 gives acceptable graphical markings.

o. Insert the following new AMC 25.1357(f):

AMC 25.1357(f)
System Power Removal

(1) Subparagraph 25.1357(f) requires that circuit breakers are not used as the primary means to remove or reset system power for those aeroplane systems for which the ability to remove or reset power during normal operation is necessary.

(2) It is not the intent of the requirement that every electrically powered system in the aeroplane has a means to remove power other than a circuit breaker. The phrase "normally requiring power removal" is used to distinguish between aeroplane systems normally turned on and off during normal operations, and those systems normally powered at all times, such as flight deck multi-function displays or the flight-management computer. But if, for example, the flight-management computer did require power cycling regularly, for whatever reason, this system would be required to have a means to do this other than using the circuit breakers.

(3) Systems requiring power removal during normal operations should be designed so that power is removed from the system as closely as practical to the source of power instead of simply deactivating the outputs of the systems power supplies.

(4) A separate, or integrated, power switch may be used to show compliance with CS 25.1357(f). If an integrated switch is used (that is, a switch that controls power to multiple aeroplane systems), then it must be shown that removing or resetting power for those multiple systems will not adversely affect safe flight.

(5) A switch-rated circuit breaker can be used if it is shown to be appropriately rated for the number of switch cycles expected to be executed during the service life of the system or of the circuit breaker.

p. Insert the following new AMCs to Subpart H

AMC 25 Subpart H
Correlation with previous amendment of CS-25

The following table provides correlation between CS-25 Subpart H and CS-25 requirements at amendment 2:

Subpart H Requirements	Paragraph	Based on initial CS-25 requirements
CS 25.1701 Definition	(a)	none
	(b)	none
	(c)	none
CS 25.1703 Function and installation; EWIS	(a)(1)	CS 25.1301(a)
	(a)(2)	CS 25.1301(c)
	(a)(3)	CS 25.1301(d)
	(a)(4)	none
	(b)	none
	(c)	CS 25.869(a)(3)
	(d)	none
	(e)	none
CS 25.1705 Systems and functions; EWIS	(a)	none
	(b)(1)	CS 25.773(b)(2)
	(b)(2)	CS 25.854
	(b)(3)	CS 25.855
	(b)(4)	CS 25.857
	(b)(5)	CS 25.858
	(b)(6)	CS 25.981
	(b)(7)	CS 25.1165
	(b)(8)	CS 25.1203
	(b)(9)	CS 25.1303(b)
	(b)(10)	CS 25.1310
	(b)(11)	CS 25.1316
	(b)(12)	CS 25.1331(a)(2)
	(b)(13)	CS 25.1351
	(b)(14)	CS 25.1355
	(b)(15)	CS 25.1360
	(b)(16)	CS 25.1362
	(b)(17)	CS 25.1365
	(b)(18)	CS 25.1431(c) & (d)
CS 25.1707 System separation; EWIS	(a)	CS 25.1353(a)
	(b)	CS 25.1353(a)
	(c)	CS 25.1353(b)
	(d)(1) (d)(2)	CS 25.1351(b)(1) CS 25.1351(b)(2)
	(e)(1) (e)(2)	CS 25.869(a)(3)(i) CS 25.869(a) (3)(ii) CS 25.1353(d)(3)
	(f)(1) (f)(2)	CS 25.869(a)(3)(i) CS 25.869(a) (3)(ii) CS 25.1353(d)(3)
	(g)	CS 25.1353(d)(3)
	(h)(1) (h)(2)	CS 25.1353(d)(3)

Subpart H Requirements	Paragraph	Based on initial CS-25 requirements
	(i)(1)	CS 25.1353(d)(3)
	(i)(2)	
	(i)(3)	
	(j)(1)	CS 25.1353(d)(3)
	(j)(2)	
	(k)	none
	(l)	CS 25.1353(d)(3)
CS 25.1709 System safety; EWIS	(1)(i)	CS 25.1309(b)(1)
	(1)(ii)	CS 25.1309(b)(1)
	(2)	CS 25.1309(b)(2)
CS 25.1711 Component identification; EWIS	(a)	CS 25.1301(b)
	(b)(1)	none
	(b)(2)	none
	(c)	CS 25.1353(d)(2)
	(d)	none
	(e)	none
CS 25.1713 Fire protection; EWIS	(a)	CS 25.869(a)(1)
	(b)	CS 25.869(a)(2)
	(c)	CS 25.869(a)(4)
CS 25.1715 Electrical bonding and protection against static electricity; EWIS	(a)	CS 25.899
	(b)	none
	(b)(12)	CS 25.1331(a)(2)
	(b)(13)	CS 25. 1351
	(b)(14)	CS 25. 1355
	(b)(15)	CS 25.1360
	(b)(16)	CS 25.1362
	(b)(17)	CS 25.1365
	(b)(18)	CS 25.1431(c) CS 25.1431(d)
CS 25.1717 Circuit protection devices; EWIS		CS 25.1353(d)(1)
CS 25.1719 Accessibility provisions; EWIS		CS 25.611
CS 25.1721 Protection of EWIS	(a)(1)	CS 25.855(e)(1)
	(a)(2)	CS 25.855(e)(2)
	(b)	none
	(c)	none
CS 25.1723 Flammable fluid protection; EWIS		CS 25.863(b)(3)
CS 25.1725 Powerplants; EWIS	(a)	CS 25.903(b)
	(b)	CS 25.903(d)(1)
CS 25.1727 Flammable fluid shutoff means; EWIS		CS 25.1189(d)
CS 25.1729 Instructions for Continued Airworthiness; EWIS		CS 25.1529
CS 25.1731 Powerplant and APU fire detector system; EWIS	(a)	CS 25.1203(e)
	(b)(1)	CS 25.1203(f)(1)
	(b)(2)	CS 25.1203(f)(2)

Note: The term “none” in the above table indicates that the paragraph did not exist in the intial CS-25 requirement.

AMC 25.1701
Definition

1 Paragraph CS 25.1701 defines EWIS for the purposes of complying with the subpart H requirements and other EWIS-related requirements of CS 25. CS 25.1701 clearly identifies which wires and components these requirements apply to. Although this definition is located in subpart H to CS 25, it applies to all EWIS requirements regardless of location within CS 25.

2 Subparagraph CS 25.1701(a) defines EWIS as any wire, wiring device, or combination of these, including termination devices, installed in any area of the aeroplane for the purpose of transmitting electrical energy between two or more intended termination points. The term “wire” means bare or insulated wire used for the purpose of electrical energy transmission, grounding, or bonding. This includes electrical cables, coaxial cables, ribbon cables, power feeders, and databuses.

3 Subparagraph CS 25.1701(a) of the requirement provides a listing of the component types that are considered part of the EWIS. These component types are listed as items CS 25.1701(a)(1) through CS 25.1701(a)(13). While these are the most widely used EWIS components it is not an all inclusive list. There may be components used by an applicant to support transmission of electrical energy that are not listed but meet the EWIS definition. They will be EWIS components subject to EWIS related regulatory requirements.

4 CS 25.1701(b) says that EWIS components located inside shelves, panels, racks, junction boxes, distribution panels, and back-planes of equipment racks (e.g., circuit board back-planes, wire integration units) are covered by the EWIS definition. These components are included in the EWIS definition because the equipment they are inside of or part of, is typically designed and made for a particular aeroplane model or series of models. So the requirements that apply to aeroplane EWIS components must be applied to the components inside that equipment. These contrast with avionics components that must be sent back to their manufacturer or a specialized repair shop for service. Components inside shelves, panels, racks, junction boxes, distribution panels, and back-planes of equipment racks are maintained, repaired, and modified by the same personnel who maintain, repair, and modify the EWIS in the rest of the aeroplane. For example, in an electrical distribution panel system separation must be designed and maintained within the panel just like the EWIS leading up to that panel. Identification of components inside the panel is just as important as outside the panel since the wiring inside the panel is treated much the same. Also, while this type of equipment is designed for its intended function and is manufactured and installed to the same standards as other EWIS, it is typically not qualified to an environmental standard such as EUROCAE ED-14 / RTCA DO-160.

5 There are some exceptions to the EWIS definitions and those are given in CS 25.1701(c). Paragraph excepts EWIS components inside the following equipment, and the external connectors that are part of that equipment:

5.1 Electrical equipment or avionics that are qualified to environmental conditions and testing procedures when those conditions and procedures are –

- appropriate for the intended function and operating environment, and
- acceptable to the Agency.

5.2 Portable electrical devices that are not part of the type design of the aeroplane including personal entertainment devices and laptop computers.

5.3 Fibre optics.

6 The first exception means EWIS components located inside avionic or electrical equipment such as flight management system computers, flight data recorders, VHF radios, primary flight displays, navigation displays, generator control units, integrated drive generators, and galley ovens, if this equipment has been tested to industry-accepted environmental testing standards. Examples of acceptable standards are EUROCAE ED-14 / RTCA DO-160, and equipment qualified to a European Technical Standard Order (ETSO)

7 An applicant may use any environmental testing standard if the applicant can demonstrate that the testing methods and pass/fail criteria are at least equivalent to the widely accepted standards of EUROCAE ED-14 / RTCA DO-160, or a specific ETSO. Applicants should submit details of the environmental testing standards and results of the testing that demonstrate the equipment is suited for use in the environment in which it will be operated.

AMC 25.1703
Function And Installation; EWIS

1 CS 25.1703 requires that applicants select EWIS components that are of a kind and design appropriate to their intended function just as CS 25.1301 requires this for other pieces of equipment installed on the aeroplane. Factors such as component design limitations, functionality, and susceptibility to arc tracking and moisture or other known characteristics of the particular component must be considered.

2 Subparagraph 25.1703(a)(1) requires that each EWIS component be of a kind and design appropriate to its intended function. In this context, the requirement means that components must be qualified for airborne use, or otherwise specifically assessed as acceptable for their intended use. To be “appropriate” means that the equipment is used in a manner for which it was designed. For example, a wire rated at 150 degrees Celsius would not be appropriate for installation if that installation would cause the wire to operate at a temperature higher than 150 degrees Celsius. Wire and other components made for household or consumer products use may not be appropriate for airborne use because they are manufactured for the consumer market and not for use in an airborne environment. Other factors that must be considered for EWIS component selection are mechanical strength, voltage drop, required bend radius, and expected service life.

3. Subparagraph 25.1703(a)(2) requires that EWIS components be installed according to their limitations. As used here, limitations means the design and installation requirements of the particular EWIS component. Examples of EWIS component limitations are maximum operating temperature, degree of moisture resistance, voltage drop, maximum current-carrying capability, and tensile strength. EWIS component selection and installation design must take into account various environmental factors including, but not limited to, vibration, temperature, moisture, exposure to the elements or chemicals (de-icing fluid, for instance), insulation type, and type of clamp.

4 Subparagraph 25.1703(a)(3) requires that EWIS function properly when installed. The key word in understanding the intent of this paragraph is “properly,” as that relates to airworthiness of the aeroplane. For an EWIS component to function properly means that it must be capable of safely performing the function for which it was designed. For example, the fact that an in-flight entertainment (IFE) system fails to deliver satisfactory picture or sound quality is not what the term “properly” refers to. This is not a safety issue and therefore not a concern for certification aspects. The failure of an EWIS component has the potential for being a safety hazard whether it is part of a safety-related system or an IFE system. Therefore, EWIS components must always function properly (safely) when installed, no matter what system they are part of and any malfunction of the EWIS must not degrade the airworthiness of the aeroplane (refer to CS 25.1709 for terminology relating to failure classifications).

5 Subparagraph 25.1703(a)(4) requires that EWIS components be designed and installed so mechanical strain is minimised. This means the EWIS installation must be designed so that strain on wires would not be so great as to cause the wire or other components to fail. This paragraph requires that adequate consideration be given to mechanical strain when selecting wire and cables, clamps, strain reliefs, stand-offs, and other devices used to route and support the wire bundle when designing the installation of these components.

6 Subparagraph 25.1703(b) requires that selection of wires take into account known characteristics of different wire types in relation to each specific application, to minimise risk of damage. It is important to select the aircraft wire type whose construction matches the application environment. The wire type selected should be constructed for the most severe environment likely to be encountered in service. This means, for example, that insulation types susceptible to arc tracking should not be used in areas exposed to high vibration and constant flexing in a moisture-prone environment.

7 Subparagraph 25.1703(c) contains the requirement formerly located in CS 25.869(a)(2) that design and installation of the main power cables allow for a reasonable degree of deformation and stretching without failure. Although it is now located in CS 25.1703(c), the meaning of the requirement has not changed. The reason for this requirement is the same as for CS 25.993(f), which requires that each fuel line within the fuselage be designed and installed to allow a reasonable degree of deformation and stretching without leakage. The idea is that the fuselage can be damaged with partial separation or other structural damage without the fuel lines or electrical power cables breaking apart. Allowing for a certain amount of stretching will help to minimise the probability of a fuel-fed fire inside the fuselage. As it is used in this requirement, a "reasonable degree of deformation and stretching" should be about 10% of the length of the electrical cable.

8 Subparagraph 25.1703(d) requires that EWIS components located in areas of known moisture build-up be adequately protected to minimise moisture's hazardous effects. This is to ensure that all practical means are used to ensure damage from fluid contact with components does not occur. Wires routed near a lavatory, galley, hydraulic lines, severe wind and moisture problem areas such as wheel wells and wing trailing edges, and any other area of the aeroplane where moisture collection could be a concern must be adequately protected from possible adverse effects of exposure to moisture.

9 EWIS component selection

9.1 Expected service life.

Expected service life is a factor needing consideration in selecting EWIS components to use. Expected service life means the expected service lifetime of the EWIS. This is not normally less than the expected service life of the aircraft structure. If the expected service life requires that all or some of the EWIS components be replaced at certain intervals, then these intervals must be specified in the ICA as required by CS 25.1529.

9.2 Qualified components.

EWIS components should be qualified for airborne use or specifically assessed as acceptable for the intended use and be appropriate for the environment in which they are installed.

Aircraft manufacturers list approved components in their manuals, such as the standard wiring practices manual (ATA Chapter 20). Ideally, only the components listed in the applicable manual or approved substitutes should be used for the maintenance, repair or modification of the aircraft. EWIS modifications to the original type design should be designed and installed to the same standards used by the original aircraft manufacturer or other equivalent standards acceptable to the Agency. This is because the manufacturer's technical choice of an EWIS component is not always driven by regulatory requirements alone. In some cases specific technical constraints would result in the choice of a component that exceeds the minimum level required by the regulations.

9.3 Mechanical strength. EWIS components should have sufficient mechanical strength for their service conditions.

a. The EWIS should be installed with sufficient slack so that bundles and individual wires are not under undue tension.

b. Wires connected to movable or shock-mounted equipment should have sufficient length to allow full travel without tension on the bundle to the point where failure of the EWIS could occur.

c. Wiring at terminal lugs or connectors should have sufficient slack to allow for 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.

d. In order to prevent mechanical damage wires should be supported by suitable clamps or other devices at suitable intervals. The design should be such that the failure of a single clamp will not in itself result in the wire or wire bundle coming into contact with other wires, equipment, structure, fluid lines, control cables, or other items that could cause damage to the wire. Because of in-service experience with abrasion and chafing of wires contained in troughs, ducts, or conduits justification should be given if additional support of the wires will not be used. 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 Society of Automotive Engineers SAE AS50881 or equivalent standard

9.4 Minimum bend radius.

To avoid damage to wire insulation, the minimum radius of bends in single wires or bundles should be in accordance with the wire manufacturer's specifications. Guidance on the minimum bend radius can be found in the manufacturer's standard wiring practices manual. Other industry standards such as AECMA EN3197 or SAE AS50881 also contain guidance on minimum bend radius. For example, SAE AS50881b states: "For wiring groups, bundles, or harnesses, and single wires and electrical cables individually routed and supported, the minimum bend radius shall be ten times the outside diameter of the largest included wire or electrical cable. At the point where wiring breaks out from a group, harness or bundle, the minimum bend radius shall be ten times the diameter of the largest included wire or electrical cable, provided the wiring is suitably supported at the breakout point. If wires used as shield terminators or jumpers are required to reverse direction in a harness, the minimum bend radius of the wire shall be three times the diameter at the point of reversal providing the wire is adequately supported."

9.5 Coaxial cable damage.

Damage to coaxial cable can occur when the cable is clamped too tightly or 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. Installation design should minimise the possibility of such damage. Coaxial cables have a minimum bend radius. SAE AS50881b states: "The minimum radius of bend shall not adversely affect the characteristics of the cable. For flexible type coaxial cables, the radius of bend shall not be less than six times the outside diameter. For semi-rigid types, the radius shall not be less than ten times the outside diameter."

9.6 Wire bundle adhesive clamp selection.

Certain designs use adhesive means to fasten bundle supports to the aircraft structure. Service history shows that these can work loose during aircraft operation, either as a result of improper design or inadequate surface preparation. You should pay particular attention to the selection and methods used for affixing this type of wire bundle support.

9.7 Wire bundle routing.

Following are some considerations that should go into the design of an EWIS installation.

a. Wire bundles should be routed in accessible areas that are protected from damage from personnel, cargo, and maintenance activity. As far as practicable 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 (reference CS 25.1719 and 25.1721).

b. 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. Wherever wires cannot be clamped, 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.

c. As far as practicable wiring should be routed away from high-temperature equipment and lines to prevent deterioration of insulation (reference CS 25.1707(j)).

d. Wiring routed across hinged panels, should be routed and clamped so that the bundle will twist, rather than bend, when the panel is moved.

9.8 Conduits.

Conduits should be designed and manufactured so that potential for chafing between the wiring and the conduit internal walls is minimised.

a. Non-metallic conduit. Insulating tubing (or sleeving) is sometimes used to provide additional electrical, environmental, and limited additional mechanical protection or to increase the external wire dimension. Insulating tubing should not be considered as the sole mechanical protection against external abrasion of wire because it does not prevent external abrasion. At best, it provides only a delaying action against the abrasion. The electrical and mechanical properties of the tubing need to be considered to ensure that it its use is appropriate for the type of protection that the designer intends it to be used for. Additional guidance on the use of insulating tubing or sleeving is given in AMC 25.1707 paragraph (2)(c).

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

9.9 Connector selection.

The connector used for each application should be selected only after a careful determination of the electrical and environmental requirements.

a. Particular attention should be given to any use of components with dissimilar metals, because this may cause electrolytic corrosion.

b. Environment-resistant connectors should be used in applications that will be subject to fluids, vibration, temperature extremes, mechanical shock, corrosive elements, etc.

c. Sealing plugs and contacts should be used in unused connector cavities where necessary. In addition, firewall class connectors incorporating sealing plugs should 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.

d. When electromagnetic interference and radio frequency interference (EMI and RFI) protection is required, Special attention should be paid 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.

9.10 Splice selection.

Environmentally sealed splices should be used in accordance with the requirements of the airframe manufacturer’s standard wiring practices or SAE AS81824/1, or equivalent specification, particularly in un-pressurized and severe wind and moisture problem (SWAMP) areas. However, the possibility of fluid contamination in any installation needs to be considered.

a. Splices in pressurised areas. In pressurised areas, pre-insulated splices conforming to SAE AS7928, or equivalent specification, may be used if these types of splices are listed as acceptable for use by the manufacturer in their standard wiring practices manual. The possibility of fluid contamination in any installation should also be considered.

b. Mechanically protected splices. Mechanical splices allow maintenance personnel an alternative method to using a heat gun for splices in fuel vapour areas on post-delivery aircraft. The generally available environmental splices use heat shrink material that needs application of heat. Most of these heat sources cannot be used in flammable vapor areas of an aircraft without proper precautions. Mechanical splices are acceptable for use in high temperature and fuel vapor areas, provided the splice is covered with a suitable plastic sleeve, such as a dual wall shrink sleeve or high temperature tape, such as Teflon, wrapped around the splice and tied at both ends. If high temperature tape is used, it should be permanently secured at both ends. Mechanical splices should be installed according to the airframe manufacturer's standard practices, or equivalent specification. The manufacturer's standard wiring practices manual should provide part number detail and best practices procedures for mechanical splices. It should also detail the applicability of each of the recommended splices for all required critical aeroplane installations.

c. Aluminum wire splice. Splices for aluminum wires should be in accordance with the requirements of the airframe manufacturers standard practices or SAE AS70991, MS25439, or equivalent specification. Conditions that result in excessive voltage drop and high resistance at junctions that may ultimately lead to failure of the junction should be avoided. The preferable location for aluminum splices is in pressurized areas. To avoid contamination from foreign particles the crimp tool should be dedicated to aluminum wire crimping.

9.11 Wire selection.

a. Installation environment.

(1) Careful attention should be applied when deciding on the type of wire needed for a specific application. Due consideration should be given such that the wire's construction properly matches the application environment. For each installation, you should select wire construction type suitable for the most severe environment likely to be encountered in service. For example use a wire type that is suitable for flexing for installations involving movement, use a wire type that has a high temperature rating for higher temperature installations.

(2) When considering the acceptability of wire, you should refer to the industry standards defining acceptable test methods for aircraft wire, including arc tracking test methods. (e.g. EN3475, SAE AS4373, or alternative manufacturer standards)

(3) Wires such as fire detection, fire extinguishing, fuel shutoff, and fly-by-wire / engine control system wiring that must operate during and after a fire must be selected from wire types qualified to provide circuit integrity after exposure to fire for a specified period.

b. Wire insulation selection.

Wire insulation type should be chosen according to the environmental characteristics of wire routing areas. One wire insulation characteristic of particular concern is arc tracking. Arc tracking is a phenomenon in which a conductive carbon path forms across an insulating surface. A breach in the insulation allows arcing and carbonizes the insulation. The resulting carbon residue is electrically conductive. The carbon then provides a short circuit path through which current can flow. This can occur on either dry or wet wires. Certain types of wire insulation are more susceptible to arc tracking than others, and wire insulated with aromatic polyimide is one. Therefore, its use should be limited to applications where it will not be subjected to high moisture, high vibration levels, or abrasion, or where flexing of the wire will occur. There are new types of aromatic polyimide insulated wire, such as hybrid constructions (e.g., the aromatic polyimide tape is the middle layer, and the top and bottom layer is another type of insulation such as Teflon tape) which are less susceptible to arc tracking.

c. Mechanical strength of wire.

Wires should be sufficiently robust to withstand all movement, flexing, vibration, abrasion and other mechanical hazards to which they may be reasonably subjected on the aeroplane. Generally, conductor wire should be stranded to minimise fatigue breakage. Refer to AS50881 and AECMA EN3197 for additional guidance. Additionally, wires should be robust enough to withstand the mechanical hazards they may be reasonably subjected to during installation into the aircraft.

d. Mixing of different wire insulation types.

Different wire types installed in the same bundle should withstand the wire-to-wire abrasion they will be subject to. Consideration should be given to the types of insulation mixed within wire bundles, especially if mixing a hard insulation type with a relatively softer type, and particularly when relative motion could occur between the wires. Such relative motion between varying wire insulation types could lead to accelerated abrasion and subsequent wire failure.

e. Tin plated conductors.

Tin plated conductors may be difficult to solder if not treated properly, so preparation of the conductor is necessary to ensure a good connection is made.

(f) Wire gauge selection.

To select the correct size of electrical wire, the following requirements should be considered:

(1) The wire size should be matched with the circuit protective device with regard to the required current.

(2) The wire size should be sufficient to carry the required current without overheating.

(3) The wire size should be sufficient to carry the required current over the required distance without excessive voltage drop (based on system requirements).

(4) Particular attention should be given to the mechanical strength and installation handling of wire sizes smaller than AWG 22 (e.g., consideration of vibration, flexing, and termination.) Use of high-strength alloy conductors should be considered in small gauge wires to increase mechanical strength.

Note: Additional guidance for selecting wire rating can be found in SAE AS50881 and AECMA EN2853.

g. Wire temperature rating.

Selection of a temperature rating for wire should include consideration of the worst-case requirements of the application. Caution should be used when locating wires in areas where heat is generated, for example where oxygen generators or lighting ballast units are located.

(1) Wires have a specified maximum continuous operating temperature. For many types, this may be reached by any combination of maximum ambient temperature and the temperature rise due to current flow.

(2) In general, it is undesirable to contribute more than 40^{o}C rise to the operating temperature by electrical heating.

(3) Other factors to be considered are altitude de-rating, bundle size de-rating, and use of conduits and other enclosures.

(4) Particular note should be taken of the specified voltage of any wire where higher than normal potentials may be used. Examples are discharge lamp circuits and windscreen heating systems.

h. EWIS components in moisture areas.

(1) Severe wind and moisture problem.

Areas designated as severe wind and moisture problem (SWAMP) areas are different from aircraft to aircraft but they generally are considered to be such areas as wheel wells, wing folds, pylons, areas near wing flaps, and other exterior areas that may have a harsh environment. Wires for these applications should incorporate design features that address these severe environments.

(2) Silver plated conductors.

Many high strength copper alloy conductors and coaxial cables use silver plating. Contamination of silver-plated conductors with glycol (de-icing fluid) can result in electrical fire. Accordingly, you should not use silver plated conductors in areas where de-icing fluid can be present unless suitable protection features are employed. Silver plated conductors and shields can exhibit a corrosive condition (also known as 'Red Plague') if the plating is damaged or of poor quality and is exposed to moisture. Designers should be aware of these conditions.

(3) Fluid contamination of EWIS components.

Fluid contamination of EWIS components should be avoided as far as practicable. But EWIS components should be designed and installed with the appropriate assumptions about fluid contamination, either from the normal environment or from accidental leaks or spills. 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 from toilet waste systems, galleys, and fluids containing sugar, such as sweetened drinks, can induce electrical tracking in already degraded electrical wires and unsealed electrical components. The only cleaning fluids that should be used are those recommended by the aeroplane manufacturer in its standard practices manual.

AMC 25.1703(e)
EWIS component selection for future modifications.

If a TC includes subpart H in its certification basis, future modifiers of those TCs should comply with the subpart H requirements by using the same or equivalent standards / design practices as those used by the TC holder. If modifiers choose to deviate from those standards / design practices, they should have to substantiate compliance independently. The standards / design practices used by the TC holder in order to justify their own choice of components should also be considered.

AMC 25.1707
System separation; EWIS

1 Summary

The continuing safe operation of an aeroplane depends on the safe transfer of electrical energy by the EWIS. If an EWIS failure occurs, its separation from other EWIS and from other systems and structures plays an important role in ensuring that hazardous effects of the failure are mitigated to an acceptable level. CS 25.1707 requires applicants to design EWIS with appropriate separation to minimise the possibility of hazardous conditions that may be caused by an EWIS interfering with other EWIS, other aeroplane systems, or structure.

The purpose of separation is to prevent hazards of interference between wires in a single bundle, between two or more bundles, or between an electrical bundle and a non-electrical system or structure. Such interference could take the form of mechanical and or electrical interference (EMI for example). Mechanical interference examples include chafing between electrical cables or pipes or structure and may lead to fluid leakage such as galley water waste systems.

2 Separation by physical distances versus separation by barrier.

CS 25.1707 states that adequate physical separation must be achieved by separation distance or by a barrier that provides protection equivalent to that separation distance. The following should be considered when designing and installing an EWIS:

a. In most cases, physical distance is the preferred method of achieving the required separation. This is because barriers themselves can be the cause of EWIS component damage (e.g., chafing inside of conduits) and can lead to maintenance errors such as barriers removed during maintenance and inadvertently left off. They can also interfere with visual inspections of the EWIS.

b. If a barrier is used to achieve the required separation, CS 25.1707 requires that it provide at least the same level of protection that would be achieved with physical distance. That means that when deciding on the choice of the barrier, factors such as dielectric strength, maximum and minimum operating temperatures, chemical resistivity, and mechanical strength should be taken into account.

c. In addition to the considerations given in paragraph (b) above, when wire bundle sleeving is used to provide separation, applicants should consider that the sleeving itself is susceptible to the same types of damage as wire insulation. The appropriate type of sleeving must be selected for each specific application and design consideration must be given to ensuring that the sleeving is not subjected to damage that would reduce the separation it provides.

3 Determination of separation.

Determining the necessary amount of physical separation distance is essential. But because each system design and aeroplane model can be unique, and because manufacturers have differing design standards and installation techniques, CS 25.1707 does not mandate specific separation distances. Instead it requires that the chosen separation be adequate so that an EWIS component failure will not create a hazardous condition. The following factors should be considered when determining the separation distance:

a. The electrical characteristics, amount of power, and severity of failure condition of the system functions performed by the signals in the EWIS and adjacent EWIS.

b. Installation design features, including the number, type, and location of support devices along the wire path.

c. The maximum amount of slack wire resulting from wire bundle build tolerances and the variability of wire bundle manufacturing

d. Probable variations in the installation of the wiring and adjacent wiring, including position of wire support devices and amount of wire slack possible.

e. The intended operating environment, including amount of deflection or relative movement possible and the effect of failure of a wire support or other separation means.

f. Maintenance practices as defined by the aeroplane manufacturer's standard wiring practices manual and the ICA required by CS 25.1529 and CS 25.1729.

g.The maximum temperature generated by adjacent wire/wire bundles during normal and fault conditions.

h. Possible EMI, HIRF, or induced lightning effects.

4 Cases of inadequate separation.

Some areas of an aeroplane may have localized areas where maintaining the minimum physical separation distance is not feasible. This is especially true in smaller aeroplanes. In those cases, other means of ensuring equivalent minimum physical separation may be acceptable, if testing or analysis demonstrates that safe operation of the aeroplane is not jeopardized. The applicant should substantiate to the Agency that the means to achieve the required separation provides the necessary level of protection for wire related failures. Electro-magnetic interference (EMI) protection must also be verified.

5 Meaning of the term "hazardous condition" as used in CS 25.1707.

The term "hazardous condition" in CS 25.1707 is used in a different context than in CS 25.1709. CS 25.1709 uses the terms "hazardous" and "catastrophic" for failure conditions as defined in Table 1: Classification of Failure Conditions, of this AMC, that could be associated with a numerical probability objective. The intent of CS 25.1707, is that the applicant must perform a qualitative design assessment of the installed EWIS and the physical separation to guard against hazardous conditions

This assessment involves the use of reasonable engineering and manufacturing judgment and assessment of relevant service history to decide whether an EWIS, system, or structural component could fail in such a way as to create a condition that would affect the aeroplane's ability to continue safe operation. However, the requirements of CS 25.1707 do not preclude the use of valid component failure rates if the applicant chooses to use a probability argument in addition to the design assessment to demonstrate compliance. It also does not preclude the agency from requiring such an analysis if the applicant cannot adequately demonstrate that hazardous conditions will be prevented solely by using the qualitative design assessment. Also note that a numerical probability assessment may still be required under the requirements of CS 25.1709 if the aeroplane level functional hazard assessment identifies EWIS failures that could affect safe operation of the aeroplane.

6 Subparagraph CS 25.1707(a) requires that EWIS associated with any system on the aeroplane be designed and installed so that under normal conditions and failure conditions, it will not adversely affect the simultaneous operation of any other systems necessary for continued safe flight, landing, and egress. CS 25.1707(a) also requires that adequate physical separation be achieved by separation distance or by a barrier that provides protection equivalent to that separation distance.

7 Subparagraph 25.1707(b) requires that each EWIS be designed and installed to limit electrical interference on the aeroplane.
One type of electrical interference is electromagnetic interferences (EMI). Electromagnetic interference can be introduced into aeroplane systems and wiring by coupling between electrical cables or between cables and coaxial lines or other aeroplane systems. Function of systems should not be affected by EMI generated by adjacent wire. EMI between wiring which is a source of EMI and wire susceptible to EMI increases in proportion to the length of parallel runs and decreases with greater separation. Wiring of sensitive circuits that may be affected by EMI should be routed away from other wiring interference, or provided with sufficient shielding to avoid system malfunctions under operating conditions. EMI should be limited to negligible levels in wiring related to systems necessary for continued safe flight, landing and egress. The following sources of interference should be considered:

a. Conducted and radiated interference caused by electrical noise generation from apparatus connected to the busbars.

b. Coupling between electrical cables or between cables and aerial feeders.

c. Malfunctioning of electrically-powered apparatus.

d. Parasitic currents and voltages in the electrical distribution and grounding systems, including the effects of lightning currents or static discharge.

e. Different frequencies between electrical generating systems and other systems.

8 This paragraph 25.1707(c) contains the wire-related requirements formerly located in CS 25.1353(b). Coverage is expanded beyond wires and cable carrying heavy current to include their associated EWIS components as well. This means that all EWIS components, as defined by CS 25.1701, that are associated with wires and cables carrying heavy current must be installed in the aeroplane so damage to essential circuits will be minimised under fault conditions.

9 Subparagraph 25.1707(d) contains wire-related requirements from CS 25.1351(b)(1) and (b)(2) and introduces additional requirements.

a. Subparagraph (d) requires that EWIS components associated with the generating system receive the same degree of attention as other components of the system, such as the electrical generators.

b. Subparagraph (d)(1) prohibits aeroplane independent electrical power sources from sharing a common ground terminating location. Paragraph (d)(2) prohibits aeroplane static grounds from sharing a common ground terminating location with any aeroplane independent electrical power sources. The reason for these paragraphs is twofold:

(1) to help ensure the independence of separate electrical power sources so that a single ground failure will not disable multiple power sources; and

(2) to prevent introduction of unwanted interference into aeroplane electrical power systems from other aeroplane systems.

10 Subparagraphs 25.1707(e), (f), (g), (h) contain specific separation requirements for the fuel, hydraulic, flight and mechanical control system cables, oxygen, hot bleed air systems, and waste/water systems. They require adequate EWIS separation from those systems except to the extent necessary to provide any required electrical connection to them. EWIS must be designed and installed with adequate separation so a failure of an EWIS component will not create a hazardous condition and any leakage from those systems (i.e., fuel, hydraulic, oxygen, waste/water) onto EWIS components will not create a hazardous situation.

a. Under fault conditions and without adequate EWIS separation a potential catastrophic hazard could occur should an arcing fault ignite a flammable fluid like fuel or hydraulic fluid. Also an arcing fault has the potential to puncture a line associated with those systems if adequate separation is not maintained. If there is leakage from one of those systems and an arcing event occurs, fire or explosion could result. Similarly, leakage from the water/waste system can cause damage to EWIS components and adversely affect their integrity. An EWIS arcing event that punctures a water or waste line could also introduce fluids into other aeroplane systems and create a hazardous condition.

b. In addition to the required separation distance, the use of other protection means such as drip shields should be considered to prevent the potential for fluids to leak onto EWIS.

11 Subparagraph 25.1707(i). To prevent chafing, jamming, or other types of interference, or other failures that may lead to loss of control of the aeroplane, EWIS in general and wiring in particular must be physically separated from flight control or other types of control cables. Mechanical cables have the potential to cause chafing of electrical wire if the two come into contact. This can occur either through vibration of the EWIS and/or mechanical cable or because of cable movement in response to a system command. A mechanical cable could also damage other EWIS components, such as a wire bundle support, in a way that would cause failure of that component. Also, if not properly designed and installed, a wire bundle or other EWIS component could interfere with movement of a mechanical control cable by jamming or otherwise restricting the cable's movement. Without adequate separation, an arcing fault could damage or sever a control cable. A control cable failure could damage EWIS. Therefore, paragraph (i) requires an adequate separation distance or barrier between EWIS and flight or other mechanical control systems cables and their associated system components. It also requires that failure of an EWIS

component must not create a hazardous condition and that the failure of any flight or other mechanical control systems cables or systems components must not damage EWIS and creates a hazardous condition. Clamps for wires routed near moveable flight controls should be attached and spaced so that failure of a single attachment point cannot interfere with flight controls or their cables, components, or other moveable flight control surfaces or moveable equipment.

12 Subparagraph 25.1707(j) requires that EWIS design and installation provide adequate physical separation between the EWIS components and heated equipment, hot air ducts, and lines. Adequate separation distance is necessary to prevent EWIS damage from extreme temperatures and to prevent an EWIS failure from damaging equipment, ducts, or lines. High temperatures can deteriorate wire insulation and other parts of EWIS components, and if the wire or component type is not carefully selected, this deterioration could lead to wire or component failure. Similarly, should an arcing event occur, the arc could penetrate a hot air duct or line and allow the release of high pressure, high temperature air. Such a release could damage surrounding components associated with various aeroplane systems and potentially lead to a hazardous situation.

13 Subparagraph AMC 25.1707(k). For systems for which redundancy is required either by specific certification requirements, operating rules or by CS 25.1709, each applicable EWIS must be designed and installed with adequate physical separation. To maintain the independence of redundant systems and equipment so that safety functions are maintained, adequate separation and electrical isolation between these systems must be ensured as follows:

a. 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 functionally similar EWIS components is necessary to prevent degradation of their ability to perform their required functions.

b. Power feeders from separate power sources should be routed in bundles separate from each other and from other aircraft wiring in order to prevent a single fault from disabling more than one power source.

c. 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.

14 Subparagraph 25.1707(l) requires that EWIS be designed and installed so they are adequately separated from aircraft structure and protected from sharp edges and corners. This is to minimise the potential for abrasion and chafing, vibration damage, and other types of mechanical damage. This protection is necessary because over time the insulation on a wire that is touching a rigid object, such as an equipment support bracket, will fail and expose bare wire. This can lead to arcing that could destroy that wire and other wires in its bundle. Structural damage could also occur depending on the amount of electrical energy the failed wire carries.

AMC 25.1709
System safety; EWIS

25.1709 requires applicants to perform a system safety assessment of the EWIS. The analysis required for compliance with CS 25.1709 is based on a qualitative approach to assessing EWIS safety as opposed to numerical, probability-based quantitative analysis. The safety assessment must consider the effects that both physical and functional failures of EWIS would have on aeroplane safety. That safety assessment must show that each EWIS failure considered hazardous is extremely remote. It must show that each EWIS failure considered to be catastrophic is extremely improbable and will not result from a single failure.

1 Objective.

The objective of CS 25.1709 is to use the concepts of CS 25.1309 to provide a thorough and structured analysis of aircraft wiring and its associated components. As in CS 25.1309, the fail-safe design concept applies. Any single failure condition, such as an arc fault, should be assumed to occur regardless of probability.

2 Inadequacies of CS 25.1309 in relation to EWIS safety assessments.

CS 25.1309 requires the applicant to perform system safety assessments. But current CS 25.1309 practice has not led to the type of analysis that fully ensures all EWIS failure conditions affecting aeroplane level safety are considered. This is because the current CS 25.1309(a) only covers systems and equipment that are "required for Type Certification or by operating rules," and wiring for non-required systems is sometimes ignored. Even for systems covered by CS 25.1309(b), the safety analysis requirements have not always been applied to the associated wire. When they are, there is evidence of inadequate and inconsistent application. Traditional thinking about non-required systems, such as IFE, has been that, since they are not required, and the function they provide is not necessary for the safety of the aeroplane, their failure could not affect the safety of the aeroplane. This is not a valid assumption. Failure of an electrical wire, regardless of the system it is associated with, can cause serious physical and functional damage to the aeroplane, resulting in hazardous or even catastrophic failure conditions. An example of this is arcing from a shorted wire cutting through and damaging flight control cables. There are more failure modes than have been addressed with traditional analyses. Some further examples are arcing events that occur without tripping circuit breakers, resulting in complete wire bundle failures and fire; or wire bundle failures that lead to structural damage

3 Integrated nature of EWIS.

The integrated nature of wiring and the potential severity of failures demand a more structured safety analysis approach than that traditionally used under CS 25.1309. CS 25.1309 system safety assessments typically evaluate effects of wire failures on system functions. But they have not considered physical wire failure as a cause of the failure of other wires within the EWIS. Traditional assessments look at external factors like rotor burst, lightning, and hydraulic line rupture, but not at internal factors, like a single wire chafing or arcing event, as the cause of the failure of functions supported by the EWIS. Compliance with CS 25.1709 requires addressing those failure modes at the aeroplane level. This means that EWIS failures need to be analyzed to determine what effect they could have on the safe operation of the aeroplane.

4 Compliance summary.

As specified above, the analysis required for compliance with CS 25.1709 is based on a qualitative approach to assessing EWIS safety as opposed to numerical, probability-based quantitative analysis. The intent is not to examine each individual wire and its relation to other wires. Rather, it is to ensure that there are no hazardous combinations. However, in case the "top down" analysis process described in this AMC determines 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.

5 Qualitative probability terms.

When using qualitative analyses to determine compliance with CS 25.1709, the following descriptions of the probability terms have become commonly accepted as aids to engineering judgment:

a. Extremely remote failure conditions.

These are failure conditions that are not anticipated to occur to an individual aeroplane during its total life but which may occur a few times when considering the total operational life of all aeroplanes of the type.

b. Extremely improbable failure conditions.

These are failure conditions so unlikely that they are not anticipated to occur during the entire operational life of all aeroplanes of one type.

6 Relationship to CS 25 system safety assessments.

The analysis described may be accomplished in conjunction with the required aircraft system safety assessments of CS 25.1309, 25.671, etc.

(7) Classification of failure terms.

The classification of failure conditions is given in Table 1, as specified in AMC 25.1309.

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 aeroplane or increase flightcrew workload.
Minor	Failure conditions that would not significantly reduce aeroplane safety, and involve flightcrew actions that are well within their capabilities. For example, minor failure conditions may include: • 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 aeroplane or the ability of the flightcrew to cope with adverse operating conditions to the extent that there would be, for example: • 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 aeroplane or the ability of the flightcrew to cope with adverse operating conditions to the extent that there would be, for example: • a large reduction in safety margins or functional capabilities; • 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 aeroplane. (NOTE: A catastrophic failure condition was defined differently in previous versions of JAR 25.1309 and in accompanying advisory material as “a failure condition that would prevent continued safe flight and landing.”)

8 Flowcharts depicting the analysis process.

Flowcharts 1 and 2 outline one method of complying with the requirements of CS 25.1709. The processes in both Flowcharts 1 and 2 identify two aspects of the analysis: physical failures and functional failures. The processes described in both flowcharts begins by using the aircraft level functional hazard analysis developed for demonstrating compliance with CS 25.1309 to identify catastrophic and hazardous failure events. A step-by-step explanation of the analysis depicted in the flowcharts is given in paragraphs 11 (for flowchart 1) and 12 (for Flowchart 2).

a. Flowchart 1.

This flowchart applies to applicants for pre-TC work and for amended TCs, and STCs when the applicant has all data necessary to perform the analysis. If Flowchart 1 is used for post-TC modifications the available data must include identification of the systems in the EWIS under consideration for modification and the system functions associated with that EWIS.

b. Flowchart 2.

This flowchart applies to applicants for post-TC modifications when the applicant cannot identify the systems or systems functions contained in EWIS under consideration for modification.

9 Definitions applicable to CS 25.1709.

For this discussion the following definitions apply:

a. Validation. Determination that requirements for a product are sufficiently correct and complete.

b. Verification. Evaluation to determine that requirements have been met.

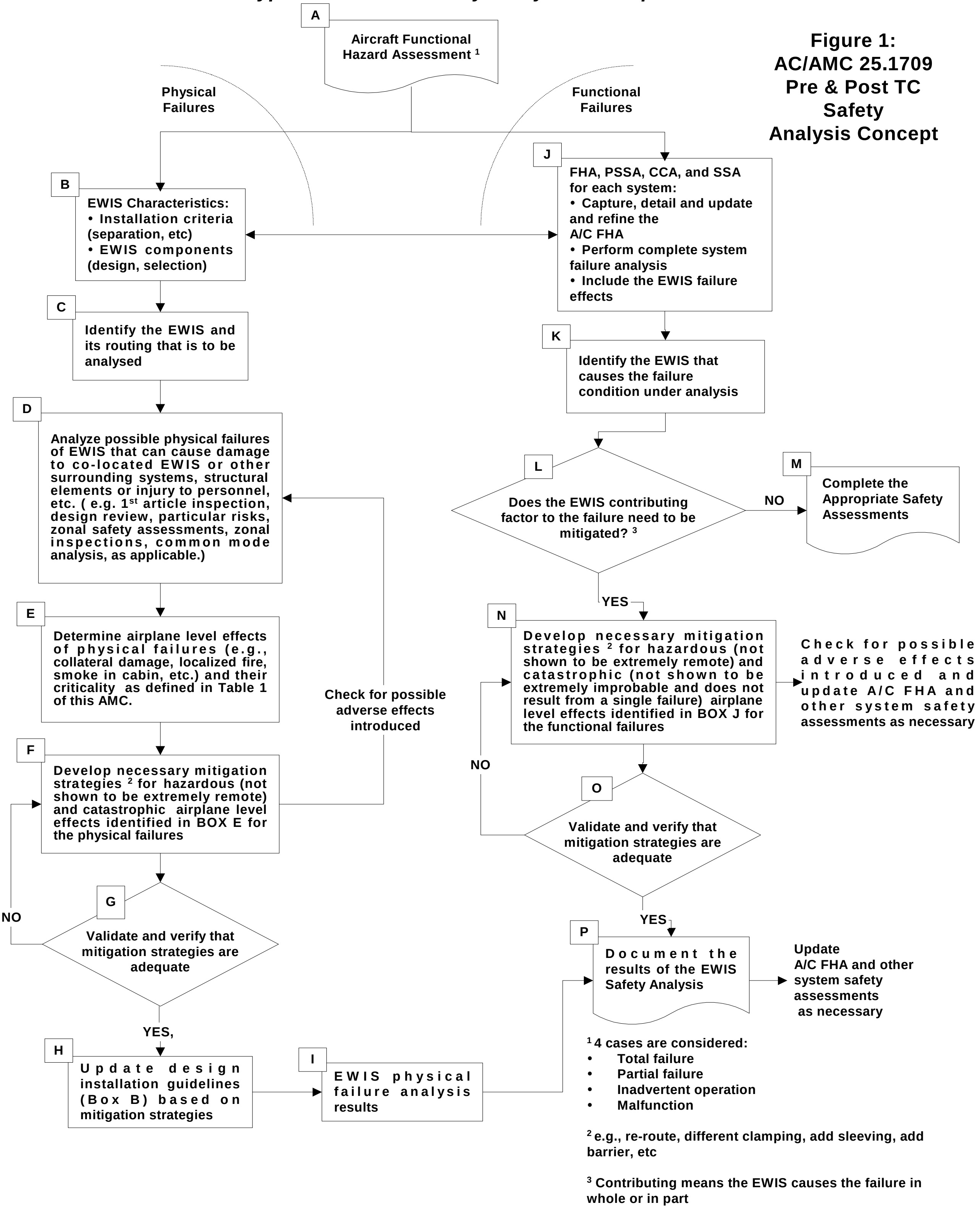
c. Mitigation. Elimination of the hazard entirely or suitable precautions taken to minimize the overall severity to an acceptable level.

10 Physical failure analysis.

a. Only single common cause events or failures need to be addressed during the physical failure analysis as described in this AMC and shown on the left hand sides of Flowcharts 1 and 2**.** Multiple common cause events or failures need not be addressed.

b. In relation to physical effects, it should be assumed that wires are carrying electrical energy and that, in the case of an EWIS failure, this energy may result in hazardous or catastrophic effects directly or when combined with other factors, for example fuel, oxygen, hydraulic fluid, or damage by passengers, These failures may result in fire, smoke, emission of toxic gases, damage to co-located systems and structural elements or injury to personnel. This analysis considers all EWIS from all systems (autopilot, auto throttle, PA system, IFE systems, etc.) regardless of the system criticality.

Flowchart 1: Pre- and Post-Type Certification Safety Analysis Concept



Note: Mitigation as used in this flowchart means to eliminate the hazard entirely or minimise its severity to an acceptable level.

11 Descriptive text for flowchart 1

a. *Box A*: Aircraft functional hazard assessment.

(1) The functional failure analysis assumes that electrical wires are carrying power, signal, or information data. Failure of EWIS under these circumstances may lead to aircraft system degradation effects.

(2) The functional hazard assessment (FHA) referred to in this box is not a stand-alone separate document specifically created to show compliance with CS 25.1709. It is the aircraft level FHA that the applicant will have developed in compliance with CS 25.1309 to help demonstrate acceptability of a design concept, identify potential problem areas or desirable design changes, or determine the need for and scope of any additional analyses (refer to AMC 25.1309)

b. Analysis of Possible Physical Failures

(1) *Box B*: EWIS characteristics.

Use the results of the FHA (BOX A) to identify EWIS installation criteria and definitions of component characteristics. Results from BOX B are fed into the preliminary system safety analysis (PSSA) and system safety analysis (SSA) of BOX J.

(2) *Boxes C, D and E*: Validation and verification of installation criteria.

(i) Ensure that the EWIS component qualification satisfies the design requirements and that components are selected, installed, and used according to their qualification characteristics and the aircraft constraints linked to their location (refer to the requirements of CS 25.1703).

(ii) Use available information (digital mock-up, physical mock-up, aeroplane data, historical data) to perform inspections and analyses to validate that design and installation criteria are adequate to the zone/function, including considerations of multi-systems impact. Such inspections and analyses may include a 1st article inspection, design review, particular risk assessment, zonal safety assessment, zonal inspection, and common mode analysis, as applicable. Use such assessments and inspections to ascertain whether design and installation criteria were correctly applied. Special consideration should be given to known problem areas identified by service history and historical data (areas of arcing, smoke, loose clamps, chafing, arc tracking, interference with other systems, etc.). Regardless of probability, any single arcing failure should be assumed for any power-carrying wire. The intensity and consequence of the arc and its mitigation should be substantiated. Give special consideration to cases where new (previously unused) material or technologies are used. In any case CS 25.1703(b) requires that the selection of wires must take into account known characteristics in relation to each installation and application to minimise the risk of wire damage, including any arc tracking phenomena.

(iii) Deviations from installation and component selection criteria identified by these activities should be evaluated. A determination can then be made about their acceptability. Develop alternative mitigation strategies as necessary.

(3) *Boxes F and G*: Development and validation of mitigation strategy.

Identify and 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:

(i) Hazardous failure conditions are extremely remote.

(ii) Catastrophic failure conditions do not result from a single common cause event or failure.

(iii) This mitigation solution does not introduce any new potential failure conditions.

(4) *Box H*: Incorporation of applicable mitigation strategies.

Incorporate newly developed mitigation strategies (BOX F) into guidelines (BOX B) for further design and inspection and analysis processes.

(5) *Box I*: Physical failure analysis results.

From the EWIS physical failure analysis, the following should be documented:

- Physical failures addressed.
- Effects of those physical failures.
- Mitigation strategies developed.

This information should be used to support the final analysis documentation (BOX P).

c. Analysis of Possible Functional Failures

(1) *Box J*: System safety assessments.

The results of the aeroplane level FHA (BOX A) should be used to guide the system level FHA (BOX J). Incorporate EWIS failures identified by CS 25.1709 into the system level and aircraft level FHA, the PSSA, the Common Cause Analyses (CCA), and the SSA. These analyses are performed to satisfy requirements of CS 25.1309. Use results of these analyses to update the EWIS definition (BOX B).

(2) *Boxes K, L and M*: Hazardous and catastrophic failure conditions.

Use the analyses in BOX J to determine if the EWIS associated with the system under analysis can contribute (in whole or in part) to the failure condition under study. Determine whether the EWIS failure needs to be mitigated. If so, develop, validate, and verify a mitigation strategy. If no mitigation is needed, complete the appropriate safety assessment per CS 25.1309, CS 25.671, etc..

(3) *Boxes N and O*: Development and validation of mitigation strategy.

Identify and develop a mitigation strategy for the functional failures and adverse effects identified in BOX J. Validation and verification of the mitigation solution should –

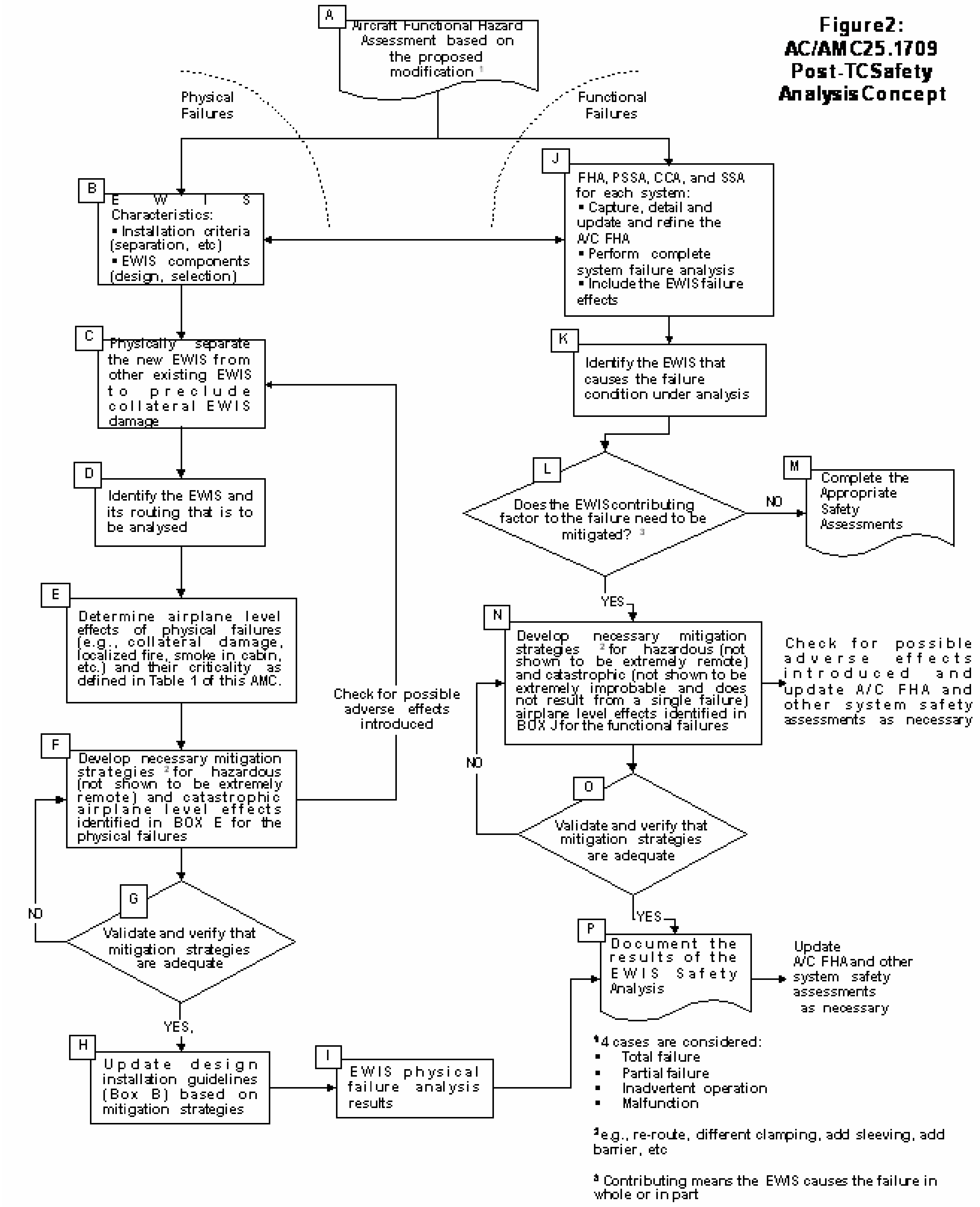
- Determine if initial objective is fully reached.
- Confirm that this mitigation solution is compatible with existing installations and installation criteria.

If the EWIS was the failure cause, the subsequent mitigation strategy developed may introduce new adverse effects not previously identified by the analysis. Check for any new adverse effects and update the aircraft level FHA and other system safety assessments as necessary.

(4) *Box P*: Documentation of EWIS safety analysis results.

After mitigation strategies have been validated and verified, the results of the CS 25.1709 analysis should be documented. Update as necessary the aircraft level FHA that has been developed in support of certification of the proposed modification, in compliance with CS 25.1309 (BOX A).

Flowchart 2: Post-TC Safety Analysis Concept



Note: Mitigation as used in this flowchart means to eliminate the hazard entirely or minimise its severity to an acceptable level.

12 Descriptive text for flowchart 2.

a. Applicants for post-TC modifications should use the analysis depicted in Flowchart 2 when the applicant cannot identify the systems or systems functions contained in existing aircraft EWIS that maybe utilized as part of the modification. An applicant should not add EWIS to an existing EWIS if the systems or systems functions contained in the existing EWIS are unknown. To do so could introduce unacceptable hazards. For example, IFE power wires could inadvertently be routed with aeroplane autoland EWIS.

b. The main objectives are to ensure that the proposed modification –

- Will be correctly designed and installed.
- Will not introduce unacceptable hazards either through its own failure or by adversely affecting existing aircraft systems.

As far as EWIS is concerned, correct incorporation of the modification should be ensured by both good knowledge of original aircraft manufacturer 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 the physical failures part of Flowchart 1).

c. *Box A*: Aircraft functional hazard assessment.

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

d. Analysis of Possible Physical Failures

(1) *Box B*: EWIS characteristics.

Use results of the Aircraft level FHA (BOX A) to identify EWIS installation criteria and definitions of component characteristics. Results of BOX B are fed into the PSSA and SSA of BOX J.

(2) *Box C*: Physical separation of new EWIS from existing EWIS.

(i) The EWIS to be added should be separated from existing aeroplane EWIS since the systems or system functions contained in the existing EWIS are unknown. Physical separation between the new and existing EWIS should be established either by separation distance or by an appropriate barrier or other means shown to be at least equivalent to the physical separation distance when allowed by CS 25.1707. Alternative methods given in the advisory material for CS 25.1707 provide an acceptable way to determine adequate separation.

(ii) In cases where separation cannot be maintained because of physical constraints (e.g., terminal strips and connectors), the applicant should accomplish the appropriate analysis to show that no adverse failure conditions result from sharing the common device. This analysis requires knowledge of the systems or system functions sharing the common device (e.g., terminal strips and connectors).

(3) *Box D and E*: Validation and verification of installation criteria.

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

(ii) Use available information (digital mock-up, physical mock-up, aeroplane data, historical data) to perform inspections and analyses to validate that design and installation criteria are adequate to the zone/function, including considerations of multi-systems impact. Such inspections and analyses may include a 1st article inspection, design review, particular risk assessment, zonal safety assessment, zonal inspection, and common mode analysis, as applicable. Use such assessments and inspections to ascertain whether design and installation criteria were correctly applied. Special consideration should be given to known problem areas identified by service history and historical data (areas of arcing, smoke, loose clamps, chafing, arc tracking, interference with other systems, etc.). Regardless of probability, any single arcing failure should be assumed for any power-carrying wire. The intensity and consequence of the arc and its mitigation should be substantiated. Special consideration should be given to cases where new (previously unused) material or technologies are used. Evaluate deviations from installation and component selection criteria identified by these activities and determine their acceptability.

(iii) Alternative mitigation strategies should be developed as necessary.

(4) *Boxes F and G*: Development and validation of mitigation strategy.

Identify and develop a mitigation strategy for the physical failures identified in BOXES D and E and resulting adverse effects. Validation and verification of a mitigation solution should ensure that:

(i) Hazardous failure conditions are extremely remote.

(ii) Catastrophic failure conditions do not result from a single common cause event or failure.

(iii) This mitigation solution does not introduce any new potential failure conditions.

(5) *Box H*: Incorporation of Applicable Mitigation Strategies.

Incorporate newly developed mitigation strategies (BOX F) into guidelines (BOX B) for further design and inspection and analysis process.

(6) *Box I*: Physical failure analysis documentation.

From the EWIS physical failure analysis, the following should be documented:

- Physical failures addressed.
- Effects of those physical failures.
- Mitigation strategies developed.

This information supports the final analysis documentation (BOX P).

e. Analysis of Possible Functional Failures

(1) *Box J*: System safety assessments.

Use the results of the aircraft level FHA (BOX A) to guide the system level FHA (BOX J). Incorporate EWIS failures identified by CS 25.1709 into the system level and aircraft level FHA, the PSSA, the CCA, and the SSA. These analyses are performed to satisfy requirements of CS 25.1309. Use results of these analyses to update the EWIS definition (BOX B).

(2) *Boxes K, L and M*: Hazardous and catastrophic failure conditions.

Use the analyses in BOX J to determine if the EWIS associated with the system under analysis can contribute (in whole or in part) to the failure condition under study. Determine whether the EWIS failure needs to be mitigated. If so, develop, validate, and verify a mitigation strategy. If no mitigation is needed, complete the appropriate safety assessment (e.g., per CS 25.1309, CS 25.671, etc.).

(3) *Boxes N and O*: Development and validation of mitigation strategy.

Identify and develop a mitigation strategy for the functional failures and adverse effects identified in BOX J. Validation and verification of the mitigation solution should:

- Determine if initial objective is fully reached.
- Confirm 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. Check for any new adverse effects and update the aircraft level FHA and other system safety assessments as necessary.

(4) *Box P*: Documentation of EWIS safety analysis results.

After mitigation strategies have been validated and verified, document the results of the CS 25.1709 analysis. Update as necessary the aircraft level FHA that has been developed in support of certification of the proposed modification, in compliance with CS 25.1309, (BOX A).

AMC 25.1711
Component identification; EWIS

1 Paragraph 25.1711 requires applicants to identify EWIS components using consistent methods that facilitate easy identification of the component, its function, and its design limitations. For EWIS associated with flight-essential functions where specific certification requirements are met by redundancy, identification of the EWIS must also include separation requirements. This paragraph requires that the identifying markings remain legible throughout the expected service life of the EWIS component, and that the method used to identify components have no adverse affect on their performance.

2 Subparagraph 25.1711(a) requires a consistent method in EWIS identification to avoid confusion and mistakes during aeroplane manufacturing, modification, and maintenance. Aeroplane manufacturers should develop an EWIS identification method that facilitates easy identification of the systems that any specific EWIS component supports and use that identification method in a consistent manner throughout the aeroplane. This consistent identification method must be used for new type certifications and changes to those designs.

3 Subparagraph 25.1711(b): Certain aeroplane systems are installed with redundancy in order to meet the reliability requirements of CS 25.1309 and 25.1709. For EWIS components associated with these systems, paragraph (b) requires specific identification indicating component part number, function, and separation requirement. This is necessary to prevent modifiers from unintentionally introducing unsafe design or installation features on previously certified aeroplanes when they install new or modified systems. Such identification will aid the designers and installers of the new system by alerting them to the presence of the critical system. It will allow them to make appropriate design and installation decisions. Component identification will also make those performing maintenance and inspections more aware of what systems are associated with specific EWIS in the areas undergoing maintenance or inspection.

4 Subparagraph 25.1711(c) requires that identifying markings required by CS25.1711(a) and (b) remain legible throughout the design life of the component. As most wire installations are designed to remain on the aeroplane throughout the aeroplane's service life, this means the identification marks must be able to be read for the life of the aeroplane. The method of marking must take into account the environment in which the EWIS component will be installed. The Society of Automotive Engineers (SAE) documents ARP 5607, "Legibility of Print on Aerospace Wire and Cables," and AS 5942, "Marking of Electrical Insulating Materials," provides guidance on this subject.

5 Subparagraph 25.1711(d) requires that the means used to identify an EWIS component may not have an adverse effect on component performance throughout its design life.

a. Certain wire marking methods have potential to damage wire insulation. Hot-stamp marking is one such method. According to SAE (Society of Automotive Engineers) aerospace information report AIR5575, “Hot Stamp Wire Marking Concerns for Aerospace Vehicle Applications,” the hot-stamp marking method is not well suited for today’s generation of thin wall aircraft wiring. As noted in that document, wire insulation has become markedly thinner over the years since the procedure was first introduced in the 1940s. Because of this, problems have arisen over wire damage from excessive penetration by the hot stamp process. The document further states: “The frequent need for adjustments in temperature, pressure, and swell time inherent to achieving legible hot stamp wire marking provides many opportunities for error. The controls, methods, and guidance necessary to achieve satisfactory performance with hot stamp marking are often not made available to operators in smaller wire maintenance facilities.” In addition it should be established from the wire manufacturer that hot stamp printing is or is not suitable for the particular wire.

b. If damage to the insulation occurs during the marking process, it may fail later in service after exposure to the sometimes-harsh environmental conditions of aircraft use. While CS 25.1711does not prohibit use of hot-stamp marking, its use is discouraged. To comply with this paragraph, if the hot-stamp marking process is used, the guidelines of SAE recommended practice ARP5369, “Guidelines for Wire Identification Marking Using the Hot Stamp Process” or equivalent should be followed.

c. In some cases it may not be practicable to mark an EWIS component directly because of component size or identification requirements. In this case other methods of identification such as a label or sleeve should be used.

6 CS 25.1711(e) requires that EWIS modifications to the type design maintain consistency with the identification scheme of the original type design. It requires that EWIS modifications to the type design take into consideration the identification scheme of the original type design. This is to ensure that the consistency required by CS 25.1711(a) is maintained when a modification is installed. The intent of this requirement is to provide continuity for EWIS identification on a particular model. It is not the intent of the requirement to impose on the modifier the exact wire identification methods of the aeroplane manufacturer. However, since the purpose of CS 25.1711 is to make it easy to identify those aeroplane systems essential to the safe operation of the aeroplane, it is in the best interest of safety that designers of any modifications to the original design consider the approved type design identification methods. For example it would not be appropriate for a modifier to use purple wire to identify a specific flight critical system when the approved type design used the colour green, especially if the type design already uses purple wire to identify non-essential systems. Such a scheme could cause confusion and lead future modifiers or maintainers to believe that the routing of purple wires with green wires (and thus critical systems with non-essential systems) is acceptable. The paragraph does not prescribe a particular method for identification but is meant to ensure that consistent identification is maintained throughout the life of the aeroplane.

7 CS 25.981(b) states that "...visible means to identify critical features of the design must be placed in areas of the aeroplane where maintenance, actions, repairs, or alterations may be apt to violate the critical design configuration limitations (e.g., colour-coding of wire to identify separation limitation)." 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 who may perform and approve such repairs and alterations.

An example of a critical design configuration control limitation that would result in a requirement for visible identification means would be a requirement to maintain wire separation between FQIS (fuel quantity indication system) wiring and other electrical circuits that could introduce unsafe levels of energy into the FQIS wires. Acceptable means of providing visible identification means for this limitation would include color-coding of the wiring or, for retrofit, placement of identification tabs at specific intervals along the wiring.

8 Types of EWIS component identification.

There are at least four types of EWIS component identification, which are accomplished at different stages. They are listed and described below.

a. Component manufacturer part number.

EWIS components should be identified by their manufacturer in accordance with the International Organization for Standardization document ISO 2574, “Aircraft – Electrical Cables – Identification Marking,” or similar specifications. This identification comprises product part number, manufacturer identification, and, when possible or specifically required, batch identification or year of manufacture.

This helps ensure:

- Identification and traceability of the component.
- Verification of compliance with the aircraft certification basis.
- Accuracy in manufacture, maintenance, quality control, storage and delivery.
- Verification of the use of approved/qualified sourcing.
- Monitoring of the aircraft configuration during the aircraft life.

(1) EWIS component manufacturer identification.

It is common practice to use the five-digit/letter C.A.G.E. code (Government and Commercial Entity Code), for manufacturer identification, particularly for wires. Alternatively, for small components whose size may make it difficult to use other forms of clear identification, a logo may be used.

(2) Identification intervals.

Wires and cables should be identified at intervals of not more than 38 cm (15 inches). This interval is different than the interval used by airframe manufacturers to prevent the possibility of two idents overlapping over the entire length of the run, which could render both idents illegible.

(3) Types of wire manufacturer markings.

Wire manufacturer markings should generally be green to differentiate them from the black marking typically used by the aeroplane manufacturer, but other contrasting colors are also acceptable. The preferred marking process is the “ink transfer” or “ink jet” type, with post curing to increase resistance to mechanical or chemical wear. As stated above, hot stamp marking method has the potential to damage wire insulation and its use is discouraged.

(4) The component technical specification should include methods used for identification and legibility during the design life of the component.

b. Airframe manufacturer component function identification number.

In addition to the type identification imprinted by the original wire manufacturer, aircraft wire should also contain a unique circuit identification coding that is accomplished at time of harness assembly. This allows existing installed wire to be identified as to its performance capabilities when considering replacement. Inadvertent use of a lower performance and unsuitable replacement wire can thus be avoided. Identification of EWIS components by the airframe manufacturer helps ensure:

- Identification and inspection of cable runs.
- Accuracy of manufacture, maintenance, quality control, storage and delivery.
- Verification of the system to which the component belongs.
- Identification of components related to systems required for safe flight, landing, or egress or that have the potential to impact the flight crew's ability to cope with adverse operating conditions.

Identification of EWIS components should clearly correspond to aircraft wiring manuals.

c. Airframe manufacturer routing identification and modification.

Electrical drawings should describe wire routings through the entire aeroplane (for example: incompatibility between routes, minimum distance between routes, absolute ban of combining bundles) and be available in the maintenance documentation as required by Appendix H to CS 25. This information ensures that modification designers and maintenance personnel are aware of the defined physical segregation of the different routes of the aircraft model they are working on. Coding for identification of routes or bundles used on aircraft should be displayed by adequate means such as labels, tags, placards, colored ties, bar-codes. This type of component identification helps ensure:

- Identification and inspection of bundles.
- Accuracy of manufacture, maintenance, quality control, storage and delivery.
- 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).
- 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.

(1) Means used for this identification should be appropriate for the component type. The identification process used should not cause degradation of the characteristics of any of the wire cables or other EWIS components in the harness.

(2) Modification and repairs identification, in a form that helps ensure the original aeroplane manufacturer's identification scheme, should be maintained throughout the service life of the aeroplane.

(3) Wires and cables should be identified at intervals of preferably not more than 46 cm (18 inches) and should not obscure the identification markings of the EWIS component manufacturer or airframe manufacturer component function identification number. This identification interval is different than the interval used by wire manufacturers to prevent the possibility of two idents overlapping over the entire length of the run, which could render both idents illegible. Also, exceptions can be made for short runs of wires or cables or when the majority of the wire or cable is installed in a manner that facilitates easy reading of the identification markings

d. Identification of user EWIS modification or repair – (operator's identification coding).

Repairs or modifications to EWIS should follow the identification guidance given in the above paragraphs for aeroplane manufacturers. This helps ensure that the original aeroplane manufacturer's identification scheme is not compromised by future modifications or repairs and is maintained throughout the service life of the aeroplane.

AMC 25.1713
Fire protection: EWIS

The intent of CS 25.1713 is to ensure that the EWIS does not fail in such a way as to propagate fire and produce hazardous quantities of smoke and toxic fumes.

1 Subparagraph 25.1713(a) requires that all EWIS components meet the applicable fire and smoke protection requirements of CS 25.831(c). After reasonably probable failures or malfunctions, EWIS components should not cause harmful or hazardous concentrations of gases or vapors in excess of the levels prescribed in CS 25.831(b)(1) and (2).

2 Subparagraph 25.1713(b) requires that EWIS components located in designated fire zones and are used during emergency procedures must be at least fire resistant. This requirement is intended to help ensure that emergency services on the aeroplane are available in the event of a fire. EWIS components in regions immediately behind firewalls and in engine pod attachment structures should be made of such materials and installed at such a distance from the firewall that they will not suffer damage that could hazard the aeroplane if the surface of the firewall adjacent to the fire is heated to 1100° C for 15 minutes.

3 Subparagraph 25.1713(c) requires that insulation on electrical wire and electrical cable installed anywhere in the aeroplane be self-extinguishing when tested in accordance with the applicable portions of part I Appendix F of CS 25.

In addition, to protect against propagation of a fire, EWIS components other than wire and cable should be designed using non-flammable and self-extinguishing materials as tested to meet the intent of Part I appendix F.

AMC 25.1715
Electrical bonding and protection against static electricity: EWIS

1 The build-up and subsequent discharge of static electricity has the potential to create hazardous conditions for both aeroplane systems and the aeroplane occupants. Static can cause physical injury, interfere with installed electrical/electronic equipment, and cause ignition of flammable vapours. All EWIS components used for bonding and protection against static electricity play a vital role in ensuring the integrity of the bonds.

2 CS 25.1715(a) requires that EWIS used for electrical bonding and protection against static electricity meet the requirements of CS 25.899. To minimise the hazardous effects of static discharge, EWIS components should be selected, designed, and installed so that the cross-sectional area of bonding paths used for primary and secondary bonding ensure that an appropriately low electrical impedance is obtained and maintained throughout the expected service life of the components. The maximum resistance for electrical bonds varies depending on the type of bond, e.g., ground stud, between connector shell and structure.

3 CS 25.1715(b) requires that EWIS components used for any electrical bonding purposes (not just those used for protection against static electricity) provide an adequate electrical return path under both normal and fault conditions. EWIS components should be selected, designed, and installed so that the cross-sectional area of bonding paths used for primary and secondary bonding paths ensure that appropriately low electrical impedance is obtained and maintained throughout the expected service life of the components.

AMC 25.1717
Circuit protective devices: EWIS

CS 25.1717 requires that all applicable EWIS components (for example wires, connector pins, terminal blocks, relays, splices) be compatible with the circuit protective devices required by CS 25.1357. This means that when selecting the EWIS components to be used for a specific application, care must be taken to ensure that the proper type and rating of the circuit protective device (e.g., circuit breaker) is selected so that the wire and cables are adequately protected from over-current situations.

AMC 25.1719
Accessibility provisions: EWIS

CS 25.1719 requires that means be provided to allow for inspection of EWIS and replacement of their components as necessary for continued airworthiness.

1 The intent of CS 25.1719 is to ensure that EWIS components are installed so that inspections, tests, repairs, and replacements can be undertaken with a minimum of aircraft disassembly. When adjacent structures and aircraft systems components must be removed to allow access to wire installations, new possibilities for contamination, chafing, and other types of damage are introduced.

2 As far as practicable, EWIS components should be installed so that inspections, tests, repair, and replacements can be done without undue disturbance to the EWIS installation or to surrounding aircraft systems. During the design phase, consider minimizing the amount of aircraft disassembly required to perform such tasks. For example, wiring inside conduit may incur damage from chafing against the sides of the conduit. If failure of wiring inside a conduit can lead to an unsafe condition, a means should be provided for inspection of those wires. Inspection may be by testing or other means acceptable to the Agency and should be included in the maintenance requirements that are part of the Instructions for Continued Airworthiness.

AMC 25.1721
Protection of EWIS.

1 The requirements of this paragraph are intended to prevent damage to EWIS by passengers, crew members, baggage or cargo handlers, or maintenance and service personnel. CS 25.1721(a) is applicable to EWIS located in cargo or baggage compartments, and CS 25.1721(b) and (c) apply to EWIS located elsewhere in the aeroplane.

2 CS 25.1721(a), specifies that EWIS cannot be located in cargo or baggage compartments if its damage or failure may affect safe operation unless it cannot be damaged by movement of cargo or baggage in the compartment, or its breakage or failure will not create a fire hazard. This means that any EWIS located in a cargo or baggage compartment must be protected against damage. EWIS in general and wiring in particular should 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 minimise the potential for maintenance personnel stepping, walking, or climbing on them. Wire bundles should be routed along heavier structural members whenever possible. If the structure does not afford adequate protection, other protection means such as a mechanical guard should be provided. When EWIS is close to sharp metal edges, the edges should be protected to prevent chafing. Additionally, wires should not be routed between aircraft skin and fuel lines.

3 Subparagraph 25.1721(b) requires that EWIS be designed and installed to minimise the risk of damage by movement of people in the aeroplane during all phases of flight, or during maintenance, and servicing. Some examples of areas of concern are the flight deck, passenger compartment, crew rest area, wheel wells, and wing leading and trailing edges.

a. Special consideration should be given to EWIS that are routed to, around, and on passenger seats. It should be protected so that passengers cannot damage it with their feet or access it with their hands.

b. EWIS located in the lavatories should not be readily accessible by passengers or aircraft cleaners. It should be designed and installed so that it cannot be damaged by the removal and replacement of items such as rubbish containers.

c. EWIS located in the galleys should not be readily accessible by cabin crew, aircraft cleaners, or passengers. EWIS should be designed and installed so that galley equipment, including galley carts, cannot come into contact with it and cause damage.

d. As with EWIS located in baggage and cargo compartments, EWIS in areas such as landing gear bays, the APU compartment, and electrical and electronic bays should be designed and installed to minimise potential for maintenance personnel stepping, walking, or climbing on them. Where the structure does not afford adequate protection, other protection such as a mechanical guard should be provided.

AMC 25.1723
Flammable fluid protection: EWIS

CS 25.1723 requires that EWIS located in areas where flammable fluid or vapours might escape must be considered to be a potential ignition source. As a result, these EWIS components must meet the requirements of CS 25.863. CS 25.863 requires that efforts be made to minimise the probability of ignition of fluids and vapours, and the hazards if ignition does occur. See CS 25.1707 for the separation requirements between EWIS and flammable fluids.

EWIS components located in fuel vapour zones should be qualified as explosion proof in accordance with Section 9 of EUROCAE ED-14 / RTCA Document DO160 or other equivalent approved industry standard. The possibility of contamination with flammable fluids due to spillage during maintenance action should also be considered.

q. Insert the following new AMCs to Appendix H

AMC Appendix H 25.4(a)(3)
Mandatory replacement time of EWIS components as defined in CS 25.1701

In accordance with subparagraph H 25.4(a)(3) applicants are required to include in the Airworthiness Limitations section of the Instructions for Continued Airworthiness any mandatory replacement times for EWIS components. EWIS components are those defined by CS 25.1701. Generally, EWIS components are designed and selected to last for the service life of the aeroplane. Any EWIS component that must be replaced at regular intervals to maintain the airworthiness of the associated system or aeroplane must be specified, with its required replacement interval, in the Airworthiness Limitations section of the ICA.

AMC Appendix H25.5
Instructions for Continued Airworthiness applicable to EWIS.

In accordance with subparagraph H 25.4(a)(3) the applicant must prepare Instructions for Continued Airworthiness (ICA) applicable to EWIS as defined by 25.1701 that are approved by the Agency and should include the following:

1 Maintenance and inspection requirements for the EWIS developed with the use of an enhanced zonal analysis procedure (EZAP) that include:

a. Identification of each zone of the aeroplane.

b. Identification of each zone that contains EWIS.

c. Identification of each zone containing EWIS that also contains combustible materials.

d. Identification of each zone in which EWIS is in close proximity to both primary and back-up hydraulic, mechanical, or electrical flight controls and lines.

e. Identification of –

- Tasks, and the intervals for performing those tasks, that will reduce the likelihood of ignition sources and accumulation of combustible material, and
- Procedures, and the intervals for performing those procedures, that will effectively clean the EWIS components of combustible material if there is not an effective task to reduce the likelihood of combustible material accumulation.

f. Instructions for protections and caution information that will minimize contamination and accidental damage to EWIS, as applicable, during the performance of maintenance, alteration, or repairs.

2 Acceptable EWIS maintenance practices in a standard format:

Applicants should document EWIS maintenance practices in a standard format. This is typically accomplished with publication of a standard wiring practices manual (SWPM). The rule is not intended to require that every manufacturer's SWPM is identical. The intent is to enable people performing EWIS maintenance and repairs to find information in the SWPM more quickly and easily, regardless of what aeroplane model they are currently working on. Standard wiring practices include procedures and practices for the installation, repair, and removal of EWIS components, including information about wire splices, methods of bundle attachment, connectors and electrical terminal connections, bonding, and grounding. A SWPM is not a design manual, and designers of EWIS modifications for specific aeroplane models should not use it as such. But it does provide the designer with insight into the types of EWIS components used by the TC holder and the procedures recommended by the manufacturer for maintenance or repair that supports continued airworthiness of the components. AMC 20-23 "Development of Standard Wiring Practices Documentation," provides guidance on how to comply.

3 Wire separation requirements as determined under 25.1707:

Applicants should include EWIS separation requirements in the ICA. EWIS separation guidelines are important for maintaining the safe operation of the aeroplane. Maintenance personnel need to be aware of the type certificate holder's separation requirements so they do not compromise separation in previously certified systems.

Determination of EWIS separation requirements is required by 25.1707. To comply with H25.5, the applicant should develop a way to convey these separation requirements and place them in the ICA. For example, if an aeroplane has a fly-by-wire flight control system and a minimum of 2 inches of physical separation is needed between the EWIS associated with the flight control system and other EWIS, this information should be available in the ICA.

Similarly, the separation of certain wires in fuel tank systems may be critical design configuration control items and therefore qualify as an airworthiness limitation. Maintenance personnel need these guidelines and limitations because many times wire bundles must be moved or removed to perform maintenance.

The separation data included in the ICA can take many forms. If a particular aeroplane model has fly-by-wire flight controls, the manufacturer may designate the EWIS associated with the flight control systems by a certain identification scheme (as required by 25.1711), and in the ICA state that EWIS so designated must be maintained with XX amount of separation from all other EWIS and YY amount of separation from other aeroplane systems and structure. The manufacturer can then repeat this information for other EWIS associated with other aeroplane systems. The ICA could indicate how EWIS associated with IFE and other passenger convenience systems is identified, and that this EWIS must be maintained XX inches from other categories of EWIS or structure.

It is not the intent of the regulation to require a type design holder or an applicant to divulge proprietary information in order to comply. Certain information, however, needs to be made available to modifiers and maintainers to ensure that future modifications and repairs do not invalidate previously certified designs.

4 Information explaining the EWIS identification method and requirements for identifying any changes to EWIS under CS 25.1711. This paragraph requires that the ICA contain information explaining the EWIS identification method and requirements for identifying any changes to EWIS. This requirement is intended to ensure that future modifications that add EWIS, identify the added EWIS with the same type of identification scheme used by the original aeroplane manufacturer. This information will help modification designers and modification personnel avoid improper modification and repair of existing EWIS or improper installation of new EWIS. These personnel need to review the applicable standard wiring practices, EWIS identification requirements, and electrical load data for the aeroplane they are modifying.

5 Electrical load data and instructions for updating that data. The ICA should contain electrical load data and instructions for updating that data. Electrical load data and the instructions for updating that data are necessary to help ensure that future modifications or additions of equipment that consume electrical power do not exceed the generating capacity of the onboard electrical generation and distribution system. Maintaining a record of actual airplane electrical loads is important to ensure that modifications to the original design do not impose electrical loads on the electrical generating system in excess of the system's capability to provide the necessary power and maintain necessary margins. To comply with the requirements of this paragraph applicants need to provide:

a. Electrical generating capacity of each source of normal electrical power generation.

b. Electrical generating capacity of each source of emergency power generation.

c. Electrical load capacity of each of electrical bus.

d. Actual electrical loading of each electrical bus.

6 The ICA must be in the form of a document appropriate for the information to be provided, and they must be easily recognizable as EWIS ICA.

II. Amendment to Commission Regulation (EC) No. 2042/2003 Part M:

a. Add a new subparagraph (i) to M.A.706 as follows:

M.A.706 Personnel requirements

….

(i) The organisation shall establish and control the competence of personnel involved in the continuing airworthiness management, airworthiness review and/or quality audits in accordance with a procedure and to a standard agreed by the competent authority.

b. Amend Part 66 Appendix I, Basic knowledge requirements paragraph 7.7 of module 7 as follows:

	Level		
	A	**B1**	**B2**
7.7 Electrical ~~Cables and Connectors~~ Wiring Interconnection System (EWIS) Continuity, insulation and bonding techniques and testing; Use of crimp tools: hand and hydraulic operated; Testing of crimp joints; Connector pin removal and insertion; Co-axial cables: testing and installation precautions; Identification of wire types, their inspection criteria and damage tolerance. Wiring protection techniques: Cable looming and loom support, cable clamps, protective sleeving techniques including heat shrink wrapping, shielding. EWIS installations, inspection, repair, maintenance and cleanliness standards	1	2	~~2~~3

III. Amendments to AMC/GM to Part M

a. Amend paragraph 5 of AMC M.A.302 as follows

AMC M.A.302
Maintenance programme

5. The approved aircraft maintenance programme should reflect applicable mandatory regulatory requirements addressed in documents issued by the ~~TC~~ holder of the type certificate, restricted type-certificate, supplemental type-certificate, major repair design approval, ETSO authorisation or any other relevant approval deemed to have been issued under Commission Regulation 1702/2003 to comply with Part 21A.61 or additional airworthiness specifications.

b. *Insert the following new AMC:*

AMC M.A.706(f)
Personnel Requirements

Adequate initial and recurrent training should be provided and recorded to ensure continued competence.

IV. Amendments to AMC-20

a. *Introduce the following new AMC's in AMC-20*

AMC 20-21: Programme to enhance aeroplane Electrical Wiring Interconnection System maintenance;

AMC 20-22: Aeroplane Electrical Wiring Interconnection System training programme

AMC 20-23: Development of electrical standard wiring practices documentation.

See following pages

Insert the following new AMCs (AMC 20-21, AMC 20-22, AMC 20-23) to AMC 20

AMC 20-21: Programme to enhance aeroplane Electrical Wiring Interconnection System maintenance

1 Purpose

This AMC provides guidance for developing enhanced Electrical Wiring Interconnection System (EWIS) maintenance for operators, holders of type certificates, holders of supplemental type certificates (STCs) and maintenance organisations. The information in this AMC is derived from the maintenance, inspection, and alteration best practices identified through extensive research. This AMC provides an acceptable means of compliance with the appropriate certification, maintenance and operating rules. This AMC promotes a housekeeping philosophy of “protect, clean as you go” when performing maintenance, repair, or alterations on or around aircraft EWIS.

2 Objective

The objective of this AMC is to enhance the maintenance of aircraft EWIS through adoption by the aviation industry of the following:

a. Enhanced Zonal Analysis Procedure (EZAP). This AMC presents an “enhanced zonal analysis procedure” and logic that will benefit all aircraft regardless of whether they currently have a structured zonal inspection programme (see Appendix A. Enhanced Zonal Analysis Logic Diagram and Steps and Appendix B. EZAP Worksheets). Application of this procedure will ensure that appropriate attention is given to wiring installations. Using EZAP it will be possible to select stand-alone inspections (either General or Detailed) and tasks to minimize the presence of combustible material. The procedure and logic in this AMC complement existing zonal analysis procedures and will also allow the identification of new wiring tasks for those aircraft that do not have a structured zonal inspection programme.

b. Guidance for General Visual Inspection (GVI). This AMC provides clarification of the definition for a General Visual Inspection and provides guidance on what is expected from such an inspection, whether performed as a stand-alone GVI or as part of a zonal inspection. It is assumed this new inspection standard will be the standard applied by operators, or their maintenance provider, when the new tasks are incorporated in to their maintenance programme.

c. Protections and Cautions. This AMC identifies protection and cautions to be added to maintenance instructions, thereby enhancing procedures that will lead to minimization of contamination and accidental damage while working on the aircraft.

The enhanced aircraft wiring maintenance information described in this AMC is intended to improve maintenance and inspection programmes for all aircraft systems. This information, when used appropriately, will improve the likelihood that wiring system degradation, including age related problems, will be identified and corrected. Therefore, the goal of enhanced wiring maintenance information is to ensure that maintenance actions, such as inspection, repair, overhaul, replacement of parts, and preservation, do not cause a loss of wiring system function, do not cause an increase in the potential for smoke and fire in the aircraft, and do not inhibit the safe operation of the aircraft.

To fully realize the objectives of this AMC, operators, type certificate holders, STC holders and maintenance providers, will need to rethink their current approach to maintaining and modifying aircraft wiring and systems. This may require more than simply updating maintenance manuals and work cards and enhancing training. Maintenance personnel need to be aware that aircraft EWIS should be maintained with the same level of intensity as any other system in the aircraft. They also need to recognize that visual inspection of wiring has inherent limitations. Small defects such as breached or cracked insulations, especially in small gauge wire may not always be apparent. Therefore effective wiring maintenance combines visual inspection techniques with improved wiring maintenance practices and training.

Good wiring maintenance practices should contain a **"protect, clean as you go"** housekeeping philosophy. In other words, care should be taken to protect wire bundles and connectors during work, and to ensure that all shavings, debris and contamination are cleaned up after work is completed. This philosophy is a proactive approach to wiring system health. Wiring needs to be given special attention when maintenance is being performed on it, or around it. This is especially true when performing structural repairs, work under STCs or field approvals, or other modifications.

To fully achieve the objectives of this AMC it is imperative that all personnel performing maintenance on or around EWIS receive appropriate training. (See AMC 20-22: Aeroplane Electrical Wiring Interconnection System training programme)

3 Applicability

a. The guidance provided in this document is directed to operators, type certificate holders, STC holders and maintenance providers:

(1) The holders of type certificates for large aeroplanes provided the type certificate was issued after January 1, 1958, and the aeroplane has a maximum type certificated passenger capacity of 30 or more, or a maximum type certificated payload capacity of 7500 pounds or more.

(2) The holders of supplemental type certificates for aeroplanes described in paragraph (a)(1) of this chapter, where the STC may cause wiring to be installed, removed, altered, disturbed, subjected to contamination, or may cause a change in the wiring system's operating environment.

b. The guidance provided in this AMC can be applied to all aeroplane maintenance or inspection programmes. The Enhanced Zonal Analysis Procedure in Appendix A of this AMC is specifically directed towards enhancing the maintenance programmes for aircraft whose current programme does not include tasks derived from a process that specifically considers wiring in all zones as the potential source of ignition of a fire.

c. This AMC, when followed in its' entirety outlines an acceptable means of compliance to the requirement for the development of enhanced scheduled maintenance tasks for the EWIS for the aircraft mentioned in 3 a.(1) and (2) above. *(see the possible Airworthiness Directive at the end of this NPA)*

d. Similarly it also provides an acceptable means of compliance for CS 25.1739 and 25.1529 Appendix H25.5 for new designs.

4 Related Documents

- Regulation (EC) No. 1592/2002
- Commission Regulation (EC) No. 1702/2003
- Commission Regulation (EC) No. 2042/2003
- EASA Certification Specification CS-25 Large Aeroplanes
- JAR-OPS 1 Commercial Air Transportation (Aeroplanes)

5 Related reading material

a. FAA Advisory Circulars (ACs).

- AC 25-16 Electrical Fault and Fire Protection and Prevention
- AC 25.981-1B Fuel Tank Ignition Source Prevention Guidelines
- AC 43-12A Preventive Maintenance
- AC 43.13-1B Acceptable Methods, Techniques and Practices for Repairs and Alterations to Aircraft
- AC 43-204 Visual Inspection For Aircraft
- AC 43-206 Avionics Cleaning and Corrosion Prevention/Control
- AC 65-15A Airframe & Powerplant Mechanics Airframe Handbook, Chapter 11, Aircraft Electrical Systems
- AC 120-YYY Training modules for wiring maintenance

b. EASA AMC 20

- AMC 20-22 Aeroplane Electrical Wiring Interconnection System training
- AMC 20-23 Development of electrical standard wiring practices documentation

c. Reports

- Transport Aircraft Intrusive Inspection Project, (An Analysis Of The Wire Installations Of Six Decommissioned Aircraft), Final Report, The Intrusive Inspection Working Group, December 29, 2000. http://www.mitrecaasd.org/atsrac/intrusive_inspection.html
- FAA Aging Transport Non-Structural Systems Plan, July 1998. http://www.faa.gov/apa/PUBLICAT/fatnspcov.htm
- National Transportation Safety Board, Safety Recommendation, September 19, 2000, A-00-105 through -108. http://www.ntsb.gov/recs/letters/2000/A00_105_108.pdf
- Wire System Safety Interagency Working Group, National Science and Technology Council, Review of Federal Programmes for Wire System Safety 46 (2000). http://www.ostp.gov/html/wire_rpt.pdf
- Aging Transport Systems Rulemaking Advisory Committee, Task 1 & 2, Aging Systems, Final Report. http://www.mitrecaasd.org/atsrac/final_reports/Task_1&2_Final%20_August_2000.pdf
- Aging Transport Systems Rulemaking Advisory Committee, Task 3, Final Report. http://www.mitrecaasd.org/atsrac/final_reports/Task_3_Final.pdf
- Aging Transport Systems Rulemaking Advisory Committee, Task 4, Final Report, Standard Wiring Practices. http://www.mitrecaasd.org/atsrac/final_reports/Task_4_Final_Report_Sept_2000.pdf
- Aging Transport Systems Rulemaking Advisory Committee, Task 5, Final Report, Aircraft Wiring Systems Training Curriculum and Lesson Plans. http://www.mitrecaasd.org/atsrac/final_reports/Task_5_Final_March_2001%20.pdf
- ATA Specification 117 (Wiring Maintenance Practices/Guidelines). http://www.airlines.org/public/publications/display1.asp?nid=939

d. Other Documents

- Operator/Manufacturer Scheduled Maintenance Development, ATA Maintenance Steering Group (MSG-3). May be obtained from the Air Transport Association of America; Suite 1100, 1301 Pennsylvania Ave, NW, Washington, DC 20004-1707.

6 Definitions

Arc tracking: A phenomenon in which a conductive carbon path is formed across an insulating surface. This carbon path provides a short circuit path through which current can flow. Normally a result of electrical arcing. Also referred to as "Carbon Arc Tracking," "Wet Arc Tracking," or "Dry Arc Tracking."

Combustible: For the purposes of this AMC the term combustible refers to the ability of any solid, liquid or gaseous material to cause a fire to be sustained after removal of the ignition source. The term is used in place of inflammable/flammable. It should not be interpreted as identifying material that will burn when subjected to a continuous source of heat as occurs when a fire develops.

Contamination: For the purposes of this AMC, wiring contamination refers to either of the following:
- The presence of a foreign material that is likely to cause degradation of wiring;
- The presence of a foreign material that is capable of sustaining combustion after removal of ignition source.

Detailed Inspection (DET): An intensive examination of a specific item, installation, or assembly to detect damage, failure or irregularity. Available lighting is normally supplemented with a direct source of good lighting at an intensity deemed appropriate. Inspection aids such as mirrors, magnifying lenses or other means may be necessary. Surface cleaning and elaborate access procedures may be required.

Electrical Wire Interconnection System (EWIS): An electrical connection between two or more points including the associated termination devices (e.g., connectors, terminal blocks, splices) and the necessary means for its installation and identification. (See Appendix D, Electrical Wire Interconnection System.)

Functional Failure: Failure of an item to perform its intended function within specified limits.

General Visual Inspection (GVI): A visual examination of an interior or exterior area, installation, or assembly to detect obvious damage, failure or irregularity. This level of inspection is made from within touching distance unless otherwise specified. A mirror may be necessary to enhance visual access to all exposed surfaces in the inspection area. This level of inspection is made under normally available lighting conditions such as daylight, hangar lighting, flashlight or droplight and may require removal or opening of access panels or doors. Stands, ladders or platforms may be required to gain proximity to the area being checked.

Lightning/High Intensity Radiated Field (L/HIRF) protection: The protection of aeroplane electrical systems and structure from induced voltages or currents by means of shielded wires, raceways, bonding jumpers, connectors, composite fairings with conductive mesh, static dischargers, and the inherent conductivity of the structure; may include aircraft specific devices, e.g., RF Gaskets.

Maintenance: As defined in Commission Regulation 2042/2003 Article 2(h) “maintenance means inspection, overhaul, repair, preservation, and the replacement of parts, but excludes preventive maintenance.” For the purposes of this advisory material, it also includes preventive maintenance.

Maintenance Significant Item (MSI): Items identified by the manufacturer whose failure could result in one or more of the following:
- could affect safety (on ground or in flight);
- is undetectable during operations;
- could have significant operational impact;
- could have significant economic impact.

Needling: The puncturing of a wire's insulation to make contact with the core to test the continuity and presence of voltage in the wire segment.

Stand-alone GVI: A General Visual Inspection which is not performed as part of a zonal inspection. Even in cases where the interval coincides with the zonal inspection, the Stand-alone GVI shall remain an independent step within the work card.

Structural Significant Item (SSI): Any detail, element or assembly that contributes significantly to carrying flight, ground, pressure, or control loads and whose failure could affect the structural integrity necessary for the safety of the aircraft.

Swarf: A term used to describe the metal particles, generated from drilling and machining operations. Such particles may accumulate on and between wires within a wire bundle.

Zonal Inspection: A collective term comprising selected General Visual Inspections and visual checks that are applied to each zone, defined by access and area, to check system and power plant installations and structure for security and general condition.

7 Background

Over the years there have been a number of in-flight smoke and fire events where contamination sustained and caused the fire to spread. Regulators and Accident Investigators have conducted aircraft inspections and found wiring contaminated with items such as dust, dirt, metal shavings, lavatory waste water, coffee, soft drinks, and napkins. In some cases dust has been found completely covering wire bundles and the surrounding area.

Research has also demonstrated that wiring can be harmed by collateral damage when maintenance is being performed on other aircraft systems. For example a person performing an inspection of an electrical power centre or avionics compartment may inadvertently cause damage to wiring in an adjacent area.

In recent years regulator and industry groups have come to the realization that current maintenance practices may not be adequate to address aging non-structural systems. While age is not the sole cause of wire degradation, the probability that inadequate maintenance, contamination, improper repair, or mechanical damage has caused degradation to a particular EWIS increases over time. Studies by industry and regulator working groups have found that although EWIS management is an important safety issue, there has been a tendency to be complacent about EWIS. These working groups have concluded that there is a need to better manage EWIS so that they continue to function safely.

8 Wire Degradation

Normal maintenance actions, even using acceptable methods, techniques and practices, can over time be a contributing factor to wire degradation. Zones that are subject to a high level of maintenance activity display more deterioration of the wiring insulation than those areas not subject to frequent maintenance. Degradation of wiring is further accelerated when inappropriate maintenance practices are used. Examples include the practice of needling wires to test the continuity or voltage, and using a metal wire or rod as a guide to feed new wires into an existing bundle. These practices could cause a breach in the wiring insulation that can contribute to arcing.

Over time, insulation can crack or breach, thereby exposing the conductor. This breakdown, coupled with maintenance actions, can exacerbate EWIS malfunction. Wiring that is undisturbed will have less degradation than wiring that is disturbed during maintenance.

For additional information on the principle causes of wire degradation see Appendix E.

9 Inspection of Electrical Wiring Interconnection Systems

Typical analytical methods used for the development of maintenance programmes have not provided a focus on wiring. As a result most operators have not adequately addressed deterioration of EWIS in their programmes. EASA has reviewed the current inspection philosophies with the objectives of identifying improvements that could lead to a more consistent application of the inspection requirements, whether they are Zonal, Stand-alone GVI, or DET inspections.

EASA believes that it would be beneficial to provide guidance on the type of deterioration that a person performing a GVI, DET, or Zonal Inspection would be expected to discover. Though it may be realistically assumed that all operators provide such guidance to their inspectors, it is evident that significant variations exist and, in certain areas of the world, a significant enhancement of the inspection could be obtained if internationally agreed guidance material could be produced. The guidance provided by this AMC assumes each operator will adopt recent improvements made to the definitions of GVI and DET Inspections. This information should be incorporated in operators' training material and in the introductory section of maintenance planning documentation.

This section is divided into three parts. The first part addresses the levels of inspection applicable to EWIS, the second part provides guidance for performing zonal inspections, and the third part provides lists of installations and areas of concern.

a. Levels of inspection applicable to EWIS

(1) Detailed Inspection (DET)

An intensive examination of a specific item, installation or assembly to detect damage, failure or irregularity. Available lighting is normally supplemented with a direct source of good lighting at an intensity deemed appropriate. Inspection aids such as mirrors, magnifying lenses or other means may be necessary. Surface cleaning and elaborate access procedures may be required.

A DET can be more than just a visual inspection since it may include tactile assessment in which a component or assembly is checked for tightness/security. This is of particular significance when identifying applicable and effective tasks to ensure the continued integrity of installations such as bonding jumpers, terminal connectors, etc.

Though the term Detailed Visual Inspection remains valid for DETs using only eyesight, it should be recognized that this may represent only part of the inspection called for in the source documents used to establish an operator's Maintenance Programme. For this reason it is recommend that the acronym "DVI" not be used since it excludes tactile examination from this level of inspection.

(2) General Visual Inspection (GVI).

A visual examination of an interior or exterior area, installation or assembly to detect obvious damage, failure or irregularity. This level of inspection is made from within touching distance unless otherwise specified. A mirror may be necessary to enhance visual access to all exposed surfaces in the inspection area. This level of inspection is made under normally available lighting conditions such as daylight, hangar lighting, flashlight or droplight and may require removal or opening of access panels or doors. Stands, ladders or platforms may be required to gain proximity to the area being checked.

Recent changes to this definition have added proximity guidance (within touching distance) and the allowance to use a mirror to enhance visual access to exposed surfaces when performing a GVI. These changes should result in more consistent application of GVI and support the expectations of what types of EWIS discrepancies should be detected by a GVI.

Though flashlights and mirrors may be required to provide an adequate view of all exposed surfaces, there is no requirement for equipment removal or displacement unless this is specifically called for in the access instructions. Paint and/or sealant removal is not necessary and should be avoided unless the observed condition is suspect. Should unsatisfactory conditions be suspected, items may need to be removed or displaced in order to permit proper assessment.

It is expected that the area to be inspected is clean enough to minimize the possibility that accumulated dirt or grease might hide unsatisfactory conditions that would otherwise be obvious. Any cleaning that is considered necessary should be performed in accordance with accepted procedures in order to minimize the possibility of the cleaning process itself introducing anomalies.

In general, the person performing a GVI is expected to identify degradation due to wear, vibration, moisture, contamination, excessive heat, aging, etc., and make an assessment as to what actions are appropriate to address the noted discrepancy. In making this assessment, any potential effect on adjacent system installations should be considered, particularly if these include wiring. Observations of discrepancies, such as chafing, broken clamps, sagging, interference, contamination, etc., need to be addressed.

(3) Zonal Inspection

A collective term comprising selected General Visual Inspections and visual checks that are applied to each zone, defined by access and area, to check system and power plant installations and structure for security and general condition.

A Zonal Inspection is essentially a GVI of an area or zone to detect obvious unsatisfactory conditions and discrepancies. Unlike a stand-alone GVI, it is not directed to any specified component or assembly.

b. Guidance for Zonal Inspections

The following EWIS degradation items are typical of what should be detectable and subsequently addressed as a result of a zonal inspection (as well as a result of a stand-alone GVI). It is also recommended that these items be included in maintenance and training documentation. This list is not intended to be exhaustive and may be expanded as considered appropriate.

(1) Wire / Wire Harnesses

- Wire bundle/wire bundle or wire bundle/structure contact/chafing
- Wire bundle sagging or improperly secured
- Wires damaged (obvious damage due to mechanical impact, overheat, localized chafing, etc.)
- Lacing tape and/or ties missing/incorrectly installed
- Wiring protection sheath/conduit deformity or incorrectly installed
- End of sheath rubbing on end attachment device
- Grommet missing or damaged
- Dust and lint accumulation
- Surface contamination by metal shavings/swarf
- Contamination by liquids
- Deterioration of previous repairs (e.g., splices)
- Deterioration of production splices
- Inappropriate repairs (e.g., incorrect splice)
- Inappropriate attachments to or separation from fluid lines

(2) Connectors

- External corrosion on receptacles
- Backshell tail broken
- Rubber pad or packing on backshell missing
- No backshell wire securing device
- Foolproofing chain broken
- Missing or broken safety wire
- Discoloration/evidence of overheat on terminal lugs/blocks
- Torque stripe misalignment

(3) Switches

- Rear protection cap damaged

(4) Ground points

- Corrosion

(5) Bonding braid/bonding jumper

- Braid broken or disconnected
- Multiple strands corroded
- Multiple strands broken

(6) Wiring clamps or brackets

- Corroded
- Broken/missing
- Bent or twisted
- Faulty attachment (bad attachment or fastener missing)
- Unstuck/detached
- Protection/cushion damaged

(7) Supports (rails or tubes/conduit)

- Broken
- Deformed
- Fastener missing
- Missing edge protection on rims of feed through holes
- Racetrack cushion damaged
- Obstructed drainage holes (in conduits)

(8) Circuit breakers, contactors or relays

- Signs of overheating
- Signs of arcing

c. Wiring installations and areas of concern

Research has shown that the following installations and areas need to be addressed in existing maintenance material.

(1) Wiring installations

Clamping points – Wire chafing is aggravated by damaged clamps, clamp cushion migration, or improper clamp installations. Aircraft manufacturers specify clamp type and part number for EWIS throughout the aircraft. When replacing clamps use those specified by the aircraft manufacturer. Tie wraps provide a rapid method of clamping especially during line maintenance operations. Improperly installed tie wraps can have a detrimental effect on wire insulation. When new wiring is installed as part of a STC or any other modification the drawings will provide wiring routing, clamp type and size, and proper location. Examples of significant wiring modifications are the installation of new avionics systems, new galley installations and new instrumentation. Wire routing, type of clamp and clamping location should conform to the approved drawings. Adding new wire to existing wire bundles may overload the clamps causing wire bundle to sag and wires to chafe. Raceway clamp foam cushions may deteriorate with age, fall apart, and consequently would not provide proper clamping.

Connectors – Worn environmental seals, loose connectors, missing seal plugs, missing dummy contacts, or lack of strain relief on connector grommets can compromise connector integrity and allow contamination to enter the connector, leading to corrosion or grommet degradation. Connector pin corrosion can cause overheating, arcing and pin-to-pin shorting. Drip loops should be maintained when connectors are below the level of the harness and tight bends at connectors should be avoided or corrected.

Terminations – Terminations, such as terminal lugs and terminal blocks, are susceptible to mechanical damage, corrosion, heat damage and contamination from chemicals, dust and dirt. High current-carrying feeder cable terminal lugs can over time lose their original torque value due to vibration. One sign of this is heat discoloration at the terminal end. Proper build-up and nut torque is especially critical on high current carrying feeder cable lugs. Corrosion on terminal lugs and blocks can cause high resistance and overheating. Dust, dirt and other debris are combustible and therefore could sustain a fire if ignited from an overheated or arcing terminal lug. Terminal blocks and terminal strips located in equipment power centres (EPC), avionics compartments and throughout the aircraft need to be kept clean and free of any combustibles.

Backshells – Wires may break at backshells, due to excessive flexing, lack of strain relief, or improper build-up. Loss of backshell bonding may also occur due to these and other factors.

Sleeving and Conduits – Damage to sleeving and conduits, if not corrected, may lead to wire damage. Therefore, damage such as cuts, dents and creases on conduits may require further investigation for condition of wiring within.

Grounding Points – Grounding points should be checked for security (i.e., finger tightness), condition of the termination, cleanliness, and corrosion. Any grounding points that are corroded or have lost their protective coating should be repaired.

Splices – Both sealed and non-sealed splices are susceptible to vibration, mechanical damage, corrosion, heat damage, chemical contamination, and environmental deterioration. Power feeder cables normally carry high current levels and are very susceptible to installation error and splice degradation. All splices should conform to the TC or STC holder's published recommendations. In the absence of published recommendations, environmental splices are recommended to be used.

(2) Areas of concern

Wire Raceways and Bundles – Adding wires to existing wire raceways may cause undue wear and chafing of the wire installation and inability to maintain the wire in the raceway. Adding wire to existing bundles may cause wire to sag against the structure, which can cause chafing.

Wings – The wing leading and trailing edges are areas that experience difficult environments for wiring installations. The wing leading and trailing edge wiring is exposed on some aircraft models whenever the flaps or slats are extended. Other potential damage sources include slat torque shafts and bleed air ducts.

Engine, Pylon, and Nacelle Area – These areas experience high vibration, heat, frequent maintenance, and are susceptible to chemical contamination.

Accessory compartment and equipment bays – These areas typically contain items such as electrical components, pneumatic components and ducting, hydraulic components and plumbing, and may be susceptible to vibration, heat, and liquid contamination.

Auxiliary Power Unit (APU) – Like the engine/nacelle area, the APU is susceptible to high vibration, heat, frequent maintenance, and chemical contamination.

Landing Gear and Wheel Wells – This area is exposed to severe external environmental conditions in addition to vibration and chemical contamination.

Electrical Panels and Line Replaceable Units (LRUs) **–** Panel wiring is particularly prone to broken wires and damaged insulation when these high density areas are disturbed during troubleshooting activities, major modifications, and refurbishments. Wire damage may be minimized by tying wiring to wooden dowels to reduce wire disturbance during modification. There may be some configurations where connector support brackets would be more desirable and cause less disturbance of the wiring than removal of individual connectors from the supports.

Batteries – Wires in the vicinity of all aircraft batteries are susceptible to corrosion and discoloration. These wires should be inspected for corrosion and discoloration. Discoloured wires should be inspected for serviceability.

Power Feeders – High current wiring and associated connections have the potential to generate intense heat. Power feeder cables, terminals, and splices may be subject to degradation or loosening due to vibration. If any signs of overheating are seen, splices or termination should be replaced. Depending on design, service experience may highlight a need to periodically check for proper torque of power feeder cable terminal ends, especially in high vibration areas. This applies to galley and engine/APU generator power feeders.

Under Galleys, Lavatories, and Cockpit – Areas under the galleys, lavatories, and cockpit, are particularly susceptible to contamination from coffee, food, water, soft drinks, lavatory fluids, dust, lint, etc. This contamination can be minimized by adherence to proper floor panel sealing procedures in these areas.

Fluid Drain plumbing – Leaks from fluid drain plumbing may lead to liquid contamination of wiring. In addition to routine visual inspections, service experience may highlight a need for periodic leak checks or cleaning.

Fuselage Drain provisions – Some installations include features designed to catch leakage that is plumbed to an appropriate exit. Blockage of the drain path can result in liquid contamination of wiring. In addition to routine visual inspections, service experience may highlight that these installations and associated plumbing should be periodically checked to ensure the drain path is free of obstructions.

Cargo Bay/Underfloor – Damage to wiring in the cargo bay underfloor can occur due to maintenance activities in the area.

Wiring subject to movement – Wiring that is subject to movement or bending during normal operation or maintenance access should be inspected at locations such as doors, actuators, landing gear mechanisms, and electrical access panels.

Access Panels – Wiring near access panels may receive accidental damage as a result of repetitive maintenance access and thus may warrant special attention.

Under Doors – Areas under cargo, passenger and service entry doors are susceptible to fluid ingress from rain, snow and liquid spills. Fluid drain provisions and floor panel sealing should be periodically inspected and repaired as necessary.

Under Cockpit Sliding Windows – Areas under cockpit sliding windows are susceptible to water ingress from rain and snow. Fluid drain provisions should be periodically inspected and repaired as necessary.

Areas where wiring is difficult to access – Areas where wiring is difficult to access (e.g., flight deck instrument panels, cockpit pedestal area) may accumulate excessive dust and other contaminants as a result of infrequent cleaning. In these areas it may be necessary to remove components and disassemble other systems to facilitate access to the area.

10 Enhanced Zonal Analysis Procedure

The Enhanced Zonal Analysis Procedure (EZAP) identified in Appendix A of this AMC is designed to permit appropriate attention to be given to electrical wiring installations. This is achieved by providing a means to identify applicable and effective tasks to minimize accumulation of combustible materials and address wiring installation discrepancies that may not otherwise be reliably detected by inspections contained in existing maintenance programmes.

For aircraft models operating on maintenance programmes that already include a dedicated Zonal Inspection Programme (ZIP), the logic described in this AMC will result in enhancements to those programmes, and the zonal inspection requirements may not differ greatly from the existing ZIPs.

In analysis conducted under the EZAP, items such as plumbing, ducting, systems installations, etc., should be evaluated for possible contribution to wiring failures. In cases where a General Visual Inspection is required to assess degradation of these items, a Zonal GVI within a ZIP may be considered as appropriate.

For those operators that do not have a dedicated ZIP, application of the logic is likely to result in identification of a large number of wiring related tasks that will need to be consolidated within the existing Systems/Powerplant Programme.

In either case, any new tasks identified by the logic may be compared with existing tasks and credit given for equivalent tasks already contained in the maintenance programme. For operators with ZIPs that already contain Zonal GVIs, the number of new tasks that must be added to the programme may be significantly fewer than for an operator without a dedicated ZIP. Therefore, operators without a ZIP may find it beneficial to develop a ZIP in accordance with an industry-accepted methodology in conjunction with application of the EZAP.

The logic and procedures identified in this AMC apply to TCs, STCs and other modifications. It is expected that the TC and STC holders would use the logic and procedures to identify any need for additional instructions for continued airworthiness. However, the operator may be required to ensure the logic is used to identify such instructions for modifications or STCs where they are no longer supported by the design organization or STC holder.

11 Maintenance Practices: Protection and Caution Recommendations

EASA has identified some specific maintenance and servicing tasks for which more robust practices are recommended to be adopted by operators, and/or maintenance providers. These recommendations apply to all tasks, including those performed on an unscheduled basis without an accompanying routine job instruction card. Performance of these maintenance practices will help prevent contamination of EWIS that result from contact with harmful solids (such as metal shavings) or fluids during maintenance, modifications, and repairs of aeroplane structures, and components. In addition the training of maintenance and servicing personnel should address the potential consequences of their actions on the wiring in the work vicinity.

a. Item 1: Installation, repair, or modification to wiring.

Wiring and its associated components (protective coverings, connectors, clamping provisions, conduits, etc.) often comprise the most delicate and maintenance sensitive portions of an installation or system. Extreme care should be exercised and proper procedures used during installation, repair, or modification of wiring to ensure safe and reliable performance of the function supplied by the wiring.

Proper wire selection, routing/separation, clamping configurations, use of splices, repair or replacement of protective coverings, pinning/de-pinning of connections, etc., should be performed in accordance with the applicable sections of the Aircraft Maintenance Manual (AMM), Wiring Practices Manual (WPM), or other documents authorized for maintenance use. In addition, special care should be taken to minimize disturbance of existing adjacent wiring during all maintenance activities. When wiring is displaced during a maintenance activity, special attention should be given to returning it to its normal configuration in accordance with the applicable maintenance instructions.

b. Item 2: Structural repairs, STCs, modifications.

Structural repair, STC or modification activity inherently introduces tooling and residual debris that is harmful to aircraft wiring. Structural repairs or modifications often require displacement (or removal) of wiring to provide access to the work area. Even minor displacement of wiring, especially while clamped, can damage wire insulation, which can result in degraded performance, arcing, or circuit failure.

Extreme care should be exercised to protect wiring from mechanical damage by tools or other equipment used during structural repairs, STCs or modifications. Drilling blindly into the aircraft structure should be avoided. Damage to wire installation could cause wire arcing, fire and smoke. Wiring located adjacent to drilling or riveting operations should be carefully displaced or covered to reduce the possibility of mechanical damage.

Debris such as drill shavings, liberated fastener pieces, broken drill bits, etc., should not be allowed to contaminate or penetrate wiring or electrical components. This can cause severe damage to insulation and potential arcing by providing a conductive path to ground or between two (2) or more wires of different loads. Once contaminated, removal of this type of debris from wire bundles is extremely difficult. Therefore, precautions should be taken to prevent contamination of any kind from entering the wire bundle.

Before initiating structural repair, STC or modification activity, the work area should be carefully surveyed to identify all wiring and electrical components that may be subject to contamination. All wiring and electrical components in the debris field should be covered or removed to prevent contamination or damage. Consideration should be given to using drills equipped with vacuum aspiration to further minimize risk of metallic debris contaminating wire bundles. Clean electrical components and wiring after completion of work per applicable maintenance instructions.

c. Item 3: Aircraft De-Icing or Anti-Icing.

To prevent damage to exposed electrical components and wiring in areas such as wing leading and trailing edges, wheelwells, and landing gear, care should be exercised when spraying de/anti-icing fluids. Direct pressure spray onto electrical components and wiring can lead to contamination or degradation and thus should be avoided.

d. Item 4: Inclement weather.

Electrical wiring interconnection systems in areas below doorways, floors, access panels, and servicing bays are prone to corrosion or contamination due to their exposure to the elements. Snow, slush, or excessive moisture should be removed from these areas before closing doors or panels. Remove deposits of snow/slush from any items (e.g., cargo containers) before loading in the aircraft. During inclement weather, keep doors/panels closed as much as possible to prevent ingress of snow, slush, or excessive moisture that could increase potential for EWIS degradation.

e. Item 5: Component removal/installation (relating to attached wiring).

Excessive handling and movement during removal and installation of components may be harmful to aircraft wiring. Use appropriate connector pliers (e.g., soft jawed) to loosen coupling rings that are too tight to be loosened by hand. Alternately pull on the plug body and unscrew the coupling ring until the connector is separated. Do not use excessive force, and do not pull on attached wires. When reconnecting, special care should be taken to ensure the connector body is fully seated, the jam nut is fully secured, and no tension is on the wires.

When equipment is disconnected use protective caps on all connectors (plug or receptacle) to prevent contamination or damage of the contacts. Sleeves or plastic bags may be used if protective caps are not available. Use of sleeves or plastic bags should be temporary because of the risk of condensation. It is recommended to use a humidity absorber with sleeves or plastic bags.

f. Item 6: Pressure Washing.

To prevent damage to exposed electrical components and wiring in areas such as wing leading and trailing edges, wheelwells, and landing gear, care should be exercised when spraying water or cleaning fluids. Direct high-pressure spray onto electrical components and wiring can lead to contamination or degradation and should be avoided. When practical, wiring and connectors should be protected before pressure washing. Water rinse should be used to remove cleaning solution residue after washing. Breakdown of wire insulation may occur with long term exposure of wiring to cleaning solutions. Although these recommendations are good practice and technique, the aeroplane maintenance manual or STC holder's instructions should be consulted for additional detailed instructions regarding pressure washing.

g. Item 7: Cleaning of electrical wiring interconnection systems (in situ).

Extreme care should be exercised and proper procedures used during cleaning to ensure safe and reliable performance of the function supplied by the wiring.

Care should be taken to avoid displacement or disturbance of wiring during cleaning of non-aggressive contamination. However, in the event of contamination by aggressive contaminants (e.g., livestock waste, salt water, battery electrolyte, etc.) such displacement may be necessary. In these cases wiring should be released from its installation so as to avoid undue stress being induced in wiring or connectors. Similarly, if liquid contamination enters the bundle then ties should be removed before separating the wires. Although these recommendations for cleaning of EWIS are considered good practice and technique, the aeroplane maintenance manual or STC holder's instructions should be consulted for additional detailed instructions.

Clean only the area and items that have contamination. Before cleaning, make sure that the cleaning materials and methods will not cause more contamination. If a cloth is used, make sure that it is clean, dry, and lint-free. A connector should be completely dry before mating. Any fluids remaining on a connector can have a deteriorating affect on the connector or the system or both.

h. Item 8: Servicing, modifying, or repairing waste/water systems.

Electrical wiring interconnection systems in areas adjacent to waste/water systems are prone to contamination from those systems. Care should be exercised to prevent any fluids from reaching electrical components and wiring while servicing, modifying, or repairing waste/water systems. Cover exposed electrical components and wiring during waste/water system modification or repair. Operator practice may call for a weak acid solution to be periodically flushed through lavatory systems to enhance reliability and efficiency of operation. In view of the effect of acid contamination on systems and structure, the system should be confirmed to be free of leaks before using such solutions.

i. Item 9: Servicing, modifying, or repairing oil systems.

Electrical wiring interconnections in areas adjacent to oil systems are prone to contamination from those systems. To minimize the attraction and adhesion of foreign material, care should be exercised to avoid any fluids from reaching electrical components and wiring while servicing, modifying, or repairing oil systems. Oil and debris in combination with damaged wiring can present a fire hazard.

j. Item 10: Servicing, modifying, or repairing hydraulic systems.

Electrical wiring interconnection system in areas adjacent to hydraulic systems are prone to contamination from those systems. To minimize the attraction and adhesion of foreign material, care should be exercised to avoid any fluids from reaching electrical components and wiring while servicing, modifying, or repairing hydraulic systems.

k. Item 11: Gaining access (entering zones).

When entering or working on the aircraft, care should be exercised to prevent damage to adjacent or hidden electrical components and wiring, including wiring that may be hidden from view (e.g., covered by insulation blankets). Use protective boards or platforms for adequate support and protection. Avoid using wire bundles as handholds, steps and supports. Work lights should not be hung or supported by wiring. If wiring must be displaced (or removed) for work area access, it should be adequately released from its clamping (or other restraining provisions) to allow movement without damage and returned after work is completed.

l. Item 12: Application of Corrosion Preventions Compounds (CPC).

When applying CPC in aeroplane zones containing wire and associated components (i.e., clamps, connectors and ties), care should be taken to prevent CPC from coming in contact with the wire and components. Dust and lint is more likely to collect on wire that has CPC on it. Application of CPCs should be done in accordance with the aircraft manufacturer's recommendations.

12 Changes.

The programme to enhance EWIS maintenance also applies to EWIS installed, modified, or affected by changes or STCs. Changes that could affect EWIS include, but are not limited to, those that install new equipment in close proximity to wiring, introduce a heat source in the zone, or introduce potential sources of combustible material or harmful contamination into the zone.

The operator is responsible for determining if the EWIS has been changed (or affected by alteration) and ensuring that their maintenance programme is enhanced as appropriate.

Appendix A. Enhanced Zonal Analysis Logic Diagram and Steps.

Figure 1. Enhanced Zonal Analysis Procedure

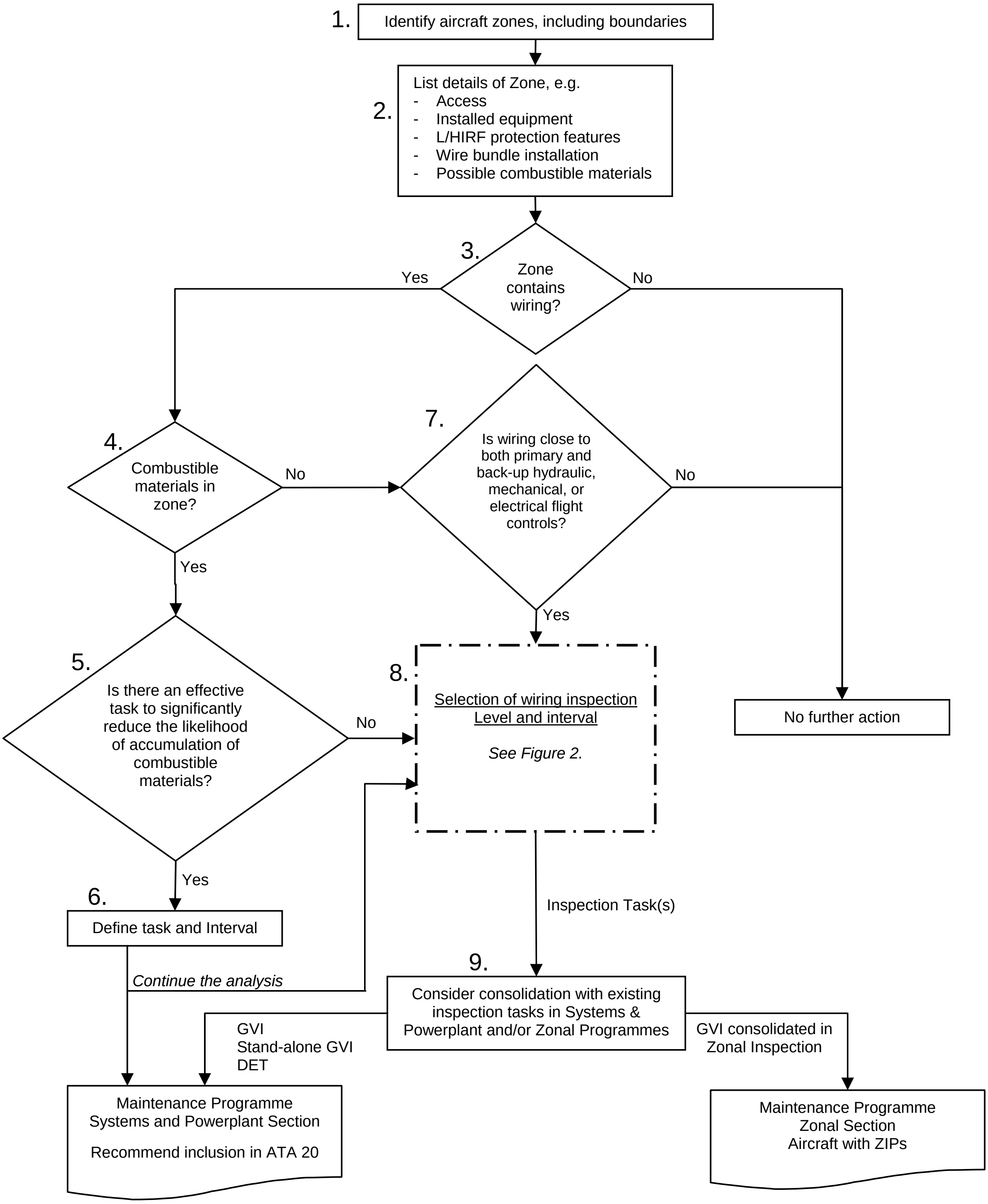
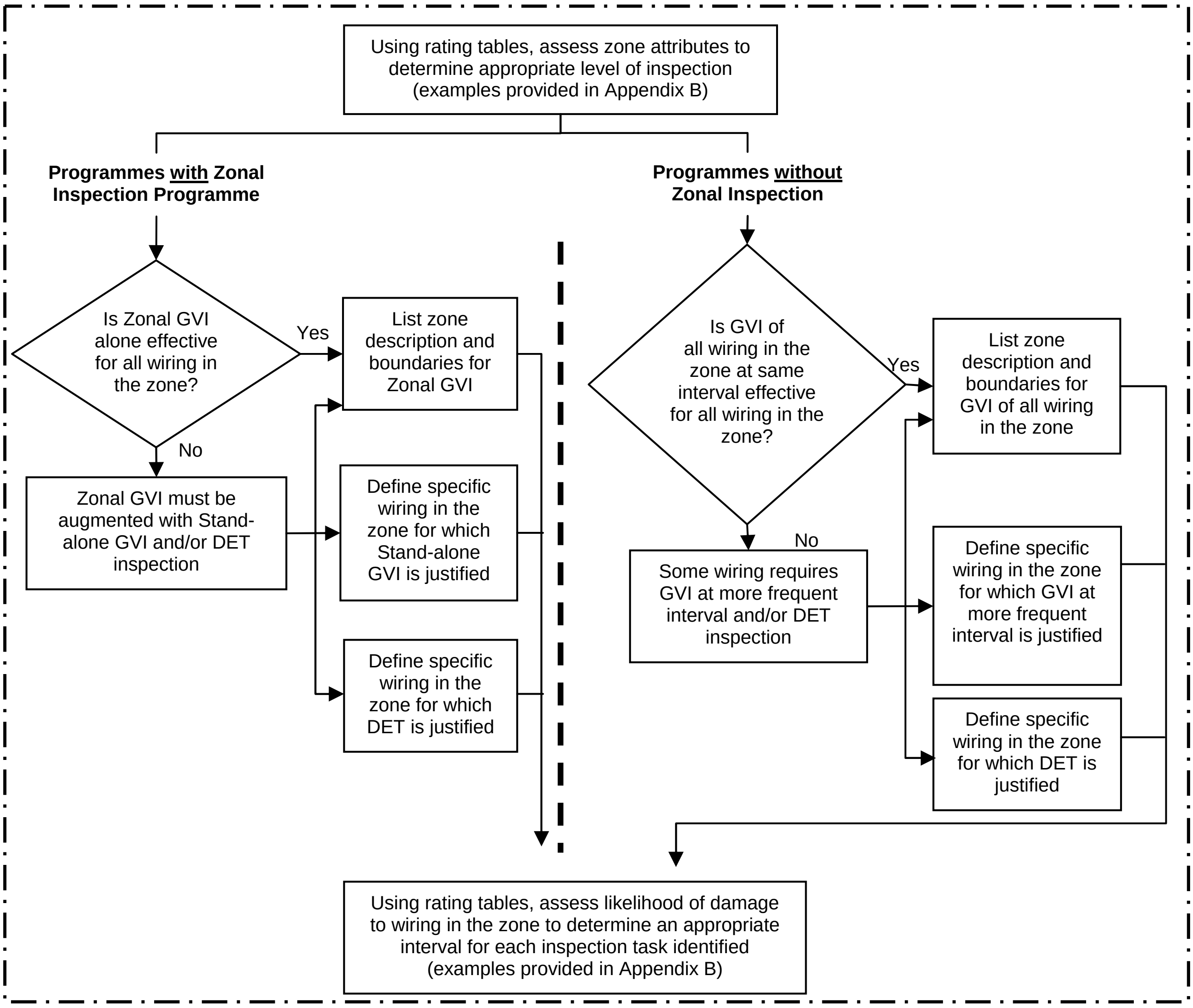


Figure 2. Step 8 - Wiring Inspection Level and Interval Selection



Explanation for Steps in Enhanced Zonal Analyses Procedure Logic Diagram. The following paragraphs provide further explanation of each step in the Enhanced Zonal Analyses Procedure logic, (Figures 1 and 2). It is recommended that, where possible, the analysts utilize the availability of actual aircraft to ensure they fully understand the zones being analyzed. This will aid in determination of density, size, environmental issues, and accidental damage issues.

Step 1 "Identify aircraft zones, including boundaries"

The system consists of Major Zones, Major Sub Zones and Zones.

The zones, wherever possible, shall be defined by actual physical boundaries such as wing spars, major bulkheads, cabin floor, control surface boundaries, skin, etc., and include access provisions for each zone.

If the type design holder or operator has not already established aircraft zones it is recommended that it do so. Whenever possible zones should be defined using a consistent method such as *ATA iSpec 2200* (formerly *ATA Spec 100*), varied only to accommodate particular design constructional differences.

Step 2 "List of details of zone"

An evaluation will be carried out to identify system installations, significant components, L/HIRF protection features, typical power levels in any installed wiring bundles, combustible materials (present or possible accumulation), etc.

With respect to power levels the analyst should be aware whether the bundle consists primarily of main generator feeder cables, low voltage instrumentation wiring or standard bus wiring. This information will later be used in determining the potential effects of deterioration.

The reference to combustible materials highlights the need to assess whether the zone might contain material/vapour that could cause a fire to be sustained in the event of an ignition source arising in adjacent wiring. Examples include the possible presence of fuel vapours, dust/lint accumulation and contaminated insulation blankets. See also under Step 4 for further information.

For aircraft types whose design directives may not have excluded the possibility of inadequate segregation between systems, the analyst should identify locations where both primary and back-up flight controls are routed within 2 inches/50 mm of a wiring harness. This information is required to answer the question in Step 7.

Step 3 "Zone contains wiring?"

This question serves as a means to eliminate from the enhanced zonal analysis procedure those zones that do not contain any wiring.

Step 4 "Combustible materials in zone?"

This question requires an evaluation of whether the zone might contain combustible material that could cause a fire to be sustained in the event of an ignition source arising in adjacent wiring. Examples include the possible presence of fuel vapours, dust/lint accumulation, and contaminated insulation blankets.

With respect to commonly used liquids (e.g., oils, hydraulic fluids, corrosion prevention compounds) the analyst should refer to the product specification in order to assess the potential for combustibility. The product may be readily combustible only in vapour/mist form and thus an assessment is required to determine if conditions might exist in the zone for the product to be in this state.

Although liquid contamination of wiring by most synthetic oil and hydraulic fluids (e.g., skydrol) may not be considered combustible, it is a cause for concern if it occurs in a zone where it causes significant adherence of dust and lint.

The analyst should assess what sources of combustible products may contaminate the zone following any single failure considered likely from in-service experience. Unshrouded pipes having connections within the zone should be considered as potential contamination sources. Inherent ventilation in the zone should be taken into account when determining the potential for subsequent combustion. This influences the response to the question of how near to the harness the source should be for there to be a concern.

Avionics and instruments located in the flight compartment and equipment bays tend to attract dust, etc. In view of the heat generated by these components and the relatively tightly packed installations, the analyst should consider these zones as having potential for combustible material. Thus the enhanced logic should always be used for these zones.

Note: Although moisture (whether clean water or otherwise) is not combustible, its presence on wiring is a cause for concern because it may increase the probability of arcing from small breaches in the insulation, which could cause a localized fire in the wire bundle. The risk of a <u>sustained</u> fire caused by moisture induced arcing is mitigated in Step 5 by identification of a task to reduce the likelihood of accumulation of combustible material on or adjacent to the wiring.

<u>Step 5</u> "Is there an effective task to significantly reduce the likelihood of accumulation of combustible materials?"

Most operator maintenance programmes have not included tasks directed towards removal or prevention of significant accumulations of combustible materials on or adjacent to wiring.

This question requires an evaluation of whether the accumulation on or adjacent to wiring can be significantly reduced. Task effectiveness criteria should include consideration of the potential for damaging the wiring.

Though restoration tasks (e.g., cleaning) are the most likely applicable tasks, the possibility to identify other tasks is not eliminated. A detailed inspection of a hydraulic pipe might be assessed as appropriate if high-pressure mist from pinhole corrosion could impinge a wire bundle and the inherent zone ventilation is low.

<u>Step 6</u> "Define task and interval"

This step will define an applicable task and an effective interval. It should be included as a dedicated task in the Systems & Powerplant section. Within MRB Reports, this may be introduced under ATA 20 with no Failure Effect Category quoted.

It is not the intent that restoration tasks should be so aggressive as to damage the wiring, but should be applied to a level that significantly reduces the likelihood of combustion.

<u>Step 7</u> "Is wiring close to primary and back-up hydraulic, mechanical, or electrical flight controls?"

Where wiring is close (i.e., within 2 inches/50 mm) to both primary and back-up hydraulic, mechanical, or electrical flight controls, this question is asked to ensure that Step 8 logic is applied even in the absence of combustible materials in the zone.

For zones where combustible materials are present (as determined in Step 4), proximity is addressed in the inspection level definition portion of Step 8 and this question need not be asked.

It addresses the concern that segregation between primary and back-up flight controls may not have been consistently achieved. Even in the absence of combustible material, a localized wire arcing could impact continued safe flight and landing if hydraulic pipes, mechanical cables, or wiring for fly-by-wire controls are routed in close proximity (i.e., within 2 inches/50 mm) to a wiring harness. In consideration of the redundancy in flight control systems, the question need be answered 'Yes' only if both the primary and back-up system might be affected by wire arcing. Note that in zones where a fire might be sustained by combustible material the enhanced logic will automatically be followed.

On all aircraft type designs, irrespective of TC date, modifications may not have taken into account the TC holder's design and installation criteria. It is thus recommended that STC holders assess their design changes with this question included in the logic unless they can demonstrate that they followed equivalent installation criteria. Similarly, air carriers and air operators will have to assess modifications that have been accomplished on their aircraft.

Step 8 "Selection of Wiring Inspection Level and Interval"

a. Inspection Level.

At this point in the analysis, it is already confirmed that wiring is installed in a zone where the presence of combustible materials is possible and/or the wiring is in close proximity to primary and backup hydraulic or mechanical flight controls. Therefore, some level of inspection of the wiring in the zone is required, and this step details how the proper level of inspection and interval can be selected.

One method of selecting the proper inspection level and interval is through the use of ratings tables which rate attributes of the zone and how the wiring is affected by, or can affect those attributes. The precise format of this will be determined by the analyst, but example rating tables appear in Appendix B and may be referred to for clarity.

The Inspection Level characteristics that may be included in the rating system are:

- Zone size (volume);
- Density of installed equipment within the zone;
- Potential effects of fire on adjacent wiring & systems.

Zone size will be assessed relative to the size of the aircraft, typically identified as small, medium or large. The smaller the zone and the less congested it is, the more likely it is that wiring degradation will be identified by GVI.

Density of installed equipment, including wiring, within the zone will be assessed relative to the size of the zone. The density of the zone is typically identified as low, medium or high.

Potential effects of fire on adjacent wiring and systems requires the analyst to assess the potential effect of a localized fire on adjacent wiring and systems by considering the potential for loss of multiple functions to the extent that continued safe operation may not be possible.

Consideration of potential effect must also include whether wiring is in close proximity (i.e., within 2 inches/50 mm) to both primary and back-up flight controls. A GVI alone may not be adequate if a fire caused by failure of the wiring poses a risk to aircraft controllability.

At minimum, all wiring in the zone will require a GVI at a common interval. For operators with a Zonal Inspection Programme, this may be defined as a Zonal GVI. For operators without ZIP, it shall be defined as a GVI of all wiring in the zone.

The question is asked, "Is a GVI (or Zonal GVI) of all wiring in the zone at the same interval effective for all wiring in the zone?" This is to consider if there are specific items/areas in the zone that are more vulnerable to damage or contamination and thus may warrant a closer or more frequent inspection.

This determination could result in the selection of a more frequent GVI, a Stand-alone GVI (for operators with a ZIP), or even a DET inspection. The intention is to select a DET of wiring only when justified by consideration of all three characteristics of the zone (size, density, and potential effect of fire). The analyst should be cautious to avoid unnecessary selection of DET where GVI is adequate. Over-use of DET dilutes the effectiveness of the inspection.

Note: The level of inspection required may be influenced by tasks identified in Steps 5 and 6. For example, if a cleaning task was selected in Step 5 and 6 that will minimize the accumulation of combustible materials in the zone, this may justify selection of a GVI in lieu of a DET for the wiring in the zone.

b. Inspection Interval.

The selection of an effective interval can also be accomplished using a rating system. The characteristics for wiring to be rated should include the following:

- Possibility of Accidental Damage;
- Environmental factors.

The rating tables should be designed to define increasing inspection frequency with increasing risk of accidental damage and increasing severity of the local environment within the zone. Examples are provided in Appendix E.

The selection of inspection tasks possible in this step is specific to whether the maintenance programme includes a dedicated Zonal Inspection Programme or not.

For ZIP programmes, the possible inspection tasks are:

- Zonal GVI;
- Stand-alone GVI;
- DET.

For non-ZIP programmes, the possible inspection tasks are:

- GVI;
- DET.

Note: At this point the analyst will have determined the required inspection level and interval for wiring in the zone. Task consolidation in Step 9 allows consideration as to whether an inspection selected as a result of this analysis can be considered accomplished as part of the existing maintenance programme.

Step 9 "Task Consolidation"

This step in the procedure examines the potential for consolidation between the tasks derived from the Enhanced Zonal Analysis Procedure and inspections that already exist in the Maintenance Programme. Consolidation requires that the inspections in the existing maintenance programme are performed in accordance with the inspection definitions provided in this AMC.

For programmes that include a Zonal Inspection Programme (ZIP):

Some GVIs identified by application of the Enhanced Zonal Analysis Procedure may be adequately covered by existing Zonal GVIs in the zone and no change or addition to the existing Zonal GVI is required. This should reduce the number of new GVIs that must be introduced into a programme that already includes a ZIP.

The consolidation of GVI tasks has to take into account the access requirements and the interval of each task. The Working Group may conclude that a stand-alone GVI of the wiring may be justified if the Zonal GVI of the other systems within the same zone does not need to have such a frequent inspection.

Stand-alone GVIs and DETs identified by application of EZAP cannot be consolidated into the Zonal Inspection Programme and must be introduced and retained as dedicated tasks in the scheduled maintenance programme under ATA 20. These tasks, along with tasks identified to reduce the accumulation of combustible materials, shall be uniquely identified to ensure they are not consolidated in the zonal programme nor deleted during future programme development. Within MSG-3 based MRB Reports, these may be introduced under ATA 20 with no Failure Effect Category quoted.

For programmes without a Zonal Inspection Programme (ZIP):

Although non-ZIP programmes may already include some dedicated inspections of wiring that may be reviewed for equivalency to new tasks identified by application of the Enhanced Zonal Analysis Procedure, it is expected that a significant number of new wiring inspections will be identified for introduction as dedicated tasks in the System & Powerplant programme. All new tasks identified by application of EZAP shall be uniquely identified to ensure they are not deleted during future programme development.

The following guide can be used to determine proper consolidation between EZAP derived inspections and existing inspections that have not been specifically identified as Stand-Alone Tasks, of the same item or area:

a. Where the EZAP inspection interval and existing inspection interval are equal, but the inspection levels are different, the more intense inspection will take precedent (i.e., a 1C DET takes precedent over a 1C GVI).

b. Where the EZAP inspection interval and existing inspection interval are different, but the inspection levels are equal, the more frequent inspection will take precedent (i.e., a 1C GVI takes precedent over a 2C GVI).

c. Where the EZAP inspection interval and level are different than the existing inspection interval and level, these tasks may be consolidated only when the more frequent inspection is the also the more intense (i.e., a 1C DET takes precedent over a 2C GVI). When the more frequent inspection is less intense, the tasks should not be consolidated.

For all programmes, these tasks shall be uniquely identified in the programme for future development consideration

For EZAP derived STC tasks, it may not be possible for the STC holder to determine whether a ZIP exists on specific aircraft that will utilize the STC. Therefore, where a ZIP exists, consolidation of EZAP derived STC tasks into a specific operator’s ZIP will be the responsibility of the operator and subject to approval by the competent authority.

In cases where the STC holder determines a requirement for a GVI that should not be consolidated into a ZIP, this Stand-alone GVI should be specifically identified as such in the EZAP derived ICAW for the STC.

Appendix B. Examples of Typical EZAP Worksheets

The following worksheets are provided as an example to assist implementation of the EZAP logic explained in this AMC. These may be adjusted by the analyst to suit specific applications.

1. Details of Zone.

2. Assessment of Zone Attributes.

3A. Inspection Level Determination based on Rating Tables (for use where a dedicated Zonal Inspection Programme exists).

3B. Inspection Level Determination based on Rating Tables (for use where no dedicated Zonal Inspection Programme exists).

4. Interval Determination based on Rating Tables.

5. Task Summary.

In particular, the interval ranges quoted in the rating table on Sheet 4 are solely to explain a typical arrangement of values. For a particular application, these must be compatible with the interval framework used in the existing maintenance or inspection programme. They may be expressed in terms of usage parameter (e.g., flight hours or calendar time) or in terms of letter check (as in the example).

Enhanced Zonal Analysis - Details of Zone

Sheet 1 of 5

ZONE NO:	ZONE DESCRIPTION:

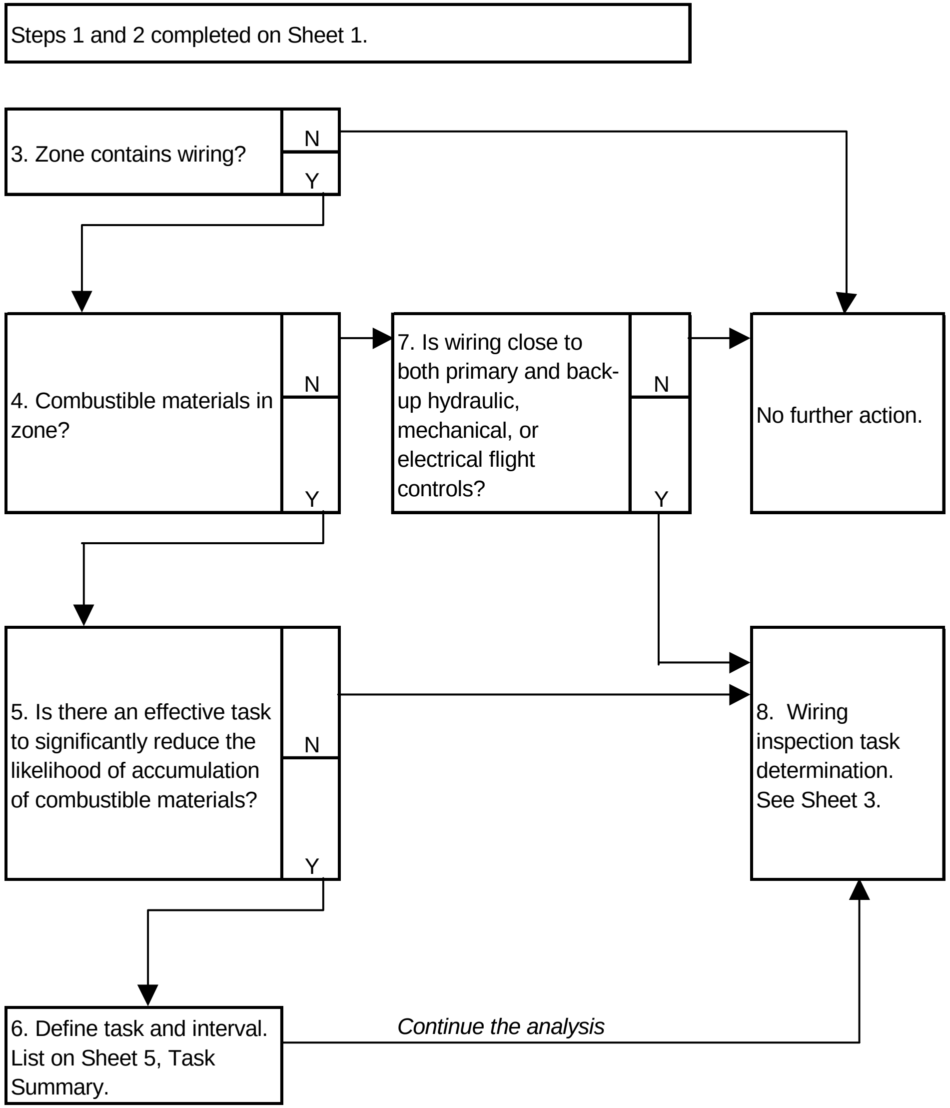
1. Zone Details (Boundaries, Access):

2. EQUIPMENT INSTALLED	COMMENTS
☐ Hydraulic Plumbing	*This sheet is used to comply with Steps 1 and 2 of the Enhanced Zonal Analysis Procedure:* *1. Describe the zone (location, access, boundaries)* *2. List the content of the zone; installed equipment, wiring, plumbing, components, etc.* *In the comments section on this sheet, it would be appropriate to note significant wire related items such as "Wire bundle routed within 2" of high-temp anti-ice ducting". The intent is to provide the analyst with a clear understanding of what's in the zone and how it could potentially affect wiring.*
☐ Hydraulic Components (valves, actuators, pumps)	
☐ Pneumatic Plumbing	
☐ Pneumatic Components (valves, actuators)	
☐ Electrical Wiring - Power Feeder (high voltage, high amperage)	
☐ Electrical Wiring - Motor Driven Devices	
☐ Electrical Wiring - Instrumentation, and Monitoring	
☐ Electrical Wiring - Data Bus	
☐ Electrical Components	
☐ Primary Flight Control Mechanisms	
☐ Secondary Flight Control Mechanisms	
☐ Engine Control Mechanisms	
☐ Fuel Components	
☐ Insulation	
☐ Oxygen	
☐ Potable Water	
☐ Waste Water	

Sample EZAP Worksheet Date: Page 1 of 5

Enhanced Zonal Analysis - Assessment of Zone Attributes **Sheet 2 of 5**

ZONE NO: **ZONE DESCRIPTION:**



Answers and Explanation to Questions
(Note: Steps 1 & 2 completed on Sheet 1.)

3.

This sheet is used to answer Questions 3 thru 7 of the Enhanced Zonal Analysis Procedure.

If the answer to Questions 3 and 7 is 'NO', then no further action is required in this analysis which is designed to address only wiring systems.

4.

If the answer to Question 5 is 'YES', and a task is identified that can significantly reduce the likelihood of accumulation of combustible materials, the task and interval must be defined in Step 6. If the task identified is a cleaning task to remove dust/lint accumulation from wiring, the interval for the task must be frequent enough to keep the wiring relatively clean based on the expected rate of accumulation of dust/lint on the wiring in the zone.

5.

In all cases, after Step 5 and/or Step 6, the analysis is continued to Step 8.

6.

7.

Enhanced Zonal Analysis - Inspection Level Determination based on Zone Size, Density, Potential Impact of Fire	Sheet 3A of 5
For Programs with dedicated Zonal Inspection Program (ZIP)	
ZONE NO:	ZONE DESCRIPTION

Zone Size/Density Assessment

		Zone Size		
		Small	Medium	Large
Density	Low	1	2	3
	Medium	2	2	3
	High	2	3	3

Circle appropriate result and insert below.

RESULT:

Inspection Level Determination Based on Potential Effect of Fire in Zone

	Size/Density Factor	1	2	3
Potential Effects of Fire in Zone	Low	Zonal GVI	Zonal GVI	Zonal GVI
	Medium	Zonal GVI	Zonal GVI + Stand-alone GVI of some wiring	Zonal GVI + Stand-alone GVI of some wiring
	High	Zonal GVI + Stand-alone GVI of some wiring	Zonal GVI + Stand-alone GVI and/or DET of some wiring	Zonal GVI + Stand-alone GVI and/or DET of some wiring

Circle appropriate result and answer questions in Boxes below.

1. Is a **Zonal GVI** alone effective for the entire Zone?
   - Yes → 2. List zone description and boundaries for **Zonal GVI**.
   - No → **Zonal GVI** must be augmented with **Stand-alone GVI**, and/or **DET** Inspection. → 2. / 3. / 4.

2. List zone description and boundaries for **Zonal GVI**.

3. Define specific items/areas in the zone for which **Stand-alone GVI** is justified

4. Define specific item/areas in the zone for which **DET** is justified

If answer to Box 1 is 'Yes" , answer Box 2 only.
If answer to Box 1 is 'No', answer Boxes 2, 3, & 4.

Answers & Explanation:

1.

2.

3.

4.

The tables on this Sheet are used to select the appropriate level of inspection for the wiring in the zone based on an assessment of zone size, density, and potential effects of fire in the zone.

This worksheet is designed for operators whose existing maintenance program already includes a dedicated Zonal Inspection Program. It is assumed that an existing ZIP already includes a Zonal GVI of all zones that contain wiring, and that the wiring is included in the Zonal GVI.

The minimum outcome of this analysis will always be a Zonal GVI of any zone where the presence of combustible materials is possible and/or wiring is located in close proximity to both primary and backup hydraulic or mechanical flight controls.

The Inspection Level Determination Table allows the Analyst to determine if a Zonal GVI alone is adequate for all wiring in the zone, or if the Zonal GVI must be augmented with a Stand-alone GVI and/or a DET inspection of some portion of the wiring.

If a Zonal GVI is adequate for all wiring in the zone, the analyst must identify the inspection area as the zone itself (Box 2). Interval selection will be made on Sheet 4.

If a Zonal GVI is not adequate for all wiring in the zone, in addition to identifying the Zonal GVI (Box 2), the analyst must also any identify the specific items/areas in the zone where a Stand-alone GVI (Box 3) and/or a DET inspection (Box 4) is justified.

Note: While it is useful to know the existing Zonal GVI interval while conducting this analysis, it is not assumed that the Zonal GVI interval selected during this analysis with respect to wiring will be the same as the existing interval. During task consolidation after completion of the analysis, the most frequent Zonal GVI interval for the zone will take precedent.

Sample EZAP Worksheet Date: Date:

Enhanced Zonal Analysis - Inspection Level Determination based on Zone Size, Density, Potential Impact of Fire — Sheet 3B of 5

For Programs without dedicated Zonal Inspection Program (ZIP)

ZONE NO: | ZONE DESCRIPTION:

Zone Size/Density Assessment

		Zone Size		
		Small	Medium	Large
Density	Low	1	2	3
	Medium	2	2	3
	High	2	3	3

Circle appropriate result and insert below.

RESULT:

Inspection Level Determination Based on Potential Effect of Fire in Zone

	Size/Density Factor	1	2	3
Potential Effects of Fire in Zone	Low	GVI of all wiring in zone at same interval	GVI of all wiring in zone at same interval	GVI of all wiring in zone at same interval
	Medium	GVI of all wiring in zone at same interval	GVI of all wiring in zone at same interval + GVI of some wiring at more frequent interval	GVI of all wiring in zone at same interval + GVI of some wiring at more frequent interval
	High	GVI of all wiring in zone at same interval + GVI of some wiring at more frequent interval	GVI of all wiring in zone at same interval + GVI of some wiring at more frequent interval and/or DET of some wiring	GVI of all wiring in zone at same interval + GVI of some wiring at more frequent interval and/or DET of some wiring

Circle appropriate result and answer questions in Boxes below.

1. Is a **GVI** alone effective for all wiring in the zone at the same interval?
   - Yes → 2. List zone description and boundaries for **GVI** of all wiring in the zone.
   - No → Some wiring requires **GVI** at more frequent interval and/or **DET** inspection.
     - 3. Define specific items/areas in the zone for which **GVI at more frequent interval** is justified.
     - 4. Define specific items/areas in the zone for which **DET** is justified.

If answer to Box 1 is 'Yes" , answer Box 2 only. If answer to Box 1 is 'No', answer Boxes 2, 3, & 4.

Answers & Explanation:

1.

2.

3.

4.

The tables on this sheet are used to select an Inspection Level based on zone size, density, and potential effect of fire in the zone. These factors are used to determine if a GVI of all wiring in the zone at the same interval is adequate, or if some wiring requires a more frequent GVI, or even a DET inspection.

This worksheet is designed for operators whose existing maintenance program does not include a dedicated Zonal Inspection Program. The minimum outcome of this analysis will always be a GVI of all wiring in any zone where the presence of combustible materials is possible and/or wiring is located in close proximity to both primary and backup hydraulic or mechanical flight controls.

If a GVI of all wiring in the zone at the same interval is adequate, the analyst must identify the inspection requirement as "GVI of all wiring in the zone" (Box 2) and proceed to Sheet 4 to determine the GVI interval.

If a GVI of all wiring in the zone at the same interval is not adequate, then the analyst must identify the specific items/areas in the zone where a more frequent GVI (Box 3) and/or a DET inspection (Box 4) is justified.

Sample EZAP Worksheet | Date: | Date:

Enhanced Zonal Analysis - Interval Determination Based on Hostility of Environment and Likelihood of Accidental Damage	Sheet 4 of 5
ZONE NO:	ZONE DESCRIPTION:

Interval selection is specific to each task identified on Sheet 3A or 3B. For GVI of entire zone, consider overall zone environment and likelihood of damage. For Stand-alone GVI or DET, consider environment and likelihood of damage only in respect to the specific item/area defined for inspection.

Item/Area Defined for Inspection:

Inspection Level:

Hostility of Environment	
1 - Passive, 2 - Moderate, 3 - Severe	
Temperature	
Vibration	
Chemicals (toilet fluids, etc.)	
Humidity	
Contamination	
Other -	
Highest Result	

Likelihood of Accidental Damage	
1 - Low, 2 - Medium, 3 - High	
Ground Handling Equipment	
F. O. D.	
Weather Effects (hail, etc.)	
Frequency of Maintenance Activities	
Fluid Spillage	
Passenger Traffic	
Other -	
Highest Result	

Interval Determination				
		Likelihood of Accidental Damage		
		1	2	3
Hostility of Environment	1	4C-6C	2C-4C	1C-2C
	2	2C-6C	1C-4C	A-1C
	3	1C-6C	1C-4C	A-1C

RESULT	

Upon completion, enter all task and interval selections onto Sheet 5, Task Summary.

Sample EZAP Worksheet Date: Sheet 4 of 5

Enhanced Zonal Analysis - Task Summary			Sheet 5 of 5
ZONE NO:	ZONE DESCRIPTION:		
Zone Description:			
TASK SUMMARY			
Task Number	Access	Interval	Task Description
			This Sheet is used to list all tasks and intervals selected as a result of EZAP analysis.
Sample EZAP Worksheet		Date:	Sheet 5 of 5

Appendix C: Determination If a Major Change to an Aircraft should be specifically subjected to an EZAP

The EZAP provides a means for TC and STC Holders to develop improvements to EWIS maintenance programs. These improvements will be in the form of new inspections and other tasks designed to prevent significant accumulation of combustible materials on or adjacent to EWIS components that would be added to the Instructions for Continued Airworthiness or Service Bulletins (SBs) for the aircraft and STC's.

While TC Holders are required to conduct the EZAP for all zones in an aircraft, it may be determined that EZAP for an SB or STC is not necessary where the modification does not appreciably affect the zones where it is installed. The "Determination if Service Bulletin Modification or STC Requires EZAP" procedure was developed to identify modifications that sufficiently affect zone attributes to warrant re-application of EZAP to the entire zone.

This logic assumes that the aircraft TC holder has accomplished the EZAP on each zone of the aircraft without consideration of the SB modification or STC installation. The objective of this analysis is to assess whether the modification itself has affected wiring or certain zone attributes that could change the outcome of the EZAP performed by the aircraft type certificate holder.

The determination if the SB or STC requires EZAP, and re-application of the EZAP to SB or STC affected zones, is the responsibility of the respective Holder of the SB or STC. It is expected that the TC and STC Holders will collaborate with each other and Operators as necessary to obtain information required to conduct the analysis. The TC or STC Holder should communicate the results of the procedure, including when no new tasks are identified. The method of communication may be via Service Bulletin, Service Letter, ICAW Revision, or other means acceptable to EASA.

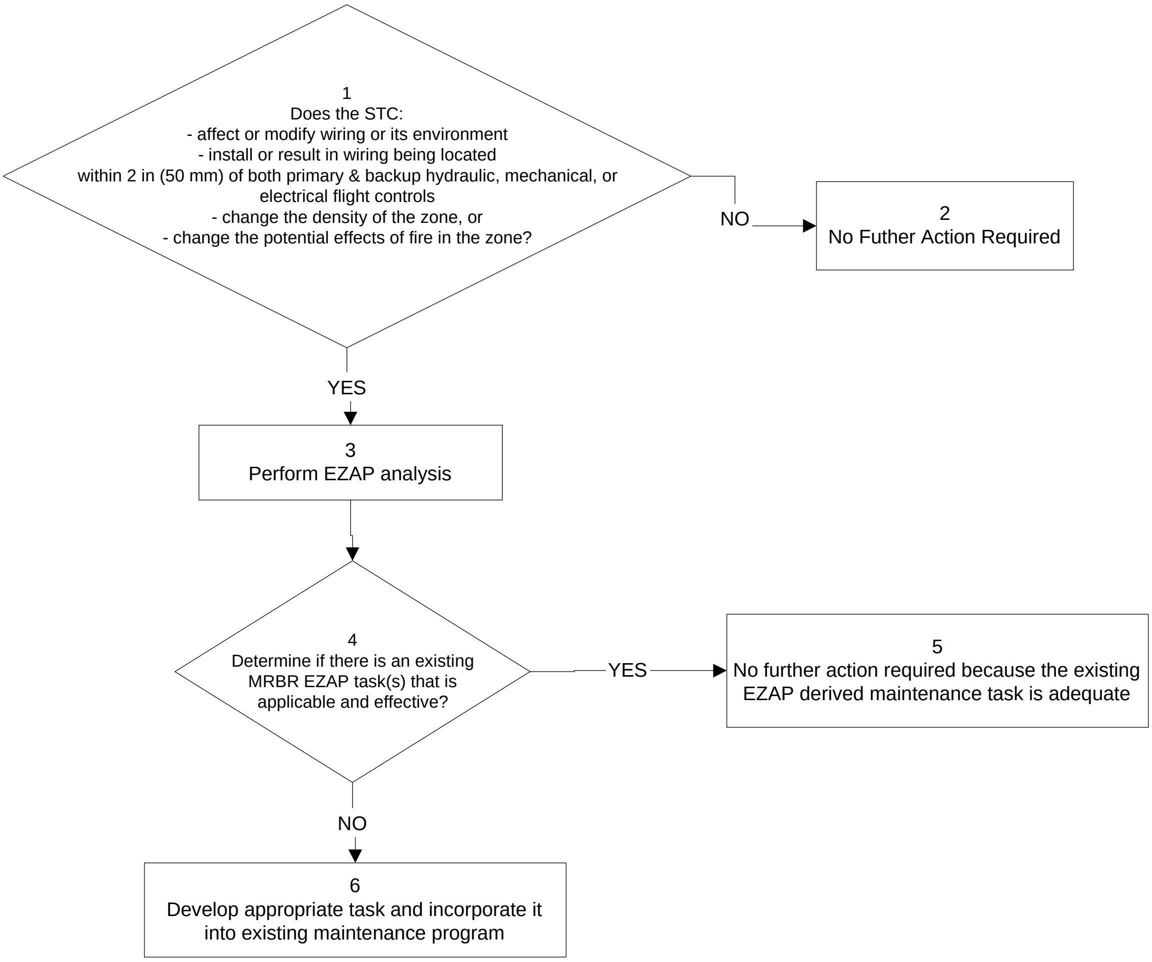
In situations where a previously installed STC is no longer supported by a viable STC Holder (e.g., STC Holder defunct), the responsibility for determining if the STC requires EZAP, and re-application of EZAP to any affected zones, is assigned to the individual operators who utilize the STC on their aircraft. In cases where the operator does not have experience in application of analytical logic processes, it will be necessary for the operator to gain competence in, or seek external assistance in conducting the analysis.

A record of the outcome of Operator accomplished analysis for STC's (even if no tasks are identified) should be permanently retained by the Operator. A copy of the record should be included in the aircraft records normally transferred upon change of aircraft operator.

The attached logic chart provides a means to assess whether an SB modification or STC has sufficiently affected wiring or certain other zone attributes as to require reapplication of the EZAP to the entire zone with consideration of the modification present. The section following the chart provides detailed explanations of each step in the Determination If Service Bulletin Modification or STC Requires EZAP with appropriate examples.

It is recommended that where possible, the analyst should utilize the availability of actual aircraft to ensure they fully understand the zones being analyzed. Specifically, it must be determined how installation of the modification could affect zone attributes such as density, environment, proximity of wiring to primary and backup flight controls, presence of combustible materials, and potential for accidental damage to wiring.

Appendix C. Figure 1. Determination if Service Bulletin or STC Requires EZAP



Explanation of Steps

Step 1: Does the SB or STC affect or modify wiring or it's environment?

The question asks whether the STC affects or modifies wiring. Modifications to wiring or other EWIS components includes, but not limited to removal, addition, relocation, etc.

Does the SB or STC install or results in wiring being located within 2 inches of primary and back-up hydraulic, mechanical or electric flight controls, change the density of the zone or change the potential effects of fire in the zone?

Does the SB or STC affect zone density? If the STC includes the addition or deletion of numerous components in a small area, the density of the zone could be changed even if wire bundles are untouched. A significant change in the zone density should warrant re-analysis of the zone.

Potential effects of fire on adjacent wiring and systems requires the analyst to assess the potential effect of a localized fire on adjacent wiring and systems by considering the potential for loss of multiple functions to the extent that a hazard could be introduced. Consideration of potential effect must also include whether wiring is in close proximity (i.e. within 2 inches/50 mm) to both primary and back-up flight controls.

Additionally, this question requires an evaluation of whether the zone might contain combustible material that could cause a fire to be sustained in the event of an ignition source arising in adjacent wiring. Examples include the possible presence of fuel vapors, dust/lint accumulation, and contaminated insulation blankets.

With respect to commonly used liquids (e.g., oils, hydraulic fluids, and corrosion prevention compounds), the analyst should refer to the product specification in order to assess the potential for combustibility. The product may be readily combustible only in vapor/mist form and thus an assessment is required to determine if conditions might exist in the zone for the product to be in this state.

Although liquid contamination of wiring by most synthetic oil and hydraulic fluids (e.g., skydrol) may not be considered combustible, it is a cause for concern if it occurs in a zone where contamination causes significant adherence of dust and lint.

If the answer to this question is “No”, then no further action is required (Step 2), because the density of the zone or the potential effects of fire in the zone has not changed.

Step 2: No further action required.

Step 3: Perform an EZAP analysis.

If the answer to question 1 is “yes,” then the only way to determine if existing EWIS maintenance tasks are sufficient is to perform the EZAP for the SB or STC and compare the results with the existing EWIS maintenance tasks (see Step 4).;

Step 4: Is there an existing MRBR EZAP task(s) that is applicable and effective?

Once the SB or STC EZAP has been accomplished, a comparison of the derived maintenance tasks can be made with the existing EWIS maintenance tasks. If the existing task are adequate, then no further action regarding EWIS maintenance actions for the STC is necessary.

Step 5: No further action required because the existing EZAP derived maintenance task is adequate.

Step 6: Develop an appropriate task and incorporate it into the existing maintenance program.

These tasks should be incorporated into the operator’s existing maintenance program.

Appendix D. Electrical Wiring Interconnection System.

As stated in the definitions section of this AMC "Electrical Wiring Interconnection System" (EWIS) is defined as follows:

An electrical connection between two or more points including the associated termination devices (e.g., connectors, terminal blocks, splices) and the necessary means for its installation and identification.

The definition of "EWIS" includes the following:

- Wires (e.g., wire, cable, coax, databus, feeders, ribbon cable).
- Bus bars.
- Connection to electrical devices (e.g., relays, push button, interrupters, switches, contactors, terminal blocks, feed-through connectors).
- Circuit breakers or other circuit protection devices (not performance).
- Electrical contacts.
- Connector and accessories (e.g., backshell, sealing boot grommet sealing plugs).
- Electrical grounding and bonding devices (e.g., modules, straps, studs).
- Electrical splices.
- Shield or braids.
- Conduits that have electrical termination.
- Clamps and other devices used to route and support the wire bundle.
- Cable tie devices.
- Labels or other means of identification methods.
- Pressure seals associated with EWIS.
- Wiring inside shelves, panels, racks, junction boxes, distribution panels, back-planes of equipment racks (including circuit board back-planes), wire integration units, etc.

The following wires and devices (along with the mating connections at the termination points of the wire on those devices) are <u>not</u> considered part of the "EWIS":

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

Appendix E. CAUSES OF WIRE DEGRADATION.

The following items are considered principal causes of wiring degradation and should be used to help focus maintenance programmes:

Vibration - High vibration areas tend to accelerate degradation over time, resulting in "chattering" contacts and intermittent symptoms. High vibration of tie-wraps or string-ties can cause damage to insulation. In addition, high vibration will exacerbate any existing problem with wire insulation cracking.

Moisture - High moisture areas generally accelerate corrosion of terminals, pins, sockets, and conductors. It should be noted that wiring installed in clean, dry areas with moderate temperatures appears to hold up well.

Maintenance - Scheduled and unscheduled maintenance activities, if done improperly, may contribute to long-term problems and wiring degradation. Certain repairs may have limited durability and should be evaluated to ascertain if rework is necessary. Repairs that conform to manufacturers recommended maintenance practices are generally considered permanent and should not require rework. Furthermore care should be taken to prevent undue collateral damage to EWIS while performing maintenance on other systems.

Metal shavings and debris have been discovered on wire bundles after maintenance, repairs, modifications, or STCs have been performed. Care should be taken to protect wire bundles and connectors during modification work. The work areas should be cleaned while the work progresses to ensure that all shavings and debris are removed; the work area should be thoroughly cleaned after the work is complete; and the work area should be inspected after the final cleaning.

Repairs should be performed using the most effective methods available. Since wire splices are more susceptible to degradation, arcing, and overheating, the recommended method of repairing a wire is with an environmental splice.

Indirect Damage - Events such as pneumatic duct ruptures or duct clamp leakage can cause damage that, while not initially evident, can later cause wiring problems. When events such as these occur, surrounding EWIS should be carefully inspected to ensure that there is no damage or potential for damage evident. The indirect damage caused by these types of events may be broken clamps or ties, broken wire insulation, or even broken conductor strands. In some cases the pressure of the duct rupture may cause wire separation from the connector or terminal strip.

Contamination - Wire contamination refers to either of the following situations:

a. The presence of a foreign material that is likely to cause degradation of wiring.

b. The presence of a foreign material that is capable of sustaining combustion after removal of ignition source.

The contaminant may be in solid or liquid form. Solid contaminants such as metal shavings, swarf, debris, livestock waste, lint and dust can accumulate on wiring and may degrade or penetrate wiring or electrical components.

Chemicals in fluids such as hydraulic fluid, battery electrolytes, fuel, corrosion inhibiting compounds, waste system chemicals, cleaning agents, de-icing fluids, paint, soft drinks and coffee can contribute to degradation of wiring.

Hydraulic fluids, de-icing fluids and battery electrolyte require special consideration. These fluids, although essential for aircraft operation, can damage connector grommets, wire bundle clamps, wire ties and wire lacing, causing chafing and arcing. Wiring exposed to these fluids should be given special attention during inspection. Contaminated wire insulation that has visible cracking or breaches to the core conductor can eventually arc and cause a fire. Wiring exposed to, or in close proximity to, any of these chemicals may need to be inspected more frequently for damage or degradation.

When cleaning areas or zones of the aircraft that contain both wiring and chemical contaminants, special cleaning procedures and precautions may be needed. Such procedures may include wrapping wire and connectors with a protective covering prior to cleaning. This would be especially true if pressure-washing equipment is utilized. In all cases the aircraft manufacturer recommended procedures should be followed.

Waste system spills also require special attention. Service history has shown that these spills can have detrimental effects on aircraft EWIS and have resulted in smoke and fire events. When this type of contamination is found all affected components in the EWIS should be thoroughly cleaned, inspected and repaired or replaced if necessary. The source of the spill or leakage should be located and corrected.

Heat - Exposure to high heat can accelerate degradation of wiring by causing insulation dryness and cracking. Direct contact with a high heat source can quickly damage insulation. Burned, charred or even melted insulation are the most likely indicators of this type of damage. Low levels of heat can also degrade wiring over a longer period of time. This type of degradation is sometimes seen on engines, in galley wiring such as coffee makers and ovens, and behind fluorescent lights, especially the ballasts.

AMC 20-22: Aeroplane Electrical Wiring Interconnection System Training Programme

1 Purpose

This AMC provides guidance for developing an enhanced Electrical Wiring Interconnection System (EWIS) training programme. The guidance and recommendations in this AMC are derived from the best practices training developed through extensive research. This AMC is an effort by the Agency to officially endorse these best practices and to dispense this information industry wide so the benefits of this information can be effectively realized. Adoption of the recommendations in this AMC will result in a training programme that will improve the awareness and skill level of the aviation personnel in Electrical Wiring Interconnection System (EWIS) production, modification, maintenance, inspection, alterations and repair. This AMC promotes a philosophy of training for all personnel who come into contact with aeroplane Electrical Wiring Interconnection Systems as part of their job and tailors the training for each workgroup to their particular needs.

2 Objective

This AMC has been published in order to provide the necessary guidance for EASA approved organisations to comply with their training obligations as required in Parts 21.A.145, 21.A.245, 145.A.30 and M.A.706 with respect to EWIS.

To fully realize the objectives of this AMC, operators, holders of type certificates, holders of supplemental type certificates (STCs), maintenance organisations, repair stations and persons performing modifications or repairs, will need to rethink their current approach to maintaining and modifying aeroplane wiring and systems. This may require more than simply updating maintenance manuals and work cards and enhancing training. Maintenance personnel need to be aware that aeroplane EWIS should be maintained with the same level of intensity as any other system in the aeroplane. They also need to recognize that visual inspection of wiring has inherent limitations. Small defects such as breached or cracked insulation, especially in small gage wire may not always be apparent. Therefore effective wiring maintenance combines visual inspection techniques with improved wiring maintenance practices and training.

The objective of this EWIS training programme is to give operators, holders of type certificates, holders of supplemental type certificates (STCs), maintenance organisations, repair stations and persons performing field approval modifications or repairs a model for the development of their own EWIS training programme. This will ensure that proper procedures, methods techniques, and practices are used when performing maintenance, preventive maintenance, inspection, alteration, and cleaning of Electrical Wiring Interconnection Systems.

The training syllabus and curriculum for those personnel directly involved in the maintenance and inspection of EWIS, identified as Target Group 1 and 2, are in Appendix A and C to this AMC.

This AMC also provides guidance on the development of EWIS training programmess for personnel who are not directly involved in the maintenance and inspection of EWIS. Although there is not a direct regulatory requirement for EWIS training of these personnel, operators may choose to provide EWIS training. The training syllabus and curriculum for these personnel, identified as Target Groups 3 through 8, are in Appendix B and C to this AMC.

It is believed that training personnel in these groups would greatly enhance awareness of the importance of EWIS safety in the overall safe operation of aeroplanes. Although these groups are not directly involved in the maintenance of EWIS, they have the potential to have an adverse impact on EWIS. This can occur through inadvertent contact with EWIS during aeroplane cleaning or when individuals perform unrelated maintenance that could impact the integrity of EWIS. Mechanics leaving drill shavings on wire bundles is one example of how this could occur. Some people prepare paperwork that guides mechanics, training this target group in EWIS should help to ensure proper attention is paid to EWIS issues.

This programme was developed for eight different target groups and may be used for the minimum requirements for initial and recurrent training (see training matrix). Depending on the duties some may fall into more than one target group and therefore must fulfil all objectives of the associated target groups. The target groups are:

a. Qualified staff performing EWIS maintenance.

These staff members are personnel who perform Wiring Systems maintenance and their training is based on their job description and the work being done by them. (e.g. avionics skilled workers or technicians cat B2)

b. Qualified staff performing maintenance inspections on Wiring Systems.

These staff members are personnel who perform EWIS inspections (but not maintenance) and their training is based on their job description and the work being done by them. (e.g. inspectors / technicians cat B2)

c. Qualified staff performing electrical/avionic engineering on in service aeroplane.

These staff members are personnel who are authorized to design EWIS installations, modifications and repairs.
(e.g. electric/avionic engineers)

d. Qualified staff performing general maintenance/inspections not involving wire maintenance, (LRU change is not considered wire maintenance).

These staff members are personnel who perform maintenance on aeroplane that may require removal/reconnection of electrical connective devices
(e.g. inspectors / technicians cat A or B1)

e. Qualified staff performing other engineering or planning work on in service aeroplane.

These staff members are personnel who are authorized to design mechanical/structure systems installations, modifications and repairs, or personnel who are authorized to plan maintenance tasks.

f. Other service staff with duties in proximity to Electrical Wiring Interconnection Systems.

These staff members are personnel whose duties would bring them into contact/view of aeroplane Wiring Systems.This would include, but not be limited to, aeroplane cleaners, cargo loaders, fuelers, lavatory servicing personnel, de-icing personnel, push back personnel.

g. Flight Deck Crew.

(e.g. Pilots, Flight Engineers)

h. Cabin Crew.

3 Applicability

This AMC describes acceptable means, but not the only means, of compliance with the appropriate certification, maintenance and operating regulations.

The information in this AMC is based on lessons learned by ATSRAC Harmonized Working Groups, regulatory authorities, manufacturers, airlines and repair stations. The recommendations in this AMC can be applied to any aeroplane training programme.

4 Related Documents

- Regulation (EC) No. 1592/2002
- Commission Regulation No. 1702/2003
- EASA Certification Specification CS-25 Large Aeroplanes
- JAR-OPS 1 Commercial Air Transportation (Aeroplanes)

5 Related Reading Material

a. EASA AMC-20

- AMC 20-21 Programme to Enhance Aeroplane Electrical Wiring Interconnection System Maintenance
- AMC 20-23 Development of Electrical Standard Wiring Practices Documentation

b. FAA 14 CFR Parts

- Part 21, Certification Procedures for Products and Parts
- Part 25, Airworthiness Standards, Transport Category Aeroplanes
- Part 43, Maintenance, Preventive Maintenance, Rebuilding, and Alteration
- Part 91, General Operating and Flight Rules
- Part 119, Certification: Air Carriers and Commercial Operators.
- Part 121, Operating Requirements: Domestic, Flag, and Supplemental Operations
- Part 125, Certification and Operations: Aeroplanes Having a Seating Capacity of 20 or More Passengers or a Maximum Payload Capacity of 6,000 pounds or More
- Part 129, Operations: Foreign Air Carriers and Foreign Operators of U.S.-Registered Aircraft Engaged in Common Carriage
- Part 135, Operating Requirements: Commuter and On-demand Operations
- Part 145, Repair Stations

c. FAA Advisory Circulars (ACs)

- AC 20-13, Protection Of Aircraft Electrical/Electronic Systems Against The Indirect Effects Of Lightning
- AC 20-53A, Protection Of Aeroplane Fuel Systems Against Fuel Vapour Ignition Due To Lightning AC 25-16, Electrical Fault and Fire Protection and Prevention
- AC 25.981-1B, Fuel Tank Ignition Source Prevention Guidelines
- AC 25.17YY Development of Standard Wiring Practices Documentation
- AC 43-3, Non-destructive Testing in Aircraft
- AC 43-4A, Corrosion Control for Aircraft
- AC 43-7, Ultrasonic Testing for Aircraft
- AC 43-12A, Preventive Maintenance

- AC 43.13-1A, Acceptable Methods, Techniques and Practices--Aircraft Inspection and Repair
- AC 43.13-1B, Acceptable Methods, Techniques and Practices for Repairs and Alterations to Aircraft
- AC 43-204, Visual Inspection For Aircraft
- AC 43-206, Avionics Cleaning and Corrosion Prevention/Control
- AC 65-15A, Airframe & Powerplant Mechanics Airframe Handbook, Chapter 11. Aircraft Electrical Systems
- AC 120-XX, Programme to enhance aircraft Electrical Wiring Interconnection System maintenance
- AC 120-YY Aircraft Electrical Wiring Interconnection System training programme

d. Reports

- Transport Aircraft Intrusive Inspection Project, (An Analysis Of The Wire Installations Of Six Decommissioned Aircraft), Final Report, The Intrusive Inspection Working Group, December 29, 2000. http://www.mitrecaasd.org/atsrac/intrusive_inspection.html
- FAA Aging Transport Non-Structural Systems Plan, July 1998. http://www.faa.gov/apa/PUBLICAT/fatnspcov.htm
- National Transportation Safety Board, Safety Recommendation, September 19, 2000, A-00-105 through -108. http://www.ntsb.gov/recs/letters/2000/A00_105_108.pdf
- Wire System Safety Interagency Working Group, National Science and Technology Council, Review of Federal Programmes for Wire System Safety 46 (2000). http://www.ostp.gov/html/wire_rpt.pdf
- Aging Transport Systems Rulemaking Advisory Committee, Task 1 & 2, Aging Systems, Final Report. http://www.mitrecaasd.org/atsrac/final_reports/Task_1&2_Final%20_August_2000.pdf
- Aging Transport Systems Rulemaking Advisory Committee, Task 3, Final Report. http://www.mitrecaasd.org/atsrac/final_reports/Task_3_Final.pdf
- Aging Transport Systems Rulemaking Advisory Committee, Task 4, Final Report, Standard Wiring Practices. http://www.mitrecaasd.org/atsrac/final_reports/Task_4_Final_Report_Sept_2000.pdf
- Aging Transport Systems Rulemaking Advisory Committee, Task 5, Final Report, Aircraft Wiring Systems Training Curriculum and Lesson Plans. http://www.mitrecaasd.org/atsrac/final_reports/Task_5_Final_March_2001%20.pdf
- ATA Specification 117 (Wiring Maintenance Practices/Guidelines). http://www.airlines.org/public/publications/display1.asp?nid=939
- Aging Transport Systems Rulemaking Advisory Committee, Task 6, Task 7 and Task 9 Working Group Final Reports.

e. Other Documents

- ATA Operator/Manufacturer Scheduled Maintenance Development as revised, ATA Maintenance Steering Group (MSG-3), may be obtained from the Air Transport Association of America; Suite 1100: 1301 Pennsylvania Ave, NW; Washington, DC 20004-1707.

- FAA Handbook Bulletin 91-15 "Origin and propagation of inaccessible aircraft fire under in-flight airflow conditions."

6 Definitions

Arc tracking. A phenomenon in which a conductive carbon path is formed across an insulating surface. This carbon path provides a short circuit path through which current can flow. Normally a result of electrical arcing. Also referred to as "Carbon Arc Tracking," "Wet Arc Tracking," or "Dry Arc Tracking."

Combustible. For the purposes of this AMC the term combustible refers to the ability of any solid, liquid or gaseous material to cause a fire to be sustained after removal of the ignition source. The term is used in place of inflammable/flammable. It should not be interpreted as identifying material that will burn when subjected to a continuous source of heat as occurs when a fire develops.

Contamination. For the purposes of this AMC, wiring contamination refers to either of the following:

- The presence of a foreign material that is likely to cause degradation of wiring.
- The presence of a foreign material that is capable of sustaining combustion after removal of ignition source.

Detailed Inspection (DET). An intensive examination of a specific item, installation, or assembly to detect damage, failure or irregularity. Available lighting is normally supplemented with a direct source of good lighting at an intensity deemed appropriate. Inspection aids such as mirrors, magnifying lenses or other means may be necessary. Surface cleaning and elaborate access procedures may be required.

Electrical Wiring Interconnection System (EWIS) is defined by CS 25 Subpart H, 25.1701 as follows:

Electrical Wire Interconnection System (EWIS): is defined by CS 25 Subpart H, 25.1701 as follows:

(a) Electrical wiring interconnection system (EWIS) means any wire, wiring device, or combination of these, including termination devices, installed in any area of the aeroplane for the purpose of transmitting electrical energy between two or more intended termination points. Except as provided for in subparagraph (c) of this paragraph, this includes:

(1) Wires and cables.

(2) Bus bars.

(3) The termination point on electrical devices, including those on relays, interrupters, switches, contactors, terminal blocks, and circuit breakers and other circuit protection devices.

(4) Connectors, including feed-through connectors.

(5) Connector accessories.

(6) Electrical grounding and bonding devices and their associated connections.

(7) Electrical splices.

(8) Materials used to provide additional protection for wires, including wire insulation, wire sleeving, and conduits that have electrical termination for the purpose of bonding.

(9) Shields or braids.

(10) Clamps and other devices used to route and support the wire bundle.

(11) Cable tie devices.

(12) Labels or other means of identification.

(13) Pressure seals.

(b) The definition in paragraph (a) of this section covers EWIS components inside shelves, panels, racks, junction boxes, distribution panels, and back-planes of equipment racks, including, but not limited to, circuit board back-planes and wire integration units.

(c) Except for the equipment indicated in paragraph (b) of this section, EWIS components inside the following equipment, and the external connectors that are part of that equipment, are excluded from the definition in paragraph (a) of this section:

(1) Electrical equipment or avionics that are qualified to environmental conditions and testing procedures when those conditions and procedures are—

(i) appropriate for the intended function and operating environment, and

(ii) acceptable to the Agency.

(2) Portable electrical devices that are not part of the type design of the aeroplane. This includes personal entertainment devices and laptop computers.

(3) Fibre optics.

Functional Failure. Failure of an item to perform its intended function within specified limits.

General Visual Inspection (GVI). A visual examination of an interior or exterior area, installation, or assembly to detect obvious damage, failure or irregularity. This level of inspection is made from within touching distance unless otherwise specified. A mirror may be necessary to enhance visual access to all exposed surfaces in the inspection area. This level of inspection is made under normally available lighting conditions such as daylight, hangar lighting, flashlight or droplight and may require removal or opening of access panels or doors. Stands, ladders or platforms may be required to gain proximity to the area being checked.

Lightning/High Intensity Radiated Field (L/HIRF) protection. The protection of aeroplane electrical systems and structure from induced voltages or currents by means of shielded wires, raceways, bonding jumpers, connectors, composite fairings with conductive mesh, static dischargers, and the inherent conductivity of the structure; may include aeroplane specific devices, e.g., RF Gaskets.

Maintenance. As defined in Commission Regulation 2042/2003 Article 2(h) "maintenance means inspection, overhaul, repair, preservation, and the replacement of parts, but excludes preventive maintenance." For the purposes of this advisory material, it also includes preventive maintenance.

Maintenance Significant Item (MSI). Items identified by the manufacturer whose failure:

- could affect safety (on ground or in flight).
- is undetectable during operations.
- could have significant operational impact.
- could have significant economic impact.

Needling. The puncturing of a wire's insulation to make contact with the core to test the continuity and presence of voltage in the wire segment.

Stand-alone GVI. A General Visual Inspection which is not performed as part of a zonal inspection. Even in cases where the interval coincides with the zonal inspection, the Stand-alone GVI shall remain an independent step within the work card.

Structural Significant Item (SSI). Any detail, element or assembly that contributes significantly to carrying flight, ground, pressure, or control loads and whose failure could affect the structural integrity necessary for the safety of the aeroplane.

Swarf. A term used to describe the metal particles, generated from drilling and machining operations. Such particles may accumulate on and between wires within a wire bundle.

Zonal Inspection. A collective term comprising selected General Visual Inspections and visual checks that are applied to each zone, defined by access and area, to check system and power plant installations and structure for security and general condition.

7 Background

Over the years there have been a number of in-flight smoke and fire events where contamination sustained and caused the fire to spread. Regulators and Accident Investigators have conducted aircraft inspections and found wiring contaminated with items such as dust, dirt, metal shavings, lavatory waste water, coffee, soft drinks, and napkins. In some cases dust has been found completely covering wire bundles and the surrounding area.

Research has also demonstrated that wiring can be harmed by collateral damage when maintenance is being performed on other aircraft systems. For example a person performing an inspection of an electrical power centre or avionics compartment may inadvertently cause damage to wiring in an adjacent area.

Aviation Accident Investigators have specifically cited the need for improved training of personnel to ensure adequate recognition and repair of potentially unsafe wiring conditions.

This AMC addresses only the training programme. It does not attempt to deal with the condition of the fleet's wiring, or develop performance tests for wiring.

This AMC captures, in EASA guidance form, the aeroplane Electrical Wiring Interconnection Systems training programme developed by ATSRAC. This includes a training syllabus, curriculum, training target groups and a matrix outlining training for each training group.

8 Essential elements for a Training Programme

a. Initial Training.

Initial training should be conducted for each designated work group. The initial training for each designated work group is outlined in Electrical Wiring Interconnection System Minimum Initial Training Programme - Appendix A and B. Curriculum and Lesson Plans for each dedicated module are included in Appendix C.

The most important criteria are to meet the objectives of the Lesson Plans – Appendix C. (Using classroom discussion, computer based training or hands on practical training)

Assessment or achieving the objectives should be at the discretion of the training organization. (Such as written test, oral test or demonstration of skills)

Supporting documentation such as AMCs is an integral part of training and should be used to support development of the Curriculum and Lesson Plans

b. Refresher Training.

Refresher training should be conducted in a period not exceeding two years. It could consist of a review of previously covered material plus any new material or revisions to publications. Refresher training will follow the Electrical Wiring Interconnection System Minimum Initial Training Programme - Appendix A or B for that particular target group.

Appendix A – EWIS Minimum Initial Training Programme for Group 1 And 2

Target Group 1: Qualified staff performing EWIS maintenance.
Target Group 2: Qualified staff performing maintenance inspections on EWIS.

TARGET GROUP	1	2
A – GENERAL ELECTRICAL WIRING INTERCONNECTION SYSTEM PRACTICES **Know or demonstrate safe handling of aeroplane electrical systems, line replaceable units (LRUs), tooling, troubleshooting procedures, and electrical measurement.**		
1. Safety practices	X	X
2. Electrostatic discharge sensitive (ESDS) device handling and protection	X	X
3. Tools, special tools, and equipment	X	
4. Verifying calibration/certification of instruments, tools, and equipment	X	
5. Required wiring checks using the troubleshooting procedures and charts	X	
6. Measurement and troubleshooting using meters	X	
7. LRU replacement general practices	X	X
B – WIRING PRACTICES DOCUMENTATION **Know or demonstrate the construction and navigation of the applicable aeroplane wiring system overhaul or practices manual.**		
8. Standard wiring practices manual structure/overview	X	X
9. Chapter cross-reference index	X	X
10. Important data and tables	X	X
11. Wiring diagram manuals	X	X
12. Other documentation as applicable	X	X
C – INSPECTION **Know the different types of inspections, human factors in inspections, zonal areas and typical damages.**		
13. General visual inspection (GVI), detailed inspection (DET), special detailed inspection (SDI), and zonal inspection, and their criteria and standards	X	X
14. Human factors in inspection		X
15. Zonal areas of inspection		X
16. Wiring system damage	X	X
D – HOUSEKEEPING **Know the contamination sources, materials, cleaning and protection procedures.**		
17. Aeroplane external contamination sources	X	X
18. Aeroplane internal contamination sources	X	X
19. Other contamination sources	X	X
20. Contamination protection planning	X	
21. Protection during aeroplane maintenance and repair	X	
22. Cleaning processes	X	
E – WIRE **Know or demonstrate the correct identification of different wire types, their inspection criteria and**		

TARGET GROUP	1	2
damage tolerance, repair and preventative maintenance procedures.		
23. Wire identification, type and construction	X	X
24. Insulation qualities and damage limits	X	X
25. Inspection criteria and standards for wire and wire bundles		X
26. Wire bundle installation practices	X	X
27. Typical damage and areas found (aeroplane specific)	X	X
28. Maintenance and repair procedures	X	X
29. Sleeving	X	X
30. Unused wires-termination and storage	X	X
31. Electrical bonding and grounds	X	X
F – CONNECTIVE DEVICES **Know or demonstrate the procedures to identify, inspect, and find the correct repair for typical types of connective devices found on the applicable aeroplane.**		
32. General connector types and identification	X	X
33. Cautions and protections	X	X
34. Visual inspection procedures	X	X
35. Typical damage found	X	X
36. Repair procedures	X	X
G – CONNECTIVE DEVICE REPAIR **Demonstrate the procedures for replacement of all parts of typical types of connectors found on the applicable aeroplane.**		
37. Circular connectors	X	
38. Rectangular connectors	X	
39. Terminal blocks-modular	X	
40. Terminal blocks- non-modular	X	
41. Grounding modules	X	
42. Pressure seals	X	

APPENDIX B – EWIS MINIMUM INITIAL TRAINING PROGRAMME FOR GROUP 3 THROUGH 8

Target Group 3: Qualified staff performing electrical/avionic engineering on in-service aeroplane.
Target Group 4: Qualified staff performing general maintenance/inspections not involving wire maintenance (LRU change is not considered wire maintenance)
Target Group 5: Qualified staff performing other engineering or planning work on in-service aeroplane
Target Group 6: Other service staff with duties in proximity to electrical wiring interconnection systems
Target Group 7: Flight Deck Crew
Target Group 8: Cabin Crew

TARGET GROUPS	3	4	5	6	7	8
<u>A – GENERAL ELECTRICAL WIRING INTERCONNECTION SYSTEM PRACTICES</u> **Know or demonstrate the safe handling of aeroplane electrical systems, line replaceable units (LRUs), tooling, troubleshooting procedures, and electrical measurement.**						
1. Safety practices		X		X	X	X
2. Electrostatic discharge sensitive (ESDS) device handling and protection		X				
7. LRU replacement general practices		X				
<u>B – WIRING PRACTICES DOCUMENTATION</u> **Know or demonstrate the construction and navigation of the applicable aeroplane wiring system overhaul or practices manual.**						
8. Standard wiring practices manual structure/overview	X					
9. Chapter cross-reference index	X					
10. Important data and tables	X					
11. Wiring diagram manuals	X					
12. Other documentation as applicable	X					
<u>C – INSPECTION</u> **Know the different types of inspections, human factors in inspections, zonal areas and typical damages.**						
13. General visual inspection (GVI), detailed inspection (DET), special detailed inspection (SDI), and zonal inspection, and their criteria and standards		X	X			

TARGET GROUPS	3	4	5	6	7	8
14. Human factors in inspection			X			
15. Zonal areas of inspection			X			
16. Wiring system damage		X	X	Low level	Low level	Low level
D – HOUSEKEEPING **Know the contamination sources, materials, cleaning and protection procedures.**						
17. Aeroplane external contamination sources		X		X	X	X
18. Aeroplane internal contamination sources		X		X	X	X
19. Other contamination sources		X		X	X	X
20. Contamination protection planning	X	X	X			
21. Protection during aeroplane maintenance and repair	X	X	X			
22. Cleaning processes	X	X	X	X		
E – WIRE **Know or demonstrate the correct identification of different wire types, their inspection criteria and damage tolerance, repair and preventative maintenance procedures.**						
23. Wire identification, type and construction	X					
24. Insulation qualities and damage limits	X					
25. Inspection criteria and standards of wire and wire bundles	X					
26. Wire bundle installation practices	X					
27. Typical damage and areas found (aeroplane specific)	X	X	X	Low level	Low level	Low level
28. Maintenance and repair procedures	X					
29. Sleeving	X					
30. Unused wires-termination and storage	X					
31. Electrical bonding and grounds	X	X Bond	X			
F – CONNECTIVE DEVICES **Know or demonstrate the procedures to identify, inspect, and find the correct repair for typical types of connective devices found on the applicable aeroplane.**						
32. General connector types and identification	X					
33. Cautions and protections	X					
34. Visual inspection procedures	X					
35. Typical damage found	X					
36. Repair procedures	X					

Appendix C – Curriculum and Lessons Plan

Electrical Wiring Interconnection System Curriculum

1 Overview

This training is targeted at each person who performs aeroplane maintenance, inspections, alterations or repairs on Electrical Wiring Interconnection Systems and/or structure. After training the person is able to properly evaluate the Electrical Wiring Interconnection System and effectively use the manufacturers Chapter 20 Wiring System overhaul manual for that aeroplane. The training programme must include; wiring system condition, applicable repair schemes, wiring modifications and ancillary repairs to wiring systems and components. All of the training components are integrated to maintain wiring system quality and airworthiness of the aeroplane.

2 Objectives

Depending on the modules taught, the person shows competency in the following skills:

a. Know or demonstrate the safe handling of aeroplane electrical systems, Line Replaceable Units (LRU's), tooling, troubleshooting procedures, and electrical measurement.

b. Know or demonstrate the construction and navigation of the applicable aeroplane Wiring System overhaul or wiring practices manual.

c. Know the different types of inspections, human factors in inspections, zonal areas and typical damages.

d. Know the contamination sources, materials, cleaning and protection procedures.

e. Know or demonstrate the correct identification of different wire types, their inspection criteria, and damage tolerance, repair and preventative maintenance procedures.

f. Know or demonstrate the procedures to identify, inspect and find the correct repair for typical types of connective devices found on the applicable aeroplane.

g. Demonstrate the procedures for replacement of all parts of typical types of connective devices found on the applicable aeroplane.

3 Scope

The course is to be used by training providers for all maintenance persons at any stage in their careers. The person can be trained to the appropriate level using the applicable modules, depending on the persons experience, work assignment and operators policy.

MODULE A – GENERAL ELECTRICAL WIRING INTERCONNECTION SYSTEM PRACTICES:

(1) Safety practices

(2) Electrostatic Discharge Sensitive (ESDS) device handling and protection

(3) Tools, special tools and equipment

(4) Verify calibration/certification of instruments, tools, and equipment

(5) Required wiring checks using the Troubleshooting Procedures and Charts.

(6) Measurement and troubleshooting using meters.

(7) LRU replacement general practices

MODULE B – WIRING PRACTICES DOCUMENTATION:

(1) Chapter 20 structure/overview

(2) Chapter 20 cross-reference Index

(3) Chapter 20 important Data and Tables

(4) Wiring Diagram Manual

(5) Other Documentation (as applicable)

MODULE C – INSPECTION:

(1) Special Inspections -

(2) Criteria and standards

(3) Human factors in inspection

(4) Zonal areas of inspection

(5) Wiring System damage

MODULE D – HOUSEKEEPING:

(1) Aeroplane external contamination sources

(2) Aeroplane internal contamination sources

(3) Other contamination sources

(4) Contamination protection planning

(5) Protection during aeroplane maintenance and repair

(6) Cleaning processes

MODULE E – WIRE:

(1) Identification, type and construction

(2) Insulation qualities

(3) Inspection criteria and standards of wire and wire bundles

(4) Wire bundle installation practices

(5) Typical damage and areas found (aeroplane specific)

(6) Maintenance and repair procedures

(7) Sleeving

(8) Unused wires-termination and storage

(9) Electrical bonding and grounds

MODULE F – CONNECTIVE DEVICES:

(1) General types and identification

(2) Cautions and protections

(3) Visual inspection procedures

(4) Typical damage found

(5) Repair procedures

MODULE G – CONNECTIVE DEVICE REPAIR:

(1) Circular Connectors

(2) Rectangular Connectors

(3) Terminal Blocks-Modular

(4) Terminal Blocks- Non-modular

(5) Grounding Modules

(6) Pressure Seals

MODULE A: GENERAL ELCTRICAL WIRING INTERCONNECTION SYSTEM PRACTICE

1 Overview

Through Module A, the instructor lays the groundwork of safe effective maintenance and repair of the aeroplane Electrical Wiring Interconnection System (EWIS) and LRU removal and replacement, including BITE test, without damage to the aeroplane or injury to the student.

The Instructor may vary the depth and scope of the topics to be covered, depending on the type of aeroplane to be maintained and skills of the persons.

2 Objectives

After this module is complete the student is able to demonstrate the following skills:

a. Know the safety procedures of normal and non-normal maintenance procedures so the person can protect him/herself and the aeroplane.

b. Recognize Electrostatic Discharge Sensitive (ESDS) equipment and demonstrate standard anti-static procedures so that no damage occurs to that equipment.

c. Demonstrate the correct use of hand tools including specialized and automated tools and equipment.

d. Verify the calibration of electrical measuring instruments, tools and equipment so that correct maintenance procedures may be carried out.

e. Demonstrate the process and procedures to successfully use the Troubleshooting Procedures and charts of current aeroplane faults and know re-occurring problems causing “No Fault Found” on removed LRU’s.

f. Demonstrate the correct use of electrical meters for measuring voltage, current, resistance, continuity, insulation and short to ground.

g. Know the removal and replacement techniques so that no damage will occur to the LRU or aeroplane connector.

3 Strategies

Normal classroom lecture can be used for the majority of the training. The following strategies can be used to expedite learning and are recommended to the instructor.

ESDS handling and protection	Multi media/Training Aids
Calibration/certification of instruments, tools, and equipment	Company Policy
Wiring checks using the Troubleshooting Procedures and Charts	Aeroplane manuals
Measurement and troubleshooting using meters	Meters and circuits
LRU removal and replacement	Aeroplane manuals

MODULE A – GENERAL ELECTRICAL WIRING INTERCONNECTION SYSTEM PRACTICES:

1 Safety practices

a. Current is lethal - First aid

b. Applying power to the aeroplane

c. Isolating the circuit

d. Aeroplane warnings

e. Human Factors

2 Electrostatic Discharge Sensitive (ESDS) device handling and protection

a. Sources of electrostatic discharge

b. Soft and hard failures

c. ESDS safety procedures

d. ESDS handling/packing procedures

3 Tools, special tools and equipment

a. General hand tools

b. Specialized tools

c. Automated tools and equipment

4 Verify calibration/certification of instruments, tools and equipment

a. Tools requiring certification

b. Determining certification requirements

c. Typical problems

5 Required wiring checks using the Troubleshooting Procedures and Charts -

a. Troubleshooting procedures manual (all chapters)

b. Aeroplane Maintenance Manual / Illustrated Parts Catalogue

c. Wiring schematics / Troubleshooting graphics

d. Wiring diagrams

e. The process of troubleshooting

f. Testing of LRU connectors

g. Troubleshooting exercises

h. Company “No Fault Found” policy and data

6 Measurement and troubleshooting using meters

a. Voltage, current and resistance

b. Continuity

c. Insulation

d. Short to ground

e. Loop impedance.

7 LRU replacement general practices -

a. Different retention devices

b. Certification considerations (e.g. CAT 2/CAT3 Landing)

c. LRU re-racking procedures

d. “No Fault Found” data (aeroplane specific)

e. Built in test equipment (BITE)

MODULE B: WIRING PRACTICES DOCUMENTATION

1 Overview

Through Module B, the instructor lays the groundwork for safe effective maintenance and repair of aeroplane Electrical Wiring Interconnection Systems. The intent of this module is to teach the person how to locate desired information in the Chapter 20 Wiring System overhaul manual, Wiring Diagram Manual and other applicable documentation. The Instructor may vary the depth and scope of the topics to be covered, depending on the type of aeroplane to be maintained and skills of the persons.

2 Objectives

After this module is complete the person is able to demonstrate the following skills:

a. Know the applicable Sub-Chapters and Section to follow during normal and non -normal electrical maintenance procedures.

b. Demonstrate the use of the Cross-Reference Index, Chapter Table of Contents, and Subject Tables of Contents so as to find specific material within each sub-chapter and section.

c. Demonstrate the use of the associated tables for replacement of wire, connective devices and contacts, and associated components, including approved replacements.

d. Demonstrate the use of the Wiring Diagram Manual.

e. Demonstrate the use of other Documentation (as applicable).

3 Strategies

Normal classroom lecture can be used for the majority of the training. The Chapter 20 Wiring Practices Manual, Wiring Diagram Manual, and other applicable documentation should be made available to the class so that hands-on exploration of the material can be achieved.

MODULE B - WIRING PRACTICES DOCUMENTATION:

1 Chapter 20 structure/overview

a. Table of contents

b. Sub-Chapter titles

c. Section Structure

d. General procedures.

2 Chapter 20 Cross-Reference Index

a. Cross-reference index – Alphanumeric

b. Cross-reference index – Standard Part number

c. Cross-reference index – Suppliers

e. Equivalence tables – Std Part Numbers EN-ASN-NSA

3 Chapter 20 Important Data and Tables

a. Contact crimp tools, insertion/extraction tools

b. Wire Insulation removal tools

c. Electrical cable binding

d. Wire type codes and part numbers identification

e. Connective devices types and contacts

f. Terminal blocks and terminations

g. Terminal blocks modules, grounding modules and contacts

h. Cleaning procedures

i. Repair procedures

4 Wiring Diagram Manual (WDM)

a. Front matter

b. Diagrams

c. Charts

d. Lists

5 Other Documentation (as applicable)

MODULE C: INSPECTION

1 Overview

Through Module C, the instructor lays the groundwork for safe effective maintenance and repair of aeroplane Wiring Systems, by teaching the skills of inspection so as to identify Wiring System damage. The Instructor may vary the depth and scope of the topics to be covered, depending on the type of aeroplane to be maintained and skills of the persons.

2 Objectives

After this module is complete the person is able to demonstrate the following skills:

a. Know the different types of inspections: General Visual Inspection (GVI), Detailed Inspection (DET), Zonal Inspection and Enhanced Zonal Analysis Procedure (EZAP).

b. Know the criteria and standards of inspection, so that the person knows which tools are used to ensure inspection procedures and standards are achieved which leads to all defects being found.

c. Know the effects of fatigue and complacency during inspection and how to combat their effects (Human Factors).

d. Know the specific zonal inspection requirements related to system affiliation and environmental conditions.

e. Recognize typical Wiring System damage, such as hot gas, fluid contamination, external mechanically induced damage, chafing, corrosion, signs of overheating of wire, wire bundles, connective and control device assemblies.

3 Strategies

Normal classroom lecture can be used for the majority of the training. ATA 117 video and colour photos of actual Wiring System damage could be used to show typical problems found on the aeroplane. Examples of discrepancies should be made available to the student. AMC 20-21, Programme to Enhance Aeroplane Electrical Wiring Interconnection System Maintenance is recommended as a source of typical aeroplane wiring installations and areas of concern.

MODULE C – INSPECTION

1. Special Inspections
a. General Visual Inspection (GVI)
b. Detailed Inspection (DET)
c. Zonal Inspection
d. Enhanced Zonal Analysis Procedure (EZAP)

2. Criteria and standards
a. Tools
b. Criteria/standards
c. Procedures of inspection

3. Human Factors in Inspection
a. Fatigue
b. Complacency

4. Zonal areas of inspection
a. Zonal areas of inspection
b. Zonal inspection procedures and standards

5. Wiring System damage
a. Swarf / FOD / metal shavings
b. External mechanically induced damage
c. Hot gas
d. Fluid contamination
e. Vibration/chafing
f. Corrosion
g. Signs of overheating

MODULE D: HOUSEKEEPING

1 Overview

Through Module D, the instructor lays the groundwork for safe effective maintenance and repair of aeroplane Electrical Wiring Interconnection Systems, by teaching housekeeping strategies, so as to keep the Electrical Wiring Interconnection System free of contamination. The Instructor may vary the depth and scope of the topics to be covered, depending on the type of aeroplane to be maintained and skills of the persons.

2 Objectives

After this module is complete the person is able to demonstrate the following skills:

a. Recognize external contamination and other damage due to external environmental conditions.

b. Know the aeroplane internal contamination sources, so that inspection processes can be effectively carried out and contamination damage easily recognized.

c. Recognize other possible contamination sources.

d. Know the planning procedures to be followed, on Electrical Wiring Interconnection System Areas in different parts of the aeroplane.

e. Know the protection procedures and processes to protect the Electrical Wiring Interconnection System during maintenance and repair.

f. Know the process of cleaning Wiring Systems during maintenance and repair.

3 Strategies

Normal classroom lecture can be used for the majority of the training. ATA 117 video and colour photos of actual Electrical Wiring Interconnection System contamination could be used to show typical problems found on the aeroplane. Relevant Aeroplane Maintenance Manual and/or Chapter 20 Wiring Practices procedures should be used. The ATSRAC Task Group 1, Non-Intrusive Inspection Final Report could be used to identify typical housekeeping issues. AMC 20-21, Programme to Enhance Aeroplane Electrical Wiring Interconnection System Maintenance is recommended as a source of typical aeroplane wiring installations and areas of concern.

MODULE D – HOUSEKEEPING

1 Aeroplane external contamination sources

a. De-ice fluids

b. Water and rain

c. Snow and ice

d. Miscellaneous (e.g. cargo / beverage spillage)

e. Air erosion

2 Aeroplane internal contamination sources

a. Hydraulic oils

b. Engine and APU oils

c. Fuel

d. Greases

e. Galleys and toilets

f. Lint/Dust

g. Bleed air and hot areas

h. Hazardous materials

3 Other contamination sources

a. Paint

b. Corrosion inhibitor

c. Drill shavings / Swarf

d. Foreign objects (screws, washers, rivets, tools, etc.)

e. Animal waste

4 Contamination protection planning

a. Have a plan / types of plan / area mapping

b. Protection and Caution Recommendations

c. Procedures

d. Keep cleaning

5 Protection during aeroplane maintenance and repair

a. Recommended general maintenance protection procedures

b. Recommended airframe repair protection procedures

c. Recommended powerplant repair protection procedures

6 Cleaning Processes

a. Fluid contamination

(1) Snow and ice

(2) De-ice fluid

(3) Cargo spillage

(4) Water and rain

(5) Galleys

(6) Toilets water waste

(7) Oils and greases

(8) Pressure washing

b. Solid contamination

(1) Drill shavings / Swarf

(2) Foreign objects (screws, washers, rivets, tools, etc.)

c. Environmental contamination

(1) Lint and dust

(2) Paint

(3) Corrosion inhibitor

(4) Animal waste

MODULE E: WIRE

1 Overview

Through Module E, the instructor lays the groundwork for safe effective maintenance, alteration and repair of aeroplane Electrical Wiring Interconnection System by teaching wire selection and inspection strategies. The Instructor may vary the depth and scope of the topics to be covered, depending on the type of aeroplane to be maintained and skills of the persons.

2 Objectives

After this module is complete the person is able to demonstrate the following skills:

a. Demonstrate the procedure used to identify specific wire types using the aeroplane manuals.

b. Know from approved data different insulation types and their relative qualities.

c. Know the inspection criteria for wire and wire bundles.

d. Know the standard installation practices for wire and wire bundles (aeroplane specific).

e. Know typical damage that can be found (aeroplane specific).

f. Demonstrate the repair procedures for typical damage found on the student's type of aeroplane.

g. Demonstrate the procedures to fitting differing types of sleeving (aeroplane specific).

h. Know the procedures for termination and storage of unused wires.

i. Know the correct installation practices for electrical bonds and grounds (aeroplane specific).

3 Strategies

Normal classroom lecture can be used for the majority of the training with hands-on practice for Section 6. Chapter 20 Wiring Practices, Wiring Diagram Manual and WDM Lists should be made available to the class so that hands-on use of the manual can be utilized so that wire identification, inspection, installation and repair procedures can be fully explored. Examples of wire discrepancies should be made available to the student. The ATSRAC Task Group 1, Intrusive Inspection Final Report could be used to identify typical wire issues. AMC 20-21, Programme to Enhance Aeroplane Electrical Wiring Interconnection System Maintenance is recommended as a source of typical aeroplane wiring installations and areas of concern.

MODULE E – WIRE

1 Identification, type and construction
a. Wire type codes – alphanumeric
b. Wire type codes – specification and standard part number
c. Wire type codes – specified wire and alternate
d. Manufacturer identification

2 Insulation qualities
a. Types of insulation
b. Typical insulation damage and limitations
c. Carbon Arcing

3 Inspection criteria and standards of wire and wire bundles
a. Inspection of individual wiring
b. Inspection of wire bundles

4 Wire bundle installation practices
a. Routing
b. Segregation rules
c. Clearance
d. Clamp inspection
e. Clamp removal and fitting
f. Conduit types and fitting
g. Raceways
h. Heat shields and drip shields

5 Typical damage and areas found (aeroplane specific)
a. Vibration
b. Heat
c. Corrosion
d. Contamination
e. Personnel traffic passage

6 Maintenance and repair procedures
a. Wire damage assessment and classification
b. Approved repairs - Improper repairs

c. Shielded wire repair

d. Repair techniques

e. Terminals and splices

f. Preventative maintenance procedures

7 Sleeving

a. Identification sleeves

b. Shrink sleeves

c. Screen braid grounding crimp sleeves

d. Screen braid grounding solder sleeves

8 Unused wires - termination and storage

a. Termination – End caps

b. Storage and attachment

9 Electrical bonding and grounds

a. Inspection standards

b. Primary Bonding (HIRF protection)

c. Secondary Bonding (System grounding)

d. Lightning strikes

MODULE F: CONNECTIVE DEVICES

1 Overview

Through Module F, the instructor lays the groundwork for safe effective maintenance, alteration and repair of aeroplane Electrical Wiring Interconnection Systems by teaching the identification, inspection and repair of connective devices found on the aeroplane. The Instructor may vary the depth and scope of the topics to be covered, depending on the type of aeroplane to be maintained and skills of the persons.

2 Objectives

After this module is complete the person is able to demonstrate the following skills:

a. Know the general types and positive identification of connective devices. (aeroplane specific).

b. Know the various safety procedures, cautions and warnings prior to inspection.

c. Know the relevant visual inspection procedures for each type of connector so that any internal or external damage can be found.

d. Recognize typical external and internal damage to the connector.

e. Demonstrate where to find the relevant repair schemes from Ch. 20 for connector repair.

3 Strategies

Normal classroom lecture can be used for the majority of the training. The Chapter 20 Wiring Practices manual should be made available to the class so that hands-on use of the manual can be utilized. Connector identification, inspection and repair procedures should be fully explored. Colour photographs of typical external damage and internal damage could be used to show problems on the aeroplane. The ATSRAC Task Group 1, Non-Intrusive Inspection and Intrusive Inspection Final Report, Chapter 7, could be used to identify typical connector issues. AMC 20-21, Programme to Enhance Aeroplane Electrical Wiring Interconnection System Maintenance is recommended as a source of typical aeroplane wiring installations and areas of concern.

MODULE F – CONNECTIVE DEVICES

1 General types and identification
a. Part number identification
b. Reference tables
c. Specific connective devices chapters

2 Cautions and protections
a. Safety precautions
b. Maintenance precautions

3 Visual inspection procedures
a. Installed inspection criteria
b. Removed inspection criteria

4 Typical damage found
a. Exterior damage
b. Internal damage

5 Repair procedures
a. Finding the correct section
b. Finding the correct part
c. Finding the correct tooling
d. Confirming the correct repair

MODULE G: CONNECTIVE DEVICES REPAIR

1 Overview

Through Module G, the instructor lays the groundwork for safe effective maintenance, alteration and repair of aeroplane Electrical Wiring Interconnection Systems. This module is primarily a hands-on class, emphasizing the repair and replacement of connective devices found on the aeroplane. This list can be used to cover typical connectors for aeroplanes, and can be adjusted to suit training requirements. The Instructor may vary the depth and scope of the topics to be covered, depending on the type of aeroplane to be maintained and skills of the persons.

2 Objective

After this module is complete the person will have the following skills.

a. Demonstrate the replacement of components for circular connectors.

b. Demonstrate the replacement of components for rectangular connectors.

c. Demonstrate the replacement of components for terminal blocks-modular.

d. Demonstrate the replacement of components for terminal blocks-non-modular.

e. Demonstrate the replacement of components for grounding modules.

f. Demonstrate the replacement of pressure seals.

3 Strategies

This class is primarily a hands-on class to give the student motor skills in the repair of connective devices from their aeroplane. The Chapter 20 Wiring Practices Manual and the appropriate connective devices should be made available to the class so repair procedures can be fully explored. Photographs of typical internal conditions and external damage could be made available. It is recommended that MODULE F: CONNECTORS should precede this module. AMC 20-21, Programme to Enhance Aeroplane Electrical Wiring Interconnection System Maintenance is recommended as a source of typical aeroplane wiring installations and areas of concern.

MODULE G – CONNECTIVE DEVICES REPAIR

1 Circular Connectors

a. Disassembly

b. Back-shell maintenance

c. Contact extraction and insertion

d. Contact Crimping

e. Assembly and strain relief

2 Rectangular Connectors

a. Disassembly

b. Back-shell maintenance

c. Contact extraction and insertion

d. Contact Crimping

e. Assembly and strain relief

3 Terminal Blocks - Modular

a. Disassembly

b. Contact extraction and insertion

c. Contact Crimping

d. Assembly and strain relief

4 Terminal Block – Non-modular

a. Disassembly

b. Terminal Lug Crimping

c. Terminal Lug Stacking

d. Assembly, torque and strain relief

5 Grounding Modules

a. Disassembly

b. Contact extraction and insertion

c. Contact Crimping

d. Assembly and strain relief

6 Pressure Seals

a. Disassembly

b. Maintenance

c. Assembly and strain relief

AMC 20-23: Development of Electrical Standard Wiring Practices documentation

1 Purpose

This AMC provides guidance for developing an electrical standard wiring practices document for operators, holders of type certificates, holders of supplemental type certificates (STCs), maintenance organisations, repair stations and persons performing field approval modifications or repairs. The guidance in this AMC is based on recommendations submitted to the FAA from the Aging Transport Systems Rulemaking Advisory Committee (ATSRAC). JAA and latterly EASA are participating members of ATSRAC. The information in this AMC is derived from the maintenance, inspection, and alteration best practices identified through extensive research by ATSRAC working groups and Federal government working groups. This AMC provides a means, but not the only means of creating a document that meets the expectations of CS 25-1529, Appendix H.

2 Objective

The objective of this AMC is to promote a common format for documents containing standard practices for electrical wiring, and to provide a summary of the minimum content expected to be contained within that document. Although the title of the document or manual is left to the discretion of the organization, such a document will be referred to in this AMC as the Electrical Standard Wiring Practices Manual (ESWPM).

Titles in other organizations for such document may be Standard Wiring Practices Manual (SWPM) or Electrical Standard Practices Manual (ESPM), but this AMC provide applicable guidelines.

3 Applicability

The guidance provided in this AMC is applicable to all operators, holders of type certificates, holders of supplemental type certificates (STCs), maintenance organisations, repair stations and persons performing field approval modifications or repairs.

4 Related Documents

- Regulation (EC) No. 1592/2002
- Commission Regulation No. 1702/2003
- Commission Regulation No. 2042/2003
- EASA Certification Specification CS-25 Large Aeroplanes
- JAR-OPS 1 Commercial Air Transportation (Aeroplanes)

5 RELATED READING MATERIAL

a. EASA AMC-20

- AMC 20-21, Programme to Enhance Aircraft Electrical Wiring Interconnection System Maintenance
- AMC 20-22, Aircraft Electrical Wiring Interconnection System Training Program

b. FAA 14 CFR Parts

- Part 21, Certification Procedures for Products and Parts

- Part 25, Airworthiness Standards, Transport Category Airplanes
- Part 43, Maintenance, Preventive Maintenance, Rebuilding, and Alteration
- Part 91, General Operating and Flight Rules
- Part 119, Certification: Air Carriers and Commercial Operators
- Part 121, Operating Requirements: Domestic, Flag, and Supplemental Operations
- Part 125, Certification and Operations: Airplanes Having a Seating Capacity of 20 or More Passengers or a Maximum Payload Capacity of 6,000 pounds or More
- Part 129, Operations: Foreign Air Carriers and Foreign Operators of U.S.-Registered Aircraft Engaged in Common Carriage
- Part 135, Operating Requirements: Commuter and On-demand Operations and Rules Governing Persons on Board such Aircraft
- Part 145, Repair Stations

c. FAA Advisory Circulars (ACs)

- AC 25-16, Electrical Fault and Fire Protection and Prevention
- AC 25.981-1B, Fuel Tank Ignition Source Prevention Guidelines
- AC 43-12A, Preventive Maintenance
- AC 43.13-1B, Acceptable Methods, Techniques and Practices for Repairs and Alterations to Aircraft
- AC 43-204, Visual Inspection for Aircraft
- AC 43-206, Avionics Cleaning and Corrosion Prevention/Control
- AC 65-15A, Airframe & Powerplant Mechanics Airframe Handbook, Chapter 11. Aircraft Electrical Systems
- AC 25.17XX Certification of EWIS on Transport Category Airplanes

d. Reports

- Aging Transport Systems Rulemaking Advisory Committee, Task 1 & 2, Aging Systems, Final Report. http://www.mitrecaasd.org/atsrac/final_reports/Task_1&2_Final%20_August_2000.pdf
- Aging Transport Systems Rulemaking Advisory Committee, Task 3, Final Report. http://www.mitrecaasd.org/atsrac/final_reports/Task_3_Final.pdf
- Aging Transport Systems Rulemaking Advisory Committee, Task 4, Final Report, Standard Wiring Practices. http://www.mitrecaasd.org/atsrac/final_reports/Task_4_Final_Report_Sept_2000.pdf
- Transport Aircraft Intrusive Inspection Project, (An Analysis Of The Wire Installations Of Six Decommissioned Aircraft), Final Report, The Intrusive Inspection Working Group, December 29, 2000. http://www.mitrecaasd.org/atsrac/intrusive_inspection.html
- Aging Transport Systems Rulemaking Advisory Committee Task 7, Final Report, Electrical Standard Wire Practices Manual (ESWPM) http://www.mitrecaasd.org/atsrac/final_reports/Task_7_Final_Report-10-31-2002.pdf

e. Other Documents

- ATA Specification 117 (Wiring Maintenance Practices/Guidelines).

- FAA Policy Statement Number ANM-01-04; System Wiring Policy for Certification of Part 25 Airplanes, June 25, 2001

6 Definitions

Consumable materials: Materials consumed during the maintenance or repair of EWIS which are not an eventual component of the EWIS.

Drip loop: the practice of looping a wire or wire bundle to provide a point lower than the adjacent connector for moisture to collect.

Electrical Wire Interconnection System (EWIS): is defined by CS 25 Subpart H, 25.1701 as follows:

(a) Electrical wiring interconnection system (EWIS) means any wire, wiring device, or combination of these, including termination devices, installed in any area of the aeroplane for the purpose of transmitting electrical energy between two or more intended termination points. Except as provided for in subparagraph (c) of this paragraph, this includes:

(1) Wires and cables.

(2) Bus bars.

(3) The termination point on electrical devices, including those on relays, interrupters, switches, contactors, terminal blocks, and circuit breakers and other circuit protection devices.

(4) Connectors, including feed-through connectors.

(5) Connector accessories.

(6) Electrical grounding and bonding devices and their associated connections.

(7) Electrical splices.

(8) Materials used to provide additional protection for wires, including wire insulation, wire sleeving, and conduits that have electrical termination for the purpose of bonding.

(9) Shields or braids.

(10) Clamps and other devices used to route and support the wire bundle.

(11) Cable tie devices.

(12) Labels or other means of identification.

(13) Pressure seals.

(b) The definition in paragraph (a) of this section covers EWIS components inside shelves, panels, racks, junction boxes, distribution panels, and back-planes of equipment racks, including, but not limited to, circuit board back-planes and wire integration units.

(c) Except for the equipment indicated in paragraph (b) of this section, EWIS components inside the following equipment, and the external connectors that are part of that equipment, are excluded from the definition in paragraph (a) of this section:

(1) Electrical equipment or avionics that are qualified to environmental conditions and testing procedures when those conditions and procedures are—

(i) appropriate for the intended function and operating environment, and

(ii) acceptable to the Agency.

(2) Portable electrical devices that are not part of the type design of the aeroplane. This includes personal entertainment devices and laptop computers.

(3) Fibre optics.

Legacy document: An organization's electrical standard wiring practices manual existing prior to the adoption of the requirements of H25.5(a)(2) of Appendix H to 14 CFR part 25.

Master Breakdown Index (MBI): An index developed to supplement a legacy document. An MBI provides a means of finding information without the need for reformatting the legacy SWPM. An example of an MBI is presented at the end of paragraph 8 of this AMC.

Separation: Defined as either spatial distance, or physical barrier, between wiring from adjacent structure, systems or wiring; or the practice of installing wiring supporting redundant or multi-channel systems.

Standard practices: Industry-wide methods for repair and maintenance of electrical wire, cable bundles and coaxial cables. Procedures and practices for the inspection, installation and removal of electrical systems components including, but not limited to; wire splices, bundle attachment methods, connectors and electrical terminal connections, bonding/grounding, etc.

7 Standardized ESWPM Format

A representative example of the standard format and sequence of major included within an ESWPM is contained within Appendix A of this AMC.

9 Minimum ESWPM Content

A definition and description of ESWPM minimum content is necessary to ensure that operators and repair stations have at their disposal the information necessary to properly maintain their airplanes. Although the original airframe manufacturer's electrical installation design philosophy concerning components, installation procedures, segregation rules, etc. need not be included within the ESWPM sufficient minimum information should be provided to enable the end-user to maintain the aircraft in a condition that conforms to the electrical installation design philosophy of the original manufacturer.

The content of any ESWPM should include, at a minimum, the following:

a. Front Matter

Provide information regarding the content and use of the ESWPM. Describe changes to the document in a record of revisions. Ensure the document contains a table of contents or index to allow the user to readily retrieve necessary information.

b. Safety Practices

Provide general instruction, cautions and warnings which describe safe practices implemented prior to the start of any or all of the specific standard electrical practices contained within the core of the ESWPM. Safety cautions, warnings or notes specific to the procedure shall be placed within the body of the procedure.

c. Cleaning Requirements and Methods

"Protect, clean as you go" philosophy.

- Non-destructive methods for cleaning dust, dirt, foreign object debris (FOD), lavatory fluid, and other contaminants produced by an aircraft environment from wiring systems.
- Wire replacement guidelines when an accumulation of contaminants, either on the surface and/or imbedded in the wire bundle, cannot be safely removed.

d. Wire and Cable Identification

(1) Specify requirements for wire and cable identification and marking to provide safety of operation, safety to maintenance personnel, and ease of maintenance.

(2) Specify methods of direct wire marking. Also, identify specific requirements and cautions associated with certain types of wire marking.

e. Wire and Cable Damage Limits

Specify limits to positively identify the thresholds where damaged wire/cable replacement may be necessary and where repairs can be safely accomplished. Establish limits for each applicable wire/cable type, if necessary.

(1) Include damage limits for terminals, studs, connectors, and other wiring system components, as necessary.

f. Installation Clamping and Routing Requirements

(1) Specify the requirements for the installation of wiring systems with respect to physical attachment to the aircraft structure. These requirements must be compatible with the different environments applicable to aircraft and aircraft systems.

(2) Specify applicable methods of clamping, support, termination, and routing to facilitate installation, repair, and maintenance of wires, wire bundles, and cabling.

(3) Specify minimum bend radii for different types of wire and cable.

(4) Specify minimum clearance between wiring and other aircraft systems and aircraft structure.

(5) Include the requirements for the installation of wiring conduit with respect to physical attachment, routing, bend radii, drain holes, and conduit end coverings.

(6) Emphasize special wiring protective features, such as spatial separation, segregation, heat shielding, and moisture protection that are required to be maintained throughout the life of the aircraft.

(7) Ensure necessary information for the maintenance of bonding, grounding and lightning, high-intensity radio frequency (L/HIRF) provisions is included.

(8) Include information on the use and maintenance of wire protective devices, conduits, shields, sleeving etc. (this bullet is deleted in the FAA AC).

g. Repair and Replacement Procedures

Describe methods to safely repair and/or replace wiring and wiring system components.

(1) Include types and maximum numbers of splice repairs for wiring, and any limitations on the use of splices. When splicing wire, environmental splices are highly recommended over non-environmental splices. Guidance should be provided on how long a temporary splice may be left in the wire.

(2) Specify procedures for the repair, replacement, and maintenance of connectors, terminals, modular terminal blocks, and other wiring components.

h. Inspection Methods

In wiring inspection methods, include a general visual inspection (GVI), or a detailed inspection (DET), as determined by the enhanced zonal analysis procedure. Typical damage includes heat damage, chafing, cracked insulation, arcing, insulation delaminating, corrosion, broken wire or terminal, loose terminals, incorrect bend radii, contamination, and deteriorated repairs.

(1) Identify detailed inspections and, where applicable, established and emerging new technologies non-destructive test methods to complement the visual inspection process.

Whenever possible, ensure that inspection methods can detect wiring problems without compromising the integrity of the installation.

i. Customized data

Provide a location and procedures that allow users to include customized or unique data such as that relating to supplemental type certificates, operator-unique maintenance procedures, etc.

A comprehensive listing of the typical content included within an ESWPM, including the minimum required content described above, is contained within Appendix A of this AMC.

10 Alternative procedure for legacy documents

The definition of a new layout and chapter format may require each organization with an existing ESWPM to reformat and to republish using the standardized format. Whether the organization produces a standalone manual or provides the electrical standard practices as Chapter 20 of a wiring diagram manual, the resultant reorganization would result in a significant economical impact for both the authoring organization and their end users.

To address this concern, a conversion tool, identified in the last paragraph of this chapter, was devised which takes the following variables into account:

- Effects on manufacturers' current technical document editorial policy as it exists in current legacy documents.
- Costs resulting from an immediate major manual overhaul.
- Inconvenience to end-users who are accustomed to the format they are currently using.

When using a traditional paper format ESWPM, the most efficient method of retrieving standard procedures and maintenance information has traditionally been to search by using:

- the table of contents (TOC) and/or
- the indexes (i.e., alpha-numerical index and/or numerical index as available).

The ease and speed with which information may be found with these methods relies heavily on the quality of the TOC and/or the indexes. For aircraft maintenance technicians needing to locate and extract the pertinent and applicable data necessary to perform a satisfactory design modification or maintenance action, finding relevant data may be time consuming.

When using an electronic format, a search engine can often be used. This allows the user to bypass the TOC or indexes in finding the needed procedure or data. By searching with such alternative methods, a user can find information without needing to know the rules, such as ATA references, governing assignment of the subject matter to its place in the TOC.

The use of a conversion tool, identified as a Master Breakdown Index (MBI) is one method of achieving a common format until existing legacy documents can be physically altered or digitized to an electronic format. The intent of the MBI is to supplement the TOC and existing indexes by providing to users a method of searching existing documents using topical information rather than by part number, alphabetic subject, or Chapter-Section-Subject reference. The arrangement of the MBI duplicates the standardized format described in Paragraph 8 of this AMC, but does not require complete rearrangement of legacy documents to achieve a common format. The MBI acts as a conversion key used to effectively convert an existing document arrangement into the proposed arrangement. In essence the MBI duplicates in paper form for legacy documents the electronic search engine for HTML-based documents.

This is an example of an MBI which could be used to mitigate the need for legacy documents to be reformatted to achieve the standardized format described above:

GROUP	MAJOR TOPIC	APPEARS IN THIS DOCUMENT AS SUBJECT
GENERAL DATA	SAFETY PRACTICES	20-10-10
	AIRPLANE ENVIRONMENTAL AREAS	20-20-12
	CONSUMABLE MATERIALS	20-00-11
	WIRING MATERIALS	20-10-13
	COMMON TOOLS	20-00-13
ELECTRICAL WIRE INTERCONNECT SYSTEM (EWIS) MAINTENANCE	EWIS PROTECTION DURING MAINTENANCE	20-10-20
	EWIS CLEANING	20-10-20
	EWIS INSPECTION	20-10-20
	EWIS TESTING	20-10-13
	EWIS DISASSEMBLY	20-10-19
	EWIS REPAIR AND REPLACEMENT	20-20-00
WIRING INSTALLATION	WIRE SEPARATION / SEGREGATION	20-10-11 20-10-12
	ELECTRICAL BONDS AND GROUNDS	20-30-60
	WIRE HARNESS INSTALLATION	20-10-17 20-10-18 Installation of Sleeves on Wiring
WIRING ASSEMBLY	WIRE AND CABLE TYPES	20-00-15
	WIRE MARKING	20-60-01
	WIRE HARNESS ASSEMBLY	20-50-01
	WIRE INSULATION AND CABLE JACKET REMOVAL	20-90-12
	TERMINATION TYPE (SPECIFICS OF TERMINATIONS)	20-61-44
ELECTRICAL DEVICES	DEVICE TYPE (SPECIFICS OF ELECTRICAL DEVICE)	20-80-09 Assembly of Leach Relay Sockets
SPECIFIC SYSTEM WIRING	UNIQUE WIRING ASSEMBLIES/INSTALLATIONS	20-73-00 Fuel Quantity Indicating System
AIRLINE CUSTOMIZED DATA	AIRLINE SPECIFIED	20-91-00

Appendix A: groups, major topics, standardized sequence and description of minimum content

GROUP	MAJOR TOPIC	DESCRIPTION
GENERAL DATA	SAFETY PRACTICES	Safety regulations and general safety precautions to prevent injury to personnel and damage to the airplane
	AIRPLANE ENVIRONMENTAL AREAS	Definition of types of areas upon which wiring configuration and wiring component selection is constrained
	CONSUMABLE MATERIALS	Wiring maintenance processing materials (solvents, aqueous cleaners, lubricants, etc.)
	WIRING MATERIALS	Materials that become an integral part of the wiring configuration excluding wire and cable; e.g., sleeves, shield material, tie material, sealants, etc.
	COMMON TOOLS	Description and operation of common tools
EWIS MAINTENANCE	EWIS PROTECTION DURING MAINTENANCE	Procedures to protect EWIS during airplane maintenance and modification
	EWIS CLEANING	In support of inspection as well as prevention of degradation and preparation for repair; recommended cleaning materials and procedures based on type of contamination
	EWIS INSPECTION	Criteria for correct installation, correct wiring assembly configuration; damage conditions and limits for wiring components (wire and cable, termination types, electrical devices); factors that warrant disassembly for inspection; determination of cause of damage
	EWIS TESTING	Wiring integrity testing
	EWIS DISASSEMBLY	Data and procedures in support of inspection, cleaning when applicable; also supports new wiring installation
	EWIS REPAIR AND REPLACEMENT	Repair of wiring installation, wiring assembly configuration, wiring components (wire and cable, wiring terminations, electrical devices); wire and cable replacement; wiring functional identification
WIRING INSTALLATION	WIRE SEPARATION / SEGREGATION	Explanation of separation / segregation categories, separation / segregation identification, and necessary conditions for maintaining separation / segregation
	ELECTRICAL BONDS AND GROUNDS	Bond surface preparation, ground hardware configurations, bond integrity testing
	WIRE HARNESS INSTALLATION	Routing, supports; wiring protection, factors affecting wiring assembly configuration; connection to equipment, new wiring, removal from service

GROUP	MAJOR TOPIC	DESCRIPTION
WIRING ASSEMBLY	WIRE AND CABLE TYPES	The principal material component of airplane wiring; includes type identification and basic description; alternative wire types (replacements, substitutions)
	WIRE MARKING	Marking; applicable conditions
	WIRE HARNESS ASSEMBLY	Wiring assembly configuration: assembly materials, layout, overall protection; factors affecting wiring installation
	WIRE INSULATION AND CABLE JACKET REMOVAL	Wire and cable: Insulation removal, jacket removal; associated damage limits, tool description and operation
	<<TERMINATION TYPE>> e.g., SOURIAU 8950 SERIES CONNECTORS	Wiring terminations and accessories (connectors, terminal lugs, splices, backshells, etc.) grouped by termination type from simple to complex: a. Common data or procedures by group (if any); e.g., tool description and operation, definition of internal damage and limits, internal cleaning, accessories b. By individual type - part numbers and description, definition of internal damage and limits (if not specified by common data), disassembly, assembly, installation
ELECTRICAL DEVICES	<<DEVICE TYPE>> e.g., KLIXON 7274 SERIES CIRCUIT BREAKER	Electrical devices (circuit breakers, relays, switches, filters, lamps, etc.) grouped by device type: a. Common data or procedures by group (if any); e.g., tool description and operation, definition of internal damage and limits, internal cleaning, accessories b. By individual type - part numbers and description, definition of internal damage and limits (if not specified by common data), disassembly, assembly, installation
SPECIFIC SYSTEM WIRING	SPECIFIC WIRING ASSEMBLY	For wiring that has a necessarily specific configuration (e.g., Primary Flight Control, Fuel Quantity Indicator System, etc.): - Applicable conditions for repair and replacement - Disassembly, assembly, installation, assembly integrity testing
AIRLINE CUSTOMIZED DATA	AIRLINE SPECIFIED	Reserved for airline use

V. Intended Airworthiness Directives[8]: requirement for TC holders to perform EZAP and develop new ICA in accordance with Part 21A.3B(c)(1)

1. Identification of the Unsafe Condition

Following a number of fatal passenger transport aircraft accidents where a centre fuel tank exploded, an international review and advisory committee called the Ageing Transport Systems Rulemaking Advisory Committee (ATSRAC) was constituted to identify ways to mitigate the risk of any future occurrences. This activity has been fully supported by JAA and latterly EASA.

a. Ageing Transport Systems Rulemaking Advisory Committee (ATSRAC)

The FAA Administrator established a formal advisory committee (the Ageing Transport Systems Rulemaking Advisory Committee, or ATSRAC) in 1998 to facilitate actions recommended by the Ageing Transport Non-structural Systems Plan. This committee is made up of representatives of regulators (which included EASA), aircraft manufacturers, large aeroplane operators, user groups, aerospace and industry associations, and governmental agencies. (FAA Order 11110.127, Ageing Transport Systems Rulemaking Advisory Committee, dated Jan. 19, 1999, included in the docket).

b. ATSRAC Tasks

In January 1998, the FAA assigned five tasks to ATSRAC. These included collecting data on ageing wiring systems through aeroplane inspections, reviewing aeroplane manufacturers' service information, reviewing operators' maintenance programs, reviewing and updating standard wiring practices, and providing the FAA with recommendations to improve the safety of those systems. ATSRAC's work on those tasks focused on large aeroplanes.

c. ATSRAC Review of Data

The review of data (The "Ageing Systems Task Force Ageing Transport Systems Task 1 and Task 2 Final Report," included in the docket) yielded the following wiring-related findings:

- Nine B-727 aeroplanes inspected; 276 discrepancies found.
- Nine B-737 aeroplanes inspected; 399 discrepancies found.
- Seven B-747 aeroplanes inspected; 238 discrepancies found.
- Fourteen DC-8 aeroplanes inspected; 974 discrepancies found.
- Fifteen DC-9 aeroplanes inspected; 116 discrepancies found.
- Fourteen DC-10 aeroplanes inspected; 714 discrepancies found.
- Three L-1011 aeroplanes inspected; 247 discrepancies found.
- Ten A-300 aeroplanes inspected; 408 discrepancies found.

The results from those five initial tasks showed that problems related to wiring systems on ageing aeroplanes were not entirely related to degradation over time. Inadequate installation and maintenance practices were identified as factors that can lead to what is

[8] May also be imposed through a new specific provision in Regulation 1702/2003.

commonly referred to as an "ageing system" problem. As a result, the scope of ATSRAC's work was expanded to include improving the continued airworthiness of aeroplane systems, particularly of wiring systems.

In May 2001, the FAA assigned four new tasks to the committee to implement the ATSRAC recommendations on the first five tasks (66 FR 29203). These next tasks were to accomplish the following:

- Address the need for new wire system certification requirements;
- Propose changes to the standard wiring practices manual;
- Develop a training program for wire systems;
- Develop maintenance criteria for wire systems.

The results discussed earlier from ATSRAC's review of the eight models of large transport category aeroplanes heightened concern about whether similar conditions existed in small aeroplanes (aeroplanes with a 6- to 30-passenger seating capacity). As a result, in March 2002, the FAA assigned another task to ATSRAC – to investigate and develop recommendations to improve the safety of electrical wiring systems in transport category aeroplanes of less than 30 passengers. In response to this task, ATSRAC examined the applicability of their previous recommendations to this group of aeroplanes and identified issues unique to electrical wiring systems on small transport category aeroplanes. The work of this working group is continuing.

d. Intrusive Inspection Working Group (IIWG)

Another investigative group functioning within ATSRAC, whose wiring inspections extended to the laboratory, was the Intrusive Inspection Working Group (IIWG). The IIWG was a separate but parallel group within the Ageing Systems Task Force (ASTF). The Air Transport Association (ATA) formed the ASTF in June 1998 to review the effectiveness of maintenance on electrical wiring systems and assess the condition of those systems on aircraft with type certificates older than 20 years. When ATSRAC was formed in 1998, it continued the work started under the ASTF. The IIWG subjected selected wire installations on six decommissioned aeroplanes to an intensive, detailed visual inspection, followed by non-destructive testing and laboratory analysis. They analyzed the results to assess the state of wire on aged aeroplanes as a function of wire type and service history. In addition, the results from the visual inspections were compared with the non-destructive testing and laboratory analysis to determine the efficacy of visual inspections for the detection of age-related deterioration.

The findings from the IIWG were documented in the "Transport Aircraft Intrusive Inspection Project (An Analysis of the Wire Installations of Six Decommissioned Aircraft) Final Report," issued on December 29, 2000 (hereafter referred to as "Intrusive Inspection Report"). A copy is included in the docket. The findings showed that wire-related failures have multiple causes. These include:

- Localized heat damage;
- Breaches in wire insulation;
- Wire embrittlement;
- Charred wire insulation;

- Missing insulation;
- Chafing;
- Arcing;
- Arc tracking;
- Reduced insulation resistance in certain wires;
- Defective and broken connectors;
- Damage to connector back-shells.

Both the non-intrusive and intrusive inspections found most wiring discrepancies were in areas of frequent maintenance activity. In addition, fluid contamination and dust and dirt accumulations were found in those areas.

The Intrusive Inspection Report identified several areas that required special emphasis. Three areas – the cockpit, electrical power centres, and power feeder cables – were considered critical. This is because if chafing exists on wiring in these areas and flammable materials are in close proximity to the chafed wiring, severe outcomes, such as wire-to-structure or wire-to-wire shorting and arcing, can result. Since a fire in these areas could present a high risk to continued safe flight and landing, the IIWG recommended more detailed inspections for those three areas. The intent was to ensure potential problems are identified and corrected. This effort led to development of an Enhanced Zonal Analysis Procedure (EZAP) to assess risk for fire to help ensure that maintenance programs developed for wire systems in such critical areas would require more detailed inspections. An EZAP is a specifically wire-focused version of the zonal analysis procedure widely used to analyze an aeroplane in terms of each of its physical areas or zones. It is used for developing maintenance tasks. The application of an EZAP is discussed more fully in AMC 20-21, “Programme to Enhance Aircraft Electrical Wiring Interconnection System Maintenance.”

2. Identification of the Requirements in Question

The above unsafe condition led to an amendment to CS-25 to better identify EWIS through the certification process and ensure that appropriate measures are implemented to maintain the design objectives for EWIS through the expected in-service life of the aircraft. A new subpart H to CS.25 has been developed that collects together existing certification standards for EWIS that were previously dispersed throughout the document and also identifies some new standards specific to EWIS. Also CS.25.1529, and its’ associated appendix H and AMC material, has been amended to address the development of instructions for continuing airworthiness.

3. Identification of the affected aircraft types

Large aeroplanes with a type certificate issued after January 1, 1958, that, as a result of original type certification or later increase in capacity, have-

a. A maximum type-certificated passenger capacity of 30 or more; or

b. A maximum payload capacity of 3402 kg (7500 pounds) or more.

4. Nature and scope of the review required

Each holder of or applicant for a type certificate of an aeroplane identified in paragraph 3 above must develop and submit for approval by the Agency instructions for continuing airworthiness derived from the EZAP, for the representative aeroplane's electrical wiring interconnection systems (EWIS) in accordance with CS 25.1529 Appendix H paragraph H25.5 for each affected type design. For purposes of this paragraph, the "representative aeroplane" is the configuration of each model series aeroplane that incorporates all of the variations of EWIS used on that series aeroplane, and that includes all TC-holder-designed modifications mandated by airworthiness directive.

5. Compliance Time for the Required Action(s)

By 16 December 2008, the persons identified in above paragraph 4 must gain approval of the enhanced ICA by the Agency.

6. Envisaged Compliance Time for the Operators

The envisaged compliance date for inclusion of inspections and procedures for electrical wiring interconnection systems (EWIS) resulting from the EZAP as indicated above for operators of aeroplane types as identified in the above paragraph 3 in the maintenance programme for that aeroplane is 16 December 2009.

The proposed EWIS maintenance programme changes must be based on the applicable EWIS instructions for continuing airworthiness developed by the type certificate holder and approved by the Agency.

7. Excluded Aeroplanes

The following aeroplane models are exempted from compliance:

(1) Convair CV-240, 340, 440, if modified to include turbine engines;

(2) Lockheed L-188;

(3) Douglas DC-3, if modified to include turbine engines;

(4) Bombardier CL-44;

(5) British Aerospace BAC 1-11.

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