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 and 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 and BOX J) 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 and 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).

[Amdt 25/5]

CS 25.1711 Component identification; EWIS

ED Decision 2008/006/R

(See AMC 25.1711)

(a) EWIS components must be labelled or otherwise identified using a consistent method that facilitates identification of the EWIS component, 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.

[Amdt 25/5]

AMC 25.1711 Component identification; EWIS

ED Decision 2010/005/R

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 these systems 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 CS 25.1711(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 25.1711 does 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(d) states that "...Visible means of identifying critical features of the design must be placed in areas of the aeroplane where foreseeable maintenance, actions, repairs, or alterations may compromise the critical design configuration control limitations (e.g., colour-coding of wire to identify separation limitation). These visible means must also be identified as CDCCL " 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 colour-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 identifications overlapping over the entire length of the run, which could render both identifications 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 colours 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, coloured 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 identifications overlapping over the entire length of the run, which could render both identifications 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.

[Amdt 25/5]
[Amdt 25/9]

CS 25.1713 Fire Protection; EWIS

ED Decision 2008/006/R

(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 of Appendix F.

[Amdt 25/5]

AMC 25.1713 Fire protection: EWIS

ED Decision 2008/006/R

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 of 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 of Appendix F.

[Amdt 25/5]

CS 25.1715 Electrical bonding and protection against static electricity; EWIS

ED Decision 2008/006/R

(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)).

[Amdt 25/5]

AMC 25.1715 Electrical bonding and protection against static electricity: EWIS

ED Decision 2008/006/R

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.

[Amdt 25/5]

CS 25.1717 Circuit protective devices; EWIS

ED Decision 2008/006/R

(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.

[Amdt 25/5]

AMC 25.1717 Circuit protective devices: EWIS

ED Decision 2008/006/R

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.

[Amdt 25/5]

CS 25.1719 Accessibility Provisions; EWIS

ED Decision 2008/006/R

(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.

[Amdt 25/5]

AMC 25.1719 Accessibility provisions: EWIS

ED Decision 2008/006/R

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.

[Amdt 25/5]