U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: PROGRAM TO ENHANCE TRANSPORT CATEGORY AIRPLANE ELECTRICAL WIRING INTERCONNECTION SYSTEM MAINTENANCE	**Date: 9/30/05** **Initiated By: AFS-300**	**AC No: 120-XX** **Change: DRAFT**

1. PURPOSE.

This advisory circular (AC) provides guidance for developing enhanced electrical wiring interconnection system (EWIS) maintenance and inspection procedures. It provides an acceptable way to show compliance with the requirements of H25.5(a)(1) of part 25. This guidance stresses the importance of inspecting EWIS and promotes a new philosophy of "protect and clean as you go" when performing maintenance, repair, or alterations on or around aircraft EWIS.

2. APPLICABILITY.

a. The guidance provided in this document is directed to air carriers, air operators, design approval holders, STC holders, maintenance providers, repair stations, and anyone performing field approval modifications or repairs.

b. This guidance can be used to meet the regulatory requirements for the development of EWIS maintenance and inspection procedures as required by 14 CFR sections 25.1739 and 25.1805. These maintenance and inspection procedures are required to be part of the instructions for continued airworthiness (ICA) specified by 14 CFR part 25, section H25.5(a)(1).

c. This guidance can be applied to airplane maintenance or inspection programs. The enhanced zonal analysis procedure in APPENDIX A is specifically directed towards improving maintenance programs that do not include tasks and intervals that specifically consider wiring in all zones as a potential source of fire ignition. For those aircraft models whose maintenance programs already include a zonal inspection program, the logic described in this AC provides guidance on improving those programs. For airplanes without a zonal inspection program, use of this logic will produce zonal inspections for wiring that can be added to the existing maintenance program.

d. This material is neither mandatory nor regulatory in nature and does not constitute a regulation. It describes acceptable means, but not the only means, for showing compliance with the applicable regulations. We will consider other methods of showing compliance that an applicant may elect to present. While these guidelines are not mandatory, they are derived from extensive FAA and industry experience in determining compliance with the relevant regulations. On the other hand, if we become aware of circumstances that convince us that following this AC would not result in compliance with the applicable regulations, we will not be bound by the terms of this AC, and we may require additional substantiation or design changes as a basis for finding compliance.

e. This material does not change or create any additional regulatory requirements nor does it authorize changes in or permit deviations from existing regulatory requirements.

f. Terms such as “shall” or must are used in this AC only in the sense of ensuring applicability of this particular method of compliance when the acceptable method of compliance described here is used.

3. HOW THIS INFORMATION WAS DERIVED. The guidance in this AC is based on recommendations given to us by the Aging Transport Systems Rulemaking Advisory Committee (ATSRAC). It is drawn from maintenance, inspection, and alteration best practices identified through extensive research by ATSRAC and Federal government working groups.

4. OBJECTIVE

a. The objective of this AC is to improve the maintenance of aircraft EWIS through adoption of the following:

(1) Enhanced Zonal Analysis Procedure (EZAP). This AC presents an “enhanced zonal analysis procedure” and logic. The EZAP will allow the user to determine the appropriate general or detailed inspections and other tasks to minimize the presence of combustible material. EZAP can be used for both zonal and non-zonal inspection programs to develop new wiring cleaning and inspection tasks. Use of this procedure in developing a maintenance program will help ensure that proper attention is given to wiring installations during maintenance. The EZAP provides a logical procedure for selecting stand-alone inspections (either general or detailed) and tasks to minimize presence of combustible material. For those aircraft without a structured zonal inspection program, it will identify new wiring tasks. APPENDIX A provides step-by-step details of the EZAP process.

(2) Guidance for General Visual Inspection (GVI). This AC clarifies the definition of 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.

(3) Protections and Cautions. This AC provides guidance for developing actions and cautionary statements to be added to maintenance instructions for the protection of wire and wire configurations. Maintenance personnel will use these enhanced procedures to minimize contamination and accidental damage to EWIS while working on aircraft.

(4) "Protect and Clean As You Go" Philosophy. This philosophy is applied to aircraft wiring through inclusion in operators' maintenance and training programs. This philosophy stresses the importance of protective measures when working on or around wire bundles and connectors. It stresses how important it is to protect EWIS during structural repairs, STC installations, or other alterations by making sure that metal shavings, debris, and contamination resulting from such work are removed. The **protect and clean as you go philosophy** is translated into specifics by the protection and caution recommendations described in paragraph 10 of this AC. More information is contained in Appendix D of this AC – "Causes of Wire Degradation."

(5) Consolidation with Fuel Tank Requirements. The FAA has developed an extensive program to address safety problems associated with fuel tanks. Fuel tank systems contain EWIS that may be routed independently or integrated with other airplane systems EWIS. One part of the Fuel Tank Safety Rule, Special Federal Aviation Regulation 88 (SFAR 88), requires development of maintenance and inspection instructions to assure the safety of the fuel tank system. Other sections of the Fuel Tank Safety Rule require operators to include fuel tank safety maintenance and inspection instructions in their maintenance or inspection programs. An objective of this AC is to ensure that fuel tank system instructions for continued airworthiness developed to comply with SFAR 88 are compatible with the EWIS instructions for continued airworthiness, including minimizing redundant requirements. See paragraph 11 of this AC for details.

b. The objective of the information in this AC is to improve maintenance and inspection programs for all aircraft system wires. It does not include certain component wiring. Applying this information will improve the likelihood that EWIS degradation from many causes, including environmental, maintenance-related, and age-related problems, will be identified and corrected. In addition, this information has been reviewed to ensure that maintenance actions, such as inspection, repair, overhaul, replacement of parts, and preservation, do not –

- Cause a loss of EWIS function.
- Cause an increase in the potential for smoke and fire in the aircraft
- Inhibit the safe operation of the aircraft.

c. To fully realize the objectives of this AC, air carriers, air operators, type certificate holders, STC holders, maintenance providers, repair stations, and anyone performing field approval modifications or repairs will need to redefine their current approach to maintaining and altering aircraft wiring and systems. This redefinition must reach both overall philosophy and specific maintenance tasks. This may require more than simply updating maintenance manuals and work cards and improving training. Maintenance personnel need to be aware that aircraft EWIS must be maintained in an airworthy condition. 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 good visual inspection techniques with improved wiring maintenance practices and training.

d. To fully achieve the objectives of this AC it is imperative that all personnel performing maintenance on or around EWIS receive appropriate training. Besides technical content for maintenance and inspection of EWIS, the training should also contain sections on good maintenance practices, including the protect and clean as you go philosophy. Advisory Circular AC 120-YY, Aircraft Wiring Systems Training Program, contains guidance on recommended content and lesson plans for such training.

5. DEFINITIONS. Additional definitions that have general applicability to this AC appear in Appendix E.

Arc tracking. A phenomenon in which a conductive carbon path forms across an insulating surface. This carbon provides a short circuit path through which current can flow. Arc tracking is 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 AC, 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 AC, wiring contamination refers to either of the following:

- Presence of a foreign material likely to cause degradation of wiring.
- Presence of a foreign material that is combustible, or capable of sustaining a fire after removal of ignition source.

Detailed Inspection (DET). An intensive examination of a specific item, installation, or assembly to detect damage, failure, or irregularity. DET is discussed in greater detail in paragraph 8a of this AC.

Effective Task/Task Interval. An “effective” task is an inspection or maintenance task, performed at defined intervals, that will ensure that the desired outcome of the task is achieved. To be effective the task must reduce the risk of wire failure, to ensure safe operation. For example, a cleaning task to remove contaminants that have accumulated on a wire bundle would be considered effective if it cleaned the bundle sufficiently to minimize the potential of contaminant-induced failure of the bundle, and allow an inspection for wire defects to be performed. The methods and intervals for performing an effective task are developed using a combination of standard industry practices, expert opinion, and engineering judgment from operators, manufacturers, and regulatory authorities. The document ATA MSG-3 "Operator/Manufacturer Scheduled Maintenance Development," discusses the various criteria for the effectiveness of a task based on safety and operational and economic considerations. Refer to Table 2-3-7.1 "Criteria for Task Selection" of that document for further information.

Electrical Wire Interconnection System (EWIS). Generally speaking, EWIS refers to wires and wiring devices used to transmit electrical energy between two or more intended termination points on an aircraft. EWIS is defined in great detail in 14 CFR section 25.1701 and this regulatory definition appears in Appendix E to this AC.

Environmentally Sealed Splice. A wire splice that ensures that moisture or fluid will not penetrate the spliced area.

FAA Oversight Office. The aircraft certification office (ACO) or the office of the Transport Airplane Directorate having oversight responsibility for the relevant type certificate or supplemental type certificate, as determined by the Administrator.

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. GVI is discussed in greater detail in paragraph 8a of this AC.

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 remains an independent step on the work card.

Swarf. A term used to describe the metal particles generated from drilling and machining operations. Swarf particles may collect 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 airplane zone, defined by access and area, to check system and power plant installations and structure for security and general condition. Zonal inspections are discussed in greater detail in paragraph 8 of this AC.

6. BACKGROUND.

a. Over the years there have been a number of in-flight smoke and fire events where contaminants ignited by electrical faults allowed the fire to be sustained and spread. The FAA and the National Transportation Safety Board (NTSB) have conducted aircraft inspections and found wiring contaminated with items such as dust, dirt, metal shavings, lavatory waste water, coffee, soft drinks, and napkins. Sometimes wire bundles and surrounding areas have been found to be completely covered with dust.

b. In recent years Federal government and industry groups have realized that current maintenance practices may not be enough to address aging non-structural systems. Over time, insulation can crack or breach, thus exposing the conductor. While age is not the sole cause of wire degradation, the likelihood of EWIS damage from inadequate maintenance, contamination, improper repair, or mechanical damage increases over time. 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.

c. Research has shown that maintenance work on other aircraft systems can cause collateral damage to nearby wiring. Normal maintenance actions, even using acceptable methods, techniques, and practices, can, over time, contribute to wire degradation. A person inspecting an electrical power center or avionics compartment, for example, may inadvertently cause damage to wiring in a nearby area. Zones of an airplane subject to a high level of maintenance activity display more deterioration of wiring insulation. Undisturbed wiring will have less degradation than wiring that is disturbed during maintenance.

d. For more information on the principal causes of wire degradation see APPENDIX D.

7. NEED FOR IMPROVEMENTS TO EWIS MAINTENANCE.

a. Typical analytical methods used for developing maintenance programs have not provided a focus on wiring. As a result, most operators have not adequately addressed EWIS deterioration in their programs. We have reviewed current inspection philosophies to identify improvements that could lead to a more consistent application of inspection requirements, whether for zonal, stand-alone GVI, or DET inspections, as they relate to airplane wiring.

b. We believe it would be valuable to provide guidance on the type of deterioration a person performing a GVI, DET, or zonal inspection could expect to discover. Though it may be assumed that all operators provide such guidance to their affected personnel, it is evident that significant variations exist, and a significant enhancement to wiring inspection could be obtained if standardized guidance material existed. Achievement of the objectives of this AC is dependent on each operator conducting GVI and DET inspections as defined in this document. These definitions should be incorporated in operators’ training material and in the introductory section of maintenance planning documentation.

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8. GENERAL EWIS MAINTENANCE GUIDANCE.

a. Levels of Inspection Applicable to EWIS. Though the term "detailed visual inspection" remains valid for detailed inspection using only eyesight, this may represent only part of the inspection called for in source documents used to establish an operator's maintenance program. We recommend that the acronym "DVI" not be used because that term may exclude tactile examination, which is sometimes needed. Instead, we provide the following definitions.

(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.

(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.*

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

(b) When performing a GVI, there is usually no need to remove equipment or displace wire unless the access instructions specifically call for it.

(c) The area to be inspected should be clean enough to minimize the possibility that collected dirt or grease might hide unsatisfactory conditions that would otherwise be obvious. For any cleaning considered necessary, you should use the airplane manufacturer's procedures or other methods, techniques, and practices acceptable to the FAA. The cleaning process itself should not compromise the integrity of EWIS.

(d) In general, the person performing a GVI is expected to identify degradation from wear, vibration, moisture, contamination, excessive heat, aging, etc., and assess what actions are appropriate to address the discrepancy. This assessment should consider potential effects on adjacent system installations, particularly if those systems include wiring. You should address any observed discrepancies, such as chafing, broken clamps, sagging, interference, contamination, etc.

(3) Zonal Inspection. *A collective term comprising selected general visual inspections and visual checks that are applied to each zone of the airplane, defined by access and area, to check system and powerplant 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 conditions are typical of what should be detectable and addressed as a result of a zonal inspection (as well as a stand-alone GVI). Maintenance and training documentation should include these items. This list is not intended to be all-inclusive and may be expanded as considered appropriate.

(1) Wire/Wire Harnesses

- Wire bundle/wire bundle or wire bundle/structure contact/chafing
- Wire bundles sagging or improperly secured
- Wires damaged (obvious damage because of mechanical impact, overheat, localized chafing, etc.)
- Lacing tape and/or ties missing/incorrectly installed
- Wiring protection sheath/conduit deformed 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 (splices, for example)
- Deterioration of production splices
- Inappropriate repairs (for example an 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
- Safety wire missing or broken
- Discoloration/evidence of overheat on terminal lugs/blocks
- Torque stripe misaligned

(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
- Unstuck/detached
- Attachment faulty (bad attachment or fastener missing)
- Protection/cushion damaged

(7) Supports (Rails or Tubes/Conduit)

- Broken
- Deformed
- Fastener missing
- Edge protection on rims of feed-through holes missing
- Racetrack cushion damaged
- Drainage holes (in conduits) obstructed

(8) Circuit Breakers, Contactors or Relays

- Signs of overheating
- Signs of arcing

c. Wiring Installations and Areas of Concern. Maintenance material should address the following installations and areas.

(1) Wiring Installations.

- **Clamping points –**Damaged clamps, migration of clamp cushions, or improper clamp installations aggravate wire chafing. 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. But improperly installed tie wraps can have a detrimental effect on wire insulation. When new wiring is installed as part of an STC, field approval, or other modification, the drawings will provide wire routing, clamp type and size, and proper location. Examples of significant wiring alterations are the installation of new avionics systems, new galley equipment, 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 clamps, causing wire bundles to sag and wires to chafe. Raceway clamp foam cushions may deteriorate with age, fall apart, and thus fail to 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. Over time, vibration can cause high-current-carrying feeder cable terminal lugs to lose their original torque value, resulting in arcing. 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 could sustain a fire if ignited from an overheated or arcing terminal lug. Terminal blocks and terminal strips located in equipment power centers (EPC), avionics compartments, and throughout the aircraft need to be kept clean and free of combustibles.

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

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

- **Grounding points –** You should check grounding points for security (i.e., finger tightness), condition of the termination, cleanliness, and corrosion.

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, we recommend use of environmentally sealed splices.

(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 –** Wing leading and trailing edges are difficult environments for wiring installations.   On some aircraft models, wing leading and trailing edge wiring is exposed whenever the flaps or slats are extended. Slat torque shafts and bleed air ducts in these areas are other potential damage sources.

- **Engine, pylon, and nacelle area –** These areas experience high vibration, heat, and 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, and hydraulic components and plumbing. They 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) –** Electrical panel wiring is particularly prone to broken wires and damaged insulation when these high density areas are disturbed during troubleshooting activities, alterations, and refurbishments. Tying wiring to wooden dowels to reduce its disturbance during modification can minimize wire damage. For some configurations, use of connector support brackets would be more desirable and cause less wire disturbance than removal of individual connectors from the supports.

- **Batteries –** Wires in the vicinity of all aircraft batteries are susceptible to corrosion and discoloration and should be inspected for those problems. You should inspect discolored wires for serviceability.

- **Power feeders –** High-current wiring and associated connections have the potential to generate intense heat. Vibration may cause degradation or loosening of power feeder cables, terminals, and splices. If signs of overheating are seen, splices or termination should be replaced. For both galley and engine/APU generator power feeders, depending on the design, service experience may indicate a need for periodic checks of proper torque on power feeder cable terminal ends, especially in high vibration areas.

- **Under galleys, lavatories, and cockpit –** Areas under the galleys, lavatories, and cockpit are particularly susceptible to contamination from such things as coffee, food, water, soft drinks, lavatory fluids, dust, and lint. Proper floor panel sealing procedures can minimize such contamination in these areas.

- **Fluid drain plumbing –** Leaks from fluid drain plumbing may lead to liquid contamination of wiring. Service experience may show a need for periodic leak checks or cleaning, in addition to routine visual inspections.

- **Fuselage drain provisions –** Some installations include plumbing features designed to catch leakage and drain it 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 signal a need to check these installations and associated plumbing periodically to ensure the drain path is free of obstructions.

- **Cargo bay/underfloor –** Damage to wiring in the cargo bay underfloor can occur from maintenance activities in the area.

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

- **Access panels –** Wiring near access panels may be accidentally damaged from repetitive maintenance access and may warrant special attention.

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

- **Under cockpit sliding windows –** Areas under cockpit sliding windows are susceptible to water entering from rain and snow. Fluid drain provisions in these areas should be periodically inspected and repaired as necessary.

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

9. ENHANCED ZONAL ANALYSIS PROCEDURE.

a. The enhanced zonal analysis procedure (EZAP) in APPENDIX A of this AC was developed to identify tasks to minimize accumulation of combustible materials. It also addresses wiring installation discrepancies that may not be reliably detected by inspections contained in existing maintenance programs.

b. The enhanced zonal analysis procedure described in this AC will result in safety improvements for airplanes operated using a maintenance or inspection program that includes a zonal inspection program (ZIP). It is unlikely that ZIPs developed in the past considered wire, except for the most obvious damage that could be detected by a GVI.

c. For those operators without a ZIP, the EZAP logic is likely to identify a large number of wiring-related tasks that will need to be consolidated in the existing systems maintenance or inspection program. Operators without a ZIP may find it worthwhile to develop a ZIP in accordance with an industry-accepted method in conjunction with application of the EZAP.

d. When performing the EZAP, evaluate items such as plumbing, ducting, and systems installations for possible contributions to wiring failures. If a general visual inspection (GVI) is required to assess degradation of these items, a zonal GVI within a ZIP may be appropriate.

e. Any new tasks identified by the EZAP logic should be compared against existing tasks in the maintenance program. Duplicate tasks should be eliminated.

f. The EZAP logic and procedures identified in this AC apply to TCs, STCs, and design changes implemented by service bulletins. Section H25.5(a)(1) of part 25 requires TC and STC holders to use an EZAP procedure to identify instructions for continued airworthiness. An EZAP for a service bulletin or STC may not identify any additional tasks if the alteration does not appreciably affect the zones where it is installed. APPENDIX C, "Determining if Service Bulletin Modification or STC Requires EZAP," was developed to identify modifications that affect zone attributes sufficiently to warrant re-application of EZAP to the entire zone.

g. Operators may need to use this logic to identify additional inspection and cleaning tasks for STCs, especially when the STC is no longer supported by the STC holder.

10. PROTECTION AND CAUTION RECOMMENDATIONS. Section 43.13(b) 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, aircraft engine, propeller, or appliance worked on will be at least equal to its original or properly altered condition (with regard to aerodynamic function, structural strength, resistance to vibration and deterioration, and other qualities affecting airworthiness).*

Anyone 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 § 43.13(a) as acceptable to the Administrator. The protection and caution recommendations, while not required as part of the EZAP process discussed in this AC, are required by H25.5 (a)(1)(vi) of part 25. They are an important part of the "protect and clean as you go" philosophy, which contributes to preserving the integrity of EWIS. Some practices in use today may actually compromise the integrity of EWIS, albeit inadvertently. Therefore, we have identified some specific maintenance and servicing tasks and recommend that air carriers and air operators adopt these more robust practices. Such information may be provided in training, on job cards or task cards, or in handout information for maintenance personnel. These maintenance practices will help prevent inadvertent contamination of EWIS with harmful solids (such as metal shavings) or fluids during maintenance, alteration, and repair of airplane structures and components. Training of maintenance and servicing personnel should address potential consequences of their actions to wiring in the work area. FAA advisory circular AC 120-YY, Aircraft Electrical Wiring Interconnection Systems Training Program, provides details of EWIS training that could be adopted by air carriers and air operators.

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

(1) 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), standard wiring practices manual (SWPM), or other documents authorized for maintenance use.

(2) Special care should be taken to minimize disturbance of existing adjacent wiring during 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. <u>Structural Repairs, STCs, Modifications, and Field Approvals</u>. Structural repairs, installation of STCs, modifications, or field-approved repair and alteration activity inherently introduces tooling and residual debris that is harmful to aircraft wiring. They often require displacement or removal of wiring to provide access to the work area. Even minor displacement of wiring, especially while clamped, can damage its insulation and result in degraded performance, leading to subsequent arcing or circuit failure.

(1) Use extreme care to protect wiring from mechanical damage by tools or other equipment during structural repairs, installation of STCs, and field approved repairs or alterations. Avoid drilling blindly into the aircraft structure. Damage to the wire installation could cause arcing, fire, and smoke. Carefully cover or displace wiring located adjacent to drilling or riveting operations to reduce the possibility of mechanical damage.

(2) Do not allow debris such as drill shavings, liberated fastener pieces, broken drill bits, etc., to contaminate or penetrate wiring or electrical components. This can cause damage to insulation and potential arcing by providing a conductive path to ground or between 2 or more wires of different loads. Once wire bundles are contaminated with this type of debris, it is extremely difficult to remove it. So take precautions to prevent contamination of any kind from entering the wire bundle.

(3) Before beginning structural repair work, STC installation, or field approved repair or modification activity, survey the work area carefully to identify all wiring and electrical components that may be subject to contamination. Wiring and electrical components in the debris field should be covered or removed. Drills equipped with vacuum aspiration can be used to minimize risk of metallic debris contaminating wire bundles or other EWIS components. When work is completed, clean electrical components and wiring per applicable maintenance instructions.

c. <u>Aircraft De-Icing or Anti-Icing.</u> Exercise care when spraying de/anti-icing fluids to prevent damage to exposed electrical components and wiring in areas such as wing leading and trailing edges, wheelwells, and landing gear. Direct pressure spray onto electrical components and wiring can lead to contamination or degradation and should be avoided.

d. <u>Inclement Weather.</u> EWIS in areas below doorways, floors, access panels, and servicing bays are prone to corrosion or contamination from exposure to the elements. Snow, slush, or excessive moisture should be removed from these areas before closing doors or panels. Before loading items into the aircraft (cargo containers, for example) remove deposits of snow or slush. Keep doors/panels closed as much as possible during inclement weather to prevent ingress of snow, slush, or excessive moisture.

e. <u>Component Removal/Installation (relating to attached wiring).</u>

(1) Excessive component handling and movement during installation and removal may harm 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, take special care to ensure the connector body is fully seated, the jam nut is fully secured, and no tension is on the wires.

(2) 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. Use of a humidity absorber is recommended with sleeves or plastic bags.

f. Pressure Washing. Exercise care when spraying water or cleaning fluids to prevent damage to exposed electrical components and wiring in areas such as wing leading and trailing edges, wheel wells, and landing gear. Avoid direct high-pressure spray onto electrical components and wiring. It can lead to contamination or degradation. When practical, protect wiring and connectors before pressure washing. Use water rinse 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, consult the airplane maintenance manual or STC holder’s instructions for additional detailed instructions about pressure washing.

g. Cleaning of EWIS (in situ). Exercise extreme care and use proper procedures when cleaning to ensure safe and reliable performance of the function supplied by the wiring. Although these recommendations for cleaning of EWIS are considered good practice and technique, consult the airplane maintenance manual or STC holder’s instructions for additional detailed instructions.

(1) Avoid displacing or disturbing wiring during cleaning of non-aggressive contamination, such as dust, dirt, or swarf. Displacement may be necessary for aggressive contaminants (livestock waste, salt water, battery electrolyte, for example). In those cases, release wiring from its installation in a way that avoids placing undue stress on the wiring connectors and wire bundle support devices. If liquid contamination enters the bundle, remove ties before separating wires.

(2) Clean only contaminated areas and items. Before cleaning, make sure that the cleaning materials and methods will not cause more contamination. Make sure cloths used are clean, dry, and lint-free. Connectors should be completely dry before mating. Fluids left on connectors can have a deteriorating effect on the connector or the system or both.

h. Servicing, Altering, or Repairing Waste/Water Systems. EWIS in areas adjacent to waste/water systems are prone to contamination from those systems. Use care to prevent fluids from reaching electrical components and wiring while servicing, modifying, or repairing waste/water systems, and cover exposed electrical components and wiring while working. Operator practice may call for a weak acid solution to be periodically flushed through lavatory systems to improve reliability and efficiency of operation. Because of the effect of acid contamination on systems and structure, confirm that the system is free of leaks before using such solutions.

i. Servicing, Altering, or Repairing Oil Systems. EWIS in areas adjacent to oil systems are prone to contamination from those systems. Oil and debris in combination with damaged wiring can present a fire hazard. To minimize the attraction and adhesion of foreign material, use care to prevent fluids from reaching electrical components and wiring while servicing, altering, or repairing oil systems.

j. Servicing, Modifying, or Repairing Hydraulic Systems. EWIS in areas adjacent to hydraulic systems are prone to contamination from those systems. To minimize the attraction and adhesion of foreign material, use care to prevent fluids from reaching electrical components and wiring while servicing, altering, or repairing hydraulic systems.

k. Gaining Access (entering zones). When entering the aircraft or working on it, use care to prevent damage to adjacent electrical components and wiring, including wiring that may be hidden from view (covered by insulation blankets, for example). Use protective boards or platforms for adequate support and protection. Avoid using wire bundles as handholds, steps, and supports. Don't use wiring to hang or support work lights. 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 to position after work is completed.

l. Applying Corrosion Prevention Compounds (CPC). When applying CPC in airplane zones containing wire and associated components (such as clamps, connectors and ties), use care to prevent CPC from contacting the wire and components. Dust and lint are more likely to collect on wire that has CPC on it. Apply CPCs according to the aircraft manufacturer's recommendations.

11. HOW THIS GUIDANCE RELATES TO PART 25 REGULATIONS.

a. Alteration. The program to enhance EWIS maintenance also applies to EWIS installed or altered or affected by operator alterations, STCs, or field approved alterations. Alterations that could affect EWIS include, but are not limited to, those that install new equipment close to wiring, introduce a heat source into 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 altered or affected by alteration and for enhancing the maintenance program as appropriate.

b. Compatibility/Consolidation of EWIS and Fuel Tank Maintenance Tasks. Typically, fuel tank systems contain elements of electrical wire interconnection systems. Section 25.1805(b) requires that TC holders review the fuel tank system instructions along with the results of the EZAP applied to EWIS to ensure the that the two sets of instructions for continued airworthiness are compatible and redundancies are minimized. Performing an

EZAP on EWIS elements that are part of the fuel tank system may not in all cases result in ICA that achieve the depth of inspection necessary to ensure their integrity. Certain EWIS elements within the fuel tank system contribute to prevention of ignition sources and therefore would require a more in-depth inspection, possibly at a more frequent interval, than what may result from only applying EZAP. In some cases the EZAP may have been carried out independently of considerations for fuel tank system safety. A review should be conducted to ensure that maintenance evaluations conducted on EWIS that are part of the fuel tank system address design features of the EWIS that preclude ignition sources. The resulting maintenance actions should preserve those design features for the operational life of the airplane. These actions may include inspection for flammable debris and swarf and inspection of wire configurations, especially in the previously discussed wire installation areas of concerns.

(1) The ICA for fuel tank system electrical wiring required by SFAR 88 should be determined in accordance with the guidance provided by Policy Statement ANM112-05-001, "Process for Developing Instructions for Maintenance and Inspection of Fuel Tank Systems Required by SFAR 88" or other acceptable process. Additionally, compliance with part 25 Subpart I requires that ICA be developed for the same wire using an EZAP. While the fuel tank process and EZAP have similarities, they may result in identification of different tasks and intervals. The ICA maintenance tasks and intervals resulting from these determinations are expected to be additive. If there is a conflict in the task or interval, it should be resolved in a manner acceptable to the FAA oversight office.

(2) The ICA for fuel tanks should be reviewed to ensure that any maintenance tasks for EWIS do not compromise fuel tank system wire requirements, such as separation or configuration specifications. If there is an inspection or maintenance requirement for EWIS and the fuel tank system within the same zone, there should be an effort to align the task interval. In addition, the design approval holder's existing documents containing EWIS and fuel tank system ICA should be reviewed to either remove or cross-reference redundant information.

c. Compliance Plan for § 25.1805. Subpart I of part 25 (§ 25.1805(d)) requires the affected design approval holder to provide a compliance plan that includes identification of those common locations in the airplane where both EWIS and fuel tank ICA apply. Considerations of compatibility and minimization of redundancy for the two systems should be reviewed and approved by the FAA oversight office. The plan for documenting the required ICA for EWIS and fuel tank system should also be reviewed as part of the compliance plan. These documents are critical to the effort that will be required of operators to show compliance with the operational rules. The ICA information, both in content and format, should be readily usable by the affected operators for developing appropriate changes to their maintenance or inspection programs.

(1) The information for EWIS ICA would generally include:

- Identification of each zone of the airplane.

- Identification of each zone that contains EWIS.
- Identification of each zone containing EWIS that also contains combustible material.
- 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.
- The location of the EWIS components to be maintained or inspected and any access requirements.
- Any unique procedures required, such as special, detailed inspections, or a dual sign-off of maintenance records.
- Specific task information, such as inspections defined by pictures or schematics.
- Intervals for any repetitive tasks.
- Methods, techniques and practices required to perform the tasks.
- Criteria for passing inspections.
- Any special equipment or test apparatus required.
- Instructions for protection and caution information that will minimize contamination and accidental damage to EWIS during performance of maintenance, alterations, or repairs.
- Guidelines for identifying wiring discrepancies and assessing what effect such discrepancies, if found, could have on adjacent systems, particularly if these include wiring.
- Critical design configuration control limitations — for example, wire separation specifications — that cannot be altered, except in accordance with the applicable limitation.

(2) Generally, the information contained in the ICA for the fuel tank system required by SFAR 88 would include:

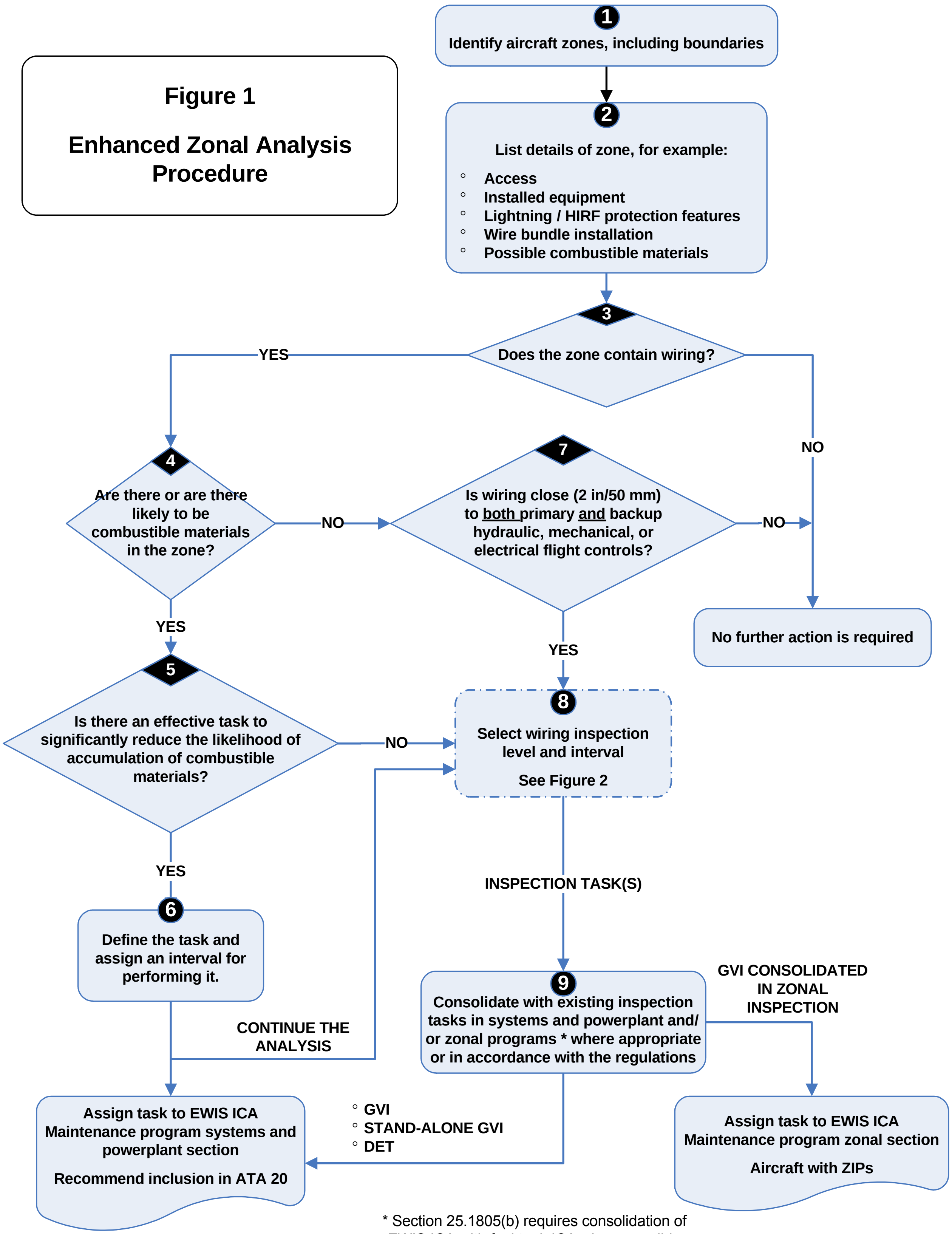
- The location of the fuel tank system components to be maintained or inspected and any access requirements.
- Any unique procedures required, such as special, detailed inspections, or dual sign-off of maintenance records.
- Specific task information, such as inspections defined by pictures or schematics.
- Intervals for any repetitive tasks.
- Methods, techniques, and practices required to perform the tasks.
- Criteria for passing inspections.
- Any special equipment or test apparatus required.
- Critical design configuration control limitations — for example, wire separation or pump impeller material specifications — that cannot be altered, except in accordance with the applicable limitation.

Policy Statement ANM112-05-001 provides guidance on acceptable processes for developing fuel tank system ICA as required by SFAR 88. The FAA oversight office will review and approve the results of the ICAs as required by § 25.1805(b).

APPENDIX A

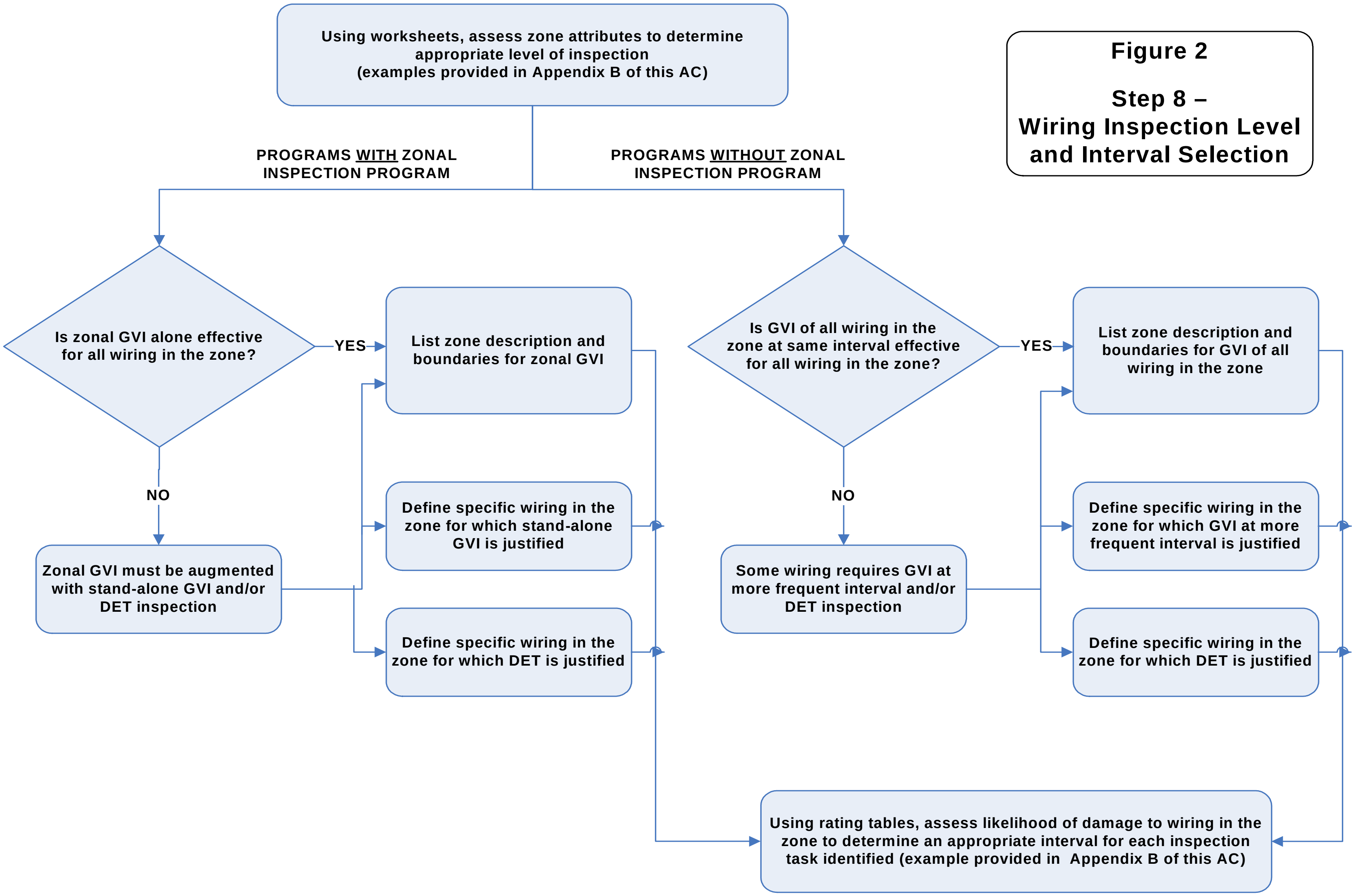
This appendix outlines the logic for evaluating aircraft wiring using an enhanced zonal analysis procedure (EZAP). Before using this logic, the person applying it should be thoroughly familiar with the contents and philosophy from the main body of this AC and the results the AC and EZAP seek to achieve.

ENHANCED ZONAL ANALYSIS PROCEDURE LOGIC DIAGRAMS



* Section 25.1805(b) requires consolidation of EWIS ICA with fuel tank ICA where possible

ENHANCED ZONAL ANALYSIS PROCEDURE LOGIC DIAGRAMS



ENHANCED ZONAL ANALYSIS PROCEDURE LOGIC DIAGRAMS

EXPLANATION FOR STEPS IN ENHANCED ZONAL ANALYSIS PROCEDURE LOGIC DIAGRAMS

The following paragraphs provide further explanation of each step in the enhanced zonal analysis procedure (EZAP) logic (Figures 1 and 2). It is recommended that, where possible, the person performing the EZAP analysis use actual aircraft to ensure they fully understand the zones being analyzed. This will help determine density, size, environmental issues, and accidental damage issues for each zone.

NOTE: The FAA oversight office will make an assessment as to the level of its involvement in these tasks. Refer to Appendix F of this AC for a list of FAA oversight offices.

STEP 1: <u>Identify aircraft zones, including boundaries</u>

If the design approval holder or operator has not already established aircraft zones, it is recommended that this be done. 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.

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

STEP 2: <u>List details of zone</u>

Within the zone, 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 person performing the EZAP analysis should know whether the wire bundle consists primarily of main generator feeder cables, low voltage instrumentation wiring, or standard bus wiring. This information will be used in determining potential effects of deterioration.

Determine whether the zone contains material or vapor that could cause a fire to be sustained in the event of an ignition source arising in adjacent wiring. Examples include fuel vapors, dust/lint accumulation, and contaminated insulation blankets. (See **<u>STEP 4</u>** for further information.)

Identify any 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: <u>Does zone contain wiring?</u> This question eliminates from the EZAP those zones that do not contain wiring.

STEP 4: Are combustible materials in zone? This question requires evaluating 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 presence of fuel vapors, dust/lint accumulation, and contaminated insulation blankets.

- With respect to commonly used liquids (oils, hydraulic fluids, corrosion prevention compounds, for example) refer to the product specification to assess potential for combustibility. The product may be readily combustible only in vapor mist form. If so, an assessment is required to determine if conditions might exist in the zone for the product to be in this state.

- Liquid contamination of wiring by most synthetic oil and hydraulic fluids (e.g., skydrol) may not be considered combustible. It is a concern, however, if it occurs in a zone where dust and lint are present because wet or oily surfaces attract dust and lint.

Assess what sources of combustible products may contaminate the zone following any single failure considered likely from in-service experience. Unshrouded pipes with connections within the zone should be considered potential contamination sources. Forced air ventilation in a zone tends to blow dust and lint through the air, causing it to lodge on wiring surfaces. Surfaces that are wet or oily attract more dust and lint. This needs to be considered when assessing the possibility of a buildup of combustibles in the zone.

- Avionics and instruments located in the flight compartment and equipment bays tend to attract dust, dirt, and other contamination. Because of the heat generated by these components and the relatively tightly packed installations, these zones should be considered to have potential for combustible material. Forced air ventilation is often used in these areas, causing a buildup of dust and lint to be blown onto wire surfaces. The EZAP logic should always be used for these zones. For flight compartment and equipment bays, the answer to the question in Step 4 should be "yes."

Although moisture (whether clean water or otherwise) is not combustible, its presence on wiring increases the probability of arcing from small breaches in the insulation, which could cause a localized fire in the wire bundle. The fire could spread if there are combustibles in close proximity. The risk of a sustained 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.

STEP 5: Is there an effective task to significantly reduce the likelihood of accumulation of combustible materials? Most operator maintenance programs have not included tasks directed towards removing combustible materials from wiring or adjacent areas or preventing their accumulation. Evaluate whether accumulation on or adjacent to wiring can be significantly reduced. Task effectiveness criteria should include considering the potential for damaging the wiring.

Though restoration tasks such as cleaning are the most likely applicable tasks, the possibility of identifying other tasks is not eliminated. For example, a detailed inspection of a hydraulic pipe might be appropriate if high-pressure mist from pinhole corrosion could impinge a wire bundle and the inherent zone ventilation is low.

STEP 6: Define task and assign an interval for performing it

This step will define an applicable EWIS ICA task and an effective interval for performing that task. The defined task should be included as a dedicated task in the systems & powerplant section of the maintenance program. Within MRB reports, it may be introduced under ATA 20 with no failure effect category quoted.

Restoration tasks should not be so aggressive that they damage wiring, but should be applied to a level that significantly reduces the likelihood of combustion.

STEP 7: Is wiring close to both primary and backup hydraulic, mechanical, or electrical flight controls? Where wiring is close (i.e., within 2 inches/50 mm) to both primary and backup 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.

This step 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 prevent continued safe flight and landing if hydraulic pipes, mechanical cables, or wiring for fly-by-wire controls are routed in close proximity (within 2 inches/50 mm) to a wiring harness. In consideration of the redundancy in flight control systems, this question should be answered ‘Yes’ if both the primary and back-up system might be affected by wire arcing. The question should also be answered yes in zones where a fire might be sustained by combustible materials.

On all aircraft type designs, regardless of TC date, alterations performed by an STC holder or a field-approved repair or alteration may not have taken into account the TC holder’s design criteria. It is recommended that STC holders assess whether their design changes route wires within 2 in. or 50 mm of both primary and back-up hydraulic, mechanical, or electrical flight control cables and lines. Similarly, air carriers and air operators should assess any field-approved repairs or alterations or other modifications that have been accomplished on their aircraft to identify any added or altered wiring that may be close to flight control cable and lines.

STEP 8: <u>Selection of wiring inspection level and interval (Figure 2)</u>

a. <u>Inspection level.</u> 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. This step details how the proper level of inspection and interval can be selected.

The recommended way of selecting the proper inspection level and interval is by using ratings tables which rate attributes of the zone and how the wiring is affected by, or can affect, those attributes. The analyst will determine the precise format of such a rating table, but example rating tables appear in APPENDIX B.

The inspection level characteristics that may be included in the rating system are:

- **Zone size** – assessed in relation to the size of the airplane under analysis, may be identified as small, medium or large. For example, the aft cargo bay on a large transport category airplane would be considered a large zone, but the radome on the same airplane would be considered a small zone. The smaller the zone and the less congested it is, the more likely it is that wiring degradation will be identified by GVI. According to Air Transport Association (ATA) Specification 100, "Manufacturer's Technical Data," zones are identified by the airplane manufacturer "to facilitate maintenance, planning, preparation of job instructions, location of work areas and components, and a common basis for various maintenance tasks." ATA 100 contains guidelines for determining airplane zones and their numbering. The EZAP process utilizes these manufacturer-identified zones. The zones are not created uniquely for EZAP. .

- **Density of installed equipment, including wiring and other EWIS components, within the zone** – assessed in relation to the size of the zone and may be identified as low, medium or high. The developed rating system will take into account the density of the zone. This may impact the type of inspection required to ensure safety. If the rating system uses density categories of low, medium, and high, an example of one zone that would be considered high density is the electrical and electronics compartment located in the forward nose section, below the flight deck of most large transport category airplanes. This is because the relatively small physical area is crowded with avionics equipment and a large number of wires and other EWIS components. A zone that on some models may be medium density would be the nose gear well. Although there are multiple systems located in the nose gear well, it has open space in order to accommodate the landing gear.

- **Potential effects of fire on adjacent wiring and systems** – This assessment should include the potential for loss of multiple functions and the resulting effect on continued safe operation of the airplane. Determination of potential effects of a fire on adjacent wiring and systems should be based on knowledge of what airplane systems are in the area under analysis (i.e., what's in the zone) and how loss or degradation of these systems could affect safe operation. The rating system developed should take into account these potential effects.

Potential effects of fire must also be considered when wiring is in close proximity (within 2 inches/50 mm) to both primary and backup 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 program, this may be defined as a zonal GVI. For operators without a zonal inspection program, it's a GVI of all wiring in the zone.

The logic in Figure 2 begins by asking the following question: "Is a GVI (or zonal GVI) of all wiring in the zone at the same interval effective for all wiring in the zone?" This calls for consideration of whether there are specific items or areas in the zone that are more vulnerable to damage or contamination and thus may warrant a closer or more frequent inspection.

Such a determination could result in selection of a more frequent GVI, a stand-alone GVI (for operators with a zonal inspection program), or even a DET. The intent is to select a DET of wiring only when it is determined that a GVI will not be adequate. The person performing the EZAP should avoid unnecessary selection of DET where GVI is adequate. Over-use of DET dilutes the effectiveness of the inspection.

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

b. Selecting an inspection interval. After defining the hostility of the environment and the likelihood of accidental damage, an inspection interval needs to be established. Selection of an effective inspection 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.

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 Worksheet 4 in APPENDIX D.

The sample “Interval Determination” table on Worksheet 4 provides a range of intervals from which to choose. The chosen interval should be based on the reasons for assigning specific rating values for hostility of environment and likelihood of accidental damage. Knowledge of the types of EWIS components to be inspected should also be used.

As an example, for a hostility of environment rating of 3 and a likelihood of accidental damage rating of 3, the table gives a range of inspection intervals. It says that the inspection should occur as frequently as every A check but the interval could be as long as once every 1C check. The choice should be based on the reasons that a 3 rating was assigned.

- In the case of accidental damage, the higher the likelihood of accidental damage from multiple sources, the more frequent the maintenance task should be. If, on the other hand, all of the factors except one have been rated as a 1, then the maintenance interval could be somewhat longer.

- The choice of the inspection interval should also be based on what type of environment the EWIS is located in. Just as with the ratings for likelihood of accidental damage, the more the EWIS is exposed to various harsh environmental conditions, the more frequent the maintenance interval should be. The person performing the EZAP should consider the assigned ratings from both sources and use sound maintenance judgment to assign the maintenance task interval.

The selection of inspection tasks possible in this step is specific to whether the maintenance program includes a zonal inspection program (ZIP) or not.

For ZIP programs, the possible inspection tasks are:

- Zonal GVI
- Stand-alone GVI
- DET

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

- GVI
- DET

At this point the person performing the EZAP will have determined the required inspection level and interval for wiring in the zone. Task consolidation in **STEP 9** allows consideration of whether an inspection selected as a result of this analysis can be considered accomplished as part of the existing maintenance program.

STEP 9: Task Consolidation

This step in the procedure examines the potential for consolidation between the tasks derived from the EZAP and inspections that already exist in the maintenance program. Consolidation would require that the inspections in the existing maintenance program are performed in accordance with the inspection definitions provided in this AC. Consolidation with the fuel tank ICA where possible is required by § 25.1805(b).

For inspection programs that include a zonal inspection program (ZIP):

- Application of the EZAP may identify some GVIs that are adequately covered by existing zonal GVIs in the zone. In those cases 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 program that already includes a ZIP.

- Consolidation of GVI tasks should consider access requirements and the interval of each task. A stand-alone GVI of the wiring may be justified if the zonal GVIs of the other systems within the same zone do not need such frequent inspection.

- Stand-alone GVIs and DETs identified by application of EZAP should not be consolidated into the zonal inspection program and must be introduced and retained as dedicated tasks in the scheduled maintenance program under ATA 20. These tasks, along with tasks identified to reduce accumulation of combustible materials, should be uniquely identified to ensure they are not consolidated into the zonal program or deleted during future program development. Within MSG-3-based MRB reports, these may be introduced under ATA 20 with no failure effect category quoted.

For programs without a ZIP:

Although some non-zonal inspection programs may already include some dedicated inspections of wiring that may be equivalent to new tasks identified by application of an EZAP, it is expected that a significant number of new wiring inspections will be identified for introduction as dedicated tasks in the system & powerplant program. All new tasks identified by application of EZAP should be uniquely identified to ensure they are not deleted during future program development.

For programs with or without a ZIP

The following guide can be used for programs with or without a ZIP to determine proper consolidation between EZAP-derived inspections and existing inspections of the same item or area. EZAP stand-alone GVIs and DETs should not be consolidated into a zonal GVI. When a task is selected for consolidation, the documentation should include a record identifying it for traceability purposes.

- Where the EZAP inspection interval and existing inspection interval are equal, but the inspection levels are different, the more detailed inspection will take precedence (for example a 1C DET takes precedence over a 1C GVI).

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

- 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 also the more detailed (a 1C DET takes precedent over a 2C GVI, for example). When the more frequent inspection is less detailed, the tasks should not be consolidated.

For all programs, EZAP stand-alone tasks should be uniquely identified in the program for traceability during future changes to the program. This is intended to prevent inadvertent deletion or escalation of EZAP stand-alone tasks without proper consideration of the basis for the task and its interval. Following approval of the EWIS ICAs by the FAA oversight office, the operator will propose changes to its maintenance or inspection program based on those approved ICA and the approved fuel tank ICA (as appropriate to the applicable operational rules) and submit them to its principal inspector or cognizant FSDO (Flight Standards District Office) for review and approval.

For EZAP-developed 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. If a ZIP exists, consolidation of EZAP-developed STC tasks into an operator's ZIP will be the responsibility of the operator and should be approved by its FAA principal inspector or cognizant FSDO. The operator will incorporate changes to its maintenance or inspection program based on the approved EWIS ICA and fuel tank ICA (as appropriate to the applicable operational rules) and submit them to its principal inspector or cognizant FSDO for review and approval.

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-developed ICA for the STC.

Section 25.1805(b) requires that the fuel tank system instructions be aligned with the results of the EZAP applied to EWIS to ensure compatibility and minimize redundancies. It is likely some EWIS are also part of the fuel tank system. The requirements for their maintenance and inspection might be more specific than those for wiring in general, and might contain additional requirements. For proper compatibility, it is important that their maintenance and inspections be carefully reviewed. If there is an inspection or maintenance requirement for EWIS and the fuel tank system within the same zone, there should be an effort to align the task interval. The ICA should be reviewed to ensure that any maintenance tasks for EWIS do not compromise fuel tank system wire requirements, such as separation or configuration specifications. In addition, design certificate holders' existing documents containing EWIS and fuel tank system ICA should be reviewed to either remove or cross-reference redundant information.

APPENDIX B

EXAMPLES OF TYPICAL EZAP WORKSHEETS

The following worksheets are examples to assist in application of the EZAP logic. The analyst may adjust the worksheets to suit specific applications.

- Worksheet 1 Details of Zone
- Worksheet 2 Assessment of Zone Attributes
- Worksheet 3A Inspection Level Determination based on Rating Tables (for use when a dedicated zonal inspection program exists)
- Worksheet 3B Inspection Level Determination based on Rating Tables (for use when a dedicated zonal inspection program does not exist)
- Worksheet 4 Interval Determination based on Rating Tables
- Worksheet 5 Task Summary

NOTE: Interval ranges are quoted in the rating table on Sheet 4 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 program. They may be expressed in terms of usage parameter (e.g., flight hours or calendar time) or in terms of letter check.

Enhanced Zonal Analysis - Details of Zone	Worksheet 1
ZONE NO:	ZONE DESCRIPTION:
1. Zone Details (Boundaries, Access):	
2. EQUIPMENT INSTALLED	**COMMENTS**
☐ Hydraulic Plumbing	
☐ 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	

This sheet is used to comply with Steps 1 and 2 of the Enhanced Zonal Analysis Procedure:

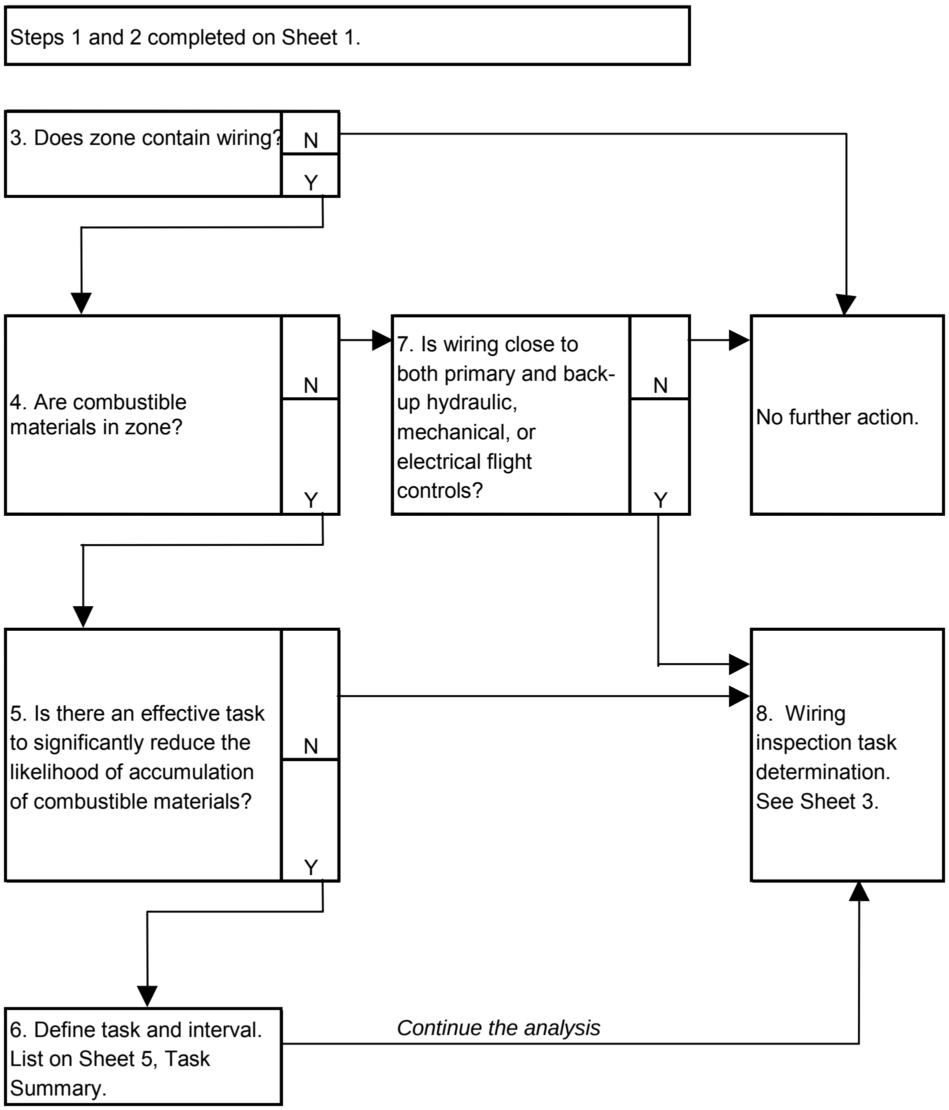
1. *Describe the zone (location, access, boundaries)*
2. *List the content of the zone; installed equipment, wiring, plumbing, components, etc.*

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.

Sample EZAP Worksheet Date: Page 1 of 5

Enhanced Zonal Analysis - Assessment of Zone Attributes — Workheet 2

ZONE NO: | **ZONE DESCRIPTION:**



Answers and Explanation:

(Note: Steps 1 & 2 completed on Sheet 1.)

3.

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

If the answer to questions in STEPS 3 and 7 is 'NO', then no 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.

EZAP WORKSHEETS

Enhanced Zonal Analysis - Inspection Level Determination based on Zone Size, Density, Potential Impact of Fire — **Worksheet 3A**

For Programs with dedicated Zonal Inspection Program (ZIP)

ZONE NO:	ZONE DESCRIPTION

Zone Size/Density Assessment

Density	Zone Size: Small	Medium	Large
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

Potential Effects of Fire in Zone / Size/Density Factor	1	2	3
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

3. Define specific items/areas in the zone for which **Stand-alone GVI** 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 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 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 (***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 **Worksheet 3B**

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 → 2, 3, 4

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.

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 Worksheet 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 (Box 4) is justified.

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Sample EZAP Worksheet | Date: | Date:

Enhanced Zonal Analysis - Interval Determination Based on Hostility of Environment and Likelihood of Accidental Damage **Worksheet 4**

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	
Foreign Object Debris (FOD)	
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.

Enhanced Zonal Analysis - Task Summary			Worksheet 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

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APPENDIX C

DETERMINING IF SERVICE BULLETIN MODIFICATION OR STC REQUIRES EZAP

Section 25.1805 requires that an EZAP be performed on certain large transport category airplanes that were type certified prior to the effective date of the rule (please refer to the language of § 25.1805 for the exact applicability of this rule). Section 25.1805 also applies to future STCs. However, there is not a parallel requirement to perform an EZAP on STCs that have already been certified.

One reason that existing installed STCs were not included in the language of § 25.1805 is that the EWIS maintenance tasks developed with an EZAP by the manufacturer for a particular model would most likely cover any EWIS added to that model with an STC. So a separate EZAP for an STC would not be necessary. There may be certain types of STCs, however, that add, modify, or otherwise affect airplane EWIS to the extent that portions of the EZAP analysis performed by the manufacturer may no longer be entirely valid. In those cases it would best serve aviation safety to identify the STCs and determine if their installation has had an impact on the § 25.1805 maintenance tasks.

To help identify the types of STCs that may impact the manufacturer's EWIS maintenance tasks, the FAA tasked the Aging Transport Systems Rulemaking Advisory Committee (ATSRAC) to provide a recommendation to facilitate development of appropriate EWIS maintenance tasks associated with these STC installations and a way for air carriers to incorporate them into their maintenance programs.

ATSRAC developed a list of four different types of STCs that they believe have the greatest possibility of impacting existing EWIS maintenance tasks. These are:

- In-flight entertainment systems
- Digital flight data recorder systems
- Powered cargo handling systems
- Galley and lavatory modifications that include power wiring redistribution

Although many types of STCs were considered by ATSRAC in creating the above list, these four types were chosen because they included a combination of the following conditions that made them stand out as most likely to benefit from an EZAP analysis:

- The STC adds substantial wiring in some cases to areas that may have had a low wiring density prior to the installation of the modification.
- The wiring added by the STC is located in a uniquely harsh environment where no wire existed before.
- The modification involves high power wiring located in a harsh environment.

EZAP DIAGRAM FOR MODIFICATIONS

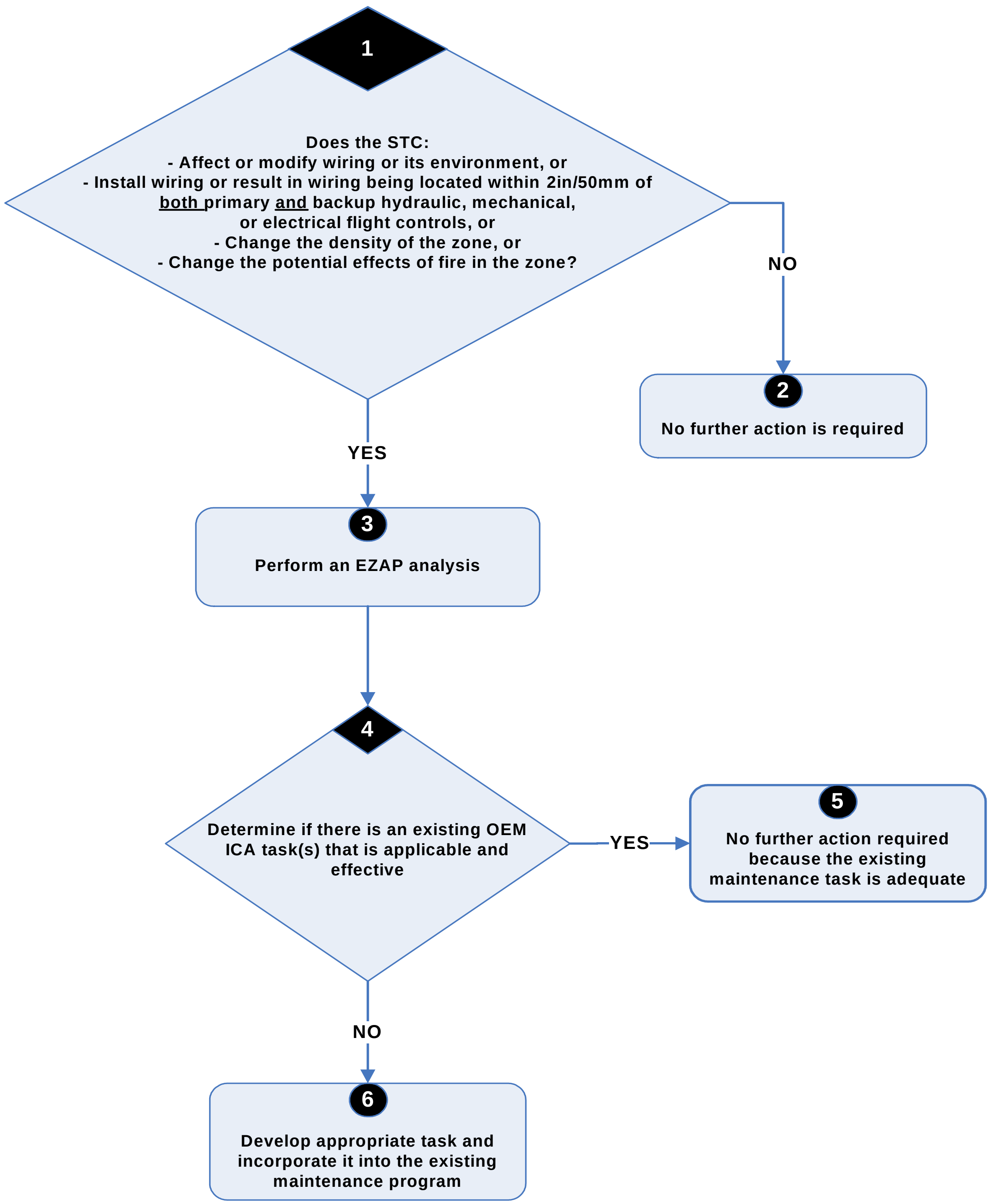
The FAA recommends that operators consider reviewing these categories of STCs that are installed on their airplanes and determine whether or not they impact the EWIS maintenance tasks developed by the airplane manufacturer for compliance with § 25.1805. Flowchart 1 can be used to determine if an EZAP should be performed on those zones of the airplane altered by the STC installation. Operators should encourage STC holders to work with them to complete this task since it is the STC holder who has the necessary technical data for the STC. Operators who complete such an STC review should realize reliability improvements. They will be ensuring that all EZAP maintenance tasks are properly identified and incorporated into their maintenance program.

In addition to using Flowchart 1 to determine if an EZAP is necessary for the above-listed categories of STCs, operators may choose to apply the chart logic to any or all of the other STC modifications installed on their airplanes.

EZAP DIAGRAM FOR MODIFICATIONS

Flowchart 1

Determining if Service Bulletin Modification or STC requires EZAP



EZAP DIAGRAM FOR MODIFICATIONS

DETERMINING IF SERVICE BULLETIN MODIFICATION OR STC REQUIRES EZAP

Explanation of Steps in Flowchart 1

Step 1.

Does the STC affect or modify wiring or its environment?
Does it -

- Install or result in wiring being located within 2 inches of primary and back-up hydraulic, mechanical or electric flight controls?
- Change potential effects of fire in the zone?
- Affect zone density?
- Introduce other systems into the area such as hot air ducting, hydraulic tubing, water tubing, etc.?
- Introduce new sources of contamination?

This step asks whether the STC affects or modifies wiring. Modifications to wiring or other EWIS components include, but are not limited to, removal, addition, and relocation.

NOTE: This question may have been answered for SFAR88 compliance, thus simplifying the task.

The additional questions in step 1 serve as examples for consideration of ways the STC may have affected or modified wiring or its environment.

- Consideration of potential effects of the STC must include whether wiring is in close proximity (i.e. within 2 inches/50 mm) to both primary and back-up flight controls.

- If the STC includes the addition or removal 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 reanalysis of the zone.

- Potential effects of fire on adjacent wiring and systems must be assessed, and this requires the analyst to consider potential for loss of multiple functions to the extent that a hazard could be introduced.

- Addition of other systems into the area, such as hot air ducting, hydraulic tubing, water tubing, etc., could introduce potential sources for contaminants. The possibility of wire arcing could pose a safety threat to the added systems.

- Additionally, step 1. 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 significant dust and lint occur. Contamination of wires with oils and other fluids increases adherence of airborne dist and lint to those wires.

Here are some examples that illustrate the questions asked in step 1:

- **Example 1:** The service bulletin or STC modification installs a “T” fitting in a fuel pressure line to support a new fuel pressure indication system. Prior to the alteration, the fuel line transited the zone with no connections or couplings in the zone that could be potential leak sources, and the zone had no other potential sources of combustible materials. In this example, the answer to the question would be 'YES’ – the newly installed T fitting introduces a potential source of combustible materials in the zone for the first time.

- **Example 2:** The service bulletin or STC installs a “T” fitting in a fuel pressure line to support a new fuel pressure indication system. The “T” is installed at an existing coupling in the line. In this example, the answer to the question would be 'NO,’ because the potential for a fuel leak already existed at the fuel line connection in the zone.

- **Example 3** The service bulletin or STC installs new terrain awareness warning system (TAWS) wiring adjacent to existing wiring associated with primary flight instrumentation. This alteration could increase the potential effect of a fire in the zone by the adding TAWS to the multiple systems contained within a single wire bundle that could be lost due to a localized arc or fire. The answer to the question is ‘YES.’

- **Example 4** The service bulletin or STC replaces existing analog flight instrumentation with new digital displays that include replacement of a single, large, multi-function wire bundle with separately routed wire bundles for the pilot and co-pilot flight displays. This alteration reduces the potential effect of a fire in the zone by providing greater separation of wiring for primary flight instruments. In this example, the answer is “YES,” with the possibility that re-application of EZAP to the entire zone may determine that GVI rather than DET is adequate for the wiring in the zone after alteration.

If the answers to the questions in step 1 are negative, then no further action is required.

Step 3.

Perform an EZAP analysis per AC 120-XX

If the answer to any of the questions in step 1 is "yes," then the only way to determine if existing EWIS maintenance tasks are sufficient is to perform the EZAP for the STC and compare the results with the existing EWIS maintenance tasks (see Step 4).

Step 4.

Is there an existing OEM ICA task(s) that is applicable and effective?

Once the 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 is adequate, then no further action regarding EWIS maintenance actions for the STC is necessary.

Step 5.

No further action required because the existing 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

CAUSES OF WIRE DEGRADATION

The following are considered principal causes of wiring degradation and should be used to help focus maintenance programs:

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 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 degradation of wiring. 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. 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 STC work have been performed. Care should be taken to protect wire bundles and connectors during modification work. 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 work is complete, and the 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 environmentally sealed 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. 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:

- Presence of a foreign material that is likely to cause degradation of wiring
- Presence of a foreign material that is combustible, or capable of sustaining a fire after removal of ignition source

The contaminant may be in solid or liquid form.

Solid Contaminants

Solid contaminants such as the following can accumulate on wiring and may degrade or penetrate wiring or electrical components.

- metal shavings
- swarf
- debris
- livestock waste
- lint
- dust

Fluid Contaminants

Chemicals in fluids such as the following can contribute to degradation of wiring.

- hydraulic fluid
- battery electrolytes
- fuel
- corrosion inhibiting compounds
- waste system chemicals
- cleaning agents
- deicing fluids
- paint
- soft drinks
- coffee

Contaminants Requiring Special Consideration

Special consideration is required for –

- hydraulic fluids
- deicing fluids
- battery electrolyte

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 the above 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 used. In all cases the aircraft manufacturer recommended procedures should be followed.

Waste System Contamination

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 in coffee makers and ovens, and behind fluorescent lights, especially ballasts.

APPENDIX E

DEFINITIONS AND RELATED REGULATIONS AND DOCUMENTS

DEFINITIONS

Aircraft Evaluation Group (AEG). Flight Standards Service (AFS) representatives who know the operational and maintenance aspects of a certification project and are responsible for helping to determine their operational suitability. This role includes providing support to the cognizant ACO in the review and approval of the initial ICA and later changes to it related to the safety initiatives referenced in this AC.

Flight Standards Service (AFS) Offices. Offices located in FAA headquarters (for transport category airplanes, AFS-200/-300) responsible for developing guidance and policy for AEG personnel who may assist cognizant ACOs and AFS field personnel (aviation safety inspectors) in the conduct of their responsibilities.

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.

Instructions for Continued Airworthiness (ICA). The documented information that includes the applicable methods, inspections, processes, procedures, and airworthiness limitations required to keep the product airworthy throughout its operational life in accordance with 14 CFR 25.1529.

Lightning/High Intensity Radiated Field (L/HIRF) Protection. The protection of airplane 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 (radio frequency) gaskets.

Maintenance. As defined in 14 CFR 1.1, "maintenance means inspection, overhaul, repair, preservation, and the replacement of parts, but excludes preventive maintenance." For the purposes of this advisory circular, maintenance also includes preventive maintenance, as described in both § 1.1 and 14 CFR part 43, Appendix A(c). Section 1.1 of 14 CFR provides the following definition: "Preventive maintenance means simple or minor preservation operations and the replacement of small standard parts not involving complex assembly operations." Appendix A(c) of 14 CFR part 43 lists the tasks that are considered preventive maintenance.

Maintenance Instructions. Information that provides recommended periods for cleaning, inspection, adjustment, testing, lubrication, degree of inspection, applicable wear tolerances, and recommended work necessary for each part of the airplane and its engine auxiliary power units, propellers, accessories, instruments, and equipment to provide for continued airworthiness of the airplane. Recommended overhaul periods and necessary cross-references to the Airworthiness Limitations section of the maintenance manual are also included.

Maintenance Review Board (MRB) Report (Transport Category Aircraft). A report intended for use by air carriers that contains the initial minimum scheduled maintenance and inspection requirements for a particular transport category aircraft maintenance program. Air carriers use the MRB report and its associated requirements to develop maintenance programs. See AC 121-22A, Maintenance Review Board Procedures, for more information.

Maintenance Significant Item (MSI). Items (system or component) identified by the manufacturer whose failure could have one or more of the following results or characteristics –

- Could affect safety (on ground or in flight).
- Is undetectable during operations (on ground or in flight).
- Could have significant operational impact.
- Could have significant economic impact.

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.

REGULATIONS

a. 14 CFR § 25.1701, EWIS Definition.

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

(1) Wires and cables.

(2) Bus bars.

(3) The termination point on electrical devices, including relays, interrupters, switches, contactors, terminal blocks, relays, 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) above, EWIS components inside the following equipment, and the external connectors that are part of that equipment, are excluded from the definition in paragraph (a):

(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 FAA.

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

(3) Fiber optics.

b. <u>Applicability for § 25.1739</u>. Section 25.1739 requires applicants to prepare Instructions for Continued Airworthiness (ICA) applicable to EWIS in accordance with Appendix H., section H25.5 of part 25. Paragraph H25.5(a)(1) requires that the ICA contain maintenance and inspection requirements for EWIS developed with the use of an enhanced zonal analysis procedure. This means that applicants for type certificates, amended type certificates, and supplemental type certificates with § 25.1739 in their type certification basis are required to perform an EZAP.

c. <u>Applicability for § 25.1805.</u> Section 25.1805 requires that each person identified below develop and submit for approval by the FAA Oversight Office ICA for the representative airplane's EWIS in accordance with Appendix H., section H25.5(a)(1) and (b) of part 25. The following persons must comply with the requirements of paragraph (b) of § 25.1805 before the dates specified.

(1) Holders of type certificates (TC): December 16, 2007.

(2) Applicants for TCs, and amendments to TCs (including service bulletins describing design changes), if the date of application was before **[effective date of final rule]** and the certificate was issued on or after **[effective date of final rule]**: December 16, 2007, or the date the certificate is issued, whichever occurs later.

(3) Unless compliance with § 25.1739 of this part is required or elected, applicants for amendments to TCs, if the application was filed after **[effective date of final rule]**: December 16, 2007, or the date of approval of the application, whichever occurs later.

(4) Applicants for supplemental type certificates (STC), if the date of application was before **[effective date of final rule]** and the certificate was issued on or after **[effective date of final rule]**: June 16, 2008, or the date of approval of the application, whichever occurs later.

(5) Unless compliance with § 25.1739 of this part is required or elected, applicants for STCs, if the application was filed after **[effective date of final rule]**: June 16, 2008, or the date of approval of the application, whichever occurs later.

<u>d. Applicability for STCs already installed prior to the effective date of the rule.</u> Section 25.1805 requires that an EZAP be performed on certain large transport category airplanes that were type certified prior to the effective date of the rule. This is a retroactive requirement to go back and perform an EZAP on these existing airplanes. However, there is not a parallel requirement to retroactively perform an EZAP on the STCs that have been certified and installed on those airplanes. Some air carriers, air operators, or STC holders may choose to analyze the modification with an EZAP even though there is no regulatory requirement to do so. Appendix C provides guidance for such an analysis. It simplifies determining whether a previously installed STC may impact the maintenance and inspections tasks developed according to the requirements of § 25.1805 for an existing airplane model.

RELATED REGULATIONS

<u>Title 14 Code of Federal Regulations (CFR) parts and specific regulations</u>.

Part 21, Certification Procedures for Products and Parts.

Special Federal Aviation Regulation No. 88 – Fuel Tank System Fault Tolerance Evaluation Requirements

Part 25, Airworthiness Standards: Transport Category Airplanes.

Subpart H – Electrical Wiring Interconnection Systems (EWIS)
Subpart I – Continued Airworthiness and Safety Improvements
Appendix H – Instructions for Continued Airworthiness

Part 43, Maintenance, Preventive Maintenance, Rebuilding, and Alteration.

§ 43.13(b)

Part 91, General Operating and Flight Rules.

§ 91.1507 Fuel tank system maintenance program.

Part 119, Certification: Air Carriers and Commercial Operators.

Part 121, Operating Requirements: Domestic, Flag, and Supplemental Operations.

§ 121.913 Fuel tank system maintenance program.

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.

§ 125.507 Fuel tank system inspection program.

Part 129, Operations: Foreign Air Carriers and Foreign Operators of U.S.-Registered Aircraft Engaged in Common Carriage.

§ 129.113 Fuel tank system maintenance program.

Part 145, Repair Stations

RELATED DOCUMENTS

Advisory Circulars (ACs) and Policy.

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 Aircraft Airframe & Powerplant Mechanics Airframe Handbook, Chapter 11, Electrical Systems

AC 120-YY Aircraft Wiring Systems Training Program

FAA Policy Statement No. ANM112-05-001, "Process for Developing SFAR 88-related Instructions for Maintenance and Inspection of Fuel Tank Systems" (69FR60170)

Reports.

- "Transport Aircraft Intrusive Inspection Project, (An Analysis Of The Wire Installations Of Six Decommissioned Aircraft), Final Report," The Intrusive Inspection Working Group, Aging Transport Systems Rulemaking Advisory Committee, 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 Recommendations A-00-105 through –108, September 19, 2000. (http://www.ntsb.gov/recs/letters/2000/A00_105_108.pdf)

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- ATA Specification 117 (Wiring Maintenance Practices/Guidelines). (http://www.airlines.org/public/publications/display1.asp?nid=939)

Other Documents.

- Operator/Manufacturer Scheduled Maintenance Development, Revision 2001, 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 Inspector's Handbook Bulletin 8300.10 titled "Origin and Propagation of Inaccessible Aircraft Fire under In-flight Airflow Conditions."

APPENDIX F

FAA OVERSIGHT OFFICES

Airplane Manufacturer	FAA Oversight Office
Aerospatiale	Transport Airplane Directorate, International Branch, ANM-116
Airbus	Transport Airplane Directorate, International Branch, ANM-116
BAE	Transport Airplane Directorate, International Branch, ANM-116
Boeing	Seattle Aircraft Certification Office
Bombardier	New York Aircraft Certification Office
CASA	Transport Airplane Directorate, International Branch, ANM-116
deHavilland	New York Aircraft Certification Office
Dornier	Transport Airplane Directorate, International Branch, ANM-116
Embraer	Transport Airplane Directorate, International Branch, ANM-116
Fokker	Transport Airplane Directorate, International Branch, ANM-116
Lockheed	Atlanta Aircraft Certification Office
McDonnell-Douglas	Los Angeles Certification Office
SAAB	Transport Airplane Directorate, International Branch, ANM-116