Aging Transport Systems Rulemaking Advisory Committee

Task 9

Final Report - Revision 1

July 15, 2002

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Task 9 Harmonized Working Group Chair

Executive Summary

This Report is provided to ATSRAC by the Task 9 Harmonized Working Group (T9HWG) in conclusion of the work requested of them in March 2001.

The T9HWG was made up of sixteen (16) American, Canadian, and European engineers representing Operators, OEMs, Regulators, and wire testing specialist companies. The group met seven (7) times between May 2001 and July 2002. Meeting duration was from two (2) to eight (8) days, and attendance was sufficient to ensure the desired harmonization between American and European regulatory systems.

During these meetings, the T9HWG determined the most appropriate means to address the subtasks and worked on harmonized approaches to the different issues. While some elements were worked by individuals and presented to the group via email and during the scheduled meetings, most of the work was produced by the members working together during the meetings.

The T9HWG addressed tasks which were substantially based on work previously completed by ATSRAC's Task 3 Working Group and detailed in their *Task 3 Final Report* (March 2001) that contained specific recommendations for the improvement of wiring system maintenance.

Specifically, T9HWG was tasked to execute the primary recommendations from the *Task 3 Final Report*. These were:

1. Develop Guidance for Enhanced Maintenance Criteria for Systems

2. Assist in Development of a Special Federal Aviation Regulation (SFAR) for Performance of the Enhanced Zonal Analysis Procedure (EZAP)

3. Recommend Wire System Instructions for Continued Airworthiness

Attachments 1 - 5 of this report contain the information developed by T9HWG in response to this tasking.

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Record of Revisions

Date	Revision
19 April 2002	Original issue - Draft Interim Report - for ATSRAC review
12 June 2002	Draft Final Report – Revision 1
05 July 2002	Draft Final Report – Revision 2
05 July 2002	Final Report
15 July 2002	Final Report, Revision 1 - Includes changes requested by ATSRAC from review of Final Report on 7/10/2002.

Chapter 1

Background

A. Developing the FAA's *Aging Systems Plan*.

Safety concerns about aging wiring systems in airplanes were brought to the forefront of public and governmental attention by a fatal accident involving a Boeing Model 747-131 airplane on July 17, 1996. The National Transportation Safety Board (NTSB) determined that "the probable cause of the accident was an explosion of the center wing fuel tank (CWT) resulting from ignition of the flammable fuel/air mixture in the tank." Although it was unable to determine the specific source of the ignition, the NTSB found several potentially unsafe conditions in and near the electrical wiring of the airplane, including cracked wire insulation, metal shavings adhered to a floor beam along which fuel quantity indication system wires were routed, other debris, and sulfide deposits.

The NTSB also found that deterioration, damage, and contamination of aircraft wiring and related components and unsatisfactory repairs were common in the airline transport airplanes that it inspected during the investigation. According to the NTSB's report "the condition of the wiring system in the accident airplane was not atypical for an airplane of its age and one that had been maintained in accordance with prevailing industry practices."

The NTSB found the deteriorated conditions of aircraft wiring systems of particular concern because the existence of these conditions revealed the general shortcomings of the current maintenance practices. As a result of its examinations the NTSB stated that a large portion of the aircraft wiring is difficult, if not impossible, to inspect because of its inaccessibility and that wire damage or other potentially unsafe conditions may not be detected, even on visible and accessible portions of aircraft wiring. The NTSB concluded that "insufficient attention has been paid to the condition of aircraft electrical wiring, resulting in potential safety hazards."

The accident investigation into the July 17, 1996, fatal accident resulted in a heightened awareness of the importance of maintaining the integrity of aircraft wiring. The FAA began to investigate fuel tank wiring, and to strengthen its focus on aging wiring in general. In 1997, the White House Commission on Aviation Safety and Security (WHCSS) issued the following recommendation to the FAA: "In cooperation with airlines and manufacturers, the FAA's *Aging Aircraft Program* should be expanded to cover non-structural systems."

In July 1998, the FAA issued the *Aging Transport Non-Structural Systems Plan*, (hereinafter "*Aging Systems Plan*") which addressed the WHCSS recommendation. The *Aging Systems Plan* focused specifically on wiring systems. In the *Aging Systems Plan*, the FAA describes the results of its evaluation of six transport category airplanes deemed representative of the "aging fleet of transport airplanes." The FAA found conditions

similar to those found by the NTSB during airplane inspections in connection with the July 17, 1996, Boeing accident investigation, including the following:

- Deterioration of wiring and related components.
- Stiff and cracked wire insulation.
- Contamination of wire bundles with metal shavings, dust, and fluids.
- Corrosion on connector pins.
- Improper wire installation and repairs.

The FAA's *Aging Systems Plan* also detailed several tasks aimed at correcting these problems, including the following:

- Improving wiring inspection criteria and providing more detailed descriptions of undesirable conditions.
- Improving inspector/mechanic training to ensure that it adequately addresses the recognition and repair of aging wiring components.
- Developing new methods for nondestructive testing of wiring.

The NTSB has recommended that the FAA address all wiring issues identified in the *Aging Systems Plan*, either through rulemaking or through other means. The NTSB specifically cited the need for improved training of maintenance personnel to ensure adequate recognition and repair of potentially unsafe wiring conditions.

B. Aging Transport Systems Rulemaking Advisory Committee (ATSRAC).

To address the issues identified in the *Aging Systems Plan*, in 1998 the FAA established the Aging Transport Systems Rulemaking Advisory Committee (ATSRAC). The ATSRAC provides a forum for the airlines, manufacturers, and other regulatory authorities to make recommendations to the FAA based on the *Aging Systems Plan*.

The FAA established the ATSRAC to provide advice and recommendations to the FAA Administrator on airplane system safety issues such as aging wiring systems. The ATSRAC was initially tasked in 1998 with five tasks, which included collecting data on aging wiring systems through airplane inspections, reviewing airplane manufacturer's service information, reviewing operators' maintenance programs, and providing the FAA with recommendations to enhance the safety of these systems.

The results and recommendations from the initial tasking indicated that problems associated with systems on aging airplanes were not completely related to the degradation over time of wiring systems. Inadequate installation and maintenance practices can lead to what is commonly referred to as an "aging system" problem. As such, the scope of ATSRAC is not limited solely to age-related issues, but includes improving the continued airworthiness of airplane systems, and in particular wiring systems.

C. ATSRAC Task 3 Working Group

The Aging Transport Systems Rulemaking Advisory Committee assigned the Task 3 Working Group the task of improving the general maintenance criteria for airplane systems to assure aging systems related problems are identified and corrected. As a result of extensive research and review of aircraft wiring systems, the Task 3 Working Group developed the following recommendations to the FAA and aviation industry.

(1) Enhancement of Inspection Criteria.

- The Air Transport Association's (ATA) Maintenance Program Development Document (MSG-3) and training material utilized by regulators, Type Certificate (TC) holders and STC holders, operators and repair stations should be updated to reflect the revised definitions of General Visual Inspection and Detailed Inspection.

(2) Maintenance Program Enhancement.

- Operators should ensure that they have a dedicated Zonal Inspection section within their approved maintenance program. This may not have been developed for the original Maintenance Review Board (MRB) Report and thus TC and STC holders should be required to assist operators in developing appropriate zonal inspections.

  (Note: The T9HWG subsequently concluded in its work that the absence of a dedicated Zonal Inspection Program would not prevent or otherwise hinder the incorporation of improvements to wiring system maintenance. Therefore, the advisory material and rule language proposed by T9HWG does not mandate the development of a dedicated Zonal Inspection Program as a prerequisite to improved wiring system maintenance.)

- TC and STC holders should apply an enhanced zonal analysis procedure to their in-service products in order to identify additional tasks to better address deterioration of wiring installations. Once developed, operators should introduce these tasks into their maintenance programs.

- STC holders should update the instructions for continued airworthiness that they provided in support of their design changes. This should be done through application of the enhanced zonal analysis procedure. Once developed, these should be introduced in operators' maintenance programs.

- Where possible, tasks originating from application of the enhanced zonal analysis procedure should be included in MRB Reports. Where, due to the age of the aircraft, this is not feasible, the recommendations should be published in a document appropriate to the importance of the issue e.g., Service Bulletin. Whatever method is used to promulgate the additional tasks, the accompanying

text should highlight that the tasks should not be consolidated within the zonal inspections at any time during the aircraft life.

(3) Expectations of a Zonal General Visual Inspection.

- TC holder, STC holder and operator training material (for both aircraft inspection and MSG-3 analysis) and maintenance documentation (as appropriate) should include information on the typical deterioration that is expected to be seen and addressed during accomplishment of a zonal inspection.

(4) Minimization of Contamination.

- Protections or cautions should be added to maintenance or servicing manuals and training programs.

- The FAA should be tasked with evaluating current structural anti-corrosion products for long-term affects on wiring. The results should be recommendations for or against the use of specific products on wiring given the high probability that wiring and electrical components will always be subject to some level of contamination by these products.

- Manufacturers of corrosion inhibiting compounds should be encouraged to adjust their products to minimize detrimental effects on wiring while preserving the highest levels of structural corrosion protection possible.

- TC and STC holders should be tasked with providing specific guidance for pressure washing to minimize adverse effects on wiring and electrical components (i.e., maximum pressures, minimum nozzle-to-surface distance, maximum cleaning solution pH, maximum temperatures of water, maximum air temperature, and rinse requirements). The results should be in the form of internationally accepted practices.

- TC and STC holders/operators should examine existing documentation, with respect to Carriage of Livestock and Carriage of Hazardous Materials, to ensure that appropriate and complete instructions are given with respect to cleaning of any spillage that might occur despite the precautions taken. This documentation should emphasize the potential severity of deterioration caused to systems and structure by animal waste products, salt water, caustic chemicals, etc. Guidance should be given on the extent of the cleaning procedures since it is often insufficient to remove only the visible evidence of contamination.

(5) Need for Awareness Enhancement.

- The FAA should promote and finance the production of a video aimed at convincing senior management within TC holders, STC holders, Operators and 3rd

Party Maintenance Organizations of the need to change the attitude towards wiring. The focus should be on what does occur in service, not theoretical events.

- The importance of changing maintenance mentality towards electrical wiring installations will require more than simply updating manuals and enhancing training. The need for change must be promoted from above and thus actions must be taken to convince senior management that extended inspection time and improved working procedures are fundamental in achieving an improvement in continuous airworthiness.

The ATSRAC and the FAA accepted the recommendations from the Task 3 Working Group in January, 2001.

D. ATSRAC 2001 Tasking – Implementation of Recommendations

In May 2001 the FAA assigned four new tasks to ATSRAC. These new tasks were intended to facilitate implementation of earlier recommendations by ATSRAC. As a result, four new working groups were established as follows:

Task 6 - Address the need for new wire system certification requirement

Task 7 - Address the need for a Standard Wire Practice Manual (SWPM)

Task 8 - Develop an enhanced training program for wire systems

Task 9 - Implement an enhanced maintenance program for wiring systems.

The following Chapters provide a detailed accounting of Task 9 and the work accomplished by the Task 9 Harmonized Working Group.

Chapter 2

Task 9 - Overview

As identified in the FAA's *Aging Transport Non-Structural Systems Plan*, maintenance procedures currently in use in the air transport industry may not adequately or proactively address aging non-structural systems. There is a need to define general criteria for maintenance and inspection activities that maintenance programs should exhibit to address aging systems issues. To ensure that aging systems issues are adequately addressed, enhancements are needed to:

- Maintenance planning procedures
- Maintenance procedures
- Inspection procedures
- Inspection criteria
- Procedures for protection of systems during maintenance
- Maintenance training programs.

These enhancements, when applied to a specific airplane type, should lead to the development of an airplane model-specific maintenance program that adequately addresses relevant aging systems issues.

To implement the required enhancements, ATSRAC defined Task 9 as five (5) individual sub-tasks assigned to T9HWG as follows:

Task 9.1	Establish a Harmonization Working Group (HWG)
Task 9.2	Coordinate with Other ATSRAC HWGs
Task 9.3	Develop Guidance for Enhanced Maintenance Criteria for Systems
Task 9.4	Assist in Development of a Special Federal Aviation Regulation (SFAR) for Performance of the Enhanced Zonal Analysis Procedure (EZAP)
Task 9.5	Recommend Wire System Instructions for Continued Airworthiness

Detailed discussion of the sub-tasks follow in the next five (5) Chapters of this report

Chapter 3

Task 9.1 - Establish a Harmonization Working Group (HWG)

To assist the FAA in formulating appropriate rulemaking and guidance pertaining to the enhancement of transport airplane maintenance program for systems, ATSRAC was tasked to identify and appoint an ***Enhanced Maintenance Practices HWG***. This HWG was tasked to assist the FAA in the development of a draft advisory circular (AC) and possible rulemaking actions.

Members of the group were selected for their experience and knowledge of electrical wiring design and installation, on-aircraft maintenance, maintenance program development and/or regulatory oversight of maintenance activities. A balance was achieved between OEMs, operators, regulators and wiring specialists. In accordance with ATSRAC Operating Procedures, an outline of each member's work history was assessed with representatives from ATSRAC in order to confirm the individual's suitability for inclusion in the group.

Task 9 Harmonization Working Group

Name	Organization
Blades, Les *	Goodrich
Boren, Randy	Northwest Airlines (US Co-Chair)
Bruning, Armin	Lectromec
Brytak, Alex	Bombardier
Cheshire, Martin **	Virgin Atlantic Airlines (European Co-Chair)
Drivas, Nick	Airtran Airways
Harbottle, Tony	Airbus
Heather, Tony	CAA/JAA
Herndon, Tim	Delta Airlines
Heutmann, Stefan	Lufthansa Technik
Laxar, Thomas #	Austrian Airlines
Neudorf, Cliff ***	Transport Canada
Palafox, Gil	Boeing
Patzke, Roy	FAA
Sobeck, Fred	FAA
Zuberer, Hank #	United Airlines

* Les Blades served as alternate for Rollin Brown.
** Martin Cheshire withdrew as Co-Chair due to travel restrictions following 9/11/02
*** Cliff Neudorf served as alternate for Henry Dyck.
# Thomas Laxar and Hank Zuberer were unable to attend any WG meetings and no alternates were assigned.

In addition to the members listed, Andrew Emery of the Regulatory Group, which provides legal and documentation assistance to the FAA, attended nearly all WG9 meetings. Mr. Emery provided invaluable assistance to the WG in conforming the documents attached to this report to standard FAA format.

Meeting Schedule

Post 9/11/2001 travel restrictions forced cancellation of a meeting scheduled for October 2001, and meeting attendance fell to 50-60% for Meetings 3, 4, and 5. Normal attendance level (80%) was regained by Meeting 6. The travel restrictions also resulted in the European airline Co-Chair having to vacate his Co-Chair position. When no replacement was found after numerous requests to the European airline community, the WG proceeded its work under a single US airline Chair.

Because of the delays incurred by the events of 9/11 and an extraordinary amount of time spent on developing the guidance material required by Task 9.3, several meetings were extended by 2-5 days, and two additional meetings (5 and 6) were added to the schedule.

Meetings held

1	Atlanta, GA	May 22-23, 2001
2	London, England	June 26-27, 2001
3	Atlanta, GA	Nov 13-14, 2001
4	Toulouse, France	Jan 7-11, 2002
5	Atlanta, GA	Mar 5-7, 2002
6	Orlando, FL	April 3-12, 2002
7	Frankfurt, Germany	June 17-21, 2002

The WG completed its work with the conclusion of Meeting 7.

Chapter 4

Task 9.2 - Coordination with Other ATSRAC Harmonization Working Groups

ATSRAC was tasked to develop a process for coordination between the HWGs assigned to ATSRAC tasking to ensure that each HWG remained cognizant of other HWG status and progress, and to ensure prompt sharing of information that may be pertinent to tasks being addressed by other groups.

The required coordination was achieved via assignment of former Boeing employee, Michael Nancarrow, to serve as the ATSRAC Working Group Coordinator, reporting to Kent Hollinger, ATSRAC Chair. Mr. Nancarrow assured full coordination between the Working Groups by hosting weekly teleconferences that were attended by all HWG Chairs where issues of common concern, current task status, roadblocks, new questions, etc., were communicated and discussed.

Mr. Nancarrow provided regular reports to the ATSRAC membership detailing the progress of each HWG on its respective tasks, and apprising of issues where the working groups needed additional input from the main ATSRAC committee.

Chapter 5

Task 9.3 - Develop Guidance for Enhanced Maintenance Criteria for Systems

As a result of the initial ATSRAC tasking completed in 2000, the Maintenance Criteria Working Group (Task 3) identified enhancements to existing maintenance practices and logic methods that could be applied to in-service aircraft and new designs to ensure that adequate consideration is given to potential deterioration of system installations. The target was to develop a common process for old and new designs. The outcome was identification of improved maintenance practices and an enhanced zonal analysis procedure (EZAP).

These improvements covered the following items:

- Improved definitions of General Visual Inspection (GVI) and Detailed Inspection (DET)
- Identification of the expectations of a Zonal Inspection
- Proper assessment of single element dual load path (SEDLP) devices

  Based on concurrent FAA programs already underway that address SEDLP devices, ATSRAC voted at its January 2002 meeting to extend the deadline for SEDLP guidance to December 2002. However, as discussed in Chapter 8 of this report, T9HWG was able to provide sufficient information on this subject that ATSRAC voted on July 10, 2002 to consider the task completed and no further work or update from T9HWG is required.

- Housekeeping culture issues ("Clean as you go" philosophy, coupled with protection of wiring from contamination and accidental damage)

Utilizing elements of the previous recommendations in the ATSRAC Task 3 Report, along with recommendations contained in the Intrusive Inspection Report, T9HWG has developed Draft Advisory Circular 120-XX to satisfy the requirements of Task 9.3. See Attachment 1 to this report.

A major component of the proposed enhancement of maintenance criteria for wiring systems is the EZAP logic and its application to existing and new designs by the Type Certificate (TC) and Supplemental Type Certificate (STC) Holders of air transport category aircraft. The TC Holders bear the greatest burden to apply the logic to every zone of an aircraft where wiring is installed and there is a possibility of the presence of combustible materials and/or a close proximity of wiring to primary and backup flight controls.

For STC Holders and each STC for the affected aircraft, it must be determined how and to what extent the STC affects wiring and/or EZAP relevant zone attributes. For STCs that do not sufficiently affect wiring or its proximity to primary and backup flight controls, introduce combustible materials into the zone for the first time, or affect other EZAP relevant zone attributes such as density of installed equipment, it is doubtful that presence of the STC in the zone would alter the outcome of the EZAP conducted by the TC Holder. Therefore, although each STC must be analyzed for its affect on wiring or zone attributes, it is likely that many will not require accomplishment of the full EZAP on the zone as a result of STC installation.

Further examination of the STC issue resulted in an observation that in addition to STCs, many major modifications (and zone reconfigurations) to aircraft are performed via manufacturer Service Bulletin (SB) instructions. This led T9HWG to conclude that SBs should be included in the determination if the modification has sufficiently affected zone attributes to require reapplication of EZAP to the zone with consideration of the modification present.

As a result, a logic procedure was developed that can be used for both SBs and STCs for determining if EZAP is required. The procedure provides a step-by-step process that assesses whether the modification (SB or STC) has sufficiently affected certain zone attributes that could alter the outcome of the EZAP conducted on the zone by the aircraft manufacturer (TC Holder). If the modification has not sufficiently affected the zone as to alter the outcome of the TC Holder's EZAP, no further action is required. If the modification could have affected the TC Holder's outcome, the TC Holder (for SBs) or STC Holder is required to conduct EZAP on the entire zone with consideration of the modification present.

The new logic is titled "Determination if Service Bulletin Modification or STC Requires EZAP". Explanatory text was also finalized for the logic chart. The new logic chart and explanatory text is detailed in Appendix C of Draft Wiring AC 120-XX in Attachment 1 to this report.

While the EZAP determination logic for Service Bulletins and STCs is identical, there is a significant difference between STCs and Service Bulletins in the proposed rule language that mandates the requirement to conduct the EZAP determination. This is discussed in greater detail in Chapter 8.

Attachment 1 to this report, Draft Wiring AC120-XX, provides the guidance material for enhancement of maintenance criteria for systems required by Task 9.4.

Chapter 6

Task 9.4 - Assist in Development of a Special Federal Aviation Regulation (SFAR) for Performance of the Enhanced Zonal Analysis Procedure (EZAP)

Performing the EZAP requires a thorough understanding of the wire system design and philosophy. The holders of type certificates (TC) and supplemental type certificates (STC) who install wiring are the technical experts that possess this understanding. Their assistance in performing the EZAP is crucial.

In order to obtain this assistance, the FAA plans to issue an SFAR. The proposed SFAR will apply to TC holders and STC holders who install wire bundles or significantly affect the installation of existing wiring. Under the proposed SFAR, the TC and STC holders will be required to develop an enhanced maintenance and inspection program based on the EZAP logic. The TC and STC holders will likely be required to augment the Instructions for Continued Airworthiness or maintenance instructions based on the EZAP logic.

Therefore, ATSRAC was tasked first to review pertinent recommendations of the Task 3 Report, and in particular, its "enhanced zonal analysis procedure" (EZAP). After this review, ATSRAC was to recommend the proposed contents of a rule change to require the enhancement of existing maintenance and inspection programs based on the EZAP logic. In addition to EZAP, the enhancements should also include protection and caution information for EWIS, and new training requirements for personnel who perform maintenance and other related activities on or around EWIS. The recommendation should contain appropriate timelines for aircraft type design holders to complete their application for the EZAP logic for each aircraft, and timelines for implementation of the maintenance program enhancements once they are identified.

The SFAR is specifically intended to require TC and STC Holders to apply EZAP logic to existing type designs, including those currently being produced and designs that are no longer in production. For STCs there may be some cases where the STC is no longer supported by a particular STC Holder, and the operators of the STC will be responsible to ensure such STCs are analyzed with EZAP logic.

In addition to the SFAR that requires application of the EZAP to existing designs, additional rule changes were identified to require application of the logic during the development of maintenance programs for new aircraft type designs and supplemental type designs.

Attachment 2 to this report contains the complete Draft EZAP NPRM that includes the proposed SFAR-XX and other related rules that satisfies the requirements of Task 9.4. The SFAR is the portion of the proposed rulemaking that requires TC and STC Holders

to conduct EZAP on existing designs. For ease of reference, the proposed SFAR text is provided below.

SFAR No. XX – Program to Enhance Aircraft Wiring System Maintenance

1. Applicability.

(a) This SFAR applies to:

(i) The holders of type certificates for turbine-powered transport category airplanes, provided the type certificate was issued after January 1, 1958, and the airplane has a maximum type certificated passenger capacity of 30 or more, or a maximum type certificated payload capacity of 7,500 pounds or more.

(ii) The holders of supplemental type certificates for airplanes described in paragraph (a)(i) of this section, where the STC may cause wiring to be installed, removed, altered, disturbed, subjected to contamination,

(b) If the application was filed before [Insert date 30 days after date of publication in the Federal Register], the effective date of this SFAR, and the certificate was not issued before [Insert date 30 days after date of publication in the Federal Register] this SFAR also applies to:

(i) Applicants for new type certificates for turbine-powered transport category airplanes having a maximum type certificated passenger capacity of 30 or more, or a maximum type certificated payload capacity of 7,500 pounds or more.

(ii) Applicants for amendments to an existing type certificate for airplanes described in paragraph (a)(i) of this section.

(iii) Applicants for new supplemental type certificates for airplanes described in paragraph (a)(i) of this section, that may cause wiring to be installed, removed, altered, disturbed, subjected to contamination, or may cause a change in the electrical wiring interconnection system's operating environment.

2. Compliance.

(a) No later than {insert date 24 months after the effective date of the final rule}, or within 18 months after the issuance of a certificate for which application was filed before {Insert date 30 days after date of publication of the final rule in the Federal Register}, whichever is later, each type certificate holder, or supplemental type certificate holder must accomplish the following for each Type Certificate and Supplemental Type Certificate:

(1) Perform an analytical logic procedure specifically designed to identify applicable and effective tasks that minimize accumulation of combustible materials, address wiring discrepancies, and address installations where wiring is in close proximity to both primary and backup flight controls.

(2) Communicate to FAA and operators the results of the analytical logic procedure.

(3) Update the instructions for continued airworthiness to include tasks derived from the analytical logic procedure performed in (1) above

(4) Ensure that the standard practices section of the maintenance instructions include protection and caution information to minimize contamination and accidental damage to electrical wiring interconnection systems.

(b) After {insert date 24 months after effective date of final rule}, each type certificate holder, or supplemental type certificate holder must include protection and caution information to minimize the contamination and accidental damage to electrical wiring interconnection systems in all newly created maintenance instructions, including service bulletins, where applicable.

End of SFAR portion of the proposed rule.

Chapter 7

Task 9.5 - Recommend Wire System Instructions for Continued Airworthiness

Previous recommendations from ATSRAC have shown that improper maintenance, repair, and modifications often accelerate the "aging" of wire systems. To properly maintain, repair, and modify airplane wiring, certain data must be available to the designer, engineer, and installer. This data should be part of the Instructions for Continued Airworthiness as required by § 25.1529 (*Instructions for Continued Airworthiness*). Therefore, ATSRAC is tasked to provide comment and recommendation for inclusion of the following items in Appendix H to part 25, Instructions for Continued Airworthiness:

- Standard Wire Practices data, as improved under ATSRAC TASK 7;
- Wire Separation Design Guidelines;
- Special Identification Requirements;
- Electrical Load Analysis; and
- Enhanced Zonal Analysis Procedure (EZAP)

Attachment 2 to this report, Draft EZAP NPRM, includes proposed changes to FAR 25.1529, Appendix H, *Instructions for Continued Airworthiness*, that satisfy the requirements of Task 9.5 which requires TC and STC Holders to conduct EZAP and provide other enhancements for new designs.

For ease of reference, the proposed changes to Appendix H are provided below. For this section only, shaded text indicates new proposed language and unshaded text identifies the existing rule language.

Appendix H to Part 25 -- Instructions for Continued Airworthiness

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H25.3 Content.

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(b) Maintenance instructions.

(1) Scheduling information for each part of the airplane and its engines, auxiliary power units, propellers, accessories, instruments, electrical wiring interconnection systems, and equipment that provides the recommended periods at which they should be cleaned, inspected, adjusted, tested, and lubricated, and the degree of inspection, the applicable wear tolerances, and work recommended at these periods. However, the applicant may refer to an accessory, instrument, or equipment manufacturer as the source of this information if the applicant shows that the item has an exceptionally high degree of complexity

requiring specialized maintenance techniques, test equipment, or expertise. The recommended overhaul periods and necessary cross references to the Airworthiness Limitations section of the manual must also be included. In addition, the applicant must include an inspection program that includes the frequency and extent of the inspections necessary to provide for the continued airworthiness of the airplane.

The scheduled maintenance instructions for electrical wiring interconnection systems shall be derived from an analytical logic procedure that provides a means to identify applicable and effective tasks that minimize accumulation of combustible materials, address wiring discrepancies, and address installations where wiring is in close proximity to both primary and backup flight controls. Such tasks will be uniquely identified for future traceability. The application of an analytical logic procedure requires the assumption of particular inspection standards (i.e., definition of a GVI, DET). The implementation of the tasks derived from the analytical logic procedure requires that they are performed to the same standard.

(2) Troubleshooting information describing probable malfunctions, how to recognize those malfunctions, and the remedial action for those malfunctions.

(3) Information describing the order and method of removing and replacing products and parts with any necessary precautions to be taken.

(4) Other general procedural instructions including procedures for system testing during ground running, symmetry checks, weighing and determining the center of gravity, lifting and shoring, and storage limitations.

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(5) Instructions for maintenance, alteration, or repairs must include protection and caution information designed to minimize contamination and accidental damage to electrical wiring interconnection systems.

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(h) Electrical wire interconnection system (EWIS) practices in a standard format, which includes wire separation guidelines and special wiring identification requirements

(i) Electrical load data, and instructions for updating electrical load data.

End of proposed changes to FAR Part 25, Appendix H.

Chapter 8

Key Issues and Decisions by T9HWG

T9HWG's basic task was to assist the FAA in implementation of the recommendations contained in the Task 3 Report, which included EZAP, improved maintenance practices, guidance for inspection of wiring, etc. In its deliberations to accomplish this task, several key issues were identified that required disposition by the T9HWG. This section briefly identifies the key issues and disposition.

1. ZIP as Prerequisite to EZAP

The Task 3 report recommended that all operators be required to establish a dedicated Zonal Inspection Program (ZIP) either as a prerequisite to or in conjunction with application of the EZAP. As T9HWG developed the advisory material required by Task 9.3, it was observed that lack of a dedicated ZIP simply means that all GVIs in the program would have to be stand-alone since no Zonal GVIs are available that could "take credit" for an EZAP derived GVI for wiring.

While T9HWG encourages all operators to include dedicated ZIPs in their maintenance programs, non-ZIP programs can be equally enhanced by the application of the EZAP. Therefore, T9HWG did not include ZIP as a prerequisite to EZAP in its final products.

2. Single Element Dual Load Path (SEDLP) Devices

As discussed in Chapter 5 of this report, T9HWG was tasked with making recommendations to improve the proper assessment of single element dual load path (SEDLP) devices in the development of maintenance programs. These devices typically incorporate dual load paths, one of which is usually hidden, either of which can safely carry static or flight loads should one of the load path elements be degraded or fail. The tasking is based on a concern that failure of the hidden load path in these devices may not have been adequately identified or considered in the maintenance program development analysis by the TC Holders.

Although ATSRAC voted at its January 2002 meeting to extend the deadline for SEDLP guidance to December 2002 in deference to other concurrent programs that address SEDLP devices, T9HWG was able to briefly discuss the issue with the following results:

- T9HWG believes that the current predominant maintenance program development concept, MSG3 Revision 2001.1 or 2002.1, is adequate to address these devices, and the instructional material for the analysis specifically states that the failure of each load path must be considered individually.

- If determined that the analysis performed on some SEDLP devices was sufficiently inadequate as to result in a legitimate safety concern, FAA may need to take action to force reanalysis of these devices.

  On July 10, 2002, upon review of this report, ATSRAC determined that T9HWG had provided sufficient information to enable ATSRAC to make a recommendation to FAA regarding SEDLP devices. By unanimous vote, ATSRAC considered this task complete and no further work or update by T9HWG is required.

3. Industry Definition of General Visual Inspection (GVI)

A significant element of the improvements to be made in the care and maintenance of EWIS relies on the accomplishment of GVIs by properly trained personnel. Draft Wiring AC 120-XX contains the current industry definition for GVI, which includes a required proximity (to be conducted within touching distance unless otherwise specified) and the allowance to use a mirror to gain visual access to all exposed surfaces. The guidance material for expectations for a Zonal Inspection and the EZAP inspection level selection criteria in the AC are based on this definition.

It was observed by T9HWG that not all operators have incorporated the current industry definition of GVI into their maintenance standards, and some may not allow use of a mirror in the performance of a GVI. While T9HWG encourages all operators to adopt the industry definition of GVI, it does not consider this a mandate of its ATSRAC tasking. However, T9HWG does state in the preamble portion of the Draft EZAP NPRM that the SFAR considers the definitions of GVI and DET contained in Draft Wiring AC 120-XX as the minimum standard for EWIS inspections that may be derived from the application of the analytical logic procedure. (Reference Attachment 2, Page 28).

Therefore, operators whose definition of GVI does not include “touching distance” proximity or use of a mirror should still be expected to use the current industry definition for performing GVIs derived from EZAP. It would also be inappropriate to consolidate EZAP GVIs with zonal GVIs by an operator whose definition of GVI is less restrictive than the current standard.

4. Avoidance of Reference to MSG3

Although T9HWG and most of the industry recognize MSG3 Revision 2001 (or later, which already includes the EZAP) as the predominant standard for development of maintenance programs, specific use of MSG3 it is not mandated by current rules. In an effort to ensure the products from T9HWG were universally applicable and acceptable to all segments of the international air transport industry, T9HWG avoided endorsement of a particular copy written standard in its products as much as possible.

5. FAA Field Approvals, SFAR 36 Repairs, and Operator Approved Modifications

Initial comments from FAA indicated a desire to apply EZAP to all possible modifications that could have been installed on the affected aircraft types. T9HWG questioned how far FAA wanted to go in mandating EZAP for FAA Field Approvals, SFAR 36 repairs, and operator-approved modifications, and the practicality of such a sweeping application of EZAP. This would involve the review of thousands of modification instructions to determine if the modification was significant enough to alter the outcome of EZAP accomplished on the aircraft by the TC Holder. It was widely held among T9HWG members that relatively few of these modifications would alter the outcome of EZAP as applied to the aircraft by the TC Holder, and that it would be extremely difficult for operators and the FAA to manage such a large undertaking.

T9HWG established a position on each of the issues as follows:

- **FAA Field Approvals**
  Inclusion of all modifications approved on FAA Form 337 (Field Approvals) in the requirement for EZAP will significantly increase the cost and complexity of EZAP analysis and implementation. EZAP applied by the TC Holder will, at a minimum, require a GVI of all wiring in a zone, along with other tasks to reduce the accumulation of combustible materials. Because T9HWG believes only a small number of these modifications could be expected to have altered the outcome of the TC Holders EZAP analysis, no specific rule is proposed to apply EZAP to Field Approvals.

- **SFAR 36 Repairs**
  SFAR 36 is primarily for approval of repair data (usually for structure) which is typically individual aircraft specific. Inclusion of all SFAR 36 repairs in the requirement for EZAP will increase the cost and complexity of EZAP analysis and implementation although the impact may be less than other operator approved modifications due to SFAR 36 being a relatively new rule. EZAP applied by the TC Holder will, at a minimum, require a GVI of all wiring in a zone, along with other tasks assigned to reduce the accumulation of combustible materials. Because T9HWG believes only a small number of these modifications could be expected to have altered the outcome of the TC Holders EZAP analysis, no specific rule is proposed to apply EZAP to SFAR 36 repairs.

- **Operator Approved Modifications**
  Inclusion of all operator developed and approved modifications in the requirement for EZAP will significantly increase the cost and complexity of EZAP analysis and implementation. Given the proposed effectivity of the SFAR to include aircraft produced since1958, this would involve the

review of perhaps tens of thousands of engineering documents, many of which installed modifications that have long since been replaced by other modifications. EZAP applied by the TC Holder will, at a minimum, require a GVI of all wiring in a zone, along with other tasks assigned to reduce the accumulation of combustible materials. Although it is possible that some operator modifications could have sufficiently affected wiring as to warrant application of EZAP specific to the modified zones, T9HWG believes it to be logistically impossible for both the operators and FAA to effectively manage application of EZAP to all operator modifications going back to 1958. Therefore, no specific rule is proposed to apply EZAP to operator approved modifications.

6. EZAP for Service Bulletin Modifications

As previously discussed in Chapter 5, T9HWG developed a logic procedure for TC and STC Holders for determining if a Service Bulletin Modification or STC had modified wiring or zone attributes to an extent that would require application of EZAP to the zone with consideration of the modification present. T9HWG assumes the inevitability that some existing SB modifications probably have sufficiently affected wiring and/or zone attributes that would result in the identification of new tasks if the EZAP were applied to the affected zones.

The number of SBs in existence for aircraft dating back to 1958 is unknown, but is likely to be a large number. It is also suspected that a significant number of older SBs have likely been superseded with more recent SBs. Similar to operator approved modifications, T9HWG believes it to be logistically impossible to effectively manage application of EZAP to all SBs issued for air transport aircraft since 1958. A requirement to review all existing SBs for EZAP applicability would significantly add to the cost of the proposed rule could delay its implementation. Therefore, T9HWG does not propose a rule to require review of existing SBs.

However, T9HWG does believe it necessary (and manageable) to require <u>new</u> SBs that modify aircraft to be analyzed to determine if the modification sufficiently affects wiring and/or relevant zone attributes to require application of EZAP with consideration of the SB modification present. Therefore, the Draft EZAP NPRM includes a proposed rule to require the EZAP determination for new SBs that modify aircraft. The rule is presented in the NPRM section for FAR Part 25, Airworthiness Standards, but T9HWG defers to FAA for proper placement. (Reference Attachment 2, Page 50)

7. Special Reporting of EZAP for Existing STCs

Service Bulletins and STCs use identical logic to determine if EZAP is required. However, unlike existing SBs, which are excluded from the EZAP review, T9HWG does conclude that application of the logic should be required for existing STCs. It is expected that most STCs do not sufficiently affect the zone as to alter the outcome of

the EZAP analysis applied to the aircraft by the TC Holder. This raised a concern as to how the industry could monitor compliance with EZAP for STCs where it was determined that the STC did not require EZAP, or for STCs that did require EZAP, no new tasks were identified.

This is addressed in the proposed SFAR by inclusion of a requirement for STC Holders to specifically report to FAA and industry the results of EZAP determination. Either of the following conditions must be reported:

a) It is determined that EZAP is not required for the STC
b) EZAP is required for the STC, but no new tasks are identified by application of the EZAP to the STC affected zone(s)

The reporting requirement may be satisfied via revision to the STC Instructions for Continued Airworthiness, Service Bulletin, or other means acceptable to the FAA. (Reference Attachment 2, Page 45)

8. Orphan STCs (STC Holder no longer viable)

In situations where a previously installed STC is no longer supported by a viable STC Holder (e.g., STC Holder defunct), the responsibility for determining if the STC requires EZAP, and re-application of EZAP to any affected zones, must be assigned to the individual operators who utilize the STC on their aircraft. This raised the following concerns for T9HWG:

- **Operator competence to conduct the EZAP**
  It is expected that most operators will rely on the TC and STC Holders to conduct the EZAP and communicate new EZAP derived tasks via MRB revision, ICAW revision, or Service Bulletin. To address a concern that some operators may not have the skill and experience necessary to properly conduct the EZAP for their particular orphan STCs, T9HWG included the following guidance in Draft Wiring AC 120-XX, Appendix C:

  > "In cases where the operator does not have experience in application of analytical logic processes, it will be necessary for the operator to gain competence in, or seek external assistance in conducting the analysis." (Reference Attachment 1, Page 39)

- **Operator documentation of EZAP results**
  Similar to the STC Holders, the operators will need to document the results of the EZAP application to their orphan STCs to demonstrate compliance with the rule when no new tasks were identified. Although the EZAP outcome for each operator's respective orphan STCs need not be reported to the industry, T9HWG does recommend a record of the EZAP results be permanently retained and included in the aircraft records that are normally transferred with change of

ownership or operator. This recommendation is included in Appendix C of Draft Wiring AC 120-XX. (Reference Attachment 1, Page 39)

- **Assignment of SFAR action to Operators for orphan STC review**
  The proposed SFAR that mandates the EZAP of STCs is actually a Part 21 rule. is Assigning responsibility to make the EZAP determination for existing orphan STCs to the operators of those STCs essentially causes the SFAR to also apply to operators. The Draft EZAP NPRM includes proposed rule language for Parts 91, 121, 125 and 129 that accomplishes the assignment of orphan STC responsibility to operators, but T9HWG defers to FAA as to how and where the rule should be placed. (Reference Attachment 2, Pages 53, 59, 65, & 71)

9. EZAP Implementation Cost

FAA requested that the T9HWG include in its final report a cost estimate for implementation of the proposed rules to facilitate the required economic analysis by FAA. T9HWG agrees that industry should assist FAA as much as possible in this analysis, but is concerned that a single estimate by the T9HWG may not necessarily be acceptable to the industry. This concern was presented to FAA Economist Anthony Apostolides at the January 2001 ATSRAC meeting who agreed to accept cost estimates directly from T9HWG participants as an alternative to inclusion of an estimate in this report. At least one operator has provided an EZAP implementation estimate to FAA and other T9HWG members are encouraged to do the same.

Chapter 9

EZAP Implementation

The ATSRAC Chair advised T9HWG that it was expected to include a recommended timetable for implementation of the proposed rules in its final report. After lengthy debate, and a failure by T9HWG to reach consensus on a particular implementation timetable, the ATSRAC Chair advised that if necessary, it was acceptable to include multiple recommendations for ATSRAC consideration.

One key issue in the timetable was the proposed use of aircraft age as a parameter for determining the implementation schedule for EZAP derived tasks in the major areas of concern (cockpit area, electrical equipment bays, and power-feeder wiring). Previous ATSRAC research concluded that maintenance intervention was the most likely cause of wiring degradation and damage, and age itself was not necessarily detrimental to wiring.

T9HWG concludes a direct correlation between age and maintenance intervention events that offer opportunity for damage to wiring, and therefore in the interest of simplicity, recommends using aircraft age as a factor for determining the EZAP implementation schedule.

While T9HWG could not reach consensus on a particular schedule, it did however reach consensus that if aircraft age was used as a threshold for determining the implementation schedule for EZAP derived task in the areas of concern, the threshold should not be less than 10 years, nor more than 20 years from the date the particular aircraft serial number was issued it’s first Certificate of Airworthiness.

The following implementation plans are offered for ATSRAC consideration:

SFAR and Related Rules

Timeline to conduct analysis & incorporate new tasks based on proposed rules

NLT 6 Months from date of rule:

Operators and Repair Stations:

(1) Incorporate protection and caution information into manuals (General Engineering Manual or equivalent is acceptable)

NLT 12 Months from date of rule:

Operators and Repair Stations:

(1) Implement new Wiring System Training Program

NLT 24 months from date of rule:

TC / STC Holders provide:

(1) Protection and Caution Information for existing aircraft

(2) EZAP derived ICAWs for existing aircraft

(3) TC / STC Holders begin including wiring system protection and caution information in all newly created maintenance instructions for existing aircraft, including service bulletins

Operators of orphan STCs identify:

(1) EZAP derived tasks for orphan STCs

Commencing 24 months from date of rule:

TC / STC Holders provide:

(1) EZAP derived tasks in new Service Bulletin instructions (SBs that modify aircraft)

NLT 36 Months from date of rule:

Operators incorporate:

(1) Protection and caution information into maintenance instructions

(2) New EZAP derived ICAWs into maintenance program (including orphan STC tasks)

Initial Accomplishment of EZAP tasks by Operators

20 Year Threshold

	Age of Airplane on the effective Date of the Rule (Based on First Issuance of the Certificate of Airworthiness for the Individual Airplane)	
	0-20Y	**>20Y**
Initial Accomplishment of EZAP Derived Cockpit, Electrical Equipment Bays, and Primary Power Feeder Cable Tasks	**6Y or Repeat Interval, whichever is less**	**3Y or Repeat Interval, whichever is less**
Initial Accomplishment of all other EZAP derived Tasks	**6Y or Repeat Interval, whichever is less**	**6Y or Repeat Interval, whichever is less**

Operators may adjust initial accomplishment schedule with approval of the cognizant PMI.

<u>Points in support of 20Y Threshold</u>

1. **FAA and industry already concerned with implementation cost of EZAP. 20Y threshold significantly reduces EZAP implementation cost as opposed to a 10Y threshold.**

2. **Current shortage of aircraft check hangars and maintenance providers. Threshold less than 20Y may cause parking of aircraft to wait for hangar slots.**

3. **Some operators have operated aircraft beyond 30Y successfully without EZAP.**

4. **20Y precedent set in CPCP rules**

Initial Accomplishment of EZAP tasks by Operators

10 Year Threshold

	Age of Airplane on the effective Date of the Rule (Based on First Issuance of the Certificate of Airworthiness for the Individual Airplane)	
	0-10Y	**>10Y**
Initial Accomplishment of EZAP Derived Cockpit, Electrical Equipment Bays, and Primary Power Feeder Cable Tasks	**6Y or Repeat Interval, whichever is less**	**3Y or Repeat Interval, whichever is less**
Initial Accomplishment of all other EZAP derived Tasks	**6Y or Repeat Interval, whichever is less**	**6Y or Repeat Interval, whichever is less**

Operators may adjust initial accomplishment schedule with approval of the cognizant PMI.

<u>Points in support of 10Y Threshold</u>

1. **Most aircraft experience multiple C-Checks and at least one major check (D-Check) within its first 10Y which offer sufficient cumulative opportunities for damage to wiring due to maintenance and modification activities.**

2. **In some zones, significant accumulation of harmful or combustible contamination on or adjacent to wiring can occur within 10Y.**

3. **More aircraft would be included in the accelerated accomplishment of EZAP tasks in the areas of greatest concern (Cockpit, E/E, Power-Feeders).**

4. **Older aircraft are often operated by start-up / supplemental operators who may not have maintenance experience equivalent to larger, more experienced operators.**

<u>The following implementation plan was developed by ATSRAC on July 10, 2002 upon review of this report, and is the preferred plan of ATSRAC:</u>

Initial Accomplishment of EZAP tasks by Operators

Threshold to be determined by FAA study

	Age of Airplane on the effective Date of the Rule (Based on First Issuance of the Certificate of Airworthiness for the Individual Airplane)	
	10Y or 20Y, depending on FAA economic evaluation	
Initial Accomplishment of EZAP Derived Cockpit, Electrical Equipment Bays, and Primary Power Feeder Cable Tasks	**Comply with revised maintenance program**	**3Y or Repeat Interval, whichever is less**
Initial Accomplishment of all other EZAP derived Tasks	**Comply with revised maintenance program**	**Comply with revised maintenance program**

Operators may adjust initial accomplishment schedule with approval of the cognizant PMI.

Chapter 10

Additional Recommendations to FAA

In its work to produce the products required by ATSRAC tasking, T9HWG also identified a number of issues that it believes warrant FAA attention. T9HWG asks that the FAA consider the following observations and recommendations:

1. FAR Part 25, Appendix H

Many problems were noted in the format and presentation of the existing rule language contained in Part 25, Appendix H. These include use of overly complex text, jumble of unrelated topics within same paragraphs, obsolete phraseology, and poor organization of the information.

While T9HWG is recommending new rule language that requires use of an analytical logic procedure to identify maintenance instructions for wiring systems, the balance of this section that addresses maintenance instructions on items/systems other than wiring makes no mention of using any logic procedure or process, although use of such logic is considered an industry standard practice. Further, several T9HWG members noted deficiencies in the instructions in this section regarding the proper recording of Certification Maintenance Requirement (CMRs).

> *T9HWG recommends that FAA update and simplify Part 25, Appendix H, particularly Sections H.3 and H.4.*

2. FAA Validation of New Technology / Methods for Maintenance and Inspection of EWIS

Several ATSRAC members commented that T9HWG and the FAA seem to discourage consideration of Non-Destructive Testing (NDT) and other new technologies in its recommendations for improving the maintenance of EWIS. T9HWG maintains that most EWIS related NDT methods are insufficiently mature for practical application on a scheduled maintenance basis, and FAA concedes that its does not have a standardized process for communicating the results of testing of new devices and methods. Therefore, the industry largely has to rely on supplier marketing efforts to learn of new devices and methods that the FAA has validated.

> *T9HWG recommends that FAA develop a standard means of communicating to industry the results of FAA testing of new technologies and methods, particularly those in the Non-Destructive Testing (NDT) category designed to assess wiring condition and performance.*

3. Training of Aircraft Production Personnel

The proposed rule language from T9HWG requires training of personnel who perform maintenance and related activities on or in the vicinity of EWIS components. During its deliberations, several operator members of T9HWG recounted EWIS failures, findings of improper assembly, and contamination of wiring by production debris on newly delivered aircraft. T9HWG was not tasked to recommend training of aircraft production personnel, nor was an existing rule found that addresses training requirements for personnel engaged in the assembly of aircraft.

> *T9HWG recommends that FAA require aircraft manufacturer training programs to contain EWIS training for production workers that is comparable to the training required for operator maintenance personnel.*

4. EWIS for Aviation Training Schools

T9HWG believes that the electrical and wiring portions of the training curriculum for Part 147 aviation technician schools should be updated to address EWIS as it is now defined and understood as a result of ATSRAC activities.

> *T9HWG recommends inclusion of EWIS training (similar to that required for operators) in Part 147 aviation technician school curriculums.*

End of Task 9 Final Report.