United States Department of Transportation

Federal Aviation Administration

ENHANCED AIRWORTHINESS PROGRAM FOR AIRPLANE SYSTEMS

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EXECUTIVE SUMMARY

Safety concerns about aging wiring systems in airplanes were brought to the forefront of public and governmental attention by an accident involving a Boeing Model 747-131 airplane, operated as TWA Flight 800, on July 17, 1996. That accident prompted the FAA to initiate investigations into fuel tank wiring, and to strengthen its focus on aging wiring in general. Age is not the sole cause of the wire degradation we call "aging." The probability that inadequate maintenance, contamination, improper repair, or mechanical damage has occurred to a particular wiring system will increase over time. To add to existing knowledge about aging wiring, the aging non-structural study team, already in place at the FAA, was expanded. The Aging Transport Non-Structural Systems Plan was begun.

To facilitate the completion of the Aging Transport Non-Structural Systems Plan, the FAA established a formal advisory committee in 1999 called the Aging Transport Systems Rulemaking Advisory Committee (ATSRAC). ATSRAC has gathered data about aging wiring systems and provided the FAA with recommendations on how to better manage them. ATSRAC and the FAA will now distribute this new information to every level of airplane manufacturers, operators, repair stations, and FAA (including engineers and inspectors) to ensure that the highest standards of safety are retained. Voluntary compliance will be encouraged and facilitated, but rulemaking will ensure continuing airworthiness in an aging airplane fleet.

The Enhanced Airworthiness Program for Airplane Systems (EAPAS), presented in this report, outlines the results and recommendations of many fact-finding groups and the ways in which the knowledge they have collected will be applied, both in near-term and longer-term actions.

Section 1 introduces this report. **Section 2** outlines the plan strategy. **Section 3** defines the tasks and schedules for implementing this plan, listing them under the topics of training, maintenance, design, research and development (R&D), wire reporting, information sharing and outreach, oversight, and rulemaking. At the end of this report, **Section 4** presents conclusions.

SECTION 1. INTRODUCTION

The Enhanced Airworthiness Program for Airplane Systems (EAPAS) addresses the realities of an aging transport airplane fleet. These realities include not only airworthiness safety concerns about the large number of operating airplanes now ten to thirty years old, but also about the future state of airplanes being designed and built now, which will someday be considered aged.

The current focus of this program revolves around aging wiring systems. The impetus for this was an accident involving TWA flight 800 in July of 1996. That accident brought about an investigation into fuel tank wiring, which then expanded the examination of all wiring systems and the way they age.

The failure of electrical wiring may lead to loss of function or smoke and/or fire. Wire degradation can occur with age and be accelerated by exposure to moisture, vibration and mechanical stress, and temperature variation. Over time, the possibilities increase that improper installation or repair, contamination, or inadequate maintenance has caused further exposure to these conditions. In addition, wiring assemblies that were certified safe when designed may, over the years, be transformed in their construction by rerouting or other modifications which diverge from the original safe design philosophy.

To address these issues, the efforts of many groups and agencies have been brought to bear. At the recommendation of the White House Commission on Aviation Safety and Security (WHCSS), the FAA expanded its Aging Aircraft Program to cover non-structural systems, forming an aging non-structural systems study team. This team made detailed physical evaluations of three representative aging aircraft and reported on its findings. Combining those reports with results of informational meetings with principal maintenance inspectors (PMI) and representatives of Airbus and Boeing, as well as an analysis of service histories, the FAA developed the Aging Transport Non-Structural Systems Plan.

The FAA Administrator established a formal advisory committee in 1999 to facilitate the Aging Transport Non-Structural Systems Plan. This committee, called the Aging Transport Systems Rulemaking Advisory Committee (ATSRAC), holds meetings open to the public every quarter. ATSRAC is made up of representatives of aircraft

manufacturers, transport airplane operators, user groups, aerospace and industry associations, and governmental agencies.

The Enhanced Airworthiness Program for Airplane Systems is the compilation of information gained from these groups and others, now organized into a set of near-term actions and longer-term actions, through which increased awareness of aging wiring systems and improved procedures for their inspection, maintenance, and repair, will be disseminated throughout the industry. FAA engineers, inspectors, airplane operators, and repair stations will be given enhanced information and training. Airframe manufacturers will share the lessons learned from their own service histories. Information will be shared with airworthiness certification authorities in other countries, and research will be pursued into areas that still require data. Bulletins, handbooks, and job aids will be produced to put the newest information into usable form. Voluntary compliance to ensure the highest air safety standards will be encouraged. Rulemaking will be employed in areas where clear solutions have been found and need to be applied.

Section 2 of this document, "Strategy for Implementing EAPAS Plan," describes some of the near-term and longer term-actions needed. Near-term actions will increase the "margin of safety" for aging airplanes by taking essential regulatory corrective action, promoting better maintenance procedures, increasing knowledge through training and guidance for FAA engineers and inspectors, and sharing information with industry worldwide. All near-term actions should be completed by mid-2001.

Longer-term actions will include enhanced certification standards, training and reporting requirements, continued analysis into wire malfunction, and research and development. The target date for the completion of these longer-term actions is fourth quarter of 2004. A few additional research and development programs, whose importance became clear as the original tasks were being completed, also appear on the task tables and will build on and facilitate work done in this program. These programs will continue work beyond the original task completion dates.

Section 3, "EAPAS Implementation Plan," lists the actions to be accomplished and their scheduled completion dates.

Section 4 presents conclusions.

SECTION 2. STRATEGY FOR IMPLEMENTING THE EAPAS PLAN

The Enhanced Airworthiness Program for Airplane Systems (EAPAS) is designed to enhance those existing airworthiness programs in place at every transport operator facility, repair station, and manufacturing plant by using the information obtained from reviews performed under the Aging Transport Non-Structural Systems Plan. The expectation is that airworthiness authorities and present and future transport operators, repair stations, and manufacturers can incorporate these enhancements into their certification, maintenance, training, modification, and design programs to prevent certain aging systems characteristics from occurring.

The EAPAS plan provides strategies for how the FAA and industry will work to improve the airworthiness of wire systems through near-term and longer-term actions. These actions will fulfill the objectives of the FAA Aging Transport Non-Structural Systems Plan. The actions identified in the EAPAS plan will apply the inspections, recommendations, and research of both the FAA and the Aging Transport Systems Rulemaking Advisory Committee (ATSRAC).

Certain assumptions about wire systems regarding their failure characteristics, need for maintenance, and degradation over time, have led to an assessment of a reduced safety margin for aging aircraft from that intended at the time of certification. In response, the first actions to be pursued are near term-actions that increase the safety margin to account for specific risk concerns. Raising the awareness of how wire systems fail and how they should be maintained will provide the basis for returning the margin of safety to wire systems.

As wire systems continue to age, problems may occur that are as yet undiscovered. Further, airplanes recently built and those that will be certified in the future will eventually be considered “aged.” Therefore, the EAPAS plan identifies actions that establish a higher level of safety through improved certification, maintenance, training, and reporting requirements. Through the Aging Systems Research and Development (R&D) Program, and with assistance from industry, the FAA will be

monitoring the aging of airplanes to assess the effectiveness of the longer-term strategies.

The investigations and inspections of the FAA and ATSRAC have found that the "aging" of wire systems encompasses more than the physical and chemical degradation of wire over time. It is evident that aging characteristics increase not only with time in service but with the consequent increased probability that mechanical damage, contamination, improper installation or repairs, and inadequate maintenance has occurred. Hence, actions contained in the EAPAS plan extend beyond correcting the pure aging phenomenon.

The consequence of wire systems failures can be manifested in two ways: loss of function, or resulting smoke and/or fire. Actions in the EAPAS plan will minimize the occurrences of these failure modes through improved training, standard wiring practices documentation, maintenance, and design and certification considerations.

The EAPAS plan recognizes that aging systems issues extend beyond the realm of FAA authority. The plan therefore provides actions that will promote the enhancements of EAPAS to other airworthiness authorities. One method that will be used is the encouragement of harmonization with the JAA in regard to rulemaking and associated advisory material development.

EAPAS actions have been developed to encourage voluntary compliance. By using the existing infrastructures for maintenance and training and through close communication with industry, EAPAS actions are designed to be implemented without complication. Since the objective of the EAPAS is to institutionalize an acceptable level of safety, however, voluntary compliance alone will not be relied on. As can be seen in the near-term and longer-term actions outlined in Table 1 below, mandatory requirements will be proposed in numerous rulemaking initiatives.

The EAPAS plan presently targets wire systems. Service histories indicate that priority must be placed on improving the management of wire system airworthiness. One exception to the focus on wire systems is the discussion of single-element dual-load-path (SE-DLP) flight control elements. The EAPAS plan contains actions for improving the maintenance tasks for SE-DLP flight control elements.

Maintenance tasks for mechanical systems are better established than those for wire systems. The failure modes and detection of these failure modes are also better understood. However, lessons learned regarding aging aircraft tell us that we must address the aging of mechanical systems as well. Therefore, an R&D program has been established to assess and investigate possible aging concerns associated with mechanical systems. Once the Aging Mechanical Systems R&D Program is completed, this EAPAS plan will be updated. All the actions and related completion dates of the EAPAS are contained in Section 3, the "EAPAS Implementation Plan."

An Oversight Committee consisting of top management within the Associate Administrator for Regulation and Certification (AVR), the Aircraft Certification Service (AIR), Flight Standards Service (AFS) and the Office of System Safety (ASY) will oversee the progress and completion of the EAPAS actions.

Following are discussions of only some of the near-term and longer-term strategies. For a complete listing go to Section 3, "EAPAS Implementation Plan."

Near-Term Actions

Near-term actions are those that raise the awareness of "aging" systems and/or implement basic changes to maintenance and training programs. These changes will be based on data and information that is readily available and requires little or no additional analysis. All near-term actions should be completed by mid- to late 2001.

Table 1: Near-Term Actions

1. Original equipment manufacturers (OEM) will distribute to operators a "lessons learned" document.
2. The FAA Flight Standards Service (AFS) will issue an aging systems handbook information bulletin.
3. The FAA will hold a meeting, open to the public, on this report.
4. The FAA will communicate its EAPAS Implementation Plan to airworthiness authorities worldwide.
5. AFS will propose the adoption of operations specifications (OpSpecs) for aging systems maintenance and training programs and a handbook change to explain to principal maintenance inspectors (PMI) the OpSpecs issues and subsequent rule changes.
6. The FAA will draft an EAPAS Advisory Circular (AC) for aging systems maintenance and training programs.
7. The FAA will complete a wire systems training program for Aircraft Certification Office (ACO) engineers.
8. The FAA will issue Notice of Proposed Rule (NPRM) Airworthiness Directives (AD) based on ATSRAC recommendations.
9. The FAA will publish a wire installation drawing policy letter.
10. The FAA will task ATSRAC for assistance in future rulemaking.
11. Flight Standards will develop internal guidance and an AC for service difficulty reporting (SDR) rules.

1. Airbus, Boeing, and Lockheed will communicate to operators the summary data and lessons learned from the ATSRAC programs. This will provide a basis for the operators to begin considering the types of changes necessary to the configurations of their airplanes and to their maintenance and training programs.

2. The FAA will issue a handbook information bulletin providing an overview of aging system activities and EAPAS plans to PMIs. This handbook information bulletin will identify the "lessons learned" from the ATSRAC programs, using similar industry communications as a baseline.

3. The FAA will hold a meeting in conjunction with an ATSRAC meeting on this report to raise awareness of aging systems issues and to prepare industry and the public for the changes we will implement. This meeting will be open to the public. One intent of this meeting is to communicate the FAA's focus on implementation. The meeting will include a broader representation of industry than that represented within ATSRAC.

4. The FAA will communicate this report to airworthiness authorities worldwide, such as the Joint Aviation Authority (JAA), Transport Canada Aviation, Asian-Pacific authorities, Civil Aviation Safety Authority Australia (CASA), and Central/South American authorities. The first action will be to meet with JAA senior management in Spring 2001.

5. The FAA recognizes that the sooner changes are made to maintenance and training programs, the sooner the safety margin will increase. At present, we have basic data in the form of ATA Specification 117 ("Wiring Maintenance Practices/Guidelines") and ATSRAC recommendations that can be used to make these changes. To facilitate incorporation of these basic data, the FAA will propose the adoption of OpSpecs that require operators to add an aging systems maintenance program and an aging systems training program into their systems. This is the first phase for these types of actions. To institutionalize the EAPAS, to facilitate compliance and enforcement, and to provide comprehensive actions, we will pursue rulemaking in our longer-term actions. In addition to OpSpecs, a handbook change will also be issued to describe the above actions.

The FAA will provide a draft OpSpecs page to the ATA, the Regional Airlines Association (RAA), and the National Air Carrier Association, Inc. (NACA), to get their cooperation and to request voluntary amendments to the OpSpecs, including an aging wiring maintenance program. This OpSpecs page will identify important components of the wiring maintenance program, which will be derived from the recommendations of ATSRAC.

6. To support the proposed adoption of operations specifications additions, the FAA will also draft an AC that establishes implementation guidance for an aging systems maintenance and training program, which comprises a portion of the EAPAS. This AC will be based on the latest available information (i.e., ATA Specification 117, "Wiring Maintenance Practices/Guidelines") and ATSRAC reports and recommendations, and will be drafted in coordination with industry and ATSRAC. The AC will be completed prior to rulemaking to allow for voluntary compliance by operators and repair stations. This AC may need to be updated based on the EAPAS rules developed in the longer-term actions.

7. The FAA will complete a wire systems training program for ACO engineers and designated engineering representatives (DER) in early 2001. This training will consist of interactive video teleconferencing (IVT) and an update to the FAA core training for systems engineers (Systems Job Function class). The IVT for engineers and DERs will be broadcast in two parts during the spring and early summer of 2001. The IVT for inspectors will be broadcast in Fall 2001. An internet-based job aid will also be developed by Summer 2001 and made available to FAA personnel, regulatory authorities worldwide, and industry. This training will provide information on the background that led to the aging systems program, aging systems phenomena, standard wiring practices, and techniques for certification.

8. ATSRAC has provided recommendations that may lead to issuance of model-specific ADs. The basis of these ATSRAC recommendations was a review of pertinent service bulletins, existing repetitive inspection ADs (with no terminating

action), and conclusions and recommendations from the ATSRAC's intrusive inspection program.

9. The FAA will publish a policy letter regarding necessary data to be included in wire installation drawings. This is to ensure critical installation features and promote consistency of installation. FAA on-site visits to maintenance facilities revealed a problem with the FAA's process for approving wiring installation drawings. One factor contributing to this problem is over-reliance on general practices, which leads to variability in wire system installation between airplanes of the same model. Other actions to address this problem will be contained in the longer-term actions.

10. ATSRAC has completed its initial tasking as of January 2001. ATSRAC has been retasked to assist the implementation of their recommendations that have been accepted by the FAA. New taskings have been published and accepted by ATSRAC. These tasks will provide the FAA with necessary information to prepare the rules and advisory materials that are part of the longer-term actions.

11. The FAA has revised the rules for service difficulty reporting. The new rules require additional data from manufacturers. While the rules do not contain specific elements for wiring failures, the associated Advisory Circular will contain an improved method for reporting wire problems.

Longer-Term Actions

The longer-term strategy will be to institutionalize the management of aging systems. This strategy will use an approach similar to that of the "Fuel Tank Safety Rule." Holders of Type Certificates (TC) and Supplemental Type Certificates (STC) will be required to make changes to existing Instructions for Continued Airworthiness based on the Enhanced Zonal Inspection Program (EZIP). In addition, parts 91, 121, 125, and 129 of the Federal Aviation Regulations (FAR) will be amended to include the EZIP. Improvements to certification standards and Instructions for Continued Airworthiness in part 25 of FAR will also be required. The EAPAS rules will be developed through specific tasking to ATSRAC and will consist of the following parts:

Table 2: Longer-Term Actions

Action	Comments
1. Issue a Special Federal Aviation Regulation (SFAR) for development of an Enhanced Zonal Assessment Process (EZAP).	Use ATSRAC recommendations to develop the SFAR.
2. Propose changes to update parts 91,121, 125, and 129 of FAR to add aging systems to the maintenance program.	This includes incorporating an EZAP and updating maintenance and training documentation that focuses on the airworthiness of airplane systems, including the effects of aging.
3. Develop a Phase II part 121 Advisory Circular (AC) to define an aging systems maintenance and training program.	This AC would include the recommendations from the ATSRAC Maintenance Task Group, Standard Wiring Task Group, and Training Task Group, and would consider the findings in the Non-Intrusive and Intrusive Inspection Programs.

Action	Comments
4. Change part 25 of FAR.	(a) Create a new rule that raises awareness of the design and certification of wire systems by combining all related subparagraphs (25.831, 25.869, 25.1309, 25.1353, etc.) into a single paragraph. This rule will also incorporate an integrity requirement for wire systems. Additional revision may be necessary following the outcome of the R&D program on wire separation. (b) Create an AC that addresses how to certify wire systems for this rule. (c) Update Appendix H, "Instructions for Continued Airworthiness," for specific reference to wire systems.

Other Longer-Term Strategies

- Develop a Technical Standard Order (TSO) and an AC for arc fault circuit breakers (AFCB).
- Develop a TSO for wire performance criteria.
- Update maintenance programs based on R&D results.

SECTION 3. EAPAS IMPLEMENTATION PLAN

The FAA has organized this implementation plan into seven major components:

- **Training (T)**
- **Maintenance (M)**
- **Design (D)**
- **Research and Development (R)**
- **Wire Reporting (W)**
- **Information Sharing and Outreach (I)**
- **Oversight (O)**

Note: The investigations and inspections of the FAA and ATSRAC have found that the "aging" of wire systems encompasses more than the physical and chemical degradation of wire over time. It is evident that aging characteristics increase not only with the number of years in service but with the consequent increased probability that mechanical damage, contamination, improper installation or repairs, and inadequate maintenance have occurred. Hence, actions contained in the EAPAS Implementation Plan extend beyond correcting the pure aging phenomenon.

Throughout this Implementation Plan, the term "degeneration" is used to indicate the conditions resulting from all possible stresses upon wiring systems and other systems within operating airplanes.

Training Strategy

The goal of the tasks listed in the following training schedule is to increase the knowledge and awareness of aircraft wiring design, installation, handling, maintenance, repair, and certification, especially as they relate to continued airworthiness. This goal will be accomplished by developing new interactive video teleconferencing (IVT) training materials for FAA engineers, inspectors, and designated engineering representatives (DER), by updating core job classes for engineers, and by developing an EAPAS wiring systems training web site. Operational specifications (OpSpecs) will be published to encourage and facilitate voluntary training at airlines and repair stations. Subsequent rulemaking will make such training mandatory.

Table 3: Training Schedule (T)

Goal	Strategy	Scheduled Completion	Product	Status/ Remarks
To increase the knowledge and awareness of aircraft wiring design, installation, handling, maintenance, repair, and certification, especially as they relate to continued airworthiness, among FAA engineers, inspectors, DERs, operators, repair station personnel, and others in the technical community.	**T. 1. Develop IVT and train engineers and DERs**.	**2nd Q 2001**	IVT (interactive video training)	First IVT: March 2001 – Completed; Second IVT: June 2001 – Completed; Additional IVT: December 2001

Goal	Strategy	Scheduled Completion	Product	Status/ Remarks
Training	. **T. 2. Develop and present wire systems technical and procedural training for Flight Standards Service (AFS) inspectors (includes guidance on compliance with EAPAS rulemaking). Develop IVT for AFS inspectors.**	**1st Q 2003**	Course	First IVT: September 2001
	T. 3. Update the existing FAA Systems and Propulsion Job Function classes to include wire system training for system engineers.	**2nd Q 2001**	Class module update	Completed - Modules developed
	T. 4. Develop, from the IVT training materials, an online wire systems job aid for the technical community.	**2nd Q, 2001**	Internet job aid	Complete. Available to the public. Internet site: http://www.academy.jccbi.gov/AIRDL/wiringcourse/

Goal	Strategy	Scheduled Completion	Product	Status / Remarks
Training	**T. 5. Require operators and repair stations to establish and maintain an EAPAS training program (part of EAPAS rulemaking).**	**EAPAS Final Rulemaking 4th Q 2004**	Changes to FAR, AC	
	T. 6. Issue Operational Specifications (OpSpecs) for an EAPAS training program for operators.	**3rd Q 2004 (concurrent with EAPAS final rule)**	OpSpecs	

Maintenance Strategy

The goal of the tasks in this table is to enhance airplane maintenance to better address degeneration within airplane systems. This goal will be accomplished by developing rulemaking and guidance for an Enhanced Airworthiness Program for Airplane Systems (EAPAS) maintenance program. Operational specifications (OpSpecs) will be issued, requiring operators and repair stations to establish and maintain an EAPAS wiring systems maintenance program. The FAA will work with original equipment manufacturers (OEM), operators, and Supplemental Type Certificate (STC) holders to encourage them to voluntarily include information in service data on minimizing contamination. An enhanced zonal inspection program will be incorporated into maintenance programs for the inspection of wiring systems. The "Standard Wiring Practices Manual" will be updated.

Table 4: Maintenance Schedule (M)

Goal	Strategy	Scheduled Completion	Product	Status/ Remarks
To enhance airplane maintenance to better address degeneration within airplane systems and to incorporate improved and preventative maintenance procedures.	**M. 1. Issue OpSpecs for an EAPAS wiring systems maintenance program for operators.**	**3rd Q 2004 (concurrent with EAPAS final rule)**	OpSpecs	
	M. 2. Require operators and repair stations to establish and maintain an EAPAS wiring systems maintenance program.	**4th Q 2004 (EAPAS Rulemaking)**	Changes to FAR, Advisory Circular (AC)	

Goal	Strategy	Scheduled Completion	Product	Status/ Remarks
Maintenance	**M.3. Work with OEMs, operators, and STC holders to voluntarily include information in service data on minimizing contamination.**	**3rd Q 2001**	FAA letter encouraging inclusion of cautionary notes in service bulletins (SB) and Engineering Orders.	
	M. 4. Develop enhanced zonal analysis procedure for incorporation into the enhanced maintenance program (ref. M. 3).	**4th Q 2004 (EAPAS Rulemaking)**	SFAR Rule (EAPAS Notice of Proposed Rulemaking - NPRM)	ATSRAC task
	M. 5. Update the "Standard Wiring Practices Manual."	**1st Q 2003 (EAPAS Rulemaking)**	AC for "Standard Wiring Practices Manual"	

Design Strategy

The goals of the tasks listed in the design table are to correct known deficiencies in existing airplane wiring systems and to enhance requirements and guidance for design, installation, Instructions for Continued Airworthiness, and certification of aircraft electrical wiring systems. These goals will be accomplished by issuing Airworthiness Directives (AD) to correct known deficiencies as identified by the Aging Transport Systems Rulemaking Advisory Committee (ATSRAC), by issuing policies for criteria for approving wire system installation drawings, and by developing comprehensive performance and test requirements for the design and manufacture of wires for aircraft use. Standards and guidance for design, installation, maintenance, and certification of arc fault circuit breakers will also be developed, and part 25 of the Federal Aviation Regulations (FAR) will be expanded to more specifically address wiring systems.

Table 5: Design Schedule (D)

Goal	Strategy	Scheduled Completion	Product	Status/ Remarks
• **To correct known deficiencies in existing airplane wiring systems.** • **To enhance requirements and guidance for design, installation, Instructions for Continued Airworthiness, and certification of aircraft electrical wiring systems.**	**D. 1. Issue ADs to correct known deficiencies by requiring service bulletins identified by ATSRAC.**	**4th Q 2001 (Notice of Proposed Rulemaking - NPRM June 1)**	ADs	Last NPRM will be published in September 2001
	D. 2. Issue superseding ADs requiring modifications instead of repetitive inspections, which may be causing damage to wiring and other systems.	**4th Q 2001 (NPRM June 2001)**	ADs	All NPRMs are published
	D. 3. Issue policy for criteria for approving wire system installation drawings.	Policy memo (published in Federal Register)	2nd Q 2001	Completed – Policy published in July 2 Federal Register

Goal	Strategy	Scheduled Completion	Product	Status/ Remarks
Design	**D. 4. Determine need for developing comprehensive performance and test requirements for design and manufacture of wires for aircraft use.**	**2nd Q 2003 (Under review at AAR)**	Technical Standard Order (TSO) or revision to Appendix F of Part 25, FAR.	
	D. 5. Determine corrective action, if necessary, on five A300 "Significant Items" identified during the non-intrusive wiring survey of 81 airplanes.	**4th Q 2001**	AD or memo	
	D. 6. Issue report on validation of the OEM's review and assessment of "Significant Items" on domestic airplanes identified during the ATSRAC non-intrusive survey of 81 airplanes.	**3rd Q 2001**	Memo	
	D. 7. Review, analyze, and prepare recommendations in response to "Intrusive Inspection Conclusions and Recommendations."	**3rd Q 2001**	Report and recom-mendations	
	D. 8. Determine corrective action, if necessary, on "Reportable Significant Conditions" from Intrusive Inspection Program.	**4th Q 2001**	AD or memo	

Goal	Strategy	Scheduled Completion	Product	Status/ Remarks
Design	**D. 9. Develop standards and guidance for design, installation, maintenance, and certification of arc fault circuit breakers (AFCB).**	**1st Q 2002**	TSO Advisory Circular (AC)	Society of Automotive Engineers (SAE) plans to publish Minimum Operational Performance Standards (MOPS) on December 30, 2001.
	D. 10. Develop FAA position on incorporation of AFCBs into the fleet.	**TBD**		Pending development of design criteria and maturity in product
	D. 11. Change Part 25 of FAR.	**4th Q 2004 (EAPAS Rulemaking)**	Rule change	

Research and Development (R&D) Strategy

The goal of the tasks listed in the research and development (R& D) table is to investigate problems found, devise solutions, and develop better technologies for improved performance, inspections, and safety of airplane electrical systems wiring and components. These tasks will be accomplished through a series of short-term and long-term research and development projects, including investigation into wire degradation in relation to maintenance operations and separation/segregation, development of non-destructive wiring inspection tools, analysis of circuit protection, and development of new and miniaturized versions of circuit protection devices. R & D programs will also focus on the development of safety assessment methods, performance requirements, test criteria and procedures for aircraft wire, and an overall assessment of degeneration within mechanical systems. Research projects will be evaluated, expanded, and added to if necessary as incoming data indicates.

Table 6: Research and Development Schedule (R)

Goal	Strategy	Scheduled Completion	Product	Status/ Remarks
To investigate problems found, devise solutions, and develop better technologies for improved performance, inspections, and safety of airplane electrical systems wiring and components.	**R. 1. EAPAS Project Manager (PM) provides input to Technical Community Representation Group (TCRG), which defines requirements for research to be performed by the Technical Center regarding degeneration within aircraft systems.**	**Biannual Meetings**	Updated research program descriptions (RPD)	

Goal	Strategy	Scheduled Completion	Product	Status/ Remarks
R & D	**R. 2. Perform assessment of wire degradation--Phase II (continuation of Intrusive Inspection Program).**	**2nd Q 2004**	Reports	
	R.3. Assess effects of related and unrelated maintenance tasks on aircraft wiring.	**3rd Q 2002**	Report	
	R.4. Analyze and issue report on the condition of aged circuit protection components (removed from aged aircraft) based on laboratory analysis and testing and determine failure and degeneration mechanisms.	**3rd Q 2001**	Report	
	R.5. Develop non-destructive inspection (NDI) tools for inspection of aircraft electrical wiring systems.	**One technology delivery per year starting in 2002**	Report, prototype systems	
	R.6. Develop arc fault circuit breakers (AFCB) (400Hz, 28VDC, 3 Phase, miniaturized).	**3rd Q 2004**	Report (possible ADs)	

Goal	Strategy	Scheduled Completion	Product	Status / Remarks
R & D	**R. 7. Develop advanced circuit protection devices (new generation of arc fault circuit breakers, solid state devices, etc.).**	**4th Q 2005**	Reports, prototype devices	Project will start in January 2003.
	R. 8. Validate and perform quick turnaround assessment of new technologies for wire inspection and tests as needed.	**Two technology reports per year after September 2002.**	Reports (as needed)	This program will begin in September 2002.
	R. 9. Examine safety assessment methods for identifying failure modes and probability of failure of aircraft wiring, and resulting hazards.	**3rd Q 2004**	Report with software, possible commercial standard	
	R. 10. Investigate whether current wiring practices adequately address wire separation/segregation, both physically and electrically, and identify failure mode and hazard conditions.	**3rd Q 2004**	Report (inclusion in Part 25 EAPAS Rule, or follow-on)	This task may be accelerated. If research is not completed to support EAPAS rulemaking, may need update to applicable Part 25 ACs for wire separation.
	R. 11. Investigate and develop performance requirements, test criteria and procedures for aircraft wire.	**3rd Q 2002**	Report for inclusion in TSO or Appendix F,. Part 25, FAR.	Reference Design Schedule D. 3.

Goal	Strategy	Scheduled Completion	Product	Status / Remarks
R & D	**R. 12. Determine effects of various operating conditions and time on different wire types and bundle configurations installed in newly delivered aircraft by periodic monitoring and tracking of operating conditions of sample airplanes.**	**2nd Q 2003 Ongoing**	Memorandum of Understand-ing (MOU) with industry	This monitoring program will begin in April 2003 and will be ongoing.
	R. 13. Assess overall general risk for mechanical systems. (Determine risk for degeneration characteristics and failures within the mechanical systems of transport airplanes.)	**3rd Q 2003**	Report with software, possible commercial standard	
	R. 14. Update, if necessary, the Aging Systems R&D Program based on Intrusive Inspection recommendations.	**1st Q 2001**	Updated RPD	

Wire Reporting Strategy

The goal of the tasks listed in the wire reporting table is to develop improved problem reporting to include detailed and specific information about problems in wires within all aircraft systems, and to enable trend analysis. This goal will be accomplished by updating the Joint Aircraft Systems/Components (JASC) Inspection Code to add Air Transport Association of America (ATA) Code Subchapter 97 information on wiring for service difficulty reporting (SDR), by developing tools to collect, compile, and monitor wire problem data for trend analysis, and by developing guidance for problem reporting for FAA inspectors.

Table 7: Wire Reporting Schedule (W)

Goal	Strategy	Scheduled Completion	Product	Status/ Remarks
To develop improved reporting to include detailed and specific information about problems in wires within all aircraft systems, and to enable trend analysis.	**W. 1. Develop FAA internal wire reporting and analysis system.**	**3rd Q 2001**	Wire reporting and analysis system	
	W. 2. Develop guidance for improved wire reporting.	**2d Q 2002**	Advisory Circular (AC) and handbook change, JASC update, SDR AC	
	W. 3. Review Office of System Safety (ASY) recommendations for improving wire problem reporting (Tasks 5 elements (ref. Section 4.) from FAA's Aging Transport Non-Structural Systems Plan).	**1st Q 2001**	Concurrence	Completed.

Goal	Strategy	Scheduled Completion	Product	Status/ Remarks
Wire Reporting	**W. 4. Develop automated SDR reporting system, allowing trend analysis.**	**3rd Q 2003**	Automated reporting system	

Information Sharing and Outreach Strategy

The goal of these tasks is to encourage a proactive, continuing focus on degeneration within non-structural systems on the part of regulatory agencies and the industry worldwide. This goal will be accomplished by sharing new information developed within EAPAS at meetings with the public and with aviation agencies around the world, by holding periodic workshops for principal maintenance inspectors (PMI) and engineers on issues regarding degeneration within systems, and by working with original equipment manufacturers (OEM) to distribute the "Lessons Learned" from the wire systems investigations they have performed for this program.

Table 8: Information Sharing and Outreach Schedule (I)

Goal	Strategy	Scheduled Completion	Product	Status/ Remarks
To encourage a proactive, continuing focus on degeneration within non-structural systems on the part of regulatory agencies and the industry worldwide.	**I. 1. Hold meeting open to the public on Enhanced Airworthiness Program for Airplane Systems (EAPAS) Implementation Plan.**	**2nd Q 2001 (follows ATSRAC meeting)**	Meeting, briefing, open to the public	ATSRAC meeting held in July2001
	I. 2. Communicate EAPAS plan to worldwide airworthiness authorities.	**4th Q 2001**	Website, CD ROM	Coordination is ongoing.

Goal	Strategy	Scheduled Completion	Product	Status/ Remarks
Information Sharing and Outreach	**I. 3. Hold initial and recurring periodic workshops for PMIs and engineers on certification and Continued Airworthiness (C/A) issues regarding degeneration within systems.**	**First workshop 4th Q 2001**	Workshop	
	I. 4. Work with OEMs to distribute to operators the "Lessons Learned" from the Non-Intrusive Inspection Program.	**1st Q 2001**	Telex by OEMs	Boeing, Airbus, and Lockheed distribution completed.
	I. 5. Communicate with PMIs by Flight Standards Information Bulletin (FSIB), highlighting ATSRAC Maintenance Group recommendations and Air Transport Association of America (ATA) Spec 117.	**1st Q 2002**	New FSIB linked to EAPAS AC	
	I. 6. Communicate with industry regarding proposed EAPAS OpSpecs for "voluntary compliance."	**4th Q 2001**	AFS Letter, briefings to industry proposing draft OpSpecs	

Oversight Strategy

The goal of the tasks listed in this oversight table is to provide the necessary support, resources, and budget to the Enhanced Airworthiness Program for Airplane Systems (EAPAS) to meet commitments, to ensure that EAPAs has priority, and to see that its schedule is adhered to. This will be accomplished by the Oversight Committee as its mandate, outlined in its charter.

Table 9: Oversight Committee Schedule (O)

Goal	Strategy	Scheduled Completion	Product	Status/ Remarks
To provide the necessary support, resources, and budget to the EAPAS to meet commitments, to ensure that EAPAS has priority, and to see that its schedule is adhered to.	**O. 1. Organize Oversight Committee.**	**2nd Q 2001**	Charter	completed
	O. 2. Approve EAPAS Implementation Plan.	**2nd Q 2001**	Approved EAPAS Implementation Plan	Completed

SECTION 4. CONCLUSIONS

The Enhanced Airworthiness Program for Airplane Systems (EAPAS) outlines how the tasks of the Aging Transport Non-Structural Systems Plan are being brought to completion.

The seven tasks identified by the Aging Transport Non-Structural Systems Plan are the following:

1. **Establish an Aging Transport Systems Oversight Committee to coordinate the various aging systems initiatives within the FAA.**

2. **Conduct an in-depth review of the aging transport fleet and make model-specific safety recommendations related to airplane systems.**

3. **Enhance airplane maintenance to better address aging airplane systems.**

4. **Add aging systems tasks to the aging airplane research program.**

5. **Improve reporting of accident/incident and maintenance actions involving wiring system components.**

6. **Evaluate the need for additional maintenance of transport airplane fuel system wiring and address any unsafe conditions.**

7. **Improve wiring installation drawings and Instructions for Continued Airworthiness**.

Assigned under the categories of training, maintenance, design, research and development, wire reporting, information sharing and outreach, and oversight, these tasks have now all been addressed. They have either been completed or are scheduled for completion, depending on whether they are near-term or longer-term actions. As a result of new data gained from some of these completed tasks, current inquiries may be broadened and additional venues for information sharing planned.

Because the latest aging wiring data is important to all operators, manufacturers, and repair stations, not just those within U.S. jurisdiction, meetings are planned at which information will be shared with airworthiness authorities worldwide. The Oversight Committee, as described in **Task 1**, will facilitate the completion of all these tasks and will conduct quarterly meetings at which the progress of each program will be updated.

In response to **Task 2**, an in-depth review has been conducted on representative models of aging airplanes, comprised of detailed visual inspections and extensive intrusive physical examinations. Much information was gathered and still more questions were raised. The non-intrusive survey found 3,372 wiring discrepancies within 81 airplanes and identified 182 of those for further review and possible corrective action.

New recommendations for maintenance and inspection practices came from the study and will be incorporated into training and information sharing to meet the goals of **Task 3**.

The intrusive study analyzed four different wiring types on six decommissioned airplanes and results were analyzed for wire type and service history in relation to aging characteristics. Degradation findings were organized in terms of their severity in plausible, hypothetical conditions, and categorized in terms of the types of conditions and how different environments might increase the risk of each type. This inspection also considered the relative accuracy of visual vs. intrusive inspections and did find that, though visual inspection is clearly not sufficient in some high-risk situations, there can be more correlation between what can be surmised from a visual inspection and what is eventually found with a physical one than might have been expected.

As a result of new information, operators and repair stations will be required to institute an aging systems training program for their inspectors. Engineers, manufacturing inspectors, flight standards inspectors, and designees will receive training not only in aging wiring systems, but also in how to monitor an aging system maintenance and training program at operator facilities and repair stations.

The Maintenance Task Group clarified definitions and expectations of general visual inspections, made recommendations to minimize contamination and accidental damage to wiring, and developed guidelines to ensure identification of appropriate Instructions for Continued Airworthiness of single-element dual-load-path design features in flight controls. That task group also developed logic to enhance existing maintenance programs for

inclusion in the Maintenance Steering Group (MSG) guidelines, and new logic called the Enhanced Zonal Analysis Procedure.

The intrusive inspection also became the impetus for continued research into the assessment of wire degradation, the effects of related and unrelated maintenance operations on aircraft wiring, circuit protection components, wire separation/segregation, the long-term effects of structural anti-corrosion products on wiring, and the effects of mixed wire types. All of these research programs follow the goals of **Task 4**.

The Training Task Group has developed a curriculum and lesson plans to address inspection and repair of aging wiring system components that are intended to be incorporated into manufacturers', operators', and repair stations' training programs. To add to the store of knowledge about aging wiring systems, the Advisory Circular (AC) for the new service difficulty reporting (SDR) rule will be updated to include voluntary reporting of airworthiness concerns due to wire system malfunctions and an aging systems databank will be developed to meet the goals of **Task 5**.

Task 6, the evaluation of fuel system wiring, was the original fact-finding action initiated by the Flight 800 accident in 1996. That task was completed by the Fuel Tank Safety Team in 1998. The FAA has issued either final rule Airworthiness Directives (AD) or Notices of Proposed Rulemaking (NPRM) to address those unsafe conditions that were identified. The FAA has also issued a Special Federal Aviation Requirement (SFAR) addressing fuel system wiring design and maintenance practices.

ADs addressing repetitive inspections of wiring systems have been examined, and three were identified for mandating wire replacement rather than repetitive checks. The notice of proposed rulemaking (NPRM) actions for these ADs have been issued. Over 700 service documents on airplane wiring were examined, and 69 were found to contain information that will be more broadly shared, or perhaps become mandatory.

The Aircraft Certification Service has developed an interactive video training tool (IVT) on wire systems for Aircraft Certification Office engineers and designated engineering representatives (DER) which addresses aging wiring systems and define best practices for wire installation. This training is also organized in a Job Aid format and placed on the internet to be accessible and provide the information to all technical communities. The internet site for this Job Aid is http://www.academy.jccbi.gov/AIRDL/wiringcourse/. To

facilitate the inspection of completed wiring systems, and the requirements of **Task 7**, a policy memo was published in July 2001 identifying data that a wire system installation drawing must contain in order to be approved by the FAA. To reduce one possible source of wire system degradation, original equipment manufacturers will develop guidelines for pressure washing.

Although much has been accomplished, and significant new milestones will be achieved within the next few years, the subject of aging wiring systems airworthiness will no doubt continue to evolve as planned study, research, and analysis increases our knowledge of all the complex factors involved.