Before the Subcommittee on Oversight, Investigations, and Emergency Management Committee on Transportation and Infrastructure, U.S. House of Representatives

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Observations on FAA and Industry Efforts to Address Concerns about Aircraft Wiring

Statement of
Alexis M. Stefani
Assistant Inspector General for Auditing
U.S. Department of Transportation

Madam Chair and Members of the Subcommittee:

We appreciate the opportunity to discuss the Federal Aviation Administration's (FAA) efforts to address concerns about the safety of non-structural aircraft systems. Non-structural systems on aircraft include electrical systems, hydraulic and fuel lines, and mechanical systems. At the request of this Subcommittee and the House Committee on Science, we are examining FAA's aircraft safety research efforts on non-structural aircraft systems with respect to cost and schedule, and will report on these results later this year.

The U.S. aviation system is remarkably safe. The Nation's impressive safety record is a product of close cooperation among the FAA, airlines, aircraft manufacturers, and other members of the aviation community. Yet, recent accidents and incidents, most notably TWA Flight 800 and Swissair Flight 111, have heightened concerns about the safety of non-structural aircraft systems, such as wiring.

Since these accidents, Government and industry have taken a number of actions. FAA has issued over 40 Airworthiness Directives on wiring for large commercial aircraft to correct problems and enhance inspection procedures. FAA and industry have also conducted inspections of in-service aircraft that are 20 years old or more to assess the condition of the U.S. transport fleet with respect to wiring and identify areas of concern. In addition, the White House created a new interagency working group to coordinate research on the safety of aging wiring in aircraft, space shuttles, and nuclear power plants.

Today, I would like to make three points on areas where FAA can enhance its safety efforts regarding non-structural aircraft systems.

- First, the safety of non-structural aircraft systems is a complex issue. Solutions focus on more than just research and development and involve various segments of FAA and the aviation industry. A multi-faceted approach is needed to address this important safety issue. FAA needs to now focus its efforts not just on data gathering but also on implementation.

  The National Transportation Safety Board's findings related to wiring on TWA Flight 800 and joint Government/industry inspections of older aircraft underscore the need for action by various parties. The findings show the need for (1) improved maintenance practices, (2) better training for maintenance personnel and FAA inspectors, and (3) new technologies for detecting and preventing problems with aircraft wiring.

FAA is moving in the right direction, but it is uncertain when revised maintenance programs, new training programs, and especially new technology can be implemented. These changes will affect a wide range of key workforces, including FAA inspectors and certification staff as well as airline and repair station personnel (both domestic and international).

It is not too soon for FAA to develop an overall implementation strategy to guide Government and industry efforts currently underway. This would also help set expectations for Congress, FAA, and the aviation community about what can be done (through rulemaking action or other initiatives) in the near- and far-term on this important safety issue.

- Second, FAA spends about $40 million annually on aircraft safety research to prevent accidents and make them more survivable. The largest single line of effort focuses on aging aircraft ($22 million requested for fiscal year 2001). However, FAA spends the bulk of its aging aircraft research funds on methods to predict and detect fatigue cracking and corrosion of aircraft structures. *In fiscal year 2000, FAA spent about $1.3 million, or 6 percent of the agency's research and development funds for aging aircraft, on non-structural systems.*

  FAA is currently funding two efforts (approximately $1 million over 5 years) to address problems with aircraft wiring that are worth highlighting. First, FAA is working with the Air Force to evaluate a new wire inspection system that has proven useful for analyzing wire on combat aircraft such as the F-16. Second, FAA is working with the Navy to develop an arc fault circuit breaker. An arc fault circuit breaker works much like a conventional circuit breaker except that it has the added capability to shut down a circuit when it detects an arc fault[1] caused by a breach in the wire's insulation. Initial efforts are expected to be complete within 1 to 3 years.

  For future years, FAA has increased its budget requests for non-structural research on electrical (wiring) and mechanical aircraft systems. FAA requested $4.8 million for fiscal year 2001 and $5 million annually through fiscal year 2004. In March 2000, we reported that FAA needed to determine the appropriate mix of structural and non-structural research. This has not yet been done, and it may change future budget requests. Further, FAA has not definitized milestones for planned non-structural projects. For example, FAA has not determined milestones for the evaluation of aircraft mechanical systems.

[1] When wire insulation has been damaged, and an opening in the insulation occurs, the current can jump or "arc" from the wire to another metal object such as another wire.

To leverage its research funds, FAA must continue to take advantage of research and development conducted by other Federal agencies, academia, and the private sector. The White House initiative to coordinate wiring research Government-wide is an important step in this process. Close cooperation between FAA, the Navy, and industry with respect to arc fault detectors could aid the implementation of this new technology in commercial aircraft.

- Finally, to be proactive in preventing accidents, FAA needs reliable information on non-structural safety problems to assess the overall health of the U.S. transport fleet. However, current reporting systems are not geared toward reporting problems with wiring.

  Airlines and repair stations must report failures, malfunctions, and aircraft defects (including aircraft engines and other systems) to FAA through Service Difficulty Reports, or "SDRs." The purpose of the SDR system is to provide FAA with the data necessary for planning and directing safety-related programs.

  FAA's attempts to analyze SDRs for problems with aircraft wiring met with little success. A meaningful analysis could not be performed because coding to specifically identify wiring problems is not available. For example, industry officials told us that electrical problems with a hydraulic pump would be classified and reported for SDR purposes as a problem with the pump, not wiring.

  Today, FAA has a final rulemaking in process to change the SDR system. Despite numerous calls for improvement, there is some confusion as to whether or not revisions to the SDR system will improve reporting of wiring problems. Key issues that need to be resolved focus on how wiring data will be characterized (and coded) in the SDR system and providing the necessary resources for improving the overall health of the SDR system. FAA must resolve these issues to ensure that the revised SDR system will collect sufficient details on wiring so the agency can identify problems and implement solutions before those problems result in incidents and accidents.

The Safety of Non-Structural Aircraft Systems Is an Important Safety Issue

The TWA Flight 800 and Swissair Flight 111 accidents have led to heightened concerns about the safety of non-structural aircraft systems, including wiring. Since these accidents, FAA has issued over 40 Airworthiness Directives focusing on wiring and 18 for aircraft fuel systems to correct problems or change inspection procedures. FAA issues Airworthiness Directives to correct unsafe conditions with aircraft or aircraft components. FAA has also embarked on new research initiatives, and has worked with industry to assess older aircraft for non-structural problems.

Since the Subcommittee held its last hearing on aircraft wiring, a joint Government/Industry Task Force has completed non-intrusive (or visual) inspections of wiring in 81 in-service aircraft that are 20 years old or more, such as the DC-9, Boeing 727, and Airbus A300.[2] The purposes of the inspections were to assess the condition of U.S. transport fleet with respect to wiring and identify areas of concern. Inspections relied principally on visual examinations because handling wire bundles (and related systems) could inadvertently cause damage.

This Task Force reports to the Aging Transport System Rulemaking Advisory Committee, established by the FAA Administrator in 1998 to provide rulemaking advice and recommendations to the agency. Other task force efforts (on maintenance practices and training) should be completed before the end of the year.

In its August 2000 report, the Task Force identified over 180 concerns that may require design changes, enhanced inspection procedures, or more frequent inspections. Many of the noted problems involved improper clamping and routing of wire. The Task Force also found instances of cracked and abraded insulation, exposed conductors, and problems with previous repairs.

The majority of discrepancies with wire were found in areas of frequent maintenance activity where wiring was unprotected from debris and fluid contamination. Senior FAA officials told us that these inspections will likely generate several Airworthiness Directives.

FAA and industry have also conducted more in-depth inspections of aircraft and have removed wire for testing. The purpose of these inspections was to assess the actual condition of wire through physical examination and laboratory analysis. As of July 2000, a working group completed inspections of six older aircraft recently retired from revenue service (an Airbus A300, two DC-9s, a DC-10, an L-1011, and a Boeing 747). FAA's preliminary results indicate over 400 findings, 4 of which were deemed worthy of being brought to the attention of the manufacturer. For example, on a Boeing 747, a power feeder cable was worn through to the conductor. A final report on these inspections is expected to be completed later this month.

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[2] See Aging Systems Task Force: Aging Transport Systems Task 1 and Task 2 Final Report (August 1, 2000).

Recognizing the importance of the issue, the White House created a new interagency Wire Safety Working Group this past summer to coordinate research on the safety of aging wiring in aircraft, space shuttles, and nuclear power plants. The goal of this working group is to benchmark agency efforts to optimize Federal research leading to a national strategy for wire system safety. A report is planned for later this year.

It is important to note that concerns about the safety of non-structural systems extend beyond the traditional "aging aircraft" (such as the Boeing 737) to other aircraft in the U.S. transport fleet. For example, aircraft such as the Boeing 757 and 767 have been in service for 15 years. These aircraft include substantially more electronic equipment and wiring than their predecessors did. For example, a Boeing 767 has over 88 miles of wire compared to a Boeing 737 that has 26 miles of wire. The following table shows the age of select U.S. manufactured aircraft and the number in the worldwide fleet (as of August 2000).

Aircraft Model		**Number in World-Wide Fleet**	**Average Age (in years)**
Boeing	727	1,153	26.1
Boeing	737 (CFMI)	1,951	8.8
	737 (JT8D)	843	21.5
	737 (NEXGEN)	628	1.3
Boeing	757	928	8.1
Boeing	767	785	9.0
Boeing	DC-9	664	29.1
Boeing	DC-10	327	22.4
Boeing	MD-11	185	6.6
Boeing	MD-80	1,151	11.8

Source: Airclaims

At its August meeting on TWA Flight 800, the National Transportation Safety Board cautioned that until recently, insufficient attention has been paid to the condition of aircraft electrical wiring, which resulted in potential safety hazards. This past July, the Safety Board recommended, among other things, that FAA review the design specifications for aircraft wiring systems, identify which systems are critical for safety, and ensure that safety-critical systems are properly safeguarded.

There are no simple answers for addressing non-structural concerns—a multi-faceted approach is needed. The Safety Board's findings—and the recently completed joint Government/industry inspections of older aircraft—show the need for a number of changes. These changes focus on (1) improved maintenance practices, (2) better training for maintenance personnel and FAA inspectors, and (3) new technologies for detecting and preventing problems with aircraft wiring. FAA and industry officials we spoke with recognize that these changes are needed.

Generally speaking, FAA is moving in the right direction. The 1998 Aging Transport Non-Structural Systems Plan, which outlines Government and industry efforts, and the results of various work groups serve as excellent starting points to determine next steps. However, it is uncertain when revised maintenance programs, new training programs, and new technology can be implemented. These changes will affect a wide range of key workforces, including FAA inspectors and certification staff as well as airline and repair station personnel (both domestic and international).

Our work on other safety issues, such as runway incursions, shows the need for a clear strategy to coordinate improvements (in terms of new technology and improved training) that cut across Government and industry workforces. FAA needs to develop such an implementation strategy to articulate what can be done (through rulemaking action or other initiatives) in the near- and far-term on this important safety issue.

The Safety Board's work and inspections of older aircraft also underscore the need for continued, focused research and development effort on non-structural systems. This is important not only to develop new inspection technologies but also to identify problems before they result in incidents and accidents.

FAA's Aircraft Safety Research Program and Efforts to Address Non-Structural Aircraft Issues

FAA's Aircraft Safety Research Program focuses on preventing accidents and making them more survivable. FAA's research programs are expected to play a critical role in developing and validating the technologies, designs, and procedures necessary to achieve FAA's goal of reducing the U.S. aviation fatal accident rate by 80 percent by 2007.

FAA invests about $40 million annually in aircraft safety research. FAA requested $49.4 million in fiscal year 2001 for aircraft safety Research, Engineering, and Development (RE&D)—an increase of $4.9 million over last year's level. (An attachment to our statement provides funding information on FAA's Aircraft Safety Research Program by major line of effort.)

The largest single effort in FAA's aircraft safety research portfolio focuses on aging aircraft ($22 million requested for fiscal year 2001). Following the Aloha Airlines incident in 1988 in which a Boeing 737 suffered structural failure of the fuselage due to corrosion and disbonding, FAA took a number of regulatory actions and developed the National Aging Aircraft Research Program.

Over 3 years ago in February 1997, the White House Commission on Aviation Safety and Security recommended that FAA expand its aging aircraft research program to include non-structural systems. After a late start, FAA's aging aircraft research program began to evolve in 1999 from only looking at structural items, such as aircraft skins, to also covering non-structural systems, such as wiring and mechanical systems.

FAA continues to spend the bulk of its aging aircraft research funds on methods to predict and detect fatigue cracking and corrosion of aircraft structures. This past year, FAA spent about $1.3 million, or 6 percent of the agency's research and development funds for aging aircraft, on non-structural components.

FAA is funding two efforts that will detect and prevent problems with aircraft wiring that are worth highlighting.

- FAA is working with the Air Force to evaluate the Eclypse automated wire test system. FAA will contribute about $200,000 (total for fiscal years 1999 to 2004) to this effort. The Eclypse wire test system has proven useful in analyzing wire on combat aircraft like the F-16.

  The U.S. military is Eclypse's largest customer, but the system could be used on commercial aircraft as well. FAA is conducting a field evaluation of the system at FAA's Aging Aircraft Validation Center at Sandia National Laboratories for civil applications. The system assesses the condition of wiring by detecting variances in current flow in particular wires. Officials from United Airlines told us they have ordered two Eclypse systems but have not yet taken delivery of them.

- FAA is also working with the Navy to develop an arc fault circuit breaker. FAA will contribute a little over $800,000 (total for fiscal years 1999 to 2002) for this effort. An arc fault circuit breaker works much like a conventional circuit breaker except that it has the added capability to shut down a circuit when it detects an arc fault caused by a breach in the wire insulation. According to FAA, a large commercial aircraft would require up to several hundred of these devices.

> FAA and the Navy are funding two contracts for development of an arc fault circuit breaker that could replace one type of conventional circuit breaker found primarily on military aircraft. It is uncertain how many aircraft types in the U.S. transport fleet could benefit from this technology. Initial steps are expected to be complete in 1 to 3 years but research is needed to miniaturize remaining circuit breakers. Senior FAA officials told us that once development is complete and the new arc fault circuit breakers are proven to be reliable, they must be certified by FAA for industry use.

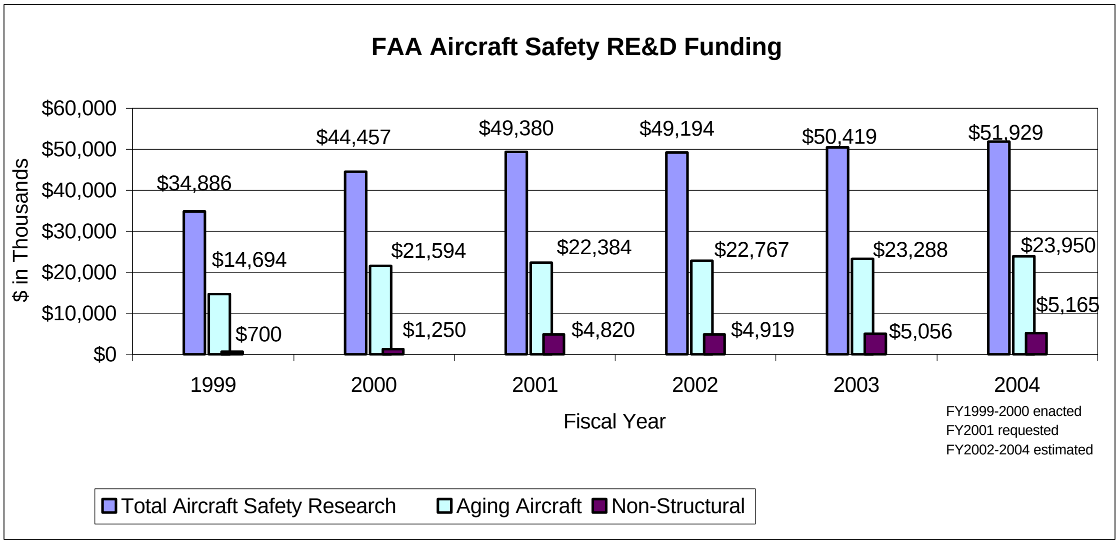
In addition to FAA's efforts, the Boeing Company is conducting its own research on arc fault circuit breakers. Boeing plans to develop a direct circuit breaker replacement package for non-flight-critical cabin systems that will fit approximately 80 percent of the existing panel installations.

Boeing expects to begin flight testing prototype arc fault circuit breakers in current-production 717 and 737 aircraft shortly and have production hardware by the 3rd quarter of 2001. In a follow-on effort, Boeing will focus on developing a "full family" of arc fault circuit breakers including protection for fuel and fuel vapor areas. Boeing hopes to bring this "full family" of arc fault circuit breakers up to production quality standards by the 2nd quarter of 2002.

FAA has estimated it needs $4.8 million for electrical and mechanical research in fiscal year 2001, and the agency plans to spend an average of $5 million annually through 2004 on these efforts. About two-thirds of the funds will be spent on wiring research. As we noted earlier this year,[3] FAA needs to determine the appropriate mix of structural and non-structural research.

The following chart reflects FAA's past and future funding trends for aging aircraft research (with a breakout showing funds for non-structural) compared to FAA's total aircraft safety research funding for fiscal years 1999 through 2004.

[3] See Improving Aviation Safety, Efficiency, and Security: FAA's Fiscal Year 2001 Request for Research, Engineering, and Development (Report Number AV-2000-054).



Source: FAA

Work on a wider range of non-structural issues is scheduled to begin in fiscal year 2001. However, plans for future non-structural research have not been definitized and milestones have not been firmly established. For example, FAA is planning to conduct assessments of maintenance practices for aging mechanical systems but has not set starting or reporting timeframes.

Given tight Federal research budgets, FAA must take full advantage of research and development conducted by other Federal agencies, academia, and the private sector. The White House's recent initiative to coordinate FAA, Department of Defense, and the National Aeronautics and Space Administration efforts on wiring research is an important step.

Government and industry efforts for new technologies need to be closely coordinated to facilitate the approval of new systems for industry use and speed the implementation of new technologies for detecting and preventing problems with aircraft wiring. This is particularly important because FAA, the Navy, and Boeing are pursuing arc fault circuit breakers.

Also, FAA has opportunities to speed the introduction of new technologies and new inspection methods. FAA has purchased a retired Boeing 747 for its laboratory at Sandia National Laboratories. This will allow FAA to test and baseline new inspection systems for detecting problems with wiring. This is an important resource for current and future Government and industry initiatives.

Reporting of Wiring Problems Needs to Be Improved

FAA and industry are working to get a better understanding of the severity of non-structural aircraft problems and the actions necessary to prevent future incidents and accidents. The key to being proactive and data driven in preventing accidents is having reliable information to assess the overall health of the U.S. transport fleet.

There is almost universal agreement that reporting for aircraft non-structural problems (principally wiring) must be improved. While FAA has used incident and accident data to shape the direction of agency efforts with respect to aircraft wiring, its efforts have been frustrated by a lack of a source of in-service and maintenance information needed to identify trends.

Airlines and repair stations must report failures, malfunctions, and defects (including aircraft engines and other systems) to FAA through Service Difficulty Reports, or "SDRs." The purpose of the SDR system is to provide FAA with the data necessary for planning and directing safety-related programs.

However, FAA's attempts to analyze SDRs for problems with aircraft wiring met with little success. A meaningful analysis could not be performed because coding to specifically identify wiring problems is not available. For example, industry officials told us that electrical problems with a hydraulic pump would be classified (and reported) for SDR purposes as a problem with the pump, not as a problem with wiring even though the root cause was wire-related. Similarly, FAA's inspection systems are not helpful because, according to FAA officials, these systems are not geared toward wiring.

FAA recognizes that a void exists, and it has a rulemaking initiative underway to enhance reporting of aircraft problems through the SDR system. The goal of this rulemaking, which has been underway for at least 5 years, is to get more detailed and accurate information on aircraft problems so that better trend analysis can be done.

However, revamping the SDR system has been controversial with industry, and confusion exists—within industry and FAA—regarding whether or not revisions will improve how wiring problems are reported. Two key issues need to be resolved. First, decisions need to be made about how wiring data will be characterized (and coded) in the SDR system—as a primary or secondary cause. Based on these decisions, FAA must issue guidance to airlines and repair stations that clarifies what specifically should be reported and the level of detail required. Second, the overall health of the SDR system is a concern. FAA officials told us that a lack of resources has limited the effectiveness of the SDR system. FAA must resolve these issues to ensure that the revised SDR system will collect sufficient details on wiring so the agency can identify problems before they result in incidents and accidents.

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Madam Chair and Members of the Subcommittee, I would be pleased to answer any questions you might have.

Attachment

FAA's Past and Planned Investments in
Aircraft Safety Research
(Dollars in thousands)

Research Program	**FY 1999 Appropriated**	**FY 2000 Appropriated**	**FY 2001 Request**
Aviation Safety Risk Analysis	**$ 6,471**	**$ 6,824**	**$ 6,657**
Fire Safety	**4,750**	**4,750**	**5,451**
Advanced Materials/Structural Safety	**1,734**	**2,338**	**2,797**
Propulsion Systems Research	**2,831**	**3,126**	**5,200**
Flight Safety/Atmospheric Hazards	**2,619**	**3,844**	**4,109**
Aging Aircraft			
Structural	13,994	20,344	17,564
Non-structural	700	1,250	4,820
(Sub-total)	**14,694**	**21,594**	**22,384**
Aircraft Catastrophic Failure Prevention	**1,787**	**1,981**	**2,782**
Totals	**$34,886**	**$44,457**	**$49,380**

Source: FAA