ADVANCED AIRCRAFT TECHNOLOGY AND FEDERAL AVIATION ADMINISTRATION AIRCRAFT CERTIFICATION

(103-38)

IG

BEFORE THE

SUBCOMMITTEE ON AVIATION

OF THE

COMMITTEE ON

PUBLIC WORKS AND TRANSPORTATION

HOUSE OF REPRESENTATIVES

ONE HUNDRED THIRD CONGRESS

FIRST SESSION

OCTOBER 20, 1993

Printed for the use of the
Committee on Public Works and Transportation

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U.S. House of Representatives

COMMITTEE ON PUBLIC WORKS AND TRANSPORTATION

SUITE 2165 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515
(202) 225-4472

MEMORANDUM

TO: Members of the Subcommittee on Aviation

FROM: Committee's Aviation Staff

DATE: October 19, 1993

RE: **SUMMARY OF SUBJECT MATTER** for Aviation Subcommittee hearing on **ADVANCED AIRCRAFT TECHNOLOGY AND FEDERAL AVIATION ADMINISTRATION AIRCRAFT CERTIFICATION**, October 20, 1993.

The Subcommittee on Aviation will receive testimony on anticipated advances and developments in aircraft technology over the next 10-15 years and the Federal Aviation Administration's role and approach to aircraft certification in light of these advances. The U.S. General Accounting Office (GAO) issued a report in September. (New FAA Approach Needed to Meet Challenges of Advanced Technology- GAO/RCED-93-155), and the Subcommittee will also receive testimony on GAO's findings and recommendations.

This summary will provide an overview of new technologies expected to be incorporated into civil aircraft in the near term and the longer term; a description of the government's research and development programs related to these new technologies; a description of the process by which the FAA certificates aircraft; and a summary of the GAO's report and the FAA's response to it.

I. NEW AIRCRAFT TECHNOLOGY

This section provides brief descriptions of anticipated technological advances in civil aviation over the next 10-15 years.

o New Design and Certification Approaches

The Boeing 777 presents a new approach to design and certification that will likely become a precedent for how future aircraft are designed and certified. This aircraft will be first delivered in early 1995. Assembly of the initial units is underway, and the first test flight will come next year. Approximately 200 aircraft have been ordered so far. It will carry 375-400 passengers in transoceanic markets.

The 777 has been almost totally designed with computer software and computerized displays of parts, components, and sections of the aircraft, down to individual rivets and screws. Previous aircraft have been largely developed through the use of mock-ups and prototypes. For the 777, there is no mock-up, prototype, or assembly step between the computerized design and the first aircraft built. It is expected that all future aircraft will be designed in this fashion because of the cost savings and improved design.

While this aircraft will incorporate a number of new technologies, the principal issue raised by this aircraft is whether it should be certified for extended range operations substantially on the basis of laboratory simulation. With the advent of large twin engine aircraft, the FAA has developed a process to approve flights over water up to three hours away from an airport. Without this process, only flights of up to one hour from an airport are permitted. The process requires an operator to make modifications to the engines; demonstrate very high engine reliability rates, incorporate specialized pilot training; and have a maintenance program that takes account of extended range operational requirements.

To date, operators have had to demonstrate a history of performance before getting approval for extended over-water operations. It has typically taken a year or two to accumulate the requisite amount of engine hours needed to demonstrate an acceptable level of reliability. In designing the 777, Boeing wants to have the aircraft certified for extended range operations from day one, without being required to demonstrate a history of performance after the aircraft is in service.

To accomplish this, Boeing proposes to incorporate into the original design, the type of aircraft modifications that would be expected in an approval of extended operations. To validate these designs, Boeing further proposes to conduct tests in a laboratory of the key aircraft components on the ground in simulated flight regimes. This is a new approach to certification, in that it is assumed that operations can be simulated accurately enough to assure safety. The FAA has not yet certified the 777 for extended range operations, but has told Boeing that conceptually certification in this way is achievable. If the 777 is approved for extended range operations, future aircraft designs are expected to increasingly rely on laboratory simulations and modeling to be certified.

- Fly-By-Wire/Fly-By-Light

  Fly-by-wire refers to a technology already in place in some aircraft (Airbus 320, 330, and 340, and Boeing 777 in the near future). Fly-by-wire refers to using electrical signals controlled by computer technology to make changes in the aircraft's control surfaces and propulsion. Fly-by-wire is an advance because it replaces heavy hydraulic lines. 'Fly-by-light' would replace fly-by-wire with even lighter weight fiber optic systems which would not be susceptible to the electromagnetic interference sometimes occurring in fly-by-wire systems.

- New Materials and Composites

  New non-metal materials are increasingly being used in civil transport aircraft. These materials are generally carbon based epoxy resins that are light weight, very strong and resistant to corrosion. The use of these materials in aircraft structure is relatively limited now, but it is anticipated that each new aircraft will include greater use of these materials. Research is underway aimed at also using these materials in the critical structures of aircraft. This would result in many structural design assumptions having to be revalidated or modified to take account of these material's properties and fault tolerance characteristics.

- Tilt Rotor Technology

  The V-22 Osprey aircraft designed for military use combines the ability to land and take off vertically like a helicopter with the ability to fly at modern turboprop speeds of 250 knots. From studies by NASA, FAA, DOD, and the industry, it appears that tiltrotor technology has great potential in the civil aviation field as well. If airlines decide to incorporate tiltrotor technology into their operations, observers expect that this would occur around the turn of the century. The principal hurdle at this point appears to be the relatively high cost of operations on a per passenger basis and making infrastructure and airspace regulatory changes that permit the operational advantages of the tiltrotor to be realized. FAA is already taking steps to certify the unique aspects of this technology for civil use. For a more complete description of civil tiltrotor technology see Committee publication 101-44 (April 25, 1990).

- Jet Engines

  It is anticipated that jet engines will continue to be designed to deliver increasing amounts of thrust. Future designs are expected to produce fuel savings of 30% over current designs while also reducing emissions.

- Synthetic Vision

  Research is underway to determine the advantages of moving to 'synthetic vision' whereby pilots look at a simulated picture of their approach to an airport rather than looking through a window at the real world. This would have benefits in inclement weather and be able to give the pilot cues/references and information not available by simply looking out the window.

- Very Large Commercial Transport

  Preliminary studies are underway by Boeing and the European Airbus consortium to determine the feasibility of a "super jumbo" aircraft for introduction around the year 2000. This would be a 600-800 passenger double decker aircraft with trans-Pacific range. Because of the sheer size and weight of such an aircraft, design issues are raised, particularly regarding noise mitigation. Noise on such a large aircraft would not just pertain to engine emissions but to the airplane itself. It is expected that because of the large financial investment and risk, that production would likely involve a multinational consortium including the United States and European manufacturers.

- High Speed Civil Transport

  There is increasing confidence that it will be possible to introduce a new supersonic transport around the year 2005 that will be environmentally acceptable with economics comparable to today's subsonic aircraft. Most thinking is now focused on an aircraft that would fly at a speed of Mach 2.4 (approximately 1,500 miles per hour). The supersonic Concorde flies at approximately 1,100 miles per hour. Today's jet aircraft cruise at approximately 550 miles per hour. It is anticipated that this high speed transport would carry 250-300 passengers. The existing Concorde carries 100 passengers. Market analysis indicate a market for 500-1,000 aircraft between 2005 and 2015.

A new high speed transport would require new technology in many aspects of the aircraft's design. It is anticipated that it would rely on synthetic vision technology since forward facing windows would not be useful in one of the aircraft designs being considered. The anticipated design assumes that as the aircraft approaches landing it would be at an angle of attack in which forward facing windows would provide no view of the ground. The Concorde solves this problem by having the nose and cockpit of the aircraft swing downward to provide a view of the ground. This design incorporates a great deal of weight in the aircraft, that engineers would like to remove. To accomplish this, forward facing windows would be sacrificed and synthetic vision substituted.

It also anticipated that a new high speed transport would heavily rely on advanced materials and structural technology, new propulsion designs, and aerodynamic shapes.

II. FEDERAL GOVERNMENT'S ROLE IN NEW AIRCRAFT TECHNOLOGY

Most of the aeronautical technology development that results in technological advances in the U.S. civil aircraft industry is the result of research and development conducted by the National Aeronautics and Space Administration in three of its Research Centers. (Langley Research Center in Hampton, Virginia; Lewis in Cleveland; and Ames in Mountain View, California).

In FY 1993, the Congress appropriated $716.8 million for advanced aeronautical research. While the FY 1994 appropriations is not yet final, it appears that approximately $960 million will be appropriated for all aeronautical research. Specifically $267.4 million will be devoted to subsonic aircraft activities and $207.5 million to research related to the high speed civil transport. The balance of the funds go to military related programs and basic, unapplied research.

NASA has a close working relationship with the aircraft manufacturing industry so that new technological developments can be quickly assimilated into industry's thinking and designs.

III. FEDERAL AVIATION CERTIFICATION OF NEW AIRCRAFT

Section 601 (a)(1) of the Federal Aviation Act of 1958 states that is shall be the duty of the FAA Administrator to prescribe and revise from time to time..."such minimum standards governing the design, materials, workmanship, construction, and performance of aircraft, aircraft engines, and propellers as may be required in the interest of safety." The minimum standards for transport category airplanes are set out in Part 25 of the Federal Air Regulations.

All designs for aircraft must be approved by the FAA as well as the quality control methods to be used during production. The FAA also certifies that aircraft conform to the approved designs and production processes.

FAA accomplishes this through the Aircraft Certification Service which is organized into four directorates. The Transport Airplane Directorate is located in Renton, Washington, and it has two Aircraft Certification Offices one in Renton and one in Long Beach, California.

The overall Aircraft Certification Service has a staff of 848 and a budget of $67 million, and is responsible for the certification of small airplanes, helicopters, and engines as well as transport category aircraft. Approximately one-third of the Service's resources are devoted to Transport Airplane Directorate.

When a new aircraft is being developed, the manufacturer submits detailed designs to the FAA, as well as test analyses that demonstrate whether the aircraft meets FAA requirements and standards. FAA reviews the data submitted by manufacturers and conducts test of its own as well. Usually, the certification process for a new aircraft design takes approximately five years. When new technology is involved, FAA must also develop new standards of design and reliability to hold that new technology up against. This aspect of the process involves a great deal of formal and informal negotiations between the FAA and manufacturers as to what a design should incorporate.

An important feature of the certification process is the use of Designated Engineering Representatives (DERs) to act as surrogates for the FAA in much of the certification analysis, and testing work. DERs are employees of the manufacture who give approval at steps in the process on behalf of the FAA. The designee system largely exists in recognition of FAA's lack of resources to do the entire job and has been the approach used for decades. DERs are typically senior engineers of the company and being made a DER for the FAA is viewed as a recognition of an engineer's professional capabilities and stature within the company and the profession. In the Transport Directorate, there are approximately 1,300 DERs. Much of the FAA Aircraft Certification Office's activities is devoted to managing this system of designees.

The question of whether conflicts of interest exist in having employees of the manufacture perform certification activity for the FAA on their company's aircraft has been studied by independent panels. The general conclusion has been that the designee system works well and is free of conflict of interest problems because of safeguards built into the certification process.

IV. SUMMARY OF GAO REPORT FINDINGS AND RECOMMENDATIONS

The report was done at the request of Subcommittee Chairman Oberstar. The purpose of the request was to determine if FAA certification staff is effectively involved in the aircraft certification process and technically competent in technological developments that are being introduced into new aircraft designs.

With respect to the FAA's role in the certification process, the GAO found the following:

- o The current certification clearly produces very safe aircraft with a relatively small number of accidents caused by failures of aircraft design or system failures (15 worldwide between 1982 and 1992). Some new generation aircraft types (Boeing 757, Boeing 747-400, Douglas MD-11) have never suffered an accident. What is not clear according to GAO is how the FAA's role in certification contributes to this safety record.

- o Since 1980, the FAA has increasingly relied upon designees to carry out certification activities. GAO found that the number of designees used by the Seattle and Los Angeles certification offices climbed 330% from 229 to 1,287 between 1980 and 1992. While the number of FAA staff also increased from 89 to 117 or 31%, the ratio of designees to FAA staff increased from approximately 3 to 1 in 1980 to 11 to 1 in 1992. The GAO also found that in areas associated with advanced computer and software technology, the ratio of designees to FAA staff was approximately 30 to 1. In 1980, it was estimated that around 70% of all certification activity was delegated. Presently, certification activity conducted by designees amounts to 95%.

- This increased reliance on designees is due to the increased workload of certifying increasingly sophisticated and complex aircraft. GAO compares the number of certification compliance documents for the 1971 certification of the DC-10 with the 1990 certification of the MD-11. FAA was required to approve 1,400 documents for the DC-10. For the MD-11, that figure more than doubled to 3,069. Similarly, the number of documents to be approved for the yet-to-be certified Boeing 777 is expected to be double that of the 747-400.

- The increased reliance on designees is also attributed to workload increases in another major area of responsibility of the FAA certification staff, the issuance of airworthiness directives. Airworthiness directives are corrective changes to existing aircraft to ensure safety. GAO cites as an example the Seattle FAA certification office, which has seen an increase in airworthiness directives issued from 24 in 1981 to 125 in 1990.

The GAO further found, the following consequences of increased reliance upon designees:

- Because of increased delegation of certification activity to designees, some FAA officials are concerned that the agency could lose competence in understanding the technology it is responsible for certifying. GAO found that other organizations such as the National Transportation Safety Board, Congressional Office of Technology Assessment and the Aerospace Industries Association share this concern.

- The increased reliance on designees has translated into FAA delegating key tests and analyses which it once reserved to itself. The certification community believes that FAA responsibility for these tests is necessary to ensure the integrity of the certification process.

- o As delegation of key aspects of aircraft certification has increased, FAA's supervision of designee activities has decreased.

- o The FAA's role in certification has become ad hoc, unsystematic and undefined as to which technical issues, and at what level of detail the agency itself will become involved. Also, the agency's effectiveness in the certification process is unmeasured.

The GAO also found the following relating to technical competence of the FAA certification staff:

- o An FAA program to augment the FAA certification staff with technology experts, known as National Resource Specialists, has not been fully staffed.

- o There is a lack of direction as to how and when these technical specialists are to be used.

- o Training of FAA certification staff falls short of meeting the staff's needs and requirements.

- o There is high turnover in FAA's certification staff complicating FAA's efforts to ensure technical compliance.

The GAO made the following recommendations to the FAA:

1) FAA should define a minimum effective role for the FAA in the certification process.

2) FAA should formally examine the need to hire technical experts on specific fields.

3) FAA should require early involvement of its technology experts in the certification process.

4) FAA should establish annual training requirements for FAA certification staff for each certification discipline.

FAA's response to these recommendations was to concur in part with each, but to take exception with the significance GAO attributes to its findings and recommendations as a criticism of the overall success of the certification program. The Department of Transportation reply to the GAO report states:

> "The Department maintains that FAA's role in aircraft certification is well structured and functions effectively. The FAA substantially refined the Aircraft Certification Program in response to the 1980 National Academy of Sciences (NAS) report recommendations. In particular, FAA strengthened and centralized its management structure for the aircraft certification process, enhanced the FAA orders that guide the program, and implemented the National Resource Specialist Program. The FAA's Aircraft Certification Service continuously monitors program effectiveness and presently has initiatives underway to improve program guidance, training, and staffing further.
>
> "While the Department and GAO share the goal of ensuring that FAA provides the most efficient and effective aircraft certification process in the world, the Department differs with several of the methods that the GAO draft report proposes to achieve this goal. In particular, we differ with the draft report's proposal to create rigid structures governing NRS involvement in certification projects and the provision of training to FAA's certification engineers. We maintain that the most efficient means for achieving these goals is through the application of appropriate judgement through sound management practices and not by establishing rigid requirements without regard for the dynamics of the certification system or the true needs of the organization. While both methods may accomplish the objective, we maintain that the FAA's methodology will achieve the objective most efficiently and effectively and at lower cost to the taxpayers."

Copies of the full GAO report can be obtained by calling the Subcommittee on Aviation office at x59161.

V. ANTICIPATED WITNESSES

Witnesses from the following organizations are expected to present testimony:

- National Aeronautics and Space Administration
- Aerospace Industries Association
- Federal Aviation Administration
- General Accounting Office

ADVANCED AIRCRAFT TECHNOLOGY AND FEDERAL AVIATION ADMINISTRATION CERTIFICATION

WEDNESDAY, OCTOBER 20, 1993

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON AVIATION,
COMMITTEE ON PUBLIC WORKS AND TRANSPORTATION,
Washington, DC.

The subcommittee met, pursuant to call, at 9:45 a.m., in room 2167, Rayburn House Office Building, Hon. James L. Oberstar [chairman of the subcommittee] presiding.

Mr. OBERSTAR. The subcommittee will come to order.

The subject of today's subcommittee hearing is new technology that is expected to be incorporated into aircraft over the next 10 to 15 years and the role of the Federal Aviation Administration in ensuring that this new technology will be designed and will be certified to appropriate standards of safety that the public expects and has come to depend upon. This is after all, the principal charter of the Federal Aviation Administration dating back to the organic act of 1958. In that act, the Congress, so concerned about safety in creating the new FAA out of the old Civil Aviation Administration made no less than six references in the first three paragraphs of that act to safety enjoining the new agency to maintain safety, not to the level that is affordable, but to the highest possible standard of safety.

In September, the General Accounting Office prepared—completed, rather, a report they had prepared at this subcommittee's direction on the certification process at FAA and submitted a report that made numerous observations that the FAA needs to make refinements in its certification program to ensure that it is capable of meeting the challenges of technological advances in aircraft manufacture, design, and engineering.

Over the next decade and a half, there will be a number of significant advances in aviation technology that will most likely revolutionize air transportation. The Boeing 777, which will have its first flight next year, is a prototype of that new generation of aircraft and technology, but it is the first aircraft that will have its first flight without first demonstrating its capability in a mock-up. There is a mock-up, but it exists in computers, in the computer program that has been used to design this aircraft. I have seen that system. It is very impressive.

Members of our subcommittee and our subcommittee staff traveled to, first, Cincinnati to see the GE engine program and then to Seattle to observe indepth the manufacturing process for the new 777. And we were impressed with what we saw. But we also took note that the design, technology, the whole capability of this aircraft, is based upon computers.

The 777 will present a new approach to certification in that a major performance factor, extended range operations over water, may well be approved on the basis of laboratory simulation by computers.

We are looking at increasing use of new composite materials and new jet engine technology that will make operations increasingly efficient, but which also raise technological and engineering issues that push the frontier of knowledge and experience in these disciplines.

By the end of the century—just seven years hence—we may very well see large superaircraft, supersized aircraft, jumbo aircraft, carrying 600 to 800 passengers. Indeed, joint ventures are now being explored and developed at least to discuss the construction of such supersized aircraft and those discussions involve United States and European manufacturers.

There is increasing confidence that environmental problems for new generation supersonic transport can be overcome. We all know what the great environmental problem and concern was in the 1960s over the SST. And there is also a great deal of confidence that the new generation supersonic transport can make the per passenger cost comparable or at least not out of line with today's subsonic jet transports.

All of these developments come at a time when the FAA will be challenged not only by the technology, but also by the need to do business differently, given the budgetary challenges facing this agency and all of government. In short, they are going to have to do more with less money, better trained, better talented, and more experienced people.

GAO, at the direction of the subcommittee, reviewed FAA's aircraft certification activity and found that by a number of indicators the FAA increasingly is delegating certification activity of its program to designated engineering representatives. GAO concluded that steps need to be taken to ensure that the certification staff is sufficiently familiar with the technology and knows enough about it to ensure that they can carry out their responsibility. GAO expressed further concern that with this increasing reliance upon company engineering representatives, designated and certified within the aircraft manufacturing companies, that FAA may well be losing the expertise within its own personnel to keep up with and keep pace with the development of technological expertise within the manufacturing sector.

The GAO authors wondered aloud in this report, what does FAA contribute to the certification process? Does FAA really add value? And clearly, there is not a fully defined or very precisely defined role for FAA at various stages of certification. But nonetheless, I think my experience is that FAA does add a great deal to the process.

One evidence of FAA's substantive and contributory role is the accident record, which shows very few design-related accidents. Another evidence is the complaints that this subcommittee has heard over the years by manufacturers that FAA was being too intrusive and making them do too many repetitive and redundant processes.

It may be difficult to point to specifics, but I think one experience that we had is very instructive. At a visit to the Toulouse Airbus Industrie manufacturing facility in 1989, the subcommittee heard a discussion by Airbus Industrie technological personnel and its President and CEO, Jean Perrierson, going elaborately through the steps that they had to take to comply with FAA requirements. At the end of a very long recitation, Mr. Perrierson said, we want you to understand that we are not complaining. Although it sounded very much like a complaint, we are not complaining; we are describing in detail the steps we are taking to comply with FAA certification requirements, because we know that once we do, we will be able to sell our aircraft anywhere in the world because FAA's standards are the highest and the most respected anywhere in the world.

The record in that respect certainly speaks for itself. And yet as increasingly sophisticated and complex aircraft are developed, the FAA needs to be sure that it is not playing catch-up with technology and with the industry. It really needs to be ahead of the state of the art.

The GAO and its report has made some very sound observations and solid recommendations on how FAA should improve its program, although, the title of the report—New Approach Needed to Meet Challenges of Advanced Technology—might tempt the casual observer that FAA needs to start from scratch. I tried that out on some people and they said, oh, have things really gotten that bad at FAA? That is not the case, and I just wanted to observe that what GAO is saying about FAA is that they really need to work harder to stay ahead of the state of the art.

We are going to, this morning, try out a new technology in the hearing process, this is something Mr. Clinger and I have talked about in the past, to have witnesses with contrasting viewpoints at the same table at the same time so that we don't have the case of one panel coming up, making its piece and another panel coming up and rebutting, and the other sitting there, making faces and twitching in their chairs. We are going to put them at the same table. And these two witnesses, Mr. Mead, and Mr. Broderick, know each other. They have had exchanges with each other in private. They are now going to have exchanges face-to-face in public. And I think it will be genteel and appropriate, but it will be concurrent. And instructive.

Yes, cross fire, if you will, Mr. Clinger. But I think it will prompt a more free flowing discussion and we will see how it works today. If it works well, we may get into somewhat more confrontational exchanges in the future.

I think—I look forward to today's presentation because I think this is one of the important fields for us to spend time on and for the committee, its members, and for the staff and the public to understand this very, very important process. Mr. Clinger.

Mr. CLINGER. Thank you very much, Mr. Chairman. And I, along with you, look forward to today's hearing.

The Federal Aviation Administration is charged with a lot of things among which are certifying that aircraft are safe and that they meet rigorous design, engineering and production standards. The task has clearly grown a great deal more challenging in recent years as aircraft manufacturers have successfully developed and incorporated cutting-edge technologies in the design and production of new aircraft.

Unfortunately, it seems that new technology generally leads to greater complexity and the FAA's ability to understand these technologies is being sorely tested as we move down the road. While aircraft manufacturers pursue design strategies that make aircraft easier to fly and maintain and more dependable, their reliance on composites and computers and vast amounts of associated software have possibly pushed beyond the FAA's ability to fully understand and effectively monitor these emerging technologies.

There are a number of competing forces at work in this dilemma. On the one hand, our aerospace manufacturers are fighting very hard to maintain preeminence as the world's leading builders of jet aircraft, which they are indisputably recognized as today, but in order to safeguard that status they must invest hundreds of millions of dollars annually to research and develop the innovative technologies that we have seen. And just as importantly, they need to incorporate these advances as soon as practicable into new aircraft. Keep in mind that civil jet aircraft are and remain this Nation's number one export, and, therefore, it has a very critical role to play in our balance of trade.

Whether by design or by default, the FAA has come to rely heavily, as the Chairman indicated, on designated engineering representatives to help the agency overcome its lack of understanding about these new processes. To some observers it may appear as a conflict of interest that DERs are paid by the same company whose processes and designs they are charged with certifying as safe. To date, as you have indicated, Mr. Chairman, the system does not appear to have failed. We have not had any serious problems as a result of faulty design certification.

Nevertheless, I think the question arises whether the FAA is slipping further and further behind the knowledge curve and whether any effort is being mounted to bring their engineers up to some degree of equivalency with their counterparts who design and build aircraft. Based on evidence that we have seen to date, certainly on the report that we have from GAO, it is not apparent at least that FAA is making much of an effort in this regard, and I would strongly encourage the agency to improve this situation, if it is indeed true.

Related to the need to keep pace with developments, I want to raise another concern. I think the current system works well, although the FAA needs to do a better job keeping pace with technological developments. But to those who feel the Federal Government should play a bigger role, I would share my concern that if we demand that FAA fully satisfy itself with every piece of new technology built into future generations of aircraft, innovation could be imperiled and sales of new aircraft could be lost to our international competitors because certification will be unacceptably slow by that kind of demand.

I have tremendous faith in our manufacturers' ability to create new and better products, but I fear that advantage may be lost if we require FAA to move away from its reliance on DERs and instead compel the agency to sign off on each new innovation based on some sort of concurrent in-house engineering approval, which it seems to me at present would be not as reliable as the DER system that we have been used to.

So I would prefer to see the FAA continue its role as a disciplinarian overseeing a reliable process of review, testing and approval for engineers and production technologies without also having to completely comprehend all the engineering and design strategies that went into the design itself.

In closing, Mr. Chairman, I think we need to keep in mind that the manufacturers have a very selfish motive to produce reliable, efficient, and safe aircraft and the DERs are not going to do anything to undercut that. The marketplace would tolerate nothing less.

Mr. OBERSTAR. Thank the gentleman for a very thoughtful, as always, statement about those observations about the DER program.

At this time, I would like to enter into the record the statements of Mr. Costello of Illinois and Mr. Blackwell of Pennsylvania.

[The prepared statements of Mr. Costello and Mr. Blackwell follow:]

Opening Statement of Hon. Jerry F. Costello

Mr. Chairman, I want to thank you for calling today's hearing to learn about new developments in aircraft technologies expected in the next 10 to 15 years. Today's hearing will focus on the Boeing 777, a computer designed aircraft, the V–22 Osprey and its potential civilian application, as well as the super jumbo aircraft and the high speed supersonic transport.

In addition, we will consider FAA's certification program as it relates to the development of a new generation of aircraft. As such, the Subcommittee will receive the General Accounting Office's report on the certification process. I believe the FAA certification staff must maintain a high level of competency and involvement in aircraft technology development to ensure the safety of the new generation of aircraft.

I would like to welcome the witnesses who will testify before the Subcommittee. Your input on these issues is appreciated. Again, Mr. Chairman, thank you for your leadership.

Statement of Hon. Lucien E. Blackwell

Thank you, Mr. Chairman. Today as we continue to do our part by examining new aircraft technology, and the federal government's role in the certification of new aircraft technology, I commend you for your leadership, Mr. Chairman, in this process.

Any new technology that is instituted and any new design that is approved must be conditioned on the basic premise that it will return massive dividends not only to citizens, travelers and shippers, but also to airlines and others whose businesses provide or depend upon aviation services.

Now is the time for us to act by implementing the most appropriate legislative initiatives. That is why we must make every effort to take a reasoned and careful approach as we consider the issues before us today.

I have no doubt that we are capable of making a fair determination of what steps can and should be taken to establish an approach to aircraft certification in light of these new technological advances.

Our involvement during this review underscores the concept that technological development and an accompanying certification process effect a sound approach. We should consider this as an efficient means for achieving growth, new business activity, better air service and opportunities for health competition.

Thank you, Mr. Chairman.

Mr. OBERSTAR. Are there other Members who wish to make comments?

If not, we will proceed to our first witness this morning, Dr. Wesley L. Harris, Associate Administrator, Office of Aeronautics at NASA. He comes with a long and distinguished career in engineering and aeronautics, both in the academic and private sector and public domain.

You bring a wealth of experience of knowledge from your work at MIT and at the University of Connecticut, from the University of Tennessee Space Institute and at NASA. We could not have a more qualified, distinguished and experienced witness on this subject, and we appreciate your sharing this morning with us.

TESTIMONY OF DR. WESLEY L. HARRIS, ASSOCIATE ADMINISTRATOR, OFFICE OF AERONAUTICS, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Dr. HARRIS. Good morning. Thank you, Mr. Chairman, and members of the subcommittee. It is indeed my pleasure to discuss with you advanced aircraft technology.

This subcommittee is clearly aware of the importance of the aviation industry to the generation of our national wealth. Its success is largely a result of a long history of private and public sector cooperation in technology development and validation that has ensured a U.S. leadership in the world's economy in terms of jet aircraft and to a lesser degree rotor craft as well.

NASA and our government and industry must form a useful partnership, and must provide a way to make sure that this heritage is maintained. In order to do this, NASA, in working with its partners, has generated two primary goals: Number one, to improve the U.S. competitiveness in civil aviation; and, number two, to be a serious partner in enhancing the safety and capacity of our National Aviation System.

NASA's role in the partnership is to develop technology to meet the needs of our national government and industry customers. To that end, we have a very robust technology development effort which contributes to the advancement in both civil aviation and military aviation.

NASA's aeronautics program must produce useful technology and must produce this useful technology on schedule and within budget. Our Nation, however, must do more. With the FAA in the lead, and with NASA supporting, our Nation must also set international standards in all phases of civil aviation. Useful technology alone will not ensure a competitive advantage to the U.S.

We must develop our technology and simultaneously determine international standards. I would like to describe three examples of the FAA-NASA cooperation that, in my opinion, clearly illustrates the benefits to the civil aviation community of the two Federal agencies working together.

I call your attention to the recent issue of Aviation Week in which an article on our joint windshear program is described. This program has developed for us the capability to give our pilots several seconds of advance warning of windshear conditions, helping them to avoid deadly accidents.

Our work has come to fruition and today our U.S. companies are developing on-board windshear detection systems based on specifications and guidance which we jointly developed. These systems will be affordable for airlines and will significantly minimize the risk posed by windshear.

Another example is the Global Positioning System, a system initially developed by DOD. NASA and FAA are currently developing technologies, methods, and techniques that will allow our airline pilots to take advantage of GPS technology for highly accurate precision approach and safety—and safely increasing our aerospace system's efficiency.

A third example of cooperation between the FAA and NASA is in our so-called glass cockpit. NASA and the FAA have jointly acquired a glass cockpit simulator which will help us to learn more of how to operate and manage aircraft in cooperating on this next advanced generation technology.

These are but three programs which I wish to highlight that give us confidence that our technology initiatives that will be successful in meeting the FAA and industry needs. We work closely with the FAA, with DOD, with the university community, and other Federal agencies, and industry to develop and to design our very exciting Advanced Subsonics Technology initiative. This program will begin this current fiscal year.

It will, one, will be a program that is exciting, that is complete and that takes a very systemic approach to aviation. It will develop technologies that will improve the aircraft itself, that will assist the airline operators, that will increase the airspace system efficiency, will enhance safety, and will reduce harmful environmental effects. And because it takes a very systemic approach, its success will hinge upon many elements integrated together and will require very close cooperation with the FAA. My written statement certainly, which has been submitted for the record, describes the 10 elements of this program. I will take a few moments of your time to describe in very broad terms some of these elements.

The aircraft itself, for example, is one such element, and we will focus on the development of advanced composite materials and the related manufacturing processes, how that, in fact, will be tied together to reduce the weight of aircraft we hope by 20 to 50 percent, reduce the manufacturing cost by 20 to 25 percent, leading to a lowering of the direct operating cost by as much as 16 percent over today's metallic airplanes. These developments, including fly-by-wire—fly-by-light and power-by-wire technologies, will enhance the performance of our aircraft as well as reducing the weight.

While we develop that technology, we are working with our partner, the FAA, to develop analytical tools as well. These tools will be required by the FAA for certification by industrial designers to assess the effects within an aircraft and for their airline operators. We are working closely with the FAA on a Terminal Area Productivity initiative to increase our operations within single runway configurations by 10 percent and 15 percent for multirunway operations. This again will allow airlines to have more flights and more ontime departures and arrivals.

We have a primary contribution to enhance efficiency of the total airspace system through a new emphasis on shorthaul aircraft. In this area, we are developing technologies to reduce the shorthaul aircraft noise by 12 percent, and we are working with our industrial teams and the FAA to find ways to increase the utility of general aviation and commuter aircraft in the general total aviation system.

Safety remains a very important concern. And in that area we are focusing on our aging aircraft initiative in which we are looking forward to nondestructive evaluation techniques being commercially available by 1997, and such will, of course, improve our ability to predict airframe strength.

We are developing technologies that will make our aircraft more environmentally friendly, thus reducing aircraft engine noise significantly by the year 2000. We will also focus on engine emissions which we believe by the same time period will reduce emissions by 90 percent compared to current day emissions levels.

We believe our subsonic program is well balanced and addresses a variety of needs simultaneously and is one that requires consistent and persistent relationships, productive ones, with the FAA and with industry, and we are confident that those programs will lead to a growing enhancement of U.S. competitiveness and safety and efficiency of our total aviation system.

Also in my written presentation I address some elements of our high speed research program. This is a very exciting program. It is one that is based on market studies indicating that around 2005, 2015, we can anticipate 600 passengers per day traveling on high speed civil transport over transoceanic routes creating a market for between 500 to 1,000 high speed civil transport aircraft.

Our program working with the FAA and with industry is one that will lead to the development and production of an environmental friendly, economically viable fleet of high speed civil transport airplanes. That fleet of airplanes will generate $200 billion in future sales and at least 140,000 high skilled, high wage jobs, obviously critical to our national wealth.

The program has two phases. Phase I, which was initiated in 1990, is addressing critical or crucial environmental issues, the ozone impact concerns, airport noise and sonic boom. We are very encouraged by our progress to date. We are moving, therefore, into Phase II, in which we will address the high leverage technologies that will enable our industry to build the high speed civil transport that is, in fact, economical and has ticket prices which would be comparable to those of existing subsonic transports at the turn of the century.

To do this, we must make advances in materials and aerodynamic performance and propulsion and in flight deck systems. These technologies will reduce manufacturing costs, aircraft weight, fuel consumption, lower maintenance requirements, and enhance safe operation in air transportation systems while at the same time providing maximum performance.

We cannot overstate the importance of addressing certification, operation, and in-service maintenance considerations, along with affordable manufacturing issues from the very beginning of the process. We have already had discussions with the FAA and have established a continuous dialogue between NASA, our office, and FAA and industry to take us through the technology and product development and validation stages. Our plan is expected to lead to an industry decision to build a high speed civil transport in the 2001 timeframe.

Mr. Chairman, and members of the subcommittee, I hope I have conveyed to you the importance of our partnerships with the FAA and industry as we develop advanced technology for our aviation industry. Working together, we can meet our goals of improving the U.S. competitiveness and civil aviation and safely enhancing the efficiency of our national aerospace system.

I will be happy to answer any questions that you or members of the subcommittee may have.

Mr. OBERSTAR. Thank you very much, Dr. Harris, for a rather comprehensive as well as compact statement in summary form of the developments within NASA, the initiatives that are under way. Obviously, you could not give us a complete engineering discussion of all of these points, but having them all summarized in your paper is, I find, very valuable, and will be a most useful resource for us in the future.

Is NASA's budget in the range of $960 million for the current fiscal year—I mean, for fiscal 1994?

Dr. HARRIS. Mr. Chairman, I would like to put it in context. Our budget for fiscal year 1993 aeronautics was $865 million. We went in for a request for fiscal year 1994 of $1.02 billion and currently the outlook is $1.01 billion for aeronautics. That is an increase of 17 percent.

Mr. OBERSTAR. You did substantially better than the FAA did in their budget.

Dr. HARRIS. That may be true, but we are partners with them and a lot of our enhancement will certainly go to the benefit of both.

Mr. OBERSTAR. Most of FAA's reduction was in the AIP program where the Appropriations Committee did a little financial shuffle in moving monies around within the transportation function. You don't have to worry about that same sort of thing but that is a substantial amount of money. It is more for all aeronautic research that you have had in previous years and will give NASA the flexibility it needs to proceed on these various counts that you have described for us. Which are the priority areas that you are going to use these increased funds to work on?

Dr. HARRIS. Sure. Again, sir, may I address the context in which we hope to make our advances. NASA aeronautics must produce useful technology, and that technology must be produced and validated ahead of our competitors. It must be done within schedule and within budget.

The priorities are as follows: The High Speed Research program, Phases I and II, as we currently see the bills on the Hill, at $197 million; Advanced Subsonics Technology initiative currently at $89 million; High Performance Computing and Communications initiative at $65.6 million; National Aerospace Simulation initiative at $49 million; Materials and Structural Technology initiative at $25.7 million; and our Transatmospheric initiative at $20 million.

I also would like to add we have on the table in our Construction of Facilities, $212 million, expressing a need to initiate a program to provide this Nation world class capabilities in aerodynamic test facilities, two new large high productivity wind tunnels as opposed to research-driven wind tunnels that will allow industry to reach market faster with more efficient, safer airplanes testing in U.S. facilities as opposed to international facilities.

Mr. OBERSTAR. That is splendid. That is very impressive. Could you describe for us the distinction between basic research and applied or market research conducted by NASA and which areas you, your agency, is involved in and how much emphasis you give to the one as compared to the other?

Dr. HARRIS. Sure. Our rack-up, $1.01 billion, includes $448 million for R&T the base; that is our seed corn. That is our generic research where we ask generic questions as opposed to specific questions that would lead to immediate technology or insertion in a particular type aircraft. However, I hasten to add that that research has a longer time to develop, but ultimately that research also must be useful and should meet a need to enhance the competitiveness of our aviation industry. So of the $1 billion, 450 million is, in fact, the R&T base, the critical disciplines, the generic questions. The questions do not focus specifically on the high speed civil transport or a specific type subsonic aircraft.

Mr. OBERSTAR. And how much of that work is done in-house as compared to contracting out to universities or private sector research?

Dr. HARRIS. The base research has about 60 percent in-house, about 25 percent out of house, and the rest goes to our university communities. The focused programs, high speed civil transport, the advanced subsonics initiatives, the advanced atmospheric initiative, and to a lesser degree the high performance communications initiative has 65 percent out of house to industry and 25 percent inhouse and the remainder to our university communities.

Mr. OBERSTAR. And the result of that is that NASA retained internally a very high degree of expertise of its personnel in those technological areas that you have described for us?

Dr. HARRIS. I would agree with that, Mr. Chairman.

Mr. OBERSTAR. And the ability, therefore, to monitor and evaluate significantly the research of that 40 percent that is done outside of NASA but under contract with NASA?

Dr. HARRIS. Well, I think that is one important aspect of it, sir; to be able to monitor. I think it is important again to realize in this period of transition in the U.S., as we understand and observe the downsizing of DOD in aeronautics, that the Nation make a very careful assessment of its aeronautical assets and make sure that we have a critical base in place in aeronautics in those assets, both human potential, facilities, as well as our technologies that result from our hard labor, and successful labor. Those assets——

Mr. OBERSTAR. If I may interrupt you, is that shift away from advanced military propulsion and airframe designs going to result in a higher cost for development of civilian aircraft technology?

Dr. HARRIS. I think not, sir. The reason that will not happen is that our programs, the focused ones in high speed and subsonics in particular, have been built from day one with industry and with agencies, Federal agencies in Washington. So we have built in the production of useful technology from those programs. We are not looking at technology development just for the sake of technology. I think we will make significant advances ahead of schedule of our competitors.

Mr. OBERSTAR. I am going to ask you one question as my time expires. Here on page 4 you observe that NASA is "developing design methods for FAA certification and for industry designers." Could you describe in more detail what that means?

Dr. HARRIS. Let me find that page, sir.

Mr. OBERSTAR. The second paragraph, the last sentence.

Dr. HARRIS. This is under the paragraph on shorthaul aircraft?

Mr. OBERSTAR. Yes.

Dr. HARRIS. The issue is how to take advantage of some of the unique features of shorthaul aviation and enhancing the overall efficiency of our aviation system, some of the problems of congestion. And in developing these methods we must not lose the fact that the shorthaul aircraft must be certified by the FAA. So our design methods as we look at the entire system is one that takes into consideration the fact that the FAA as well as industry must be able to build shorthaul aircraft that are certified. That is what we mean.

Mr. OBERSTAR. You are designing criteria for FAA to determine whether those aircraft are being built soundly?

Dr. HARRIS. Working with the FAA, yes.

Mr. OBERSTAR. Working with FAA, thank you. Mr. Clinger.

Mr. CLINGER. Thank you, Dr. Harris, for your very helpful testimony.

You mentioned that the aviation industry is becoming increasingly competitive and that this partnership that exists between NASA and FAA has been a critical part of our ability to maintain a technological edge, as it were. Among our competitors, is there anything comparable to the partnership between FAA and NASA that you are familiar with? Is this a unique model that we have in this country?

Dr. HARRIS. Oh, I don't think it is unique at all, sir. I believe that foreign or international governments do work very closely with their industries to advance their own national wealth. I would not go so far as to say the specific character, the relationships between international governments and their industry is the same as ours, but the general idea of government working with aviation industries and their own economies is certainly well known.

Mr. CLINGER. Why do you think that we have been able to maintain the technological edge that we apparently have? What makes this as successful as it has been?

Dr. HARRIS. Well, I think, as I indicated earlier, we have a long and rich history in this country, coming out of the Second World War, for example, of our government working with our aviation industry, certainly on the DOD side, with substantial, a very handsome spin-off into the civil sector that has, in my opinion, led to a dominance on the part of the U.S. aviation industry for the last 50 years. That dominance, however, as we well know, has begun to erode. We were approximately 90 percent of the world market share in aviation in the late 1960s, early 1970s. I think we have lost at least 20 percent of that market in the last 20 years. And the profile is still negative. So the fact that technology and aviation technology in particular is a global phenomenon, the fact that the world economies have changed, indicate to us that we have a substantial challenge ahead of us.

You have mentioned Airbus. Airbus could perform well. They have built very good airplanes and we must meet that challenge head on. I think one way of doing that is the Federal Government working closer with our aviation industry.

Mr. CLINGER. You mentioned the fact that aviation generally, whether it is in commercial transport or in the development of new aircraft, is becoming increasingly globalized. Do you foresee a time when these sort of national barriers break down and we will have the kind of cooperation, say, between the U.S. and France or the U.S. and the European Community? For example, if we are going to go to a new superplane, it is obviously going to be a cooperative effort or at least that is the direction that we seem to be going.

Should it cause us any concern that there might be a technology transfer here which would not be to our advantage? Or should we look at this as an evolving situation where we are going more to an international development scheme?

Dr. HARRIS. Sir, I see the future as being a very, very unsettling one with a demand for cooperation as well as a preparation for competitiveness. I think both of those will be in front of us. I believe that NASA, working with FAA and other Federal agencies, must provide technological advances for our industry. Our industries will always be the national aviation industry, but our industries, ones that are primarily based here, must go to the negotiating tables with the technology that will give our industry an advantage in those negotiations. That is also why I believe firmly that our Nation must not only produce the technology, must be the determining driver in setting in the national standards.

For example, if we are able to provide technologies that will ensure that our high speed civil transport will produce no more than five grams of NO_x per kilogram of fuel burned and our international communities say, okay, you can get away with 10, then we have lost billions of dollars building an engine far superior to anyone else, so we lose. So we must not only develop the technologies ahead of our competitors, but we must also as a Nation set the international standards. I think they go hand in hand, and I think that this way we can face the corporation square. We—and at the same time be extremely competitive and build high skill, high wage jobs and national wealth for our country.

Mr. CLINGER. One final question. In this connection, the ongoing rivalry, competition between our manufacturers in this country and Airbus, the charge that is leveled is, well, you know basically we are indirectly subsidizing the manufacture of U.S. aircraft by all of the technology transfers that you develop in conjunction with FAA, and they really are no different than the direct subsidies that Airbus is receiving from their governments. How can we respond to that? In other words, is what we have done here in any way different than what goes on with any other country or other manufacturers?

Dr. HARRIS. Yes, I believe it is, sir. NASA, as you know, is concerned about the development and validation of technology. NASA does not design airplanes. We may develop design techniques but NASA does not design airplanes nor does NASA build airplanes. In that sense we are in the arena of precompetitive technology development and validation and I believe that is a significant difference between what we do and others do and working with our industry compared to how other international governments work with their aviation industry. We are definitely in the precompetitive arena.

Mr. CLINGER. So that in the sense the technology that you do develop is not necessarily limited to U.S. manufacturers? I mean, does it get into the public domain?

Dr. HARRIS. Oh, no. NASA aeronautics is very aware that we are servants of the U.S. taxpayer. We must protect the health and wealth of our Nation and our taxpayers. Transfer of technology that is useful to our industry is not to be. Period. It is not to be. It is not to happen.

Mr. OBERSTAR. The gentleman from Texas, Mr. Geren.

Mr. GEREN. Thank you, Mr. Chairman. I appreciate Dr. Harris's testimony. I have enjoyed having the chance to work with him on this committee and also on the Science, Space and Technology Committee. It is good to see you again today.

I don't have a question, but I want to mention a technology that NASA gave birth to many years ago, one that the Defense Department has worked with over the years, and one that I expect will play a major role in the shorthaul transportation of passengers in this country—that is tiltrotor technology. I look forward to NASA's continued support of that technology.

I am also anxious to see the FAA take an active role in getting our country ready for the eventual participation of tiltrotor technology in the effort to meet the transportation needs of this country, and, as I mentioned, I think it will be a technology that will spread all over the world.

I just wanted to raise that issue with Dr. Harris, and if you do have any thoughts on where we are going within NASA right now, I would be glad to hear your observations.

Dr. HARRIS. Thanks for the opportunity, sir. We do have an initiative that is moving along quite well. We have invited the FAA, the U.S. Army, the four main rotor craft companies in the U.S., Bell, Boeing, Sikorsky, and McDonnell Douglas Hughes, to join us in the development of a rotor craft program in which we will have new green dollars from NASA, from the FAA, from the Army matched one to one from industry to establish two new rotor craft technology centers; one in the Southwest and one in the Northeast.

Those two new centers will develop those technologies that will, again, ensure a competitive advantage to our rotor craft manufacturers in the worldwide competition. In fact, as we know, the profile for the safely fixed wing aircraft is negative for the rest of the century. The profile for rotor craft is at least flat. That is an enormous opportunity for our industries and we must step up to the need in those areas.

This is a NASA-initiated activity, however the FAA and the Army have joined us in each meeting and we have received excellent input from the four rotor craft manufacturers. That will probably be announced shortly.

Mr. GEREN. Do you have a timetable on when this initiative will move forward? You say it will be announced shortly, but do you know when you will have these centers picked or when you will set up the criteria for picking the centers?

Dr. HARRIS. Yes, the announcement, which is a matter of days, will state clearly the Federal Government is working with industry and has made decisions as to where the centers will be, how they will be staffed, and I would ask kindly that we allow that system or that process to carry to its conclusion. We would like for our Administrator to make that announcement.

Mr. GEREN. Thank you very much, Dr. Harris. Thank you for your testimony today. No further questions, Mr. Chairman.

Mr. OBERSTAR. The gentleman from Georgia, Mr. Collins.

Mr. COLLINS. I will pass.

Mr. OBERSTAR. Mr. Horn, the gentleman from California.

Mr. HORN. Thank you very much, Mr. Chairman.

I have enjoyed your testimony very much, Dr. Harris. I come from Long Beach, California, and we have a very long runway there at the Long Beach Airport in order to get the Douglas aircraft products off the ground. Unfortunately, it is also subject to expansion from commercial aircraft in particular, as well as the tens of thousands of small planes that land and take off there.

The major concern of the community and certainly myself—I am a former president of the university over which the overflights come and take about an hour out of the school of engineering lecture time every day—I am curious how fast we are proceeding to the 10 decibel reduction. Your testimony mentioned that you were proceeding in that area. When might that be achieved and what else might we do to have quieter planes that do not wreck, in our case, the three prized neighborhoods in the city on both landing and takeoff? Can you give me some encouragement?

Dr. HARRIS. I will do my very best, sir. As I indicated in a very brief description of our Advanced Subsonic initiative, environmental concerns is a major part of that program. And within the environmental piece we have two concerns: One, is airport noise. I believe I indicated we are focusing on a reduction by 10 dB by the beginning of the next century, by 2001.

We also are looking at advanced, creative ways of landing and taking off to reduce not only the amplitude of the noise but the actual footprint itself. We are cognizant of the concerns of noise in our advanced High Speed Research program, but we must assure that we are within the States' requirements, otherwise that plane will not be allowed to fly in and out of our airports around the Nation. So we are concerned. And I guarantee you, we will have advances in that area.

Mr. HORN. Let me ask you about the Global Positioning System. I am told by a private pilot the other day that in terms of our use of the positions system that was developed essentially by the armed services, we have a slight error in it because they have kept the finite measurement within the Defense Department for the use of military operations. Is there truth to that? And how close are we to having an accurate positioning system that private pilots, commercial pilots, can fly by?

Dr. HARRIS. Sir, I can't respond to whether the statement is true. I can assure you that NASA, working with the FAA, has left no part of the technology issue unquestioned. We are examining the technology. Safety is first. Safety is second. Safety is third. Safety is a major concern as we examine the readiness of GPS technology to enhance the effectiveness of our aviation system. Safety is a major concern. And I can say no more than that.

Mr. HORN. Well, presumably if safety is a major concern, accuracy is a major concern.

Dr. HARRIS. Yes, absolutely.

Mr. HORN. Last question, I learned long ago as an undergraduate student, when I was building a building for fellow students and went out to talk to the carpenter, and one of them said, if those architects had only been a carpenter over a summer, they wouldn't have drawn plans like that. Do we go out and talk to some of the mechanics who are working on the planes and think through how much easier it might be if we took the best idea that Douglas might have and Boeing doesn't or the best idea that Boeing has and Douglas doesn't or Airbus or whichever and applying them in terms of how the mechanic views a plane in thinking of safety? Because, as I understand it, there are substantial differences in this area as to the laying of wiring, which needs to be checked and all the rest.

Does NASA have an interest in that type of approach where we not only talk to the engineer who often can design wonderful models, but talk to the people who have to live with the design, work with the design and certify that that plane is still in safe condition?

Dr. HARRIS. Sir, we certainly must and will do more by receiving substantial input from all levels of specialists, let's say, that are active in the aviation system. Currently, we have input regularly from pilots, from the airline operators, from Mahogany Row right down to those that walk the concrete and worry about the baggage as well as the safety of the aircraft itself.

For example, we have concern about aging aircraft and bolt-on patches as a means of repairing cracks. We can't do that without, first of all, involving upfront the technicians that must in fact apply the bolt-on patches. That is simply one example of our need and our appreciation of the input that will come from technicians. We will do more of that, but certainly we are active currently with input from the mechanics. The heart and soul of the safety issue is in focus.

Mr. HORN. Good. As long as I am assured that mechanics are being talked to, that is great, because I look at these wonderful projects and products made by engineers and they are marvelous, such as a refrigerator, and I wonder how could somebody have designed such a product so stupidly, whether a housewife has a problem. Couldn't they talk to housewives every once in a while? It looks good and it works but you bump your knee on the doors or shelves. That is why you need some practical input.

Mr. OBERSTAR. I couldn't agree with the gentleman more on that last point. Mrs. Collins.

Mrs. COLLINS. Thank you, Mr. Chairman.

Hello, Dr. Harris. I have two questions—maybe a couple. Will your new technologies require changes in airports, say, the length of runway or investment in compatible electronic technologies, the new cutting-edge technologies?

Dr. HARRIS. Well, assuming we move forward with some of the new large airplanes, 600, 700 to 800 passenger airplanes, then certainly I foresee a change in how the airports will be used, runway size, maybe to a certain degree the thickness of the runway itself, how we handle baggage, how we move people. We can anticipate some changes.

Again, the way the FAA, NASA and industry moves toward this issue is one that is systemic with all the important ingredients on the table face up. We look for a systems approach. We look for ways to make the system more efficient and safe as we advance our technology.

The High Speed Civil Transport may require some different logistics on the ground as well. The replacement of existing subsonic aircraft probably will not demand any major changes of logistics on the ground.

Mrs. COLLINS. Also, you mentioned that your research, NASA research, must be used to help American industries, to help their competitiveness, and I agree totally. But a lot of American industries are now not just American industries, but have an awful lot of foreign investments in them. Is there a cutoff on where we will share your technology or is it just American-based industries or——

Dr. HARRIS. That is a very, very important question; one which we addressed this week at headquarters at NASA. What is a U.S. industry? And we start fine tuning that and there is a primary and a secondary U.S. industry. And we finally realized that engineers maybe ought to own up to the fact that we need lawyers to help define those terms. A very important issue.

Let me take it to a different level and simply say this. NASA currently recognizes that this production of and validation of technology must be done on time and secured for, in quotes, "the U.S. industry" and we will have to push ourselves very hard to make sure we understand that there is a limit. There is a floor below which we cannot go in defining what is a U.S. aviation industry. That definition right now, I cannot offer you, but we are working on that one.

Mrs. COLLINS. OK. Thank you very much. Mr. Chairman, when we visited the different manufacturers last year, I think it was——

Mr. OBERSTAR. Early this year, yes.

Mrs. COLLINS [continuing]. Early this year at Boeing, did we not see the designs for the 700?

Mr. OBERSTAR. 777, yes we did.

Mrs. COLLINS. Where is that now? Do we know?

Mr. OBERSTAR. Oh, they are moving toward——

Mrs. COLLINS. Building it? Are they?

Mr. OBERSTAR. Actual units have been completed and the aircraft is being assembled for flight next year, and we will have a Boeing witness on our next panel and you may wish to pursue that further.

Mrs. COLLINS. Oh, okay. Did NASA have anything to do with that design?

Dr. HARRIS. Oh, I would have to say yes, definitely.

Mrs. COLLINS. Great. Thank you very much. Thank you, Mr. Chairman.

Mr. OBERSTAR. Thank you, Mrs. Collins.

Dr. Harris, describe for us in following up on that last question, the process by which NASA interacts with the U.S. aviation industry with the private sector, to ensure that government research is focused on the anticipated market needs of the industry.

Dr. HARRIS. I think I will answer that question by outlining how we built, this Nation built what we described in the written testimony and in my oral comments as our Advanced Subsonics Technology initiative. That program is scheduled to begin in fiscal year 1994 with the 89 million number that I quoted. That program is focused on 10 elements. The elements are a result of a series of long and hard meetings, hard in terms of deciding priorities. Meetings in which the FAA, DOD and NASA and industry worked together to define what are the elements that will ensure a competitive advantage to our industry.

That program is one that has detailed specifics in terms of milestones. We know which technologies must come on line within a given timeframe. We know which of the three partners will be working the various components. The three partners being the Federal, industry, and the university communities.

The issue of resources, we have called our research and production facilities to meet those milestones. We have provided a particular set of reviews to critique our advancement. We have established metrics to ensure that they are deliverable within our plan.

I feel that whole exercise, that whole process is one which ensures that the Federal Government is working with our industry and our university communities to produce this useful technology.

Mr. OBERSTAR. Thank you.

In the area of composites, the ACT program, I see two issues. One is the validation of the materials that are used, many of which have been used already extensively in military application, and which are now being used in civilian aircraft validation of the materials, their durability and reliability. But also the mixture of composites with conventional airframe components and may produce different coefficients of contraction and expansion and interaction of metals with composites. What research and what inquiry has NASA done with respect to those issues?

Dr. HARRIS. NASA's—that program or that component of our Advanced Subsonic initiative, that is where we are putting the ACTs is one in which we are working very closely again with industry. For us within NASA, the work comes primarily out of our structures research and development activities at NASA-Langley in Hampton, Virginia. The various physical properties and the differences between the physical properties as a function of the materials is clearly in focus. We are designing appropriate test environments in which we can exercise the differences and better understand the performance of the materials of different composition as they must operate in the same environment.

Mr. OBERSTAR. At Airbus Industrie, for example in the 330 and 340 aircraft they are using composite in the tail section, which is joined with conventional metal superstructure of the aircraft. And I asked a number of questions, which raised some concerns for me—or the answers to which raised some concerns for me about over a long period of time, 10, 12 years, the different coefficients of expansion at high altitudes, low altitudes, the composites and the metal that may cause and stresses that might result in some structural problems, if not failures.

Dr. HARRIS. Well, sir, those concerns, again, certainly are on the table for us to examine. And through our simulation and projections, we feel we will be able to make a statement as to which type of composites can be used in various environments with existing types of materials. We certainly don't have all the answers but we certainly know what the right questions are in terms of which material will be used and will make very safe, timely projections of how to use those materials.

I would like to answer, there is another important part of this, in addition to the materials and their physical property, there is a concern that we have about manufacturability. The best of materials cannot be produced in a very economical way, do not provide a competitive advantage. So that is in focus in our programs, the manufacturability of these materials.

Mr. OBERSTAR. I don't intend to pursue an exhaustive inquiry in this. I am comfortable with your response, and if you feel you are asking the right questions, that is the most important thing. I will conclude with just a few more inquiries about noise.

The research on noise reduction and high speed civil transport—before we get to that point, the subsonic aircraft, the European Community is moving toward a stage four noise standard, and may soon adopt that standard. Your testimony, and I think the thrust of research of development in the U.S., has been on engine exhaust noise reduction, with nozzles and other baffles and other means of reducing noise, and I don't intend to get further into airframe noise reductions because we all know that even if you shut the engines off there is still a significant amount of noise on the approach.

The French have moved into technology of an antinoise noise device that will cancel out the apogee of the noise curve by emitting a sound that destroys that noise. I had an opportunity while in Paris to visit with SNECMA engineers and spend a good deal of time discussing this technology with them. Our approach in this country has been a very different direction. Are you familiar with the French technology? What is your assessment of it? And what is your feeling about the state of progress of engine exhaust noise reduction here?

Dr. HARRIS. I think the French have a very interesting approach and would encourage them to continue with that approach. I feel very secure in our structured program. And without question, the world's leaders in understanding jet noise, airframe noise, compressor noise resides in this country. We do not necessarily have in my opinion the best test facilities to look at full scale systems to examine those issues, but we are making progress in those areas as well.

Our approach and some of the work in noise reduction will be very substantial and we will be safely within stage three by the turn of the century.

Mr. OBERSTAR. What is your basis for ever thinking that high speed civil transport can achieve Stage Three status?

Dr. HARRIS. Our preliminary studies conducted at NASA Lewis in Cleveland, as well as the work that has been successfully conducted at GE and at Pratt on various types of ejectors and mixing of jet streams with the core.

Mr. OBERSTAR. Again, in the interest of avoiding exhaustive discussion of a subject, any one of these I would like to spend more time on, we can do that at a future date when the subcommittee members and staff and I will come to your Langley research center and spend some time there. But aging aircraft is an area that has always captured my attention. And I noted your remarks on research and continued focus on aging aircraft. And you talk about metal fatigue, structural methods, T-crack, disbonds. But corrosion is the area that I think needs the particular emphasis on. What new developments or what effort is being made in NASA on that score?

Dr. HARRIS. Again, sir, the issue of corrosion is a major piece of what we are trying to address. May I ask you to allow me to give you a written response to that one? It is a major concern and I would like to be very precise my reply.

Mr. OBERSTAR. I appreciate that. Incorporate into your submission an analysis of the new coating materials being used in aircraft manufacture and their ability to resist corrosion. But also focus on the matter of uneven surfaces that tend to collect moisture and trap it in hidden places that produce corrosion in areas that are not easily discovered.

Dr. HARRIS. We will address any assembly and manufacturing techniques that will give us an advantage in reducing corrosion as well.

[The information received follows:]

NASA CORROSION RESEARCH RELATED TO AGING AIRCRAFT

NASA is conducting research and technology development to improve current methods to detect corrosion in aging aircraft and to predict the consequences of the environment on fatigue life and durability. These advanced methods will result in a significant economic benefit to the airlines by providing the methodology to identify the location and to predict the consequences of corrosion before the deleterious effects are so widespread that expensive repairs to the structure are required. NASA is also working with the materials suppliers and the airframe manufacturers to develop more durable materials with enhanced corrosion resistance so that new airplanes will have a longer economic life. These corrosion research activities are being conducted through an interagency cooperative program involving the FAA, NASA, Air Force, Navy, aeronautical industry, and universities.

NON-DESTRUCTIVE EVALUATION METHODS FOR CORROSION DETECTION AND ASSESSMENT

Corrosion detection technology is under development in the NASA Aging Aircraft Program. Visual, ultrasonic, electromagnetic, and thermographic techniques are under development and are being specialized for airframe applications. While levels of corrosion greater than 5% of the material thickness appear to be detectable with several new techniques, the ultimate goal of the research is to detect 1% material loss. The capabilities of current prototype inspection equipment have also been demonstrated in actual airline and Air Force maintenance facilities on examinations of Boeing 707 and 727, and U.S. Air Force KC–135 and B–52 aircraft.

In ultrasonics, NASA has developed methods to minimize the effects of transducer and electronics variations thereby improving the ability of instrumentation to differentiate subtle variations in structures. The effects of variations of probe frequency, skin paint thickness, and epoxy thickness have been modeled and verified experimentally.

NASA has developed two enhanced eddy current approaches. Eddy current uses electromagnetic waves to penetrate the metallic skin to access corrosion. The first technique, developed through a cooperative agreement with an industry partner, images the magnetic field perturbations in the airframe structure and is easy to interpret and fast to use. In the second, NASA has developed a method that is significantly less expensive than conventional eddy current and has the potential to be more accurate for use in the field. This technology will be licensed to a U.S. industry partner in the near future for commercialization.

Since inner-skin material loss is difficult to find with visual inspection, thermography is also an important technology for corrosion detection. The ability of thermography to accurately quantify the size and depth of material loss was conclusively demonstrated. In thermography, a thermal wave "sees" the corrosion between the skin layers. NASA is continuing research to enhance signal processing and data interpretation.

ENHANCED CORROSION RESISTANCE AND FATIGUE PREDICTION METHODOLOGY

Life prediction methods are being developed which include the effects of corrosion on crack initiation, fatigue crack growth, and residual strength. NASA research is being conducted to establish the effects of various environments on aluminum alloys currently being used by the industry and on new alloys under consideration for the next generation fleet. The major emphasis of current work for the aging fleet is to establish the effects of corrosion on the initiation and growth of small fatigue cracks at riveted splice joints, skin-stiffener attachments, and tear straps. The development of prediction models will aid the airline industry and manufacturers to establish the service life to the onset of widespread fatigue damage. Other work is aimed at determining the structural integrity of old aircraft where degradation of the material over 20 years of environmental exposure may alter the fatigue resistance and toughness of the airframe material. Analytical methods are being developed to predict these long-term aging effects.

New alloys that exhibit the potential for being more corrosion resistant than currently used alloys are also being characterized. The behavior of these new alloys are being compared to the conventional alloys currently found on commercial transports. The objectives of this research are to develop a data base on environmental effects on material toughness and fatigue resistance, to identify controlling mechanisms so that improved materials can be developed, and to develop structural analysis design tools that will predict the effects of corrosion on the damage tolerance and durability of advanced airframe materials.

Coatings are used by the airframe manufacturers for corrosion resistance and prevention, and materials vendors are working to improve these coatings. Coatings are not used in an attempt to stop the spread of the corrosion on commercial transports. If corrosion is found, the corroded area is excised, repaired and returned to its pristine condition. Currently, NASA has no materials research in the area of coatings.

Mr. OBERSTAR. What is your assessment of FAA's technical competence to evaluate and certify new aircraft technical technologies?

Dr. HARRIS. Sir, my experience is working with our colleagues in the FAA has been a very rich and positive one. In the area of developing and validating pre-competitive technologies in the aviation area, the FAA has been a very strong, serious competent participant.

That is the extent of NASA's interest and authority in the aviation. I can only ask for more of the same. The relationship is a very good one. I hope we are delivering to the FAA the kind of assistance it needs and expects in order to advance aviation from the safety and certification end of it. Our relationship is a very good one.

I have the utmost respect for the competency of the professionals in the pre-competitive technology and validation area.

Mr. OBERSTAR. Thank you very much.

Dr. Harris, I wish you could see the smile on Dr. Broderick's face. Your presence has been very helpful to the committee. We greatly appreciate it.

Do you have some questions?

Mr. BOEHLERT. Mr. Chairman, I have a question.

Mr. OBERSTAR. We are glad to have you here.

Mr. BOEHLERT. I am just an ordinary traveling American citizen. I wonder, Dr. Harris, tell me is there any reason to be concerned when I get on an airplane and some bopper is sitting next to me with a CD jumping like that and one in the front operating a computer. You hear a lot of speculation that there is reason for concern because that interferes with the navigation system. Does it?

Dr. HARRIS. Yes, there is an element of risk there, sir. I believe it is standard procedure now that those electronic devices are not operating on take off and landing.

Mr. BOEHLERT. I don't think it is enforced. You mean there is a rule right now that prohibits that from being used?

Dr. HARRIS. There are requirements that the seat belt be fastened and that there be no baggage under your feet in take off and landing.

Mr. BOEHLERT. Is it a specific requirement about the operation of portable electronic devices while in flight? Are there specific directives now?

Dr. HARRIS. Directives, I cannot answer that question. I know there are requests being made to the passengers to not use those devices during take off and landing.

Mr. BOEHLERT. I don't mean to be funny about this, but it is either something that is cause for concern because of a potential safety hazard if it interferes with the navigation system, and if that is the case, they better damn well say, "You cannot operate your CD and all these other things."

Dr. HARRIS. Your specific question on whether there are rules or requirements, may I prepare for you NASA's written response to that?

Mr. BOEHLERT. Yes, you may. What a diplomat you are. You should be in the State Department.

Thank you.

[The information received follows:]

RULES OR REQUIREMENTS RELATED TO USE OF PORTABLE ELECTRONIC DEVICES

The Federal Aviation Regulations (FAR), Part 91—General Operating and Flight Rules contains Section 91.21 which specifically addresses operation of Portable Electronic Devices (PED) on-board U.S. registered civil transports. In August, 1993, the FAA distributed Advisory Circular (AC) 92.21–1 which provides information and guidance for assistance in the compliance of FAR Section 91.21. FAR 91.21 prohibits the operation of any portable electronic device unless the operator of the aircraft has determined specific devices will not cause interference with the navigation or communication system of the aircraft on which it is to be used. AC 91.21–1 provides information and guidance on recommended procedures for the operation of PED's aboard aircraft, and advice on how to determine if specific PED's could be safely used aboard aircraft.

Mr. OBERSTAR. Mr. Duncan.

Mr. DUNCAN. No questions.

Mr. OBERSTAR. Mr. Horn.

Mr. HORN. Following up on Mr. Boehlert's question, the planes that I have been on have made that request, but I also read that they were unable to replicate the situation when either laptop computers, CDs or whatever were done and that there is no real evidence at this point why the aircraft involved had what happened to them happen.

I wonder if in your letter you could tell us to what degree we are trying to replicate the conditions and what has been the result of those particular experiments and is there a legitimate fear we ought to have here or is this just some freak incident that we don't know what caused it?

It would seem to me as any good scientist knows, you can replicate the experiment if there is a danger here.

Dr. HARRIS. Representative Horn, I will certainly look into that.

Mr. HORN. Thank you.

[The information received follows:]

TESTING OF PORTABLE ELECTRONIC DEVICES

The Federal Communications Commission, in conjunction with RTCA (formerly the Radio Technical Commission for Aeronautics), is currently evaluating emission standards for PED's that may be used aboard aircraft. In December 1992, RTCA, at the request of the Federal Aviation Administration, established Special Committee (SC) 177 in order to develop test criteria and guidance relative to portable electronic devices carried on board aircraft. The current standard, AC 91.21–1, states that all PED's should be designed and tested in accordance with appropriate emission control standards. RTCA/DO-160C, "Environmental Conditions and Test Procedures for Airborne Equipment" and RTCA/DO-199, "Potential Interference to Aircraft Electronic Equipment From Devices Carried Aboard" are cited as potentially acceptable methods.

Mr. OBERSTAR. My colleagues will recall that during floor debate on the DOT appropriations bill there was discussion between myself and the Transportation Appropriations Subcommittee Chairman of a provision in their bill on this subject.

While we could not precisely apply a point of order to strike it, permission has been withdrawn in conference so authority for airlines to continue making that announcement remains in place. We will pursue this matter within the FAA.

Mr. BOEHLERT. Mr. Chairman, with all due apologies, I was not paying attention to every single word that was uttered during that very distinguished debate. Can you tell me what was the essence of it? Were the appropriators trying to take language out?

Mr. OBERSTAR. The appropriators were trying to make it easier to operate electronic equipment on-board airport. I thought that was inappropriate to do on an appropriations bill.

Mr. BOEHLERT. And as usual, your wisdom prevailed?

Mr. OBERSTAR. It prevailed in conference.

Mr. BOEHLERT. It is always a pleasure to serve with you, Mr. Chairman.

I will have some follow-up questions for Dr. Harris regarding portable electronic devices.

[The questions submitted by Mr. Boehlert and responses from Dr. Harris follow:]

U.S. House of Representatives

COMMITTEE ON PUBLIC WORKS AND TRANSPORTATION

SUITE 2165 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515
(202) 225-4472

October 20, 1993

Dr. Wesley L. Harris
Associate Administrator
Office of Aeronautics
National Aeronautics and Space Administration
Washington, D.C. 20546

Dear Dr. Harris:

Thank you for your testimony before the Aviation Subcommittee today on Advanced Aircraft Technology. As you are aware, I am very interested in pursuing the issue of whether portable electronic devices, such as computers and CD players, interfere with aircraft navigation systems.

I would appreciate your response in three weeks to the list of questions below:

- Does NASA believe that portable electronic devices can interfere with aircraft navigation systems?

- Is it true that scientists have not been able to recreate the navigation interference that allegedly occurs when portable electronic devices are used in aircraft.

- Does this alleged interference occur in all types of aircraft or does it depend on the technology in the aircraft? Will this also be a problem on "fly-by-wire" aircraft such as the Boeing 777?

Please also provide a copy of your responses to the Aviation Subcommittee at 2251 Rayburn. Thank you in advance for your cooperation.

Sincerely,

Sherry Boehlert

SHERWOOD L. BOEHLERT
Member of Congress

National Aeronautics and
Space Administration
Headquarters
Washington, DC 20546-0001

Reply to Attn of LB:KJ

DEC 9 1993

The Honorable Sherwood Boehlert
House of Representatives
Washington, DC 20515

Dear Mr. Boehlert:

Thank you for your letter of October 20, 1993, to Dr. Wesley Harris, following up the Aviation Subcommittee hearing on Advanced Aircraft Technology. You asked a number of questions concerning Portable Electronic Devices (PEDs) on aircraft.

NASA is unaware of any independent evidence that suggests that PEDs interfere with aircraft navigational systems. Existing guidance material concerning PED use aboard aircraft was developed to protect navigational devices from the potential interference due to potential sources of interference internal to the aircraft, especially those caused by portable telephones. To our knowledge, the wider variety of personal electronic devices that are used by passengers traveling in aircraft today have not caused any interference that can be scientifically recreated. However, we support the RTCA, Inc. (formerly the Radio Technical Commission for Aeronautics, which has recently formed a special committee to investigate the potential for PEDs to interfere with the operation of aircraft systems) and the Federal Aviation Administration (FAA), who are responsible for responding to the concerns about PEDs expressed by the aviation community. The RTCA's special committee will devise methods and criteria for testing devices and validating those tests, both in carefully controlled environments and in actual transport aircraft.

While NASA has no research focused specifically on PEDs, we do have ongoing research in electromagnetic effects which is focused on understanding high-intensity radiated fields (HIRF). The objective is to develop tools for industry and FAA use in designing, validating, verifying and certifying aircraft that are exposed to electromagnetic fields. As industry's and FAA's need for research to support the development of PED guidance material arises, NASA will provide the applicable results.

The potential interference of personal electronic devices is not specific to a particular aircraft but is of potential concern across all aircraft. The existing guidance material proscribes a special, focused test procedure developed for the known sources of potential interference. Navigational devices can be properly protected by shielding against a relatively well-known source of interference. However, the flight controls on today's aircraft are primarily mechanical, pneumatic, or hydraulic, and we expect there to be no cause for concern of interference by PEDs. Further, the first "fly-by-wire" aircraft in today's airline fleet is the Airbus Industrie A-320, and we know of no reports of susceptibility of its flight control system to electromagnetic interference. We suspect that the extensive testing that is conducted to protect flight controls from HIRF will also protect the flight controls in "fly-by-wire" aircraft from interference from PEDs. It is our understanding that U.S. manufacturers have applied these stringent criteria for HIRF to ensure that the flight control systems on their "fly-by-wire" aircraft are immune to radiated fields.

We hope this information is helpful. Thank you for your interest in NASA's Aeronautics program.

Sincerely,

Jeff Lawrence
Associate Administrator for
Legislative Affairs

Mr. OBERSTAR. Dr. Harris, thank you very much for being with us today. We appreciate your testimony.

Thank you.

Our next panel includes Mr. John M. Swihart, Vice Chairman of the Board, National Center for Advanced Technologies; and Mr. Robert E. Robeson, Jr., Vice President, Civil Aviation of the Aerospace Industries Association of America.

Mr. GEREN. I think our colleague, Mr. Boehlert, is a little giddy today because of his victory yesterday. You will have to understand. He finally killed our big science project.

Mr. OBERSTAR. Gentlemen, we are happy to have you with us this morning. We appreciate your testimony.

Mr. Swihart, you may proceed.

TESTIMONY OF JOHN M. SWIHART, VICE CHAIRMAN OF THE BOARD, NATIONAL CENTER FOR ADVANCED TECHNOLOGIES, ON BEHALF OF THE AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA; ROBERT E. ROBESON, JR., VICE PRESIDENT, CIVIL AVIATION, AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, ACCOMPANIED BY GERALD MACK, DIRECTOR, CERTIFICATION AND TECHNICAL LIAISON, ENGINEERING DIVISION, BOEING COMMERCIAL AIRPLANE GROUP, AND WEBSTER C. HEATH, CHIEF TECHNICAL ENGINEER, AIRWORTHINESS, DOUGLAS AIRCRAFT COMPANY

Mr. SWIHART. Thank you, Mr. Chairman and members of the committee. I thank you for the opportunity to appear before the subcommittee today. I am going to talk about advanced technology and my friend Mr. Robeson will address the FAA certification issues.

This hearing on advanced aviation technology gives me a chance to gaze into industry's crystal ball and provide you with a glimpse of the types of technologies that industry is hoping to bring on line by the end of this century and early into the next century.

Mr. Chairman, I am John Swihart. I am the Vice Chairman of the Board of the National Center for Advanced Technologies. I am also a retired vice president of The Boeing Company.

As Dr. Harris knows, I spent 13 years in the wind tunnels of Langley, so I have a little background on the subject. Now the NCAT, our National Center for Advanced Technologies, is a nonprofit foundation established by the Aerospace Industries Association in 1989 to identify key technologies most critical to the continued leadership of our Nation in aerospace and to devise a roadmap and a development plan for the development of each technology. Today I am appearing on behalf of the AIA membership, the U.S. manufacturers of aircraft, engines, missiles, spacecraft and related components and equipment.

Before I address some of the new technologies for the subcommittee, I thought you may be interested in learning how industry, the government and academia have been working together toward the advancement of technology. The strategic plan on airbreathing propulsion systems developed by AIA and NCAT in February 1992 is a good example of the cooperative efforts being undertaken by industry.

AIA member companies, GE Aircraft Engines, Teledyne/CAE, UTC/Pratt and Whitney, ASAC/Garrett, Textron/Lycoming, GM/Allison, and Rockwell International prepared the plan with the assistance of a review panel comprised of leaders from industry, government and universities.

The objective of this "Airbreathing Propulsion Technology Team" was to establish a strategic plan based on roadmaps. Their goal is to provide a national plan to improve engine performance, reliability and fuel efficiency, as well as reduce weight and volume, acquisition and operating costs.

The roadmaps developed by the team include discussions of issues such as efficiently transitioning new technology into production, development of high-risk, high payoff research and techniques for addressing multidisciplinary analysis methods.

The plan covered both civilian and military aircraft since any advances in technology would be mutually beneficial.

This plan is only one example. Over the years, NCAT has developed similar roadmaps for the development of additional new technologies, such as advanced sensors, rocket propulsion, and advanced composites.

NCAT is currently working on demonstrations of engineering and manufacturing operations, which are technology demonstrations that are very close to a product when they are finished.

These will include integrated product and process development, very similar to what you referred to, Mr. Chairman, that The Boeing Company is doing on their new 777 program. IPPD is a systems view of demonstrations which will integrate several technologies and manufacturing and process technologies to improve productivity and life cycle cost.

I might add for Mr. Horn's benefit they also include the factory floor worker in the team right from the beginning.

With that as background, let me discuss some specific things about Subsonic aircraft for a minute. I want to follow up on what Dr. Harris has covered in the subsonic arena. While transport aircraft have not visibly changed much to the casual observer, technology has moved aviation forward.

The introduction of new commercial aircraft technologies has been evolutionary rather than revolutionary. It is because most of those new technologies, whether they are glass cockpits or computers, must be justified on the basis of safety and cost. Thus although the advancements may appear very small, appear to be incremental, collectively they add up to some very measurable improvements in aircraft safety and efficiency.

In the subsonic aircraft, we see continuous improvement in a number of areas. Advancements in engine technology are focused on making the engines quieter and more fuel efficient. Pratt and Whitney, General Electric and Allison have worked with NASA's Lewis Research Center on advanced core engine technology. They found that thermal efficiency can be improved, increasing core performance 60 percent.

Studies done at Lewis predict that the overall fuel consumption can be reduced 20 to 30 percent possibly reducing operating costs therefore by 6 to 14 percent. Sixty percent of that savings can be attributed to the increase in core thermal efficiency.

Noise reduction technology, as Dr. Harris has said, is a major effort for the industry. Theoretically, engineers know how to reduce engine noise, but they encounter design problems when putting the theories to work. Regardless, a quieter, more fuel-efficient engine will be developed. In addition, research is being conducted to reduce airframe noise, as the chairman mentioned, particularly when the aircraft is on landing approach.

Reduced weight is a high priority for the commercial aircraft. That will also help noise, by the way. Industry is working to continue the advances made in recent years in the development and use of composite and new metallic materials. In addition to weight reduction, composites resist corrosion better than other materials. New developments in this area may replace metal wings and fuselages with epoxy-type resins and high-strength carbon fiber. Maintainability and cost are typical of the challenges in increasing the use of composites on commercial aircraft.

If we can overcome all these things, weight savings in the final manufactured products can be 20 to 30 tons. That represents several tons of weight savings in a large commercial transport.

Continued investments in rotorcraft are needed to keep the U.S. helicopter industry competitive. Advancements are needed to yield dividends in cost, reliability, and maintainability, external and internal noise, vibration control, reduction in weight and improvements in performance. In addition, work is being done by industry and NASA to research the acoustic, structural and performance characteristics of commercial tilt-rotor aircraft.

I would like to turn now to high-speed civil transport, a subject near and dear to my heart. This aircraft itself is not a new technology. In fact I personally started working on advanced supersonic transport in 1958 when I was the chief engineer of Boeing's supersonic transport project when it got cancelled by Congress in 1971.

This project, however, is going to be different. It will incorporate a combination of many new technologies that we have learned about over the last 22 years. Not long after the turn of the century, thousands of passengers a year could be flying from Los Angeles to Tokyo in four hours, instead of the 12 hours it takes to travel on subsonic aircraft.

A safe, profitable, reliable, and environmentally friendly HSCT would drastically change international travel, just as the first subsonic jet transports did 35 years ago.

I don't know how many of you recall, but when the first 707s and DC–8s came on the market, there were a lot of brand-new DC-7s and Convairs out there and they immediately went to the junkyard.

The challenges facing the development of the HSCT are daunting, but we believe that the challenges can be overcome. In late 1989, NASA asked Boeing and McDonnell Douglas to "define the potential market for a next-generation supersonic airliner and consider the engineering advances that would make it financially successful and environmentally safe."

Both firms predicted that transpacific travel will increase 400 percent by the year 2000 and that transatlantic trips will double. According to the study, by the mid-2000s, there could be 600,000 passengers per day traveling on more than 1000 HSCTs at more than 2.4 times the speed of sound.

There are a number of difficult design problems that must be solved before aircraft development can begin. For economic reasons, an HSCT must use the same airports as conventional subsonic aircraft. This means it must meet the current Stage 3 noise rules—one-tenth the noise level of the supersonic Concorde. In addition, the engine emissions of the HSCT must not harm the earth's ozone layer.

The last and perhaps most difficult requirement is that all the new technology in the HSCT must be combined in such a way that it is cost competitive with the best subsonic jet transports.

HSCT engine research during the past two years has focused on the reduction of oxides of nitrogen (NoX) emissions from aircraft engines. Two very promising designs are being studied that either one could reduce NoX emissions by the goal of 90 percent, I think as Dr. Harris said in his testimony, five grams of NoX per thousand grams of fuel.

To resolve the noise issue, Pratt and Whitney and General Electric are working with NASA to evaluate engine choices for the HSCT. The designers want an engine that has low exhaust velocity at takeoff, like the current high-bypass turbofans used today. However, the engine must also have good supersonic cruise performance, which requires a high-velocity, turbojet-like cycle—the exact opposite of the characteristics that reduce noise. It appears that a mixed flow turbofan with a mixer/ejector nozzle is a good option to provide the supersonic performance and low takeoff noise needed.

As in subsonic design, new material research for the HSCT focuses on increased strength and reduced weight. Study focuses on ceramic matrix composites that could function without surface cooling in the high temperatures of low-emissions jet engines.

Another area of research is developing new intermetallic matrix composites for the exhaust nozzles that would reduce their weight by 30 percent over current metal alloys.

In addition, the composites being developed for the HSCT must be low-cost, able to operate at over 400 degrees Fahrenheit, and be able to operate for a lifetime goal of at least 18,000 hours.

Success in this project will save about 90,000 pounds of take-off gross weight; that is about 11 percent of the value today, which is very significant.

One way to reduce drag and increase fuel efficiency is to reduce the turbulent airflow over the wings, leaving a smooth or "laminar" flow. Initial tests, using NASA research aircraft, have provided a good basis for reduction of drag. The goal is to achieve laminar flow over 45 to 60 percent of the wing surface. This will save an additional 8 percent of take-off gross weight, or approximately 60,000 pounds. That is like 300 passengers.

Our predictions are that the first high-speed civil transport could roll off the production line by 2005, and I say 2007. The technology developed for the program will advance aviation, and will create a multi-billion dollar market. The market will be $300 billion in 1993 dollars. That money will go to the U.S. manufacturers, and air carriers.

Mr. Chairman, that concludes my prepared remarks. I would be pleased to answer questions.

Mr. OBERSTAR. Thank you very much. So it is somewhat in context, would you explain laminar flow?

Mr. SWIHART. Did you ever hold a cigarette in your hand and watch the smoke going very smoothly for about three or four inches and then start to wobble like this?

Mr. OBERSTAR. I have watched others do that.

Mr. SWIHART. The part where it is going very smooth is laminar. On an airplane wing, when you get that very smooth flow, you have one-fifth of the drag that you do when it is wobbling and turbulent.

Mr. OBERSTAR. What characteristic of the wing makes that happen?

Mr. SWIHART. Actually it first depends upon the shape of the wing and then for high-speed airplanes like a subsonic transport or supersonic transport you must actually physically suck off the very thin layer right at the bottom to keep that smooth flow going or it transitions to a burbly flow, turbulence as we call it.

Mr. OBERSTAR. Thank you.

Mr. Robeson.

Mr. ROBESON. Thank you, Mr. Chairman. My name is Bob Robeson. I am the Vice President of Civil Aviation for the Aerospace Industries Association. Mr. Swihart has already described for your what that organization does.

Accompanying me today are Gerald Mack, Director, Certification and Airworthiness, Boeing Commercial Air Plane Group, and Webster C. Heath, Chief Technical Engineer, Airworthiness, Douglas Aircraft Company.

They agreed to answer any questions the committee might have with respect to certification.

Mr. Chairman, AIA is committed to working as partners with the FAA and I might digress for a second and note the predecessor of the FAA was formed in the 1930s really at the request of manufacturers who were concerned about the state of safety in aviation at that time.

Thus, we have a long and cherished tradition of partnership working with the FAA and its predecessor agency in its mission to ensure continued improvement in the safety and efficiency of civil aviation.

In this context of partnership, I would like to address the following principal issues which have been raised by the GAO report. We see those as the introduction of new technologies, the role of the FAA in the certification process and the designee system and FAA technical competence to certify our products.

With respect to new technologies, Mr. Chairman, Mr. Swihart's testimony on new technologies that we see coming on line really provide the context for my remarks. The application of technology in civil aviation, as Mr. Swihart said, does tend to be evolutionary rather than revolutionary. That is because in the environment in which we operate commercially affordability is really paramount to success.

If you go to some of the conferences these days like the SAE Aerotech Conference, which was held in California last month, you will see that certification and affordability provide the context for many of the scientific and technical papers that are presented.

Manufacturers must provide value-added technology which means that the technology should be added only when it results in improved safety or lower cost to the operator.

The cost of a totally new technology tends to be quite high driven by development costs as well as validation required to demonstrate that the technology is safe. This is a major factor in our evolutionary approach to applying technologies to aircraft. It is important to remember that this gradual introduction of technologies usually means that the FAA already has a good foundation of knowledge which it can apply to its analysis of a type design.

Even in those unusual cases where new technologies are introduced rapidly, the FAA works closely with the private sector to ensure that the application is properly certified.

The aircraft certification process is a "closed loop" process. New aircraft designs and derivative versions evolve as the market dictates. The level of new technology incorporated into these designs depends on the proven benefits in terms of cost and efficiency and safety.

It is also a closed-loop process because it includes not only certification of the design, but monitoring the design in the operational phase. This later phase provides the feedback to correct, first of all, the specific design if an unsafe condition exists and secondly to update the Federal Aviation Regulations if the requirements were deficient. This process has worked extremely well over the past 30 years.

As Mr. Swihart pointed out, the transport airplane has become more complex over the years. Most of the recent developments have come in the area of digital data systems and the safety and cost benefits that are derived from these advancements are nothing short of phenomenal. It is accepted today that these advances such as map displays, are largely responsible for the low accident rate of new generation airplanes.

If I had to point to one, I guess I would point to ground proximity radar which is probably one of the most important applications of new technology to the airplane in terms of safety.

Applications of advancements in other technical disciplines have been more limited. Airlines want airplanes to be as simple as possible to operate and maintain, which takes us to Mr. Horn's question. Frankly, the airlines have expressed to us some problems with the maintainability of such things as composites on the aircraft and the cost involved of having those materials on the airplane.

Non-safety related advances must result in lower life-cycle costs so that the total cost to the operator of having the new technology on is less than what it would have been without it. It is this fact which drives the evolutionary approach to the application of new technologies to airplanes.

Let me turn to the question of the certification and the designee system. We believe in order to understand the role of the FAA as a certifying authority it is important to understand the development of the rules. FAA's rulemaking involvement in this business is to develop certification requirements and standards that will ensure the safety of the traveling public.

An important part of this regulatory development is the issuance of pertinent guidance or advisory material that tells both FAA and industry engineers and pilots how to apply the requirements to a specific design.

The Aviation Rulemaking Advisory Committee activity enables the public to participate fully in the regulatory development process. We believe that this ARAC process will result in much more effective requirements. It has been a little slow getting off the ground but we are beginning to see some rules now coming through the ARAC process and we hold high hopes for that.

The FAA's role in the actual certification of the aircraft or the engine or whatever the product is which requires the type certificate is where the requirements are actually applied.

The entire process must be carefully managed to ensure that resources are being used for maximum benefit can be realized. The delegation process, which has been described, includes the designated engineering representatives, designated manufacturing inspection representatives and company delegation programs, and we believe, has been proven to be a viable and effective means for certificating aircraft products.

The numerous studies of the delegation system have borne this out over time. Under the designee system, candidates are screened and trained prior to the appointment, then given progressive responsibility and authority by FAA as confidence is acquired. The number of designees has risen significantly the past ten years primarily due to the increased use of digital systems. However, the DERs are more limited in scope in these areas due to specialities. So although the FAA workload has increased in handling appointments, the workload due to supervision of DERs has not increased proportionately.

The amount of delegation given to a specific DER is based on the experience and working relationship developed between the FAA engineers and the DER. This is similar to the way any employee is given increasing responsibility as the employee develops his or her capability.

In the case of a DER, this consists of developing a capability of applying the FAA requirements. Fortunately, given the nature of the rulemaking process, many DERs have had a significant role in assisting with the development of the requirements themselves. Thus they are already very knowledgeable about the requirements and their application.

AIA is concerned about a possible ambivalence in the GAO report in its discussions of the designee system. We firmly believe that the delegation program works well precisely because the FAA and the manufacturers are in close contact from the beginning of the application for the type certification basis through the service life of the aircraft type.

For this reason, we were somewhat puzzled by the GAO recommendation on page 27 that the FAA should identify "critical activities requiring the agency's involvement of oversight * * *". We are not clear as to the meaning of this recommendation since we believe that this involvement is precisely what happens for each product that requires a type certificate.

Up front cooperation between the applicant and the FAA in concert with the DER system enables the agency to focus its resources where they are needed.

As new technologies evolve from initial concept to reaching the point of being viable for civil aircraft, many individuals with differing interests and expertise are involved. The FAA certification staff should not waste valuable time and resources in research and development activities on a technology that will never get on an aircraft.

What should happen is that the national resource specialists who are mentioned in the GAO report, the specialists for a particular specialty should, number one, maintain general oversight of a technology; and number two, begin to lead the development of reasonable standards for certifying designs with the new technology as that technology nears application on an aircraft program.

Number three, they should take a significant role of bringing the FAA certification staff up to speed using a combination of formal and on-the-job training. We believe that the FAA has partially implemented this approach, but further refinement would ensure full implementation. A true NRS/Certification staff team is mandatory to an effective program.

Finally, we wish to address questions concerning the technical competence of FAA staff. Any meaningful discussion of this question must be based on a clear understanding of the mission of the aircraft certification service. While this may appear to be stating the obvious, we must recognize that their job is to certify the design of the product and the quality systems under which the product is built.

Their job is not to design the product or to specify a particular quality system. In order to perform the job of certifier, the FAA official must be able to understand the information presented to the agency.

This is not the same as having the ability to develop the information in the first place. Today's aircraft and systems are so complex that we have become an industry or specialties and specialists down to a micro level.

That is one reason why we have so many more DERs who often have very limited areas of authority. To be the best at aircraft design in any of these specialties, you have to work in your specialty constantly. It is not reasonable, nor fair, nor necessary to expect a certifying official to be an expert at the same level of expertise as the specialist in the company who works hands-on in a given technology every day.

Certainly, training is an important tool in ensuring a qualified certification team. But we must be realistic as to goals of such training and what can be accomplished. In particular, we urge this committee to support funding for the certification service with a focus on near-term needs.

Training directed toward technologies that will not be incorporated into the fleet for another ten years we believe will be a waste of scarce resources. Training that is sharply focused on meeting the current needs of the certification service and is grounded on a clear understanding of the distinction between the aircraft designer and the aircraft certifier would help improve the efficiency of the certification process.

Mr. Chairman, that concludes my remarks. We will be pleased to answer any questions the committee might have at this time.

Mr. OBERSTAR. Thank you.

Both statements have been very much on point on the issues of technology that we are exploring in this hearing.

Mr. Swihart, what are the major advances in safety you anticipate coming along between now and the end of this decade?

Mr. SWIHART. I think that the major advancements in safety will be our continued attention at all times to every single piece of the airplane and airplane design and the air traffic control system, so to speak, the total system activity.

Mr. OBERSTAR. Mr. Robeson, do you have a comment on that question?

Mr. ROBESON. Yes. It was pointed out earlier that relatively few accidents or incidents are attributable to problems with the aircraft.

We think that there are many things that can be done to enhance crew performance such as crew monitoring through the use of the flight data recorders to examine areas generically which may need attention.

We see that as an important area. We see the introduction of wind shear detection avoidance devices as very important.

We believe that now the real areas for high payoff in terms of safety are in accident avoidance. That is where we would like to see a lot of the FAA R&D efforts up at the Tech Center be directed.

Mr. OBERSTAR. Does that focus more on human factors than on design technology?

Mr. ROBESON. If there is a question, I suppose it is whether you can totally separate the two because human factors, the design of the cockpit, for example, are right where the rubber meets the road.

Mr. OBERSTAR. The human performance factors in the cockpit. Let me be more precise about that.

Mr. ROBESON. In the cockpit, in the tower, yes, sir. Let me add one other thing——

Mr. OBERSTAR. I had felt that with the great advances in technology in air traffic control and in cockpit technology, that we are placing an awful lot of reliance on technology and that we may be moving away imperceptibly, but actually, from better training and greater human performance requirements.

Mr. ROBESON. I don't know that I would say we are moving away from it. I did notice in Dr. Harris' written presentation that there is reference to doing some human factors study with the glass cockpit that NASA has acquired.

Mr. OBERSTAR. I interrupted you before. Go ahead.

Mr. ROBESON. I was just going to say, one area of human factors also that we have identified goes back again to Mr. Horn's question; that is the ability of mechanics to read and understand the directions that come out of engineering on how to maintain the airplane. That is a human factors issue.

Mr. OBERSTAR. In response to my question, both of you referred principally to crew and to air traffic control technology. What advances in aircraft manufacture and engine manufacture technology do you see as contributing to enhancement of safety?

Mr. SWIHART. I might say, Mr. Chairman, that I think the continued effort that both the industry and NASA has on composite material will in the long run enhance safety. It does not corrode. It does not fatigue. It is lighter than what we have had in the past.

Composite material in both the engine and airframe will improve our overall performance and in turn will be a factor in the safety of the airplane.

Mr. OBERSTAR. That was my next line of inquiry. That is, what are the deterioration factors for composites, disbonding of laminates, ultraviolet thermal impacts, compatibility of composites with metals?

Mr. SWIHART. Let's ask Jerry to expound on that.

Mr. MACK. I am Jerry Mack from the Boeing Company. The composite program started back in the 1970s in terms of the NASA Ace program. Those particular concerns were addressed and looked at. A very cautious approach has been taken on the civil aircraft side of the house to make sure that those kinds of concerns are properly addressed.

I think we have a lot of confidence that the materials that have been selected do cover those concerns.

Mr. OBERSTAR. Mr. Heath, do you have a comment on that subject?

Mr. HEATH. My only comment would be that we also have right now a DC–10 with a vertical fin that is totally composite out on a field service evaluation. It has been out for five or six years.

We are looking at that from a field service evaluation with the total composite of major structures.

Mr. OBERSTAR. Do you draw on military experience with composites in your evaluation of application to civil transport?

Mr. HEATH. Yes, sir.

Mr. OBERSTAR. Mr. Boehlert.

Mr. BOEHLERT. Thank you, Mr. Chairman. I know the use of DERs is a real world solution. Obviously, we don't have enough resources to have what we need in the FAA to do the whole certification process itself.

Is there any evidence that the system is not working as designed? The testimony seems to indicate satisfaction with the present system.

Mr. ROBESON. We believe the evidence indicates quite the opposite, that it is working extremely well. The DERs are not shy about going back to the design bureaus and telling them they have to change something before the DER will approve it on behalf of the FAA.

Mr. BOEHLERT. So your experience within the company is that they have some independence of thought?

Mr. ROBESON. Yes.

Mr. BOEHLERT. I appreciate your testimony to that effect. That is good news.

Let me ask you something else: Is there any evidence that either of you can cite where the certification process that went on indeterminately simply because the people that were doing the certifying did not understand the concepts?

Mr. ROBESON. That is what I have my experts here to talk about.

Mr. HEATH. I will start. I don't think so. The reason I say that is that as the manufacturer, we will not allow that to happen. We are very conscious of our responsibility in this process. We are going to make sure that our counterpart at the FAA understands fully the complications of the program and the situation that we are trying to certify.

Mr. BOEHLERT. Is it fair to say, Mr. Heath, for me, a lay person, that you have more specialists and they have more generalists although they are specialists? Is that a fair comparison to say that you have specialists from the corporations dealing with generalists in the FAA?

Mr. HEATH. That is kind of a fair statement. It is generally so. It is like the medical profession. There are a lot more specialists out there in the medical profession than the old family doctor.

So you are looking at the same kind of thing. We have specialists who deal specifically in the takeoff performance and don't do anything else in that area.

The counterpart in the FAA is sharp. They are sharp people. They understand. They may not go down to the full nits and grits of trying to understand that, but you don't need that.

Mr. BOEHLERT. So the process is relatively smooth and it is not handicapped in any way by the fact that you have people in the FAA that might not be as sophisticated in certain areas of technology as the people they are dealing with. So you don't see any problem there.

Mr. Mack.

Mr. MACK. With regard to—Mr. Robeson covered this a little bit about the process. It becomes our responsibility in this type of a system and I believe this is perhaps what the GAO has identified, it becomes our responsibility to get the FAA up to speed on something new that we are identifying in our products.

So we have seen a need to do that much earlier as we want to firm up the requirements on our design before we get further into making the product. So we realize we have to provide some training and it is informal-type training, exposure to what we have been designing and the concepts we are going to use to validate that design.

We have incorporated a new philosophy within Boeing and I think other manufacturers have done the same thing. We call it information sharing. It is involving the FAA in the process, not only the FAA, but our customers, the airlines. ALPA has even been involved. We allow them to see our design and concepts before we start cutting metal, as they say.

Mr. BOEHLERT. Thank you.

Mr. OBERSTAR. Mr. Geren.

Mr. GEREN. Thank you, Mr. Chairman.

Mr. Swihart, I have a keen interest in tilt-rotor technology. You mentioned in your statement that industry and NASA are working on various aspects of tilt-rotor technology.

It is my understanding that the FAA's vertical flight office has also been working on certain tilt rotor issues such as air traffic control procedures. Are you aware of this and can you comment on the situation as you see it?

Mr. SWIHART. We are aware that there have been funds allocated within the FAA in the last several years for civil tilt-rotor activities. There has been activity in the flight testing and simulation and activities under way to analyze and develop regulations and procedures that we are going to need to bring those aircraft into the terminal.

I think that anything that we can do to put attention on the fact that we have a different class of airplane that may land nearly vertically or thereabouts can be integrated into the air traffic control system is good and the FAA is certainly working on that.

Mr. GEREN. Thank you, Mr. Chairman.

Thank you for your response.

Mr. SWIHART. Mr. Chairman, I would like to say one thing to Mr. Boehlert. You know it is in our best interests to have the safest possible airplane we can because an accident by anybody's airplane hurts all of us.

Therefore, the activity in DER that people go through is very, very important. We want them to be as tough as they can be because we want the most safe airplane that we can roll out the door.

Mr. BOEHLERT. Thank you very much. I appreciate that. I just wanted to have that in the record.

Mr. OBERSTAR. Mr. Horn.

Mr. HORN. Thank you, Mr. Chairman.

You might have to furnish this for the record, but I would like to ask the industry representative, as well as Boeing and Douglas specifically, the percentage by value of a Boeing or McDonnell Douglas aircraft, let us take your latest model, that is produced by foreign manufacturers.

Then I am curious to what extent, if any, the use of products from foreign manufacturers has complicated the FAA certification process. You might wish to file that for the record on the percentage. But maybe we could have your off the cuff feel for the degree to which the fact of foreign manufacture has complicated certification.

Mr. MACK. The process, as far as the certification process being complicated, it is not really a problem because the FAA of course is an international organization and they have a lot of confidence in the countries with which we deal.

In all countries where we have to have parts there are bilateral agreements so the FAA has already determined the technical competence of those countries. So the certification process, they deal with each other. I don't think the certification process is complicated at all with that regard to that aspect.

Mr. HORN. Any comment?

Mr. HEATH. It is not a complicated process. It does put a strain on the resources of the FAA to support some of the efforts that we have going around the world and we have a lot of them going around the world.

So the process of making that happen is not difficult, but the demand on their resources, not only in manpower resources, but financially is also a very heavy burden on them.

Mr. HORN. Douglas Aircraft has extensive manufacturing operations in Shanghai. You really are going to manufacture all of the product there or will some come from the United States?

Then my query is to what degree would those airplanes, which might be solely for the domestic internal Chinese market, get into the international flow of traffic and land in the United States, does FAA certification apply there?

Mr. HEATH. I could give you my opinion, but I would rather let the FAA give you their opinion as to that.

I believe that when that airplane is issued an export C of A to be shipped to the Chinese airline from the facility in Shanghai, we have already taken back into this country and delivered five of those airplanes to a domestic operator with a standard certificate of airworthiness issued by the FAA.

When we talk about those airplanes going into the international market it becomes a little bit of a different problem because we start now talking about the third-party involvement in the bilateral agreement that is between the United States and another country.

That other country may not accept that airplane built in China only because they were not a part of a bilateral discussion between us, the Chinese and another country.

But that does not mean that that airplane could not be operated there because that now says the manufacturer ought to go work with that authority in trying to convince that authority that that is equivalent to an airplane coming out of Long Beach.

Mr. HORN. Following up on that, you are telling me planes manufactured in Shanghai will be sold to domestic United States operators and already have been?

Mr. HEATH. Yes, sir.

Mr. HORN. What planes are those?

Mr. HEATH. We have sold airplanes to TWA.

Mr. HORN. They are used in domestic U.S. operations?

Mr. HEATH. Yes, sir.

Mr. HORN. So the line at Douglas in Long Beach does not make those planes or does it make any?

Mr. HEATH. They do make the airplane. That airplane is a kit airplane. The parts are all shipped from here and assembled in China.

Mr. HORN. I know that the parts are shipped from here and assembled in China, but then that plane comes back into U.S. traffic that is assembled in China?

Mr. HEATH. Yes.

Mr. HORN. Fascinating.

Thank you, Mr. Chairman.

Mr. OBERSTAR. I have two questions that I will submit in writing for this panel. I would like you to respond for the record.

[The questions submitted by Mr. Oberstar and responses received from AIA follow:]

AIA RESPONSES TO QUESTIONS POSED BY MR. OBERSTAR

Question No. 6. Mr. Robeson, you state that about technology being evolutionary, with new introductions of technology actually coming along relatively slowly in terms of actually being put on aircraft. This enables FAA to develop a knowledge base to evaluate designs. How does industry bring FAA into its early and on-going development of technology?

Response. As manufacturers identify technology that will prove to be beneficial and acceptable to their customers, the technology is incorporated into the new and derivative products. Manufacturers recognize the need to provide the FAA certification staff with early awareness of these technologies to ensure that the appropriate standards are developed for certification. In many cases, FAA engineers are invited to participate in development tests to gain an understanding of the concepts prior to entering the certification process. We also conduct, on an as required basis, new technology training seminars.

Question No. 10. You mention the role of National Resource Specialists. GAO says the FAA is understaffed on this area. Do you see a serious deficiency in this area? You say further refinements are needed. What do you suggest in this area?

Response. AIA does not believe a serious deficiency exists in the National Specialist (NRS) Program in terms of specialty coverage. We are aware that the FAA continually monitors the need for new NRS specialties, and shares with industry their plans for the specialty areas. The vacant position for aircraft icing should be filled but we understand that the field of qualified and available candidates is limited.

We believe that the NRS program should be managed such that each NRS "mentors" several FAA certification staff specialists to ensure the knowledge gained by the NRS is disseminated throughout the corresponding technical discipline in the FAA certification organization.

Mr. OBERSTAR. There are many other points I would like to pursue where your testimony raises interesting questions.

In view of the recorded vote in progress on the House Floor in which there are three minutes remaining, I think we will stop at this point and we will take a lunch break and resume at one o'clock. I thank this panel very much for its presentation.

The subcommittee will resume its sitting.

We will resume testimony with Mr. Ken Mead, Director of Transportation Issues, Resources, Community, and Economic Development Division of the U.S. General Accounting Office, and Anthony Broderick, Associate Administrator for Regulation and Certification at the Federal Aviation Administration. And let us begin with GAO.

TESTIMONY OF KENNETH M. MEAD, DIRECTOR, TRANSPORTATION ISSUES, RESOURCES, COMMUNITY, AND ECONOMIC DEVELOPMENT DIVISION, U.S. GENERAL ACCOUNTING OFFICE, ACCOMPANIED BY JONATHAN HOWE AND TIM HANNEGAN; AND ANTHONY J. BRODERICK, ASSOCIATE ADMINISTRATOR FOR REGULATION AND CERTIFICATION, FEDERAL AVIATION ADMINISTRATION, ACCOMPANIED BY THOMAS McSWEENY, DIRECTOR, AIRCRAFT CERTIFICATION SERVICE

Mr. MEAD. Thank you, Mr. Chairman, Mr. Clinger. This is a new arrangement. I enjoy sitting here next to my good friend and colleague, Mr. Broderick. We will see how it goes.

Mr. Chairman, I would like to introduce my colleagues at the table. Tim Hannegan, who directed the review. He is also the author of the preceding report on harmonization of international certification standards.

We are also accompanied by Jonathan Howe, who I believe is well known to the subcommittee. During his many years in senior positions at FAA, he worked closely with aircraft certification programs and was directly involved in certification of the 747, 757, and 767 aircraft. Mr. Howe, along with four other individuals with distinguished aviation backgrounds, provided technical perspectives on the issues we examined. He is here on behalf of that group.

I might mention the backgrounds of the folks that were on the group. Jonathan, of course, was the chairman of FAA's Aviation Rulemaking Advisory Committee. One of the members is chairman of FAA's technical oversight group for aging aircraft. Three of the members were former panelists on the National Academy of Sciences' study done in 1980, and one was a former FAA administrator.

In many ways, aviation safety begins with the design of safe aircraft. And our testimony today will focus on how FAA can improve its process for certifying large commercial airplanes and make a generally safe system even safer.

The question before us is not whether the FAA certification program is needed. In our view, it is needed and it does play an important role. Rather, the question before us is: How can FAA maximize its value and that of its staff and ensure that the program meets the challenges posed by advanced technology?

I would like to discuss three long-standing problems that affect the certification program. The first is program guidance. The second is training. The third is staff experience levels and turnover. Many of these same issues were the focus of a National Academy of Sciences' study 13 years ago.

Guidance. FAA's guidance that governs the staff's role in the certification process is, in our opinion, too general to ensure that staff are effectively involved in critical activities during the process. Today, FAA employs about 120 engineers and test pilots to certify new transport airplane designs. In carrying out those functions, FAA staff rely on and oversee about 1,300 FAA-approved employees of the aircraft manufacturers who are referred to as DERs, designated engineering representatives.

Our review found that the DER component of the program is quite strong. It is efficient. It is effective and it is needed. We are focusing more on the FAA role.

I would like to contrast to you, Mr. Chairman, some of the numbers I mentioned a moment ago. The FAA today employs about 120 engineers and test pilots who must oversee 1,300 designees. In 1980, they had 90 staff who oversaw 300 designees.

As a result of the increasing complexity of the aircraft designs and increasing work load, FAA had to shift a great deal of certification activity since 1980. According to FAA estimates, they delegated to Boeing designees about 95 percent of the certification activities for the 747–400 aircraft, which was certified in 1989.

In 1980, it was estimated by FAA that the percentage of delegated activity was about 70 to 75 percent. Likewise, the ratio of designees to FAA staff has changed from 3 to 1 in 1980 to 11 to 1 in 1993. In one part of the discipline responsible for certification of software-based systems, the ratio has reached—to use FAA's term, quote, an uncomfortably high ratio of 30 to 1.

In 1989, an internal review concluded that the amount of work delegated to designees had reached the maximum for properly managing the process. That was not a GAO conclusion; that was FAA's conclusion.

And since 1989, the level of delegation has increased. The number of designees has increased; the number of FAA staff has remained relatively the same size. Little guidance is provided, in our opinion, that defines the extent to which FAA ought to be involved in approving test plans and failure analyses for aircraft systems.

In 1980, the National Academy of Sciences cited FAA reserving those test plans and analysis for itself as necessary for a successful delegation system. We think times have changed. That is no longer properly feasible but we found that these activities are today often delegated, and the range of delegation varies widely from FAA engineer to engineer.

Some FAA staff told us that they delegate 5 percent while others said that it has reached 75 and 90 percent. The guidance is also silent on how the FAA experts should get involved, and certification staff are not required to use them. As a result, the experts are sometimes not sought for advice at all or sometimes their advice is sought too late for them to really be effective.

FAA staff have sometimes not understood the new technologies that they have been asked to certify. During the certification of the Boeing 747–400, for example, FAA engineers found it necessary to delegate to the Boeing designees the approval of the entire flight management system. That is not, again, a GAO judgment.

I would like to quote from what FAA's own study of the matter said: Quote, FAA staff were not sufficiently familiar with the system to provide meaningful inputs to the testing requirements or to verify compliance with the regulatory standards.

Let's talk about training. Training is probably the core issue here that needs attention. It has been a matter of concern to FAA for some time. We found that most courses taken by certification staff deal with subjects as supervision, human relations, equal employment opportunity or word processing. Those courses are important, but they are not a substitute for the training needs identified as most critical by the certification managers out in the field. Those needs were technical subjects in fields directly related to certification.

To put it mildly, Mr. Chairman, we found a compelling need for technical training. Our review of training records for 90 FAA engineers covering a three-year period of 1990 to 1992 found that 43 percent had received no training in their technical field whatsoever during that period. One of 12 engineers responsible for approving aircraft software attended a software training course during that period. In 1987, FAA found that a lack of technical training had caused its engineers to fall about 3 to 5 years behind industry.

We found that there is a great desire by the certification staff to obtain technical training. But they said that at the present time there are few good technical courses offered by FAA and for budgetary reasons they were often unable to take advanced technology courses outside of FAA.

I want to emphasize that we believe FAA recognizes the urgent need to improve training. The agency is in fact developing a new training program to emphasize technical areas and expects to implement new courses over the next several years. We strongly support that effort.

We have several suggestions for it, though. One would be that they establish core training requirements for each of the key disciplines and identify training available outside of FAA.

I would like to turn to experience and staff turnover. In 1980, the academy warned that the FAA certification staff were falling behind in technical competency. The academy recommended that FAA develop a more systematic approach and hire 30 experts to assist its staff. Since that time, aircraft designs and systems have become even more complex.

FAA has not fully followed through on a program to hire in-house experts to assist staff. They have hired eight experts. In 1980, they identified a need for 23, and in different disciplines. And I think that there is probably a need to formally reexamine how many experts they need in addition to the amount.

I should point out that Dr. Harris this morning in pointing to the technical competency of the FAA staff with which he interfaced was referring to some of these eight people, who are world-renowned experts.

But we found that these experts are stretched increasingly thin because they must perform duties originally intended for another position and develop expertise to cover additional areas.

FAA has experienced high staff turnover in the certification unit. We think that is principally because there is a lack of a career path within the technical unit. Nearly 50 percent of FAA's non-supervisory engineers have less than 4 years of FAA certification experience. Of the eight engineers assigned primary responsibility on the 777 project, three of the eight have already left to get promoted. In fact, two of their replacements, both in the software area, left for the same reason. FAA is working with OPM to establish a technical career path to address that high turnover. And we wish them well.

In summary, we recognize that the demands on FAA's resources and the complexity and size of certification projects make it totally unreasonable to expect FAA to be directly and intimately involved with each and every aspect of the process. What we are questioning is the extent to which the FAA staff can effectively oversee and add greater value to the process as long as these long-standing problems exist. We know the certification process usually results in completely safe designs, but mistakes can occur. Nobody can guarantee you zero risk. But one way to help increase that margin of safety is to have an effective system of checks and balances. FAA is moving out to take some action to improve its training program—actually it seems like a great deal of action—and to reduce the high level of staff turnover.

In addition to following through on those initiatives, we have made several other recommendations and I have covered them. Those need to be done as well. And we think by doing that, a safe system can be made even safer. Thank you.

Mr. OBERSTAR. Thank you, Mr. Mead. And also I express my appreciation for the very thorough report that GAO prepared for the committee, and I know that a great deal of time and effort and thought went into the preparation of that report, as well as some splendid consultation,

Mr. Howe.

Mr. Broderick, welcome. Glad to have you here again. And we await your testimony or rebuttal as it may be.

Mr. BRODERICK. Mr. Chairman, thank you. I would ask that my full statement be submitted for the record and I will summarize. I appreciate having the opportunity to appear before you today to discuss our certification process. On my left is Tom McSweeny, who is Director of the Aircraft Certification Service in FAA.

FAA's certification of aircraft and aircraft components is a fundamental part of FAA's safety mission. It is a key way in which we work with manufacturers to introduce new technology and aircraft types that can provide safe and oftentimes more efficient transportation, not only for our Nation's air travelers, but to passengers throughout the world. In fact, the impact of our certification efforts on the international environment, as you have already discussed, should not be overlooked since more than 70 percent of the commercial transport aircraft certified and built in the United States are exported.

As you noted in your opening remarks, Mr. Chairman, the FAA's stamp of approval granted through our certification work is effectively a ticket to the world's markets. FAA's certification process and standards have traditionally been and continue to be the world's model. The reasons for this are, I believe, two: First, our system is technically sound; and, second, it is very efficient.

Administrator Hinson has made it clear that he intends for the agency's international reputation to be maintained and even enhanced during his tenure. We must be mindful that in the exercise of our certification responsibilities in the FAA, we do not impede or stifle the creative technological advancement of ideas in our industry. We must work closely with manufacturers as their designs become reality, but our certification personnel will not be leading the technology curve. Instead, as a practical matter, we have to bring ourselves up to speed with new concepts once the manufacturers have settled on their proposed design choices and approaches.

The manufacturers' role focuses much more on the "hows" of the design, while FAA focuses on issues such as how the design might fail. U.S. aviation is today an integrated part of a global system. Domestic aircraft manufacturers increasingly draw on manufacturing facilities from throughout the world for components and assembly, as we heard earlier today. This means that the FAA must work closely with the international community on the internationalization of standards, as we have been. It also means that we have a heavier work load overseas than in the past.

I see no diminution of these efforts. The sophistication of transport aircraft has continued to evolve. The aircraft on today's drawing boards—those that will be carrying tomorrow's passengers—will rely more on computers and involve many complex software applications. Navigation and landing systems will be transformed by the ability of GPS satellite technology, which is a development in which this Subcommittee and I share great excitement.

Planning is under way for the proposed development of the future generation of high-speed civil transport. FAA has already been participating with NASA in discussions on this future aircraft, with a particular interest in the environmental issues that may be associated with it. We are forming a special team to work with NASA and industry on HSCT certification issues.

All of these advancements bring challenges to us, but they are exciting opportunities for our Nation to continue to expand beyond today's aviation envelope to make tomorrow's aviation system even safer and more efficient.

The FAA, of course, has to dwell in the here and now as well as prepare for the future. This means we must continue to devote significant efforts to today's certification work, along with ensuring the continued airworthiness of an aging aircraft fleet, while making incremental preparations for tomorrow's advances. I would like to take a few minutes to briefly highlight some of the issues that run through the GAO report and provide you with my general observations.

The GAO expresses concern that designated personnel working for the industry have increased dramatically, while FAA's certification work force has grown at a lesser work pace. In addition, GAO indicates concern that FAA does not have a formal mechanism as to when it should reserve a particular certification function to itself, rather than relying on a designee. It is also concerned about the training received by FAA certification personnel.

The use of designees by the FAA has been a long-standing practice. It was first explicitly provided for by Congress in about 1951, when the present Section 314 of the Federal Aviation Act was written. This system is used in many areas besides aircraft certification; pilot examining being one with which many of you are familiar. It is a sound approach to providing needed services to the aviation community in a timely way by enabling FAA to leverage its staffing many times over. This is particularly true in the time of constrained Federal resources. That picture will not change in the foreseeable future.

The designee system works well. It is a necessary and appropriate element of FAA's programs. Eliminating this system would require the addition of thousands of inspectors to FAA's work force at the taxpayers' expense, which is unrealistic in today's tight budget environment.

The appropriate level of FAA's certification staff itself is a separate question. As with all staffing levels, the certification staff will be reviewed as we formulate the 1995 budget. I can assure you that the Administration will not hesitate to recommend an increase in staffing if one is needed.

With respect to the adequacy of our technical training for our certification personnel, we have taken a number of steps over the past two years to develop a more comprehensive certification training program, as Mr. Mead has already indicated. Our technical training budget in fiscal year 1994 is more than three times what it was in 1990, and today constitutes over 6 percent of our overall aircraft certification budget. Much of these resources are devoted to development of new state-of-the-art training materials for our certification staff. In fact, the first 10 courses are nearly developed, covering general topics such as certification standards, as well as discrete technical areas like lightning protection for aircraft.

As I indicated earlier, though, I don't believe it is practicable for FAA to be undertaking this advancing technology before such technology is settled on for use in a new aircraft design. Technical training is not the entire training issue, since we are calling on our certification personnel more to manage systems in which designees play a key role. Management skills are important in overseeing these processes and shouldn't be deemphasized.

I have reservations about prescribing specific standards for FAA's hands-on involvement at defined points in the certification process. Every major certification program is different. A mechanical formula doesn't account for those differences. Instead, my view is that the FAA must manage the overall certification program in a way that recognizes the competence level of the manufacturer and assures the quality of the designees, spot-checking of designee performance, direct involvement of the FAA official in a particular certification at the point when our professional judgment says it is most valuable, and use of our certification experts in a way that leverages their talents within our work force.

Aircraft certification is a strong interest of Administrator Hinson. Maintaining our Nation's reputation as the foremost airworthiness authority in the world is critical to him. He will be closely involved with this process and will be continuing to work to improve the efficiency and effectiveness of our work in this important area.

The safety of the American traveling public, as well as our economic vitality, depends on an FAA certification process that is second to none. I can assure you, Mr. Chairman, that we in the FAA recognize the vital nature of our work in this area and will strive to continually improve it, as GAO suggests.

That completes my statement, Mr. Chairman. We would be happy to respond to questions.

Mr. OBERSTAR. All right.

Let's get right to some very important issues.

That is the 1979 study and the more recent GAO analysis says FAA staff have sometimes not understood the new technologies that they have to certify; that internal study by FAA's transport airplane directorate found that during certification of the Boeing 747–400 aircraft in the late 1980s FAA engineers did not understand the complex flight management system, closed quote.

The study further noted that FAA staff were not sufficiently familiar with the system to provide meaningful inputs to the testing requirements or to verify compliance to regulatory standards and that FAA engineers had minimal knowledge of 10 other systems, including the aircraft's braking system.

This wasn't GAO taking a pot shot. This was FAA taking aim at its own foot.

Mr. BRODERICK. Mr. Chairman, I don't think we were taking aim at our own foot. We were trying to apply the best people we know to improve the best system that we have. Let me have——

Mr. OBERSTAR. It is very commendable that FAA took this critical look at itself, but I am citing your own report. I want to know where you stand with respect to those.

Mr. BRODERICK. It is important that we understand exactly what that report was and why it says what it does. Let me have Tom McSweeny, our Director of Aircraft Certification, explain not only what involvement we had on the 747–400 flight management system, but what the context of that report was.

Mr. McSweeny. First of all, there is some doubt in my mind exactly what report we are talking about, so I will make an assumption.

In the 747 flight management system, and I think that is what the GAO report was talking about, we were extensively involved from the beginning. We reviewed proposals from the manufacturer, Boeing, and outlined certification plans that it wished to do. We reviewed those plans and we commented on them. That is our normal procedure. My checking with the offices involved indicates that that was the action we took on those projects.

In fact, the gentleman who was project manager on the 747 flight management system who, by the way, is no longer with us, was very experienced in the industry, not only as a designer of flight management systems and a programmer of the software, but as a manager of people in the industry outside the FAA who were working on flight management systems. I don't think we could have had a better person on that program at that stage.

Again, as I say, FAA was extensively involved in the program. It may have been that great amounts of reliance were put upon on the designees, but it was not without our review of that and our conscious decision to do so.

In terms of the comment made in the GAO report about internal FAA studies, the only recollection I have is with regard to a study that was done after the certification of the 747–400 and the MD–11. That internal study was to have the Seattle ACO that certified the 747 look at how the Long Beach office certified the MD–11, and have the Long Beach office look at how Seattle certified the 747. The point here was to see if we internally in aircraft certification were applying the same policy across-the-board.

To no one's surprise, there was a lot of turf in that report. The offices were saying, in effect, we did it right, they could have done it a little bit better. That was the characterization of the first draft of that report. We certainly did not intend for that report to be a critical review of people's work. We wanted to uncover in a broad sense if there were general differences in the way we applied policy from ACO to ACO. So we asked the assistant managers of both the Seattle office and the Long Beach office to get together to revise the report, take some of that potshotting out of it, and leave the substance.

During the review by the GAO, we cautioned it to not put a lot of credibility into the first report because it was a draft report, first of all, and, second of all, it had a lot of internal potshotting. Technical people are very proud of their technical background and so I don't think that the potshotting surprised us. I do not know from which of those two reports the GAO took its quote.

Mr. Hannegan. I can clarify that. We did not use the draft report. We used the final, signed report.

Mr. Oberstar. Mr. Clinger.

Mr. Clinger. Thanks, Mr. Chairman. We have a vote on so I will be brief in this round.

You both indicated that FAA has sort of set the standard for the world in terms of certification and the need to continue to do that. But it is my understanding that there is an ongoing effort to harmonize U.S. certification procedures and standards with the European airworthiness standards. I trust that that is to bring their standards up to ours and not to ameliorate our standards to a lower level. Could you enlighten us on that?

Mr. BRODERICK. From a safety viewpoint, Mr. Clinger, I would agree with you. But I wouldn't say that we have an extensive amount of pride of authorship in our regulations, and we certainly hope that our colleagues in Europe don't have too much pride of authorship in theirs. Both systems work well and we are trying to find the way to say the same thing, that is, mandate a good level of safety in a regulatory language. So I am certain that we will be adopting some of their phrasing and language and we expect them to be adopting some of ours in this process.

Mr. CLINGER. This effort is presently limited just to the European airworthiness authorities. Do we intend to expand this to Asian authorities?

Mr. BRODERICK. We are actively working to do exactly that. We are working with the Russians, the Chinese, the Canadians, and at our annual harmonization meetings we have, I would estimate, a dozen other countries that are not necessarily Europeans but include South Americans and Asians, as well as the Australians. It is something that we hope will become a worldwide effort, but we don't want to proliferate many different sets of regulations. We are trying to get everyone to rally around one set.

Mr. CLINGER. Are we moving toward closure in some of these areas and, if so, what do you anticipate might be a time frame for that?

Mr. BRODERICK. Very much so. We have a very detailed plan that has well over 60 specific items for harmonization. In the general aviation and rotorcraft area, we are officially at harmonization. There are a lot of things, little I's to dot and T's to cross, but the fundamental agreement has been reached, and of course, we are continuing to modify our regulations.

The transport area and propulsion areas are very different. But what we have done is lay out a multiyear plan with the Europeans and the industry. It is important to note that industry is deeply involved in the plan through the Aviation Rulemaking Advisory Committee.

Mr. CLINGER. Thank you. I think we have got to go vote.

Mr. OBERSTAR. We will break for this vote and return as soon as possible.

[Brief Recess.]

Mr. OBERSTAR. The subcommittee will resume its sitting.

I want to come back to the FAA Project Smart study of 1987, following upon the academy's 1980 study in which—and the 1987 FAA self-analysis says that its certification work force was three to five years behind developments in the industry. That is a pretty shocking analysis, but reassuring in one sense that the agency looked at itself and found its shortcomings and set forth a program to catch up, if you will.

What is your assessment of the six years that have passed since then, and then, Mr. Mead, what is your assessment of FAA's catch-up program?

Mr. BRODERICK. Let me ask Tom to supply some detail.

Mr. Chairman, I would just refer back to something I said in my opening remarks, and that is that we began about 1987 to do some self-examination and recognized, among other things, a real deficiency in our training budget area and our training program. We applied through the budget process for more resources and have been successful between FY 1990 and FY 1994. Over a four-year period, of the six or seven years that you talked about, our budget has gone from slightly over $1 million to over $4 million for aircraft certification technical training, or more than tripled in that period of time. And that represents a little more than 6 percent of our total resource budget. Tom, do you want to add a few more details?

Mr. McSweeny. I appreciate the comment about looking at ourselves. We take a lot of pride in that. Unfortunately, it highlights things that other people might want to look at. But I think if you can't look at yourself, then you are not doing the right kind of job.

I see the 1987 and 1980 study as one whole package, and let me explain why. In order to evaluate training, we had to define what our job was. And we felt it was important to go back and redefine that in the mid-1980s. The 1987 study, Project Smart, was a job task analysis to look at our individual jobs, how we do them, and the skills, knowledge and abilities that FAA certification people need to do those jobs.

From those skills, knowledge, and abilities came a definition of what our training needs are. That was in the 1987 report. And it basically said our training program needs a lot of work.

The next step in that process suggests another more detailed study which was performed in 1990. That study looked more at the specifics of what our training needs were and really highlighted about 80 to 100 areas of skills where we needed to make training available to our employees. I would certainly not argue that all training should all be internal. Resources for many training needs exist in local colleges.

From there, the top management team in aircraft certification met and prioritized the top 10 training needs, and immediately began developing those top 10 courses. So it is not surprising that the 1990 study came up with the same conclusion as the 1987 study, because those studies were designed to be a continuum toward the development of training.

We presently have numerous courses available. We are developing courses as fast as we can, through input from our people. That is work force intensive. So we have to be careful how much we bite off at one time.

We developed our new indoctrination course through input from the industry because our vision of training is to train the world, quite frankly. We will have aircraft certification courses like we have never had before in the history of the agency. These courses will tell people exactly what their job is, how they do their job, and how the job developed.

For instance, we will have a course that teaches airframers all of the structural requirements that we have in our rules and regulations. Our goal is to have the interface people between the FAA and the manufacturers attending the same courses. I think they will jump at that chance as they have already in the indoctrination course.

We also want world authorities to be there. What better way to harmonize than to have a training program that everyone wants to attend?

Are we as far as I would like to be? No. Are we going as fast as I think we can? I believe so. Tony mentioned the $4.3 million in training funds for 1994. That is about all we can dedicate right now to develop these training courses, but we are heading to a program of 30 to 40 FAA, or internal, courses. Exactly how we are going to teach them, we don't know yet, but that is the plan and how it all fits together.

Mr. OBERSTAR. Thank you.

Mr. Mead, your assessment?

Mr. MEAD. I think Mr. McSweeny's and Mr. Broderick's assessment, what they have in mind and where they are headed and the progress they have made to date, is substantially accurate. I would say, Mr. Chairman, that I testified before you in 1987 on a set of FAA training programs. In fact, I believe it was one of my first testimonies before the Congress. FAA has a sad history of its operating units going out, putting together plans with the support and commitment of one administrator and that administrator leaves and funding begins to dry up, and so Mr. Broderick's initiatives here are going to need substantial very top management support and sustained support.

Secondly, we would suggest that FAA establish some very core training requirements for each of the four key areas in its certification program. And we also believe it should highlight for its staff what is going to be available or what is available outside FAA.

I also wish to point out that we do not think that the certification staff should be being trained in things that are 10 years down the road. Perhaps the core of worldwide experts that FAA has on board should get that type of training but the average staff, we are not advocating that.

Mr. OBERSTAR. Any response, Mr. Broderick?

Mr. BRODERICK. I would just mention two things. I know that Tom wants to mention something about core training, but I recognize the possibility that different administrators would have different priorities. The program Tom outlined is one that is now under its fourth administrator and all four of them have supported what we are doing, starting in 1987 with Allan McArtor, moving through Jim Busey, Tom Richards, and now David Hinson. They are all supportive of this effort and I am confident that David Hinson will continue to support the delivery of the product.

Mr. OBERSTAR. To some degree, with that kind of turnover in administrators, they are captive of what has gone before them until they make their own critical analysis. I am not critical of what you say, but maybe if Mr. Hinson hangs on for a while, which I hope he does, and if our bill gets enacted into law that sets a five-year term for administrators, you will have some breathing space and you will not be captive of what is being handed to them.

Mr. BRODERICK. Good point. That may be the case. I hope that David Hinson stays around for a number of years.

The point I wanted to make is that we have not had a shifting of the winds in this important safety area. It has been a consistent thrust to get the program needs understood and to get the needs addressed and delivered.

Mr. OBERSTAR. Let me move to Mr. Clinger.

Mr. CLINGER. Well, just a couple of questions with regard to, Ken, your observation or finding about the high turnover and low experience level in the FAA certification specialists. Can you make any correlation between pay levels with regard to that? Is it that in fact people who are engineers in this field in the FAA are substantially lower paid than those in the private sector? Would that be an attributable cause to why you feel they are not as well trained or qualified?

Mr. MEAD. Yes, and I have data on the wage structure of the GS–13, GS–14, as well as what the Boeing engineers are paid. And what happens is that the GS–13 level—almost the span—the entire Step 1 to Step 10 is less than the starting salary of the DER at Boeing. The Boeing DER range is something like $55,000 to $95,000. That is why FAA needs to give the certification engineers a chance to get to GS–14 while they are still performing certification duties. That is why Mr. Broderick is trying to get OPM to approve this.

What happens now is the GS–13s to get promoted to GS–14 within the program have to go write rules. That is the only way to get promoted. The eight national experts that I referred to earlier, they are GS–15s. And I don't recall offhand what Tony's experience has been with the turnover of them.

Mr. BRODERICK. Actually, it has been pretty good. We have two of them that are scientific and technical specialist positions—our fracture mechanic specialist and our nonmetallic materials specialist—and both are very senior. We may explore again with OPM the possibility of using some of the incentives that they have got. But there is no doubt that pay, especially at the mid to higher, mid-senior technical levels that we are talking about, is a difficulty. But it is something that I think you have to live with.

There is definitely a difference in the kind of work that you do. And you have to want to do the FAA's job and you are going to sacrifice a little in the pay and benefits area to do that. But, if you make that sacrifice, you get an opportunity to make a contribution that many folks feel is second to none in their profession. So it is a balance, but it certainly would be easier if we didn't have the same thing that everybody else in the government deals with—financial constraints.

Mr. CLINGER. Has it made it easier to recruit in the highly technical areas by the fact that we have had massive layoffs in the aerospace companies in the country? Wouldn't that be a recruiting ground?

Mr. BRODERICK. It would be if we were producing airplanes, but we are certifying them and we are talking about specialists. These people are world-class experts and they are not being laid off. In fact, the GAO report notes that a number of jobs, several of which have gone unfilled due to a lack of qualified candidates.

The icing specialist is one. The Rotating machinery specialist is another one. Lightning is a third. We have not had the kind of applicants that meet the extraordinarily high standards that we want when filling those jobs. It is not just filling the slot that is important. It is getting someone who is, in fact, a world-class expert, someone who can point to the critical problems quickly; and that is what we have when you talk about national resource specialists at the FAA.

Mr. CLINGER. We have heard a lot about how you are planning to cut back, dramatic cutbacks in nonsafety personnel. Is this going to apply to the certification personnel?

Mr. BRODERICK. We, like everyone else in government, are looking very hard at how we can do our job more efficiently. Tom in the aircraft certification area and Tom Accardi in the Office of Flight Standards, are both looking at innovative ways, from a clean sheet of paper, to try and figure out how we can do the same job more efficiently and therefore with, we hope, fewer people. Because of the clean-sheet-of-paper nature of the job and the review, what we are actually finding is that in some ways we may actually add staff or open offices; we hope overall we will be able to reduce, but we are not under artificial pressure to cut arbitrarily. Only if it makes sense and doesn't affect safety will we be able to make those economies.

Mr. MEAD. May I speak to the staffing issues for a moment?

Mr. Broderick's staff is roughly 80 percent of the authorized level. This is a fairly important area. I can cite other arenas in FAA where they are staffed much closer to the authorized ceiling. You can bet your bottom dollar that the Boeing Company, as it is producing the 777, is not staffed at the 80 percent level.

Mr. HANNEGAN. And I would like to add one thing about the turnover rate that you mentioned. It is important to look at where that is occurring and get behind the numbers, and we have. Where the turnover is most pronounced is in the area of highest technical advancement as far as the changes that have occurred in the last 14 years. I refer specifically to the systems and equipment branches within the ACOs, the aircraft certification offices, particularly in Seattle.

In 1987, 58 percent of the nonsupervisory engineers in Seattle had experience levels over 6 years, FAA experience, and that has declined in 1992 to 17 percent.

And what is happening is what Mr. Mead talked about. Many of those—FAA's most advanced or most technically inclined people—have been promoted from within, but to other units outside the certification unit. And I think that is pretty important, especially when you combine that with the lack of training. Especially in the software area we found, they are having high turnover and a lack of training and so that is a key area in the advanced technologies.

And I think Jonathan had one point that he wanted to make.

Mr. HOWE. This is an area that the advisory committee looked at closely; and let me say at the outset that the advisory committee sort of concluded that FAA, the industry in general, has done a creditable job in producing, certifying and operating good, safe aircraft. I think what we were concerned with was, with the tremendous change in technology, especially in some of the nontraditional areas, the systems areas, was that when we looked at the priorities in terms of both staff levels and training programs that there seemed to be more reliance on traditional disciplines and less reliance in the new areas, such as digital electronics and flight management systems and those types of things.

And looking at the numbers of some of FAA's staffing and training levels and comparing those with some of the comparable levels that Boeing was using, you could see that this was not simply a matter of total resources but the allocation of resources. And I think we felt that some revisiting of that issue would be appropriate, particularly as all of these new courses were being developed, that there should be a very strong emphasis being given to the systems which have become much more critical to modern aircraft than they ever were in the old days.

Mr. MEAD. This is referring to the sheet that I believe you have in front of you with the numbers on it. You can see the four key disciplines: Systems and Equipment, Airframe, Propulsion; and Flight test. And systems and equipment is in bold. And you will see that they have FAA staff there of 30; and look above in the—Douglas and the other firms are putting their DERs, enormous activity in that area, and your ratio of FAA staff to the DERs is roughly one to eighteen, one to nineteen, in that area.

[The chart referred to by Mr. Mead follows:]

FAA TRANSPORT AIRPLANE DIRECTORATE

[FAA and DER Totals for Los Angeles and Seattle Offices, 1993]

FAA Branch	FAA Staff	Authorized Levels	DERs			
			Boeing/ Douglas	Other	Total	Ratio
Systems and Equipment	30	35	326	232	558	1 to 19
Airframe	25	35	189	164	353	1 to 14
Propulsion	22	28	76	71	147	1 to 7
Flight Test	19	22	138	87	225	1 to 12
Total	96	120	729	554	1,283	1 to 13

"Other" category includes DERs from small companies and subcontractors as well as independent consultant DERs.

Mr. CLINGER. Do you want to respond to this?

Mr. BRODERICK. Yes, I basically agree with the point of the importance of software training. In the back of the room, Roseann Ryburn is here at the hearing. She is a software specialist from the Los Angeles Aircraft Certification Office who has been assigned to the headquarters here for 30 days to help us develop a plan to make our software training program the best that it can possibly be. We recognize the importance of that.

But I would say something about the numbers of designees, especially in this software area. What we are finding is that there is a high degree of specialization and a very, very narrow delegation of authority to each of these people. So when we look at a structures designee, for example, structures designee can typically—at least in the old days, 10 or 15 years ago—have broad authority throughout the aircraft, not the whole aircraft, necessarily, but certainly large parts of it.

Nowadays, you might find a structures designee for the horizontal stabilizer and you might find digital designees that have very narrow limitations. So the amount of work that they put out is not necessarily reflected by the numbers.

If there is one thing I agree with wholeheartedly in the GAO report, it is that we need to develop a better system within the FAA for assuring that we are looking at an appropriate interval at designees's work. We also need to make sure that we focus on the fact that we are no longer a product-oriented organization doing a product-oriented kind of delegation. We have to get process-oriented and make sure that the processes that are in place are guaranteeing that the resulting product is a good one.

Mr. CLINGER. Thank you.

Mr. OBERSTAR. This mismatch, if you will, or ratio disparity between FAA inspection staff and manufacturers' staff remind me very much of the 1980s, and the disparity there between FAA inspection offices and the number of floor personnel that the airlines have and the problem that was described by one FAA manager, who said that we are stretched so thin that all we are doing is inspecting paperwork, not engine work. And you don't want to get into that situation.

Now, is this issue here of staffing levels and disparities in staffing levels and authorized level a function of allocation of financial resources within the FAA budget, or is it a problem of the budget itself, that is, the appropriated funds and the allocation to the FAA not being sufficient?

Mr. BRODERICK. To some extent, it is a combination of both, although let me remind you that a couple of years ago—in fact, it was just about two years ago when I testified before the Subcommittee on Reauthorization—we talked about staffing very briefly, and we were not asking for an increase at that time because we had just gone through a period of successive increases, year after year. We recognized that we had a training problem, which we have talked about here, and we wanted to revalidate our staffing needs. We wanted to look at that and find out whether or not we were about right, or whether these authorized numbers were good or bad.

Coincidentally, that was followed up by some Senate language last year in reauthorization that directed us to conduct exactly such a study and report back to the Congress. We are in the process of completing that study right now. And as I indicated in my testimony, if in fact the study indicates that the numbers that Mr. Mead cites are still the correct numbers and those are the needs, then we will have to come back through the normal budget process and request additions. We won't hesitate to do that.

Mr. OBERSTAR. Very good.

Let me go to an issue that arises out of your testimony from both GAO and FAA. And that is the adequacy of the training, retraining, and upgrading of skills process. The analysis of the DC–10 Sioux City failure in which the rotor shot through the hydraulic lines, subsequently was that Douglas, in its design of the DC–10 had a convergence of the hydraulic lines in a high vulnerability area, but in an area where there had not been a failure.

It was not anticipated that there would be a massive, catastrophic failure of this nature. Nonetheless, the manufacturer was permitted to build this aircraft; and whether anyone asked the question of the separation of these lines and putting in of shutoff valves at different points when a pressure drop was noted was not done.

Boeing designed their aircraft differently, and they separated their hydraulic lines. Then we had the Lauda air failure, to some extent which remains a mystery, but which then—reasonable questions have been raised by NTSB and FAA about Boeing concentrating its wiring bundles in such a way that chafing could have occurred and could have shorted out or in some fashion caused those thrust reversers to open in flight.

Now we come to the Boeing 777. And I asked the question of Boeing whether a lesson had been learned from these two experiences. I did not have an FAA engineer there to ask this question of: What has been learned with respect to the 777, which is designed by computer, and is in the software and is going to be flying without having this tested?

And in a related point, we might as well go to it—and Mr. McSweeny, I want to preface my remark by complimenting you on your oversight over the aging aircraft problem and the excellent job that you have done. But Boeing's proposed design for the 777 excluded crack stoppers.

Now, if we all recall, it was the 737 that was supposed to stop when a rip occurred and then make a right-angle turn, and it didn't. I also recall the 727 in which the process did work on that flight from Charlotte, North Carolina, and the rip stop did work.

Something happened here in this instance that the oversight mechanism isn't working as well as it should.

Mr. BRODERICK. Well, boy, that is a long list. But let me try to go through it just very quickly.

The DC–10 tragedy at Sioux City arose, as you correctly put it, when a fan disk, about 350-pound fan disk, disintegrated. When the picture of that empennage, as it was reconstructed, was published in Aviation Week, I think most people were shocked at the extraordinary amount of damage that was done.

When the DC–10 was designed, separation of critical hydraulic and electrical lines was, in fact, considered and was tested to the maximum extent practicable. I think most people, including the NTSB, did not fault the separation of hydraulic lines in the DC–10 as contributing to the Sioux City accident. Those hydraulic lines were, in fact, separated; but the damage was so massive in the back that no separation could have solved that problem.

What might have helped "outside of the envelope," as they say in this business, is the application of the check valves in the system. And as you know, Mr. Chairman, we have, in fact, mandated those in the DC–10 and other aircraft as well. So that is one issue.

The 747 actually doesn't have a different design philosophy in the sense that the DC–10 does. And if I can remind you, the JAL accident arose because of literally a concentration of all four hydraulic lines as they went through the aft pressure bulkhead in that airplane. A break in that pressure bulkhead, similar to the fan disintegration, something that never should happen but did, caused the loss of all hydraulics on that airplane. There is not much difference there.

What we learned in both of those cases applied in a review across the board in transport airplanes. We have to cater to massive hydraulic failures caused by things that never should happen in the first place. That is an engine disintegration. We have done that not only retroactively, but prospectively, and that is part of the lesson that we have learned.

Now to go on to Lauda. One of the two possibilities, regarding what caused the thrust reverser to deploy in the Lauda accident, is the electrical wire bundle chafing. Another possibility is contamination of the hydraulic fluid in the activator that deploys the thrust reverser system. We don't know which one of those happened, and we will probably never know. I happen to favor the theory that the Chairman mentioned.

What we learned in that case was two things. One, for prudence, separate the wire bundles in the thrust reverser system that can cause deployment. Even more important was that we learned a fundamental thing that, up until that Lauda tragedy, nobody knew. Nobody at Boeing knew it, nobody at Douglas knew it, nobody at Airbus knew it, nobody in the FAA or any other certification authority knew that if you deploy a thrust reverser in a twin-engine airplane at climb power, within five seconds that airplane is lost.

That is why when we did the testing of the 767 and the DC–10 and all the other airplanes previous to that accident, we concentrated on a different—what we thought was critical—area, low speed, high thrust operations; and we made sure that the airplane was capable. The 747 and DC–10 and 767 and others have been shown by flight test to be capable of deploying a thrust reverser on take off or climb and then going around and landing again.

What we now know is that that is probably not the critical point, especially for twin-engine airplanes. So in the 777 we have imposed, like on other transport aircraft, a new flight critical requirement. The thrust reverser, no matter what, may not deploy in flight, period. That is the way that airplane will be certified. It is a new certification regulation, something that we learned from the Lauda accident, but not directly related to either wire bundles or hydraulics.

Tom, would you like to add some information on crack stoppers?

Mr. McSweeny. Yes, I would like to add that, besides the thrust reverser lessons learned on a 777, there are certainly lessons learned from pylon fuse pins that are going to be considered in those designs; and we are already working with Boeing on them.

The crack stopper issue is an interesting issue, because I think it points out the different philosophies of design. Some airplanes today have crack stoppers, others do not. I don't think it is so much an issue of crack stoppers or no crack stoppers, although there are Ph.D.'s on each side of that issue arguing vigorously that theirs is the right view.

It is really an issue of what the safety objective is behind crack stoppers. That objective is to take a two-bay crack that is obviously inspectable and ensure that it can be noticed during a routine maintenance inspection, before it goes critical. That is really the criterion that needs to be met, whether or not there are crack stoppers.

We have discussed the issue with Boeing. I personally have discussed it several times with Tom Swift, our National resource specialist, who is concerned about crack stoppers versus noncrack stoppers. I think we have the right kind of attention to the issue in the 777 design.

But I don't think anyone is arguing with the basic safety premise.

Mr. OBERSTAR. Mr. Mead.

Mr. MEAD. Yes, the crackstopper point is an interesting one because it tends to show the importance of a couple of recommendations in our report and the importance of experts. This happens to be an example where the certification engineer on site out there was not aware of the need to get expert assistance. So one of the national resource specialists learned of the change and how the crack stopper issue was being treated, through an industry source, and intervened unilaterally. And that specialist, at least, believes that Boeing took heed and changed its test protocols as a result of this involvement.

But it illustrated to us the need for some mechanism to ensure the early involvement of the expert at FAA.

Mr. BRODERICK. I agree with that, Mr. Chairman.

Let me just make one point and that is that as Tom McSweeny said, this is an issue that can get experts in structures very excited and very vigorously engaged in a debate over whether you should or should not design an airplane with the crack stoppers. Tom Swift, who is a very close friend of mine and someone whom I take actually great pride in having brought into FAA many years ago, strongly believes that if he is the chief of structures, his airplanes will have crack stoppers in them; but that is not the only way to build an airplane.

The people who designed the 777 have applied a different philosophy and, to satisfy the FAA, because Tom Swift has raised these issues, they will, in fact, make some modifications in their testing to demonstrate that building an airplane with crack stoppers is not the only way to build an airplane. The design of the 777 is somewhat different than what Tom Swift would do if he had been chief of structures.

But I am convinced that when we see the test results, we will see that there is an alternative available to Tom Swift's design preference.

Mr. OBERSTAR. Let me move parenthetically and briefly from that point to crack stoppers in traditional hull design with conventional metals to composites where, in the course of our meetings, let us say, at Douglas and Boeing and at the Atlantic Test R&D Center of FAA, I have time and again heard that problems—the nightmare that structural engineers are concerned about is catastrophic failure of a composite.

Mr. BRODERICK. Let me ask Tom to talk about that.

Let me just point out that we have had composite airplanes or composite structures in transport aircraft for many years. We have learned an awful lot. We are going slowly, but I think with appropriate deliberation in our speed. But there is, nevertheless, a place for composite structures if you have the right application of inspection technology, which can be quite expensive.

Tom?

Mr. MCSWEENY. Yes, the issue of composite materials is a serious one, because they can, in fact, fracture in very unusual ways.

In fact, the real problem with composites is that after they fracture, you don't know how they fractured. All you have is dust in front of you and you can't piece it back together like you can with metallic material.

But early in the certification of composites, during which I was manager of the Engineering Division, and Mr. Soderquist was our national resource specialist, he and I had lots of discussions about this particular phenomenon.

And along with it is the inability to detect when the bond is 100 percent. It is either bonded or it is not. It is not 50 percent, because you really can't tell.

So we did two things very early on in composites that have stayed with us and will probably stay with us for a long time. One is, we required damage tolerance; i.e., the materials must demonstrate their ability to take significant damage and not just rip wide open.

They also are required to certify for the maximum disbond that they choose. In other words, whether it is a quarter of an inch or if it is three feet is not our concern, as long as there is a mechanical fastener that arrests that crack. That standard was applied to all the transport products, including the Beech Starship. And basically it is a penalty on composites because you can't tell if they are totally bonded all the time. But I think it is the right kind of penalty at this time, because we don't have the technology to inspect whether they have disbonded.

If you think back to the tremendous hail storm that went through Dallas/Fort Worth a year or two ago, there was extensive 767 horizontal stabilizer damage, very small external pits or dents, very massive internal disbonding—10, 15, 20 times what is actually on the surface.

That criterion that determines where stoppers should be placed on the composites gives the material the appropriate level of safety.

We are going to be up to our ears on composites in the high-speed civil transport. There is going to be a lot of new technology, but we are fortunate in that Mr. Soderquist—I call him Joe, since he is a good friend of mine—was actually one of the handful of experts advising the Air Force on its Stealth composite technology products. He is that well respected in the industry. He is going to be a part of that high-speed civil transport program in guiding our efforts in the composite area.

Mr. MEAD. I think one final point that I would like to make on this is that it is precisely the challenge and the dialogue on these issues of composite structures, how they should be tested, the crack stopper issue, that dialogue; and challenging of each other is healthy. It is built into the essential design of this program. That is real value added when you are having that.

So it is not disturbing to me that there are different experts out there that feel differently about how to approach the crack stopper issue. It is that they are having that dialogue. It is important to have people like Mr. McSweeny and Mr. Broderick, who will bring it to closure eventually, but I do think that dialogue is helpful.

Mr. OBERSTAR. Yes, you need people with experiential memory. And this cross-checking—I don't know if it was Mr. Broderick or Mr. Mead who reported on one region checking against another region; had that occurred in the case of over-wing exit removal in the mid-1980s, that incident might not have occurred.

And just parenthetically, has straight-lining cured the possibility of that kind of regional, rogue decisionmaking?

Mr. BRODERICK. We hope so.

Mr. OBERSTAR. The gentleman from Florida, Mr. Mica.

Mr. MICA. Thank you, Mr. Chairman.

A couple of questions: Can you tell me—I am not that familiar with your training program, the FAA training program—where are these people trained that we are dealing with in the certification—overseeing manufacturers' certification?

Mr. BRODERICK. Well, there are actually three places. One is in Oklahoma City. The indoctrination course and initial training are given there for all certification specialists.

Management training is given at our Center for Management Development at Palm Coast, Florida. We are also making more and more use of private universities and industrial training courses that are publicly available or that may, in fact, be tailored specifically to a curriculum that we would like. At any school that we deal with, we go through the contracting process.

Mr. MICA. I read some of the problems relating to turnover, and I think some of that has been addressed. But is there a problem in replacing these people? It looked like you had a very high turnover rate. Is there a problem in getting people to attend these courses?

I imagine part of this is initial training; you said some of it is in Oklahoma and some of it is more advanced. Are there any problems in that area?

Mr. BRODERICK. Well, the problem that we have with turnover is probably not unfamiliar to anyone in government. We are competing in a highly technological field with an industry that has the ability to offer, usually, a little more pay and a few more benefits; and when you come with expertise from the FAA, that makes you all the more attractive. So it is that kind of problem. I don't think it is anything unique.

Mr. MICA. I understand also there was a little bit of a talk before I got here about the ratios, the FAA staff ratios to the DER ratios. And would it be possible to have like a smaller ratio and a higher pay, more opportunity for advancement and training? Would that be a direction—I know that you may have already said some things for the record, but maybe you could give me what you think is the proper ratio; and if you recommended that we took a position where they paid more and they had a little bit more responsibility, that might be the approach I would look at. What would be your response?

Mr. BRODERICK. That is certainly possible. But I think we did discuss the difficulty of just using the numbers. The reason is that you have to look not only at the number of people that are designees, but how broad the scope of their delegated authority is, and, in fact, how much work do they individually generate?

What we have found over the past decade or so is that it is true that we are designating more people. But the fact is that as a general rule—and it is sometimes dangerous to generalize—they are becoming much more specialized, so that the absolute amount of work isn't nearly as great as those individual numbers might seem to indicate.

So I wouldn't want to just rely on the number of designees as an index.

As I indicated earlier, I think it is important that we formalize some kind of oversight mechanism or process, which we don't currently have, so that we ensure we are giving the appropriate amount of oversight to the FAA designees. But I don't think that pay, in and of itself, as a motivator, is necessarily the whole answer to this.

Mr. MICA. Mr. Mead, do you have a different opinion? What do you think is a good ratio?

The other thing, too, is that we are dealing here with the pie keeps getting smaller and there are less funds available, so you have to look at some innovative ways of performing a task. And you obviously are losing a high percentage of your people.

You are not able to specialize technically and train technically the way you should. And we also have the concerns of safety and other factors, you know, that have to be factored into this.

You looked at it from, you know, an auditing standpoint. What do you think? Can we get more bang for the buck with fewer people?

Mr. MEAD. I think, clearly the turnover in this program, particularly in the critical disciplines like software, needs to be stemmed.

Before you came in, I used an example, the 777 project, how they have had double turnover for the engineers responsible for the program, all since 1990 or 1991. So I do believe pay is an issue. And in some cases it could be cured without actually increasing the pay scale, simply letting these people be promoted to GS-14.

Mr. MICA. Would they get more pay by going to that next scale, too?

Mr. MEAD. Yes, sir. And Mr. Broderick is working on that. And if OPM moves on it expeditiously, I think we can see some progress by this time next year.

The second part of your question had to do the with the ratio, and I think FAA has to figure out what it wants the designated engineering representatives to do. And once it has made that judgment, you can start to arrive at a more deliberative ratio.

Mr. MICA. So it is an unclear mission, which is in your report. If you were to pick out, given the limited resources available, what would you prioritize in here—maybe one, two, three—as to the way we should approach the problems on a priority basis? Could you——

Mr. MEAD. Yes. Training would be number one; number two would be defining better when to use experts and get them involved in the process; and third would be level of experience and stability, i.e. the turnover issue. Guidance is an overall issue in deciding what your ratio should be. So I really give you four key items; you asked for three.

But training is clearly number one in my book. And I believe that from——

Mr. MICA. How would FAA respond to—as far as those priorities if—again, in this situation, prioritizing?

Mr. BRODERICK. Well, I certainly would agree with training being number one. I think number two has got to be to understand our staffing needs and fill them accordingly. I would not agree that we are at some difference here with GAO. We don't agree with the priority that they place on this guidance as to when the experts should be involved in things because, while it is true there is no specific guidance out there, I also think it is true that the product that the system today produces is an excellent one. And we shouldn't bog it down with bureaucratic rules that are inflexible.

I think we have an honest difference of opinion. But I certainly think that training is number one; and second, identifying the resources; and third, getting them.

Mr. MICA. Final question, Mr. Hannegan, Mr. Mead, you clearly have looked at the certification process. Can you tell me if it is sound? Is it an A, B, C, D, F failing grade? How would you evaluate the certification process after doing this report?

Mr. MEAD. I think the designee components of the program deserves an A; it is worth an A, the designee program. I would like to see it be A-plus in this area. And the focus of our report is on making FAA's role in certification considerably more strategic than it is now.

Mr. MICA. Some of the components you would grade—that we discussed here and the priorities might have different grades?

Mr. MEAD. Absolutely. I think the FAA is lagging behind the industry in a number of areas that it is being asked to certify. I do not mean by that remark that FAA needs to know how to build and design the aircraft. But it needs to know what the right questions are to ask, particularly on these new advanced technologies. And FAA will need training to bring staff fully up to speed to ask those right questions.

Mr. HANNEGAN. Mr. Mica, I would like to amplify on that. I have spent about two years now with the certification program, probably closer than they would like me to be. And I would say that the process generally would be an A; and in large part from the manufacturers and the self-interest they have to produce safe aircraft. We did not find any examples in which the process had been compromised because of the conflict of interest potential there or anything such as that.

But if I left you today with one impression, I would say the areas of greatest technical change over the last decade, specifically in the software and avionics areas and systems and equipment branches, I think that is where the greatest need as far as stemming the turnover, getting experienced people and getting the training needed. And I couldn't emphasize that enough.

And the NRS in that area, in fact, in February of 1992, wrote a memo internally saying exactly that, that FAA needed more people, more experienced people in the software area to get the job done. And so on that component, there is room for improvement as far as FAA.

Mr. MICA. Mr. Chairman, if I may, one last thing. I perceive problems of budget, but I also perceive problems of management guidance. Do you think most of it could be solved by more sophisticated management and guidance and then some flexibility with that, or is it going to take just pure bucks to resolve the problem?

Mr. MEAD. I err, hopefully, on the management's side, for as Mr. Howe, who has had numerous senior positions in FAA over the years, advised us, it seems to us that the amount of budget involved here is comparatively modest compared to such undertakings as the microwave landing system.

We are talking about close-of-the-day change for FAA when it comes to the training here. It isn't a great deal of money. It is overall management, but you are going to need some money for the training.

Mr. Broderick, I think, thinks he has that commitment for that money to sustain the new training program.

Mr. HOWE. I wonder if I could make a quick remark on the management issue, because that is something I feel strongly about. I, as you may know, I serve on a number of advisory committees and with me on those are at least four former FAA administrators; and every one of those former FAA administrators echoes the same theme, that the biggest difficulty that they experienced and the agency experienced was getting the continuity and the commitment of senior management to these types of issues.

There are expressions of approval from successive administrators, but history has not tended to work that way and particularly in the certification area. Our experience is that the squeaky wheel gets the oil and the certification wheel doesn't squeak that much, and so it has—over the years, it has not tended to get the same attention as air traffic and some of the other areas get. And I think what is needed in this culture with respect to software and training and those types of issues is a real focus by management, senior management—and when I say that, I mean the Secretary and the Administrator—to make this happen. And that has historically, despite all the best of intentions, not really happened in the past.

Mr. MICA. I appreciate those comments, especially with your record of accomplishment in the field. Thank you, sir.

Mr. OBERSTAR. There is a very substantial informal aspect to this certification process—negotiations, discussions back and forth, and this use of the industry personnel to do the certification. How does this actually work in the real world? Describe how the certification actually functions with the DER and the FAA personnel on a particular project like, say, the 777.

Mr. BRODERICK. I am going to let the Director of Certification explain it, sir.

Mr. MCSWEENY. I don't think it is very mysterious if you have been involved in it. Basically, our focus is more on process assurance rather than product assurance. If you have the right processes, the product is going to come out right. That has been proven over and over again in production assembly plants.

The FAA's major contribution is, up front, identifying what the process is. For instance, on the 777, there are over 70 individual certification plans that Boeing has proposed to get it to certification. They might be broken up according to disciplines and things like that. It is those basic certification plans that the FAA is extensively reviewing.

It is at that point where we then get together with the manufacturer and divide up the pie, so to speak, and say, these are going to be ours; we are not going to give those away; we are not going to delegate in these particular areas. We make that clear up front in the first or second meeting with the manufacturer.

Then we also identify that part of the pie we believe designees can appropriately handle. And then they move on and do it.

As we move through the program, we are constantly revisiting those issues because we sometimes learn of nuances in the airplane. We also create a series of documents called issue papers, which identify significant issues in the program that we want to record for posterity, or because we want to make darn sure that the proper attention is brought to it.

They are initiated by the FAA. They contain a description of the FAA's position, the manufacturer's position, a final FAA position, and then a final manufacturer's position. These are eventually signed off at high levels in the directorate up to the directorate manager, to make sure there is consistency of application.

Throughout this whole process, our experts, who we really have not talked about today, nor did the GAO report discuss, are the policy staffs in the directorates. If you look at the blue ribbon report—that is my phraseology for it—it talked about centralizing all of certification and having 20 to 30 experts driving the whole show, so to speak.

Well, we didn't agree to do that. We agreed to go to the directorate system, but we created a policy staff in each one of those directorates. The transport staff is maybe 30 people. Their job is to develop the rules, the policy, procedures, and advisory circulars. They look over the shoulder of the ACO's in every major transport project to ensure standardization of application of policy. So this is a group of highly capable technical people within the FAA who understand the technical part of it, the FAA policy and procedures, and work with the ACO in the certification and major programs.

That policy staff is part of this contingent of expert people, along with the NRS's, that we think contributes to a better certification process. I don't know if that is it in a nutshell, but that is kind of a description of how we do it.

Mr. OBERSTAR. Mr. Mead, any comment about the informality in the process—Mr. Hannegan.

Mr. HANNEGAN. Yes, I would. I think the devil is in the details. I think Mr. McSweeny has painted a broad overview of how it works and how their policy staff does sometimes get involved in the certification process.

But we found, when you go to how the engineers conduct their work, it varies widely between engineer and engineer as far as what they allow—what they delegate to designees and what they do not. And when we asked them how they decided or how they went about their work, it was—to put it mildly—very informal and varied widely.

So our perspective, especially in the areas of test plans and failure analyses, where we saw variances of delegation between 5 percent and 95 percent between branches, et cetera, is to tighten that up through guidance.

I think that Mr. Broderick mentioned that as far as an oversight mechanism—I forget the term he used—we don't disagree with that; and several internal reports that the Agency has done have mentioned that, as far as the need to do that, especially given some of the ratios that you see between DERs and FAA staff.

Mr. OBERSTAR. Does this work somewhat like the inspection process on maintenance? I have heard Mr. McSweeny's description of it, but are there any similarities where inspection——

Mr. BRODERICK. There are similarities in the sense that there are a lot of professional judgments employed by the experts in the FAA who are actually doing the work. But the difference in the maintenance area is—and again generalizations are difficult, but predictable—you know what you are doing and you have an awful lot of written guidelines, maintenance manuals, and that kind of thing from the company.

In a certification you are breaking new ground. I agree with Mr. Hannegan that we have had major changes in the way that cockpits and airplanes are built. The software and the computers that have been put in airplanes are, indeed, revolutionary; but I would also point out that we have certified four major transport category airplanes—the 757, the 767, the MD–11, and the 747–400. Not a single one of those airplanes has had a hull loss due to a problem in the very areas that we are talking about. That is a very important thing.

When we talk about the HSCT, the upcoming civil supersonic transport, the issues are not going to be brand-new technologies in the cockpit or brand-new computers, although they will be different; what we will have is propulsion and airframe things. Back to the basics is what we will be doing in the next generation of SST.

Mr. OBERSTAR. I have to address this rather sharp criticism in the GAO report in which GAO attributes the fine safety record on structural aspects of aircraft manufacture to manufacturer's expertise and manufacturer's commitment to safety rather than to the role of the FAA, and it questions whether FAA really has made a contribution.

I may have overstated that Mr. Mead, but——

Mr. BRODERICK. You may have overstated it, but I understand the thrust of it.

Let me say that I hope we never have a day when we say that we are relying on the government to design the quality airplanes that are built in the United States. I think we have seen in other countries that kind of central direction and control simply doesn't work. It is, in fact, the ingenious work of the manufacturers and the extraordinary technology they bring to the marketplace that permits the United States to be preeminent in civil transport aircraft.

It is not the FAA that is responsible for 70 percent of the airplanes being exported. It is, indeed, our industry.

But there are many, many areas that we can point to where the FAA, indeed, has made very substantial contributions to the safety of particular airplanes. Just recently there was a four-engine foreign transport airplane that was presented for certification. In the course of the review and analysis of the design of this aircraft, it became clear to the FAA people looking at it that if a particular kind of engine disintegration occurred, so much fuel might leak out of the wing tanks that one might not be able to fly an adequate distance to make it back to shore in an extended over-water flight.

Somewhat to the chagrin of the manufacturer—and, I might add, at great expense—they had to redesign the fuel tanks in the wing to design this problem away. This reconfiguration was a result of FAA's review and analysis of the design.

There are other instances where, for example, the FAA requires a dual electrical bus on all transport airplanes. Some other authorities don't, and we have had a number of instances in which single electrical buses have caused total electrical system loss. We require a dual system.

We had an unpressurized twin-engine turboprop presented to us in which the engineer exits could unlock in flight. We didn't think that was an appropriate design and required that that be fixed.

We had an airplane presented to us in which a lack of redundancy on trim tabs in the horizontal stabilizer could result in catastrophic flutter should you lose one of them. We required that to be fixed.

We could go on. There is a long list of incidents where the FAA has stepped in because of its expertise and because it was looking at the product from a completely different perspective than the manufacturer normally looks at it. In this way, we have made significant contributions to aircraft safety, and I am sure that our experts will continue to do so.

Mr. MEAD. I have no doubt that there are numerous examples that could be cited where FAA has contributed to safety. And we don't mean to imply otherwise. What we do mean to say, though, is that times have changed and FAA needs to look at the extent to which it is providing value added in today's environment with the new technologies.

It is not so much the ones that we can identify, that we clocked; it will ultimately be the ones that we miss.

Mr. OBERSTAR. One thing I have learned in the matter of safety—and Mr. Clinger and I conducted a number of hearings over the years in safety—whether it was pipeline or highway or bridge safety or aircraft safety—is that five, six, seven miles in the air, there is little margin for error. And the redundancy you build in on the ground saves you in the air.

And I have to ask this question also, because just trying this concept out on people who are not familiar with all that goes into safety and oversight in the FAA, and saying, well, you know, they certify company engineers to do this review and so forth—work; and people's eyes gradually widen. And it is a bit like the fox in charge of the chicken coop.

Besides the obvious question of conflict of interest, what is it in this process that keeps everybody honest? What is it that happens with FAA certification of a company engineer as its designated engineering representative that transforms that person into a being who brings objectivity to his work within that company?

Is this an anointing with holy oils that causes a transformation? Or is it perhaps the notion that at the end of the day, his signature has to go on something?

Mr. BRODERICK. I think it is, in large part, the last. It is professional pride to a great degree.

I mean, an FAA designation carries with it a recognition of the highest standards of technical and professional capability and ethics; and at root, it is that professionalism that allows the system to work, the professionalism on the part of the literally hundreds of engineers that are so designated.

But I also have to point to the fact that we have a very big club, and that is that we can remove that designation for cause and we do not hesitate to do so. It isn't often that this is done, but we have one to three on the average every year, for various reasons. But basically the reason is that we feel these people no longer properly represent the Administrator.

I might also mention that there is a less stringent kind of thing that happens more frequently than a revocation of authority; and that is, in cases where there is a bit of doubt in our mind, we just don't renew the designation of people.

So in large part, I would say 99 percent of it is the professionalism of the people involved. We don't select people to be designees unless they are fully capable of doing their job and have our complete confidence, not only in their capability but in their ethics. One percent of it is if they do wrong, they know that we are watching them; and we will catch them; and it would be quite a black mark on their professional record to lose that designation.

Mr. OBERSTAR. That is very helpful.

Mr. Mead.

Mr. MEAD. Yes, I would like to add to that. I think we were all impressed with the professionalism and integrity of the DERs. We were quite impressed by that. But they are not unmindful of the schedule, their manufacturer's schedule. And that is why the FAA people are there, or one reason they are there.

I should point out that the guidance for supervising these DERs that is currently on the books is from 1967. It says that the FAA people should oversee 5 percent of the work of the seasoned DERs and 30 to 50 percent of the work of the unseasoned. We found that the FAA staff either had never heard of this supervision standard or considered it meaningless. That is one reason why our report recommends an update in the guidance.

And from my understanding, Mr. Broderick said that he would like to formalize some type of oversight process, and thus he would tend to agree with my observation.

Mr. OBERSTAR. I would like to ask FAA to submit for the subcommittee this advanced training syllabus that you described earlier. I don't want the whole several hundred pages. We don't want the whole thing.

Mr. BRODERICK. I would be happy to supply the outline.

Mr. OBERSTAR. The syllabus so that we can review that document.

[The following was received from Mr. Broderick:]

AIRCRAFT CERTIFICATION TECHNICAL TRAINING COURSES
Planned for FY94

FAA COURSE NUMBER	COURSE TITLE
20814	Airplane Operations/Engineers
21415	ACSEP
21660	Aircraft Certification Indoctrination
21903	Type Production/Certification
21904	Airworthiness Certification
22501	Fundamentals of Aircraft Structures
22502	NDT
28083	Flight Test Pilot Initial
28273	Flight Test Pilot Recurrent
28331	Noise Measurement/Engineers
28335	Reliability and Probability
28368	Composites for Engineers
28374	Software Quality Assurance
28433	Safety Analysis
28476	Lightning Protection of Aircraft
00001	Accident Investigation, Part 1
00002	Accident Investigation, Part 2
00003	Accident Investigation, Part 3
00007	Rotorcraft Accident Investigation
12020	Compliance and Enforcement
20007	B727 Initial
20155	B90 Recurrent
21825	Avionics Test/Measurement Equipment
21846	Avionics Alterations
28046	L-1011 Initial
28061	DC-9 Recurrent
28078	DHC-7 Initial
28085	Balloon LTA
28121	Helicopter IFR Recurrent
28142	B-757 Recurrent
21848	CL-600 Initial
28153	CL-600 Recurrent
28163	Falcon 50 Recurrent
28165	Helicopter VFR Recurrent
28166	M-300 Initial
28168	Bell 214-ST Initial
28169	Bell 214-ST Recurrent
28170	Bell 222 Transition
28175	C-650 III Recurrent
28195	DHC-8 Initial
28201	SA365N Helicopter Initial
28219	S-76 Recurrent
28221	Airship LTA
28224	A320 Recurrent
28226	B747-400 Recurrent
28230	MD11 Recurrent

AIRCRAFT CERTIFICATION TECHNICAL TRAINING COURSES
Planned for FY94

FAA COURSE NUMBER	COURSE TITLE
28233	G-IV Initial
28237	G-IV Recurrent
28258	MD80 Recurrent
28292	Cessna 560-V Initial
28293	Cessna 560-V Recurrent
28294	Lear 31A Initial
28303	Parachute Rigger Certification
28304	Aging Aircraft Corrosion
28346	B727 Systems
28390	Principles of Composite Structures
28398	B757 Systems
28400	B737 Systems
28402	Digital Avionics Principles
28403	MSG-3 Systems
28404	B767 Systems
28437	NDI/Ultrasound
28438	NDI/Eddy Current
28442	Rotorcraft Systems
28486	B747-400 Systems

ADDITIONALLY,THE AIRCRAFT CERTIFICATION TECHNICAL WORK FORCE WILL ENROLL IN A VARIETY OF OTHER TECHNICAL TRAINING COURSES PROVIDED THROUGH COLLEGES, UNIVERSITIES, THE AVIATION INDUSTRY, AND OTHER GOVERNMENT ORGANIZATIONS.

TRAINING PROGRAM ENHANCEMENTS
FY94

Courses being developed

Part 21
ASI Job Functions
ASE/Structures Job Functions
ASE/Systems Job Functions
ASE/Propulsion Job Functions
Safety Analysis
Software QA
EFIS

Courses being designed

Software Substantiation
Aircraft Fundamentals
Designee Management

Mr. OBERSTAR. The Boeing 777 will have the most advanced digital flight management system ever used in aircraft. Give us some assurance that your oversight of that high technology program is adequate; especially when you say that our certification personnel will not be leading the technology curve. Give me confidence that your oversight of FAA in this advanced area where they are breaking new ground, perhaps, is adequate.

Mr. BRODERICK. Let me have Tom provide some details; but I will point out to you that the Boeing 777 will indeed have the most advanced flight management system available. But it won't be technology of two or three years from today; it will be technology from several years ago when they committed billions of dollars to using the technology.

So there is a difference between looking at leading the technology curve on the newest advances in technology and actually being up to speed on the kind of technology that is being put in an airplane. I think we are up to speed on that technology with the caveats about training that we talked about.

But that technology is not at the leading edge of computer and software technology. It is, in fact, kind of old stuff for the Silicon Valley folks.

Tom?

Mr. MCSWEENY. I think one of the significant things about the 777 project was the involvement of the FAA much earlier in the program than was the practice before this time. The 777 also has the benefit of bringing together the designer, certifier, maintenance people, and operating elements all into the design process. We were involved much earlier than we ever have been in a program.

We had numerous certification plans. The particular one on the software hasn't been approved yet. We are still discussing what needs to be done.

We also have more issue papers identifying critical areas in the software design and testing that we want to become directly involved in. So those are two key areas where we are focusing our efforts.

We have gone out of our way to involve the national resource specialists, specifically the digital and avionics specialists, in this program. They have received special briefings by the manufacturer. They are involved extensively in the review and support of the ACO.

We have also had recent meetings within the FAA with all of our software experts to get our policy better identified. There was a meeting a few weeks ago up in Boston, in which we basically were trying to get everybody singing from the same sheet of music. We think it was very successful. A lot of good ideas and action plans came out of that.

I would also like to point out an issue in the area of training, both in development of courses and in scoping out what we need to do. Three of the ten courses that we are working on right now for 1994 are in the software area, either design or quality assurance of software, so there is a real time focus on this issue.

Mr. HANNEGAN. Mr. Chairman, can I make a couple of comments?

On the 777 program, there are some things that I strongly agree with about what Mr. McSweeny just said. I think that FAA was involved earlier at the staff level, and they have learned from some of the internal studies that we regurgitate in our report. They have learned from that, and they are involved earlier than they have been in other programs.

But the 777 points out three things that we see. The first one is the NRS usage. I would disagree with Tom in that area. Several NRSs have come to us and said, we are not involved early enough, and we have several examples. We cited some in the report. And these are the experts saying, listen to us, it is a problem of getting involved in the program. And we are not calling for a rigid mechanism for them to get involved or that FAA define a cookie cutter approach but the guidance needs to be more specific on when they should be involved.

The second comment is on high turnover in the software area. They have assigned eight people primary responsibility in each of the four disciplines. In software, the two people that had primary responsibility have since been promoted, and two replacements have been promoted again since then; and they have had high turnover, and that affects their ability in the software area.

And the last point is on training, again in that software area. The 777 is a highly advanced aircraft. I agree with what Mr. Broderick had said about when Boeing put the investment in and some of the technology in its development stage. But it emphasizes the need, especially with the high turnover, that the staff get the training in the software area that they are starting to develop.

Mr. OBERSTAR. Mr. Mica.

Mr. MICA. Just a couple of quick questions, if I may, Mr. Chairman.

I noticed in this chart that you all had on page 14 of the report, it just shows the number of employees, both designees and FAA engineers, test pilots, and the FAA engineers; and test pilots, it appears, have stayed fairly constant since 1980. The designees have gone up.

Also, as I understand it, we have a smaller manufacturer—our manufacturing base keeps contracting in the United States. We are down to Boeing and a little bit of 3694 what, McDonnell Douglas, and our engine is GE.

Mr. BRODERICK. And Pratt & Whitney.

Mr. MICA. In any event, the aircraft manufacturing base seems to be contracting in the U.S.

Our subcommittee had a chance to visit the Illuyshin design plant in Russia during the break and we saw an emerging market with Pratt, I guess, and Collins Avionics. And we had China. We visited also Airbus Industries, which—they are now up to about a third of the market.

Now, you all do certification for these aircraft, too?

Mr. BRODERICK. For China and France or Airbus, the European consortium, that is true. We are only now beginning to work with Russia.

Mr. MICA. You see this diminishing—I understand that there have been some proposals to have the manufacturers, particularly the foreign manufacturers to absorb some of this cost. Do you see this leveling out as far as the number of employees?

And then, also, any recommendations on how you pay for this as you see the market changing and the U.S. financing the certification?

Mr. BRODERICK. Well, let me talk to the leveling out or not of the chart. If you look a decade or two into the future, no, I don't see a leveling out or a change. The fact of the matter is that we hope that the U.S. industry is going to grow. We are not going to keep pace with that growth in the government—not because of the fact that we would be shirking safety responsibilities, because we will all learn as we go along and be able to delegate things which today are new. In ten years, it is going to be old hat. Ten, or fifteen, or twenty years ago—maybe I am dating myself now—you wouldn't think of doing the kind of delegation to an industrial person on the loads analysis that we do today, because back then computerized loads analysis programs were brand-new. Today they are routine. Everybody has got them on a PC.

So as technologies become accepted and digested into the system, we are able to delegate the well-understood technologies to the company designees.

When you talk about foreign co-production products such as CFM International, a joint venture of General Electric, you are also getting another country involved; and if you have design and production work going on in that other country, you have the resources of that government and their certification system working hand-in-glove with you. We form a team with them at the beginning of a program and agree on the division of responsibility.

As I said in my opening statement, it is complex. The costs overseas are borne by the government doing them. It complicates our job to the extent that we have a lot more overseas presence, travel, that kind of thing.

I think this year we will be getting authorization to straighten out some technicalities so that we can get better reimbursement for a few of those things. But most, of course, of the FAA's activities are funded out of the Aviation Trust Fund, which is travelers paying ticket taxes and international travelers paying an international departure tax of about $250 million. The funding mechanism is well established by Congress and the Administration.

And we have the assistance of other governments when we are certifying their aircraft. If we don't have what we call the confident certification authority working in another country, we don't allow their aircraft to be imported into the U.S.

Mr. MICA. So you see the work force remaining constant and you are optimistic about more U.S. production, but actually what we are seeing is a lot of co-production?

Mr. BRODERICK. Well, I am not an economist or an expert, but if you take a look at the market share that Boeing has had, it has been relatively constant for a number of years.

The U.S. market share has declined, but I think one could argue that that is not a technology issue but a management issue both at Lockheed and Douglas. When you look at the market shares of the various aerospace companies, Boeing has done very well over the past 20 years or so. Obviously, Lockheed has gotten out of the business. Douglas is not doing as well as I am sure it would have liked in the past. And stepping into that breach has been the Airbus consortium.

Mr. MEAD. May I quickly add a perspective to that.

Mr. MICA. I think we have a minute or two before we go vote.

Mr. MEAD. I think that money, insofar as the Congress is concerned, for FAA is more of an issue with the AIP program than with this. I think FAA can make some responsible internal management decisions.

I am worried about where they got the 11,000 staff that they would move out over the next few years, where they got that number from, and what ramifications that might have for various programs. I do think that systems and equipment area in the certification program will experience an increase in staff, or at least should.

Mr. MICA. Thank you.

Thank you, Mr. Chairman.

Mr. OBERSTAR. We have a vote. I think one question and then a comment from the Chair, and then we will conclude the hearing for the day.

If there is one question that keeps recurring to me from travelers, including my colleagues on the House Floor, it is that of twin-engine aircraft operating over long distances of ocean water with no points visible on which to land when something goes wrong. What are the challenges presented to the FAA by extended range operations, or ETOPS, proposed both by the Boeing developments, by the Airbus developments, and by the market developments of city pair exchange—economic exchange in which less than major points such as Chicago, New York, Los Angeles are having nonstop operations that offer very interesting economic opportunities, but fewer passengers—therefore, very attractive to twin-engine operations. They are upgrading the 757 for overseas operations, the 777, the A–340, which—and then the Russians have an aircraft that they want to operate over long distances over water. What are the challenges in this certification process and how are you meeting them?

Mr. BRODERICK. To be very brief, Mr. Chairman, in April of 1985, I signed an advisory circular that allowed the first extended-range twin-engine operations. We have been building on the superb record of extended twin operations over the last eight years, and have now challenged Boeing and Airbus to build an airplane that meets an extensive set of precertification gates that we have laid down.

If they can meet those gates—and they have done very well so far—they will be approved for either 120 or 180 minutes of extended-range operations. If they cannot, they won't.

The simplest thing we are doing is ensuring that there is no reduction in safety due to the fact that there are only two engines. That is something we laid down in 1985, and we are holding fast to that.

Mr. OBERSTAR. Do you have an expanded staff to oversee this process?

Mr. BRODERICK. We have a set of issue papers, and as Tom indicated earlier, we are managing it that way from the certification program. In terms of operations in the airlines today, it is part of the routine oversight that our maintenance and operations people exercise in flight standards. They do pay special attention to ETOPS airlines, and you can differentiate them at the gate, by looking at the nose and seeing whether they say ETOPS or ER. That is the configuration that tells the maintenance people to pay special attention to these twins.

Mr. OBERSTAR. And you are also requiring a higher level of maintenance for these airplanes? Outline for us what those higher maintenance steps are. I don't mean in any great detail, but I would like you to submit a supplemental.

Mr. BRODERICK. Basically, we have a special minimum equipment list. They have turn-around checkings every time they land to check things like oil consumption and engine parameters to make sure that everything is operating in tip-top shape. We have an excellent record there. We won't tolerate anything less in extended twins.

Mr. MEAD. We would defer to Mr. Broderick's judgment on the ETOPS issue.

Mr. OBERSTAR. For the future, there is in the next stage supersonic transport—hypersonic transport, whatever it is—parenthetically, I must observe that the guys who want to get us across the ocean in three hours, can't get downtown in less than an hour.

Mr. BRODERICK. That is a different part of the department, sir.

Mr. OBERSTAR. Yes. Synthetic vision may turn out to be no vision if it fails. Pay very careful attention to that for the future.

Mr. BRODERICK. You can bet we will.

Mr. OBERSTAR. In sum, I think it has been a very productive hearing and a very important insight into the process that is critical to the traveling public, to the industry, and to America's leadership in aviation. FAA is the fulcrum in this process. It depends on your readiness, your ability to stay a step ahead of the state of the art, to continue to have a show-me attitude; not to be prescriptive, but to be exacting of the industry and intolerant of shortcomings that have safety implications for the lives of the traveling public as well as, of course, the crews aboard those aircraft.

And it is incumbent upon the watchers—GAO, this subcommittee, others who have an oversight role, the National Transportation Safety Board, which comes in usually at a grim stage of the system failure. But as long as we continue this joint effort, I think that we will continue to maintain that leadership in aviation, which has been the unique mark of the United States in aviation worldwide.

I thank you for your contributions throughout this day, and I am sure we will meet again on this subject.

The subcommittee stands adjourned.

[Whereupon, at 3:49 p.m., the subcommittee was adjourned.]

[Subsequent to the hearing, Mr. Boehlert submitted additional questions to Mr. Broderick regarding portable electronic devices. The questions and responses follow:]

U.S. House of Representatives

COMMITTEE ON PUBLIC WORKS AND TRANSPORTATION

SUITE 2165 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515
(202) 225-4472

October 20, 1993

Mr. Anthony J. Broderick
Associate Administrator
Regulation and Certification
Federal Aviation Administration
800 Independence Avenue
Washington, D.C. 20591

Dear Mr. Broderick:

Thank you for your testimony before the Aviation Subcommittee today on Advanced Aircraft Technology. During the hearing, an issue was raised that I am very interested in -- whether portable electronic devices, such as computers and CD players, interfere with aircraft navigation systems.

I would appreciate your response in three weeks to the list of questions below:

- What regulation is in place that allows some airlines to forbid the use of portable electronic devices in aircraft while other airlines allow their use?

- Does FAA believe that portable electronic devices can interfere with aircraft navigation systems?

- Is it true that scientists have not been able to recreate the navigation interference that allegedly occurs when portable electronic devices are used in aircraft.

- Does this alleged interference occur in all types of aircraft or does it depend on the technology in the aircraft? Will this also be a problem on "fly-by-wire" aircraft such as the Boeing 777?

Please also provide a copy of your responses to the Aviation Subcommittee at 2251 Rayburn. Thank you in advance for your cooperation.

Sincerely,

SHERWOOD L. BOEHLERT
Member of Congress

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AOA-3

MTR

NOV 26 1993

The Honorable Sherwood Boehlert
House of Representatives
Washington, DC 20515

Dear Congressman Boehlert:

Thank you for your letter of October 10, in which you raise a number of issues about portable electronic devices.

I have enclosed a copy of Part 91.19 of the Federal Aviation Regulations, the rule governing the use of portable electronic devices. As you can see their use in flight is forbidden unless the airline specifically permits it. Thus, different airlines have elected different ways to comply. I have also enclosed a copy of our recently updated advisory circular which discusses the subject in more detail. We do not have any evidence to indicate that portable electronic devices interfere with aircraft electronic systems, though the theoretical possibility that they could interfere does exist. We have been working with a special expert committee of RTCA, Inc., to better define the scientific and technical issues involved. A copy of its latest report is also enclosed for information.

The "alleged interference" could theoretically occur in any aircraft. However, because of advances in electromagnetic protection techniques used with more modern aircraft with complex electronic cockpits, and more rigorous Federal Aviation Administration certification requirements imposed on them, the potential for problems are far less than with older airplanes. The new "fly by wire" aircraft such as the Boeing 777 specifically address this kind of issue during certification tests to eliminate the problem as much as humanly possible.

As you requested, I have also provided a copy of this letter to Chairman Oberstar.

Sincerely,

...al Signed By
...ony J. Broderick

Anthony J. Broderick
Associate Administrator for
Regulation and Certification

Enclosures

cc:
I-5
AOA-3 (A931101033 sus: 11/12/93)
AGI-1
AVR-1 (AVR1-93-0505 sus: 11/10/93)

AVR1:BRODERICK:swc:11/4/93:X73131 (G:\BOEHLERT.DOC)
REWRITE PER AOA-3:swc:11/24/93

PREPARED STATEMENTS SUBMITTED BY WITNESSES

STATEMENT OF THE ANTHONY J. BRODERICK, ASSOCIATE ADMINISTRATOR FOR REGULATION AND CERTIFICATION, FEDERAL AVIATION ADMINISTRATION, BEFORE THE HOUSE COMMITTEE ON PUBLIC WORKS AND TRANSPORTATION, SUBCOMMITTEE ON AVIATION, CONCERNING AIRCRAFT CERTIFICATION. OCTOBER 20, 1993.

Mr. Chairman and Members of the Subcommittee:

I appreciate having the opportunity to appear before you today to discuss the FAA's aircraft certification process. Accompanying me is Mr. Tom McSweeney, Director of Aircraft Certification. I know the Subcommittee is interested in the potential effects of advanced technology on FAA's certification activities. Also, a recent GAO report has highlighted a number of issues associated with our certification practices that warrant public discussion.

FAA certification of aircraft and aircraft components is a fundamental part of FAA's safety mission. It is a key way in which we work with manufacturers to introduce new technology and aircraft types that can provide safe and oftentimes more efficient transportation for not only our Nation's air travelers but to passengers throughout the world. In fact, the impact of our certification efforts on the international environment should not be overlooked, since more than 70% of commercial transport aircraft certificated and built in the U.S. are exported.

The FAA's "stamp of approval" granted through our certification work is effectively a ticket to the world's markets. FAA's certification process and standards have traditionally been and continue to be the world's model. Administrator Hinson has made it clear that he intends to see that the agency's international reputation is maintained and even enhanced during his tenure.

We have been fortunate in the U.S. aviation industry to have innovative and creative manufacturers who have continuously pressed for technology improvements in the planes we build--planes that fly faster, carry larger numbers of people, and are both more fuel efficient and less noisy. Most importantly, these evolving aircraft designs have been built with safety as the foremost criterion.

We must be particularly mindful that, in the exercise of our certification responsibilities in the FAA, we not impede or stifle the creative, technology-advancing ideas of our industry. We must work closely with these manufacturers as their designs become reality, but our certification personnel will not be leading the technology curve. Instead, as a practical matter, we have to bring ourselves up to speed with new concepts once the manufacturers have settled on their proposed design choices and approaches. The manufacturer's role focuses more on the "hows" of the design, while FAA focuses more on issues such as failure modes.

U.S. aviation is today an integrated part of a global system. Domestic aircraft manufacturers increasingly draw on manufacturing facilities from throughout the world for components. This means that FAA must work closely with the international community on the internationalization of standards, as we have been. It also means that we have a heavier workload overseas than in the past. I see no diminishment in those efforts.

The sophistication of our transport aircraft has continued to evolve. The aircraft on today's drawing boards that will be carrying tomorrow's passengers will rely more on computers, and involve many complex software applications. Navigation and landing systems will be transformed by the availability of GPS satellite technology, a development in which this Subcommittee and I share great excitement. Engineers will continue to make advancements in non-metallic and metallic composite materials that will mean less weight penalties and greater fuel efficiency. We see continued progress in making less noisy and more reliable engines, although no significant noise reduction breakthroughs are on the near horizon. Planning is underway for the proposed development of a future generation high speed civil transport. FAA has been participating with NASA in discussions on this future aircraft, with a particular interest in environmental issues that may be associated with it.

All of these advancements bring challenges to us. But they are exciting opportunities for our Nation to continue to expand beyond today's aviation envelope, to make tomorrow's aviation system even safer and more efficient. The FAA, of course, has to dwell in the here and now as well as prepare for the future. This means we must continue to devote significant efforts to today's certification work, along with assuring the continued airworthiness of an aging aircraft fleet, while making incremental preparations for tomorrow's advances. For example, we are now beginning to focus on potential certification issues with the high speed civil transport aircraft, and will be forming a team to work in concert with NASA on this program.

I would like to take a few moments to briefly highlight some of the issues that run through the GAO report, and provide you with my general observations. The GAO expresses concern that "designated" personnel working for industry have increased dramatically while the FAA's certification workforce has grown at a lesser pace. GAO also indicates concern that FAA does not have a formal mechanism as to when FAA should reserve a particular certification function to itself rather than relying on a designee. They also are concerned about the training received by FAA certification personnel.

The use of designees by the FAA has been a longstanding practice. This system is used in many areas besides aircraft certification, pilot examining being one with which many are familiar. It is a sound approach to providing needed services to the aviation community in a timely way, by enabling the FAA to leverage its staffing many times over. This is particularly true in a time of constrained Federal resources. That picture will not change in the forseeable future.

Fundamentally, the designee system works well and is a necessary and appropriate element of FAA's programs. Eliminating this system would require the addition of thousands of inspectors to FAA's workforce, at the taxpayer's expense, which is unrealistic in today's tight budget environment. The appropriate level of FAA's certification staff is a separate question. As with all staffing levels, the certification staff will be reviewed as we formulate the 1995 budget. I can assure you the Administration will not hesitate to recommend an increase in staffing if one is needed.

With respect to the adequacy of our technical training for our certification personnel, we have taken a number of steps over the past two years to develop a more comprehensive certification training program. In fact, the first 10 courses are nearly developed, covering general topics such as certification standards as well as discrete technical areas such as lightning protection for aircraft. As I indicated earlier, though, I do not believe it practicable for FAA to undertake training in advancing technology before the time that technology is settled on for use in a new aircraft design. Also, technical training is not the entire training issue, since we are calling upon our certification personnel more to manage systems in which designees play a key role. Management skills are important in overseeing these processes, and should not be deemphasized.

I have reservations about prescribing specific standards for FAA hands-on involvement at defined points of the certification process. In my experience, every major certification program is different. A mechanical formula does not account for those differences. Instead, my view is that FAA must manage the overall certification program in a way that recognizes the competence level of a manufacturer, and assures the quality of the designees, spotchecking of designee performance, direct involvement of FAA personnel in a particular certification when our professional judgment says they are most valuable, and use of our certification experts in a way that leverages their talents within our workforce.

Aircraft certification is a strong interest of the Administrator's. Maintaining our Nation's reputation as the foremost airworthiness authority in the world is critical to him, and he will be closely involved with this process, and will be continuing to work to improve the efficiency and effectiveness of our work in this important area. The safety of the American traveling public as well as our economic vitality depend on an FAA certification process that is second to none. I can assure you that we in the FAA recognize the vital nature of our work in this area and will strive for continued improvement.

That completes my prepared statement. I would be pleased to respond to questions you may have at this time.

Hold for Release Until
Presented by Witness

National Aeronautics and
Space Administration

October 20, 1993

Subcommittee on Aviation

Committee on Public Works and Transportation

U.S. House of Representatives

Statement by:
Dr. Wesley L. Harris
Associate Administrator
Office of Aaeronautics

103rd Congress

HOLD FOR RELEASE UNTIL
PRESENTED BY WITNESS
OCTOBER 20, 1993

Statement of
Dr. Wesley L. Harris
Associate Administrator for Aeronautics
National Aeronautics and Space Administration

before the
Subcommittee on Aviation
Committee on Public Works and Transportation
House of Representatives

Good morning, Mr. Chairman and Members of the Subcommittee. It is always a pleasure to discuss NASA's efforts in aeronautical technology development, which we conduct in close cooperation with the FAA, other government agencies and U.S. industry. You certainly understand the importance of the aviation industry, as it is one of our largest and most successful industries. This is largely thanks to a long history of public-private sector cooperation in technology development. NASA, and its predecessor, the National Advisory Committee for Aeronautics (NACA), have been conducting aeronautics research since 1915, helping make U.S. aviation the multi-billion dollar industry it is today. But NASA is not alone, and is strongly committed to a thriving partnership with other government agencies, including the FAA, in support of U.S. aviation. These partnerships are important because they guide NASA's research and technology development toward productive ends; technology is not developed for technology's sake, but rather to meet the needs of our government and industry customers.

Although NASA's Aeronautics Program is broad, today I would like to focus on specific areas of interest to the Subcommittee, namely, technology advances for subsonic and supersonic aircraft. Our primary objectives in these areas are to improve U.S. competitiveness in civil aviation and safely enhance the capacity of our National Aviation System by fostering the development and commercialization of high-payoff technologies. Before discussing our work in advanced technology for subsonic and future supersonic aircraft, I would like to share just a few accomplishments resulting from our close working relationship with the FAA.

ACCOMPLISHMENTS IN COOPERATION WITH FAA

NASA and the FAA have a heritage of working together where our combined resources and expertise can safely improve the efficiency of the entire aviation community. I would like to cite three specific examples of cooperation.

Windshear. In 1986, the FAA, as part of its integrated windshear program, asked NASA to join its efforts and take the lead in determining the system requirements for enabling airborne forward-looking technology to mitigate the threat posed by windshear. The recently completed NASA-FAA program in Airborne Windshear Advanced Technology has resulted in specifications and guidance for airborne windshear sensors that industry is using today to design, engineer, produce, certify, and operate such sensors on aircraft.

Global Positioning System. U.S. efforts in Global Positioning System (GPS) technology in the 1980s resulted in opportunities for U.S. industry to develop marketable GPS products. Now, in cooperation with the FAA, NASA is developing the technologies, methods and techniques required to test highly accurate precision approach systems based on carrier wave tracking of differential GPS.

Glass Cockpit. In order to understand better the safety issues associated with new technology flight decks, NASA and the FAA have jointly acquired and will operate a current-technology, "glass" cockpit simulator. This simulator will allow the FAA certification issues to be analyzed and documented, as well as provide a facility for NASA to conduct and report on its aviation safety and automation research.

These experiences give us at NASA confidence to proceed with our technology initiatives, assured that our research will help not only industry, but also the FAA in its mission to continue to provide a safe air system in an environment of rapidly changing technology. I would like to turn now to NASA's technology efforts which we expect to come to fruition over the next several years.

ADVANCED SUBSONIC TECHNOLOGY

Working closely with U.S. industry and the FAA, NASA has developed plans for an Advanced Subsonic Technology (AST) Initiative to target key technologies for competitiveness, safety, and environmental compatibility. The goals of the program are to enable U.S. subsonic aircraft builders to meet the demands of global competition by producing economical and environmentally compatible aircraft, and to safely increase National Airspace System efficiency. To meet these goals, the AST program is focusing on ten high-payoff technologies: Fly-By-Light/Power-By-Wire, Composites, Propulsion, Integrated Wing Design, Noise Reduction, Technology Integration and Environmental Impact, Environmental Research Aircraft and Remote Sensor Technology, Terminal Area Productivity, Shorthaul Aircraft, and Aging Aircraft. Many of these elements continue our close cooperative alliances with the FAA.

Fly-By-Light/Power-By-Wire (FBL/PBW). The benefits of full-authority digital control have not been fully realized for U.S. transport aircraft. The FBL/PBW program will develop lightweight, highly reliable optical systems that will not be affected by the electromagnetic interference that plagues fly-by-wire systems. Additionally, technology will be developed to replace hydraulic and pneumatic control systems with simpler, more efficient and maintainable electro-optical systems. Future digitally controlled aircraft will be able to take advantage of the performance enhancements and weight savings afforded by FBL/PBW. NASA is developing analytical tools for FAA certification and industry designers to use to assess the effects of electromagnetics within an aircraft.

Composites. NASA's ongoing Advanced Composites Technology (ACT) program currently is focusing on validation of manufacturing methods for full-scale composite wings and large-scale composite fuselage components. Further validation is required to make this technology acceptable to U.S. industry. By augmenting the ACT program and working with a team of airframe manufacturers, materials suppliers, and university researchers, NASA intends to advance the development of three manufacturing processes: stitching combined with resin transfer molding, woven textile preforms, and automated fiber placement. By the program's end, a full-scale pressurized fuselage section and a full-scale wing/fuselage intersection will validate the program goals of 50 percent weight and 25 percent cost savings, leading to a 16 percent savings in direct operating cost compared to today's metallic transports.

Propulsion. Improving fuel efficiency while reducing emissions requires new technology for higher pressure ratio engines. The objectives of NASA's Propulsion program are to increase overall pressure ratios of high-bypass turbofan engines to 50-65:1 in the near term and 75:1 in the long term, requiring combustor temperatures of 3000 degrees Fahrenheit or greater. Research will focus on major transport engine core components (compressor, combustor, turbine). Future high-bypass-ratio fans offer the potential for 30 percent fuel savings, with reduced nitrogen oxide emissions, and a 10 percent reduction in direct operating cost.

Integrated Wing Design. Current approaches to the aerodynamic design of commercial transports address major aircraft subcomponents (e.g., wing, airframe, nacelles) independently, resulting in long, expensive design cycles. The Integrated Wing Design program will focus on technology development in airframe/engine integration, high-lift systems, laminar flow and wing design. Validated technology will substantially reduce design time and cost and improve aircraft performance in cruise, take-off and landing.

Noise Reduction. Aircraft noise is an international problem that is prompting airports to operate with strict noise budgets and curfews, thereby restricting airline operations. International organizations are considering more stringent noise standards which will affect the U.S. aircraft industry's competitiveness. NASA's noise reduction program, conducted with the FAA and U.S. industry, targets technologies that will yield a near-term reduction of uninstalled engine noise levels by 3-4 dB relative to the state of the art and a long-term reduction of 7-10 dB for future subsonic transports.

Technology Integration. Continuous systems analysis is essential to focus and integrate the major technology elements of the AST program. Systems analysis will assess the effects of each element on the continually evolving aviation system and also improve technology transfer to other government agencies and U.S. industry.

Environmental Impact. A key emphasis of this systems approach is atmospheric research to assess the environmental impact of subsonic transport aircraft fleets and to identify related technology requirements. The environmental impact assessments will be supplemented with in situ measurements in the troposphere made by airborne sensors. The data gathered will be used to validate the atmospheric models for subsonic transport emissions and to work with the FAA towards a basis for new emission standards.

Terminal Area Productivity. Air traffic control (ATC) delays cost airlines millions of dollars each year in wasted fuel, crew labor costs, baggage misconnects, and other problems. Weather delays account for more than 70% of the problem, while ATC volume plays a role as well. The goal of the Terminal Area Productivity initiative is to safely achieve affordable clear-weather capacity in instrument-weather conditions. In cooperation with the FAA, NASA's approach is to develop and demonstrate airborne and ground systems technology and procedures to safely reduce aircraft spacings in the terminal area, enhance air traffic management and reduce controller workload, improve low-visibility landing and surface operations, and integrate aircraft and air traffic systems. By the end of the decade, integrated airborne and ground systems will safely reduce spacing inefficiencies associated with single runway operations and the required spacing for independent, multiple-runway operations conducted under instrument flight rules.

Shorthaul Aircraft. NASA is developing a strategy to increase National Airspace System capacity by expanding the role of fixed-wing and rotary shorthaul aircraft. The objective is to develop new technology to improve the safety and expand the utility of U.S. shorthaul aircraft. Goals include environmental compatibility, advanced user-friendly cockpits, advanced controls, performance efficiency, and lower initial and operating costs. NASA is developing design methods for FAA certification and industry designers.

Aging Aircraft. Improving safety is of paramount importance and is the focus of NASA's Aging Aircraft research. In 1990, approximately 46 percent of the U.S. commercial air transport fleet was over 15 years old, and 26 percent was over 20 years old. The number of aircraft over 20 years old will double by the year 2000. Initiated in response to structural failures in the U.S. commercial fleet, the Aging Aircraft program builds on NASA's extensive research base in nondestructive evaluation (NDE) methods, metal fatigue, and structural-life prediction models. The program is intended to develop the prediction methodology that industry needs to calculate residual strength in airframes and the advanced NDE technology needed to detect disbonds, fatigue cracks, and corrosion reliably and economically. NASA's goal is to develop and verify analytical methods for quantitatively assessing inspection findings and airframe residual strength by 1995 and reliable, economical NDE technology to inspect aircraft by 1997. The program is strategically linked with complementary programs in the FAA.

HIGH SPEED RESEARCH

Projected growth in the long-range transport market sector presents a key opportunity for U.S. industry to retain its preeminent position in aircraft and engine sales through successful development and production of a high-speed (Mach 2-2.5) civil transport (HSCT) aircraft. Market studies by analysts both in the U.S. and abroad estimate that an average of 600,000 passengers per day flying over long, predominantly trans-oceanic routes could readily support 500 to 1,000 HSCT aircraft between 2005 and 2015. To enable U.S. industry to attain a leadership position in producing an environmentally compatible, economically viable HSCT and capture an estimated $200 billion in future sales and provide 140,000 high skill jobs, NASA is working closely with its industry partners to develop and validate the high-risk, long lead-time technologies needed.

Phase I. Phase I of NASA's High Speed Research (HSR) program was initiated in 1990 to provide technical solutions to the important environmental concerns of atmospheric ozone impact, airport noise and sonic boom. Progress to date on these efforts has provided growing confidence that the critical environmental concerns can be satisfied.

Atmospheric Ozone Impact. Our highest priority goal in the HSR program is to assure that future HSCT aircraft operation will not harm the Earth's protective ozone layer. We are working toward this requirement by developing the best possible atmospheric models to predict the effects of aircraft emissions, while concurrently developing new ultra-low-emissions engine combustors.

We are conducting the atmospheric modeling work in close cooperation with our Office of Mission to Planet Earth, and involving the world's premier atmospheric scientists, representatives from environmental protection groups, and key individuals from both the FAA & EPA. Results from the latest atmospheric models incorporating multiphase chemistry and improved dynamics indicate that a fleet of 500 Mach 2.4 HSCT aircraft with advanced low-emission engines would cause little or no impact in long-term stratospheric ozone levels.

We are also making excellent progress on reduced combustion emissions; laboratory testing of two advanced concepts has successfully achieved the desired reduced emission levels, with results even better than the program goal of 5 grams of nitrogen oxide per kilogram of fuel. We are currently transitioning the knowledge gained in the laboratory to practical-application combustor hardware for development and verification testing.

Obviously, an international consensus on ozone impact is paramount to future HSCT decisions by industry. As in our subsonic program, our close working relationship with the FAA comes into play; NASA is supporting the FAA's participation in the International Civil Aviation Organization's Committee on Aircraft Environmental Protection (ICAO-CAEP) activities on both emissions and noise.

Community Noise. Our research to develop the technology for achieving noise levels equivalent to the same stringent FAR 36, Stage 3 noise standards required for today's new subsonic transport aircraft is progressing extremely well. Advanced engine exhaust nozzle models incorporating mixer-ejector aerodynamics have achieved nearly 20 dB noise suppression, and high-lift wing design concept testing is showing potential for additional noise reductions. Flight simulations of these high-lift concept results, combined with advanced operational procedures such as automated engine throttling, indicate that further noise reductions of 3 dB at airport sideline locations and 5 dB at community flyover certification measurement locations could be achieved.

Sonic Boom. Continuing market and aircraft studies have indicated that an economically viable HSCT can be designed to operate efficiently at subsonic speed over land and supersonically only over water. Wind tunnel tests have shown, however, that it may also be possible to soften the sonic boom substantially, without a significant penalty in efficiency. NASA is working to quantify the performance and economics of the reduced-sonic-boom concepts, and also is developing improved atmospheric propagation models using military aircraft flight data for verification.

Based on progress in these areas, the HSR Phase I program was expanded in 1992 by adding the Enabling Propulsion Materials (EPM) element to develop materials needed to meet the requirements of the low emission, low noise engines for future HSCT aircraft. These materials include both ceramic matrix composites (CMCs) and metallic and intermetallic matrix composites (MMC's and IMC's). The CMC materials must be durable and able to operate continuously at up to 3000 degrees Fahrenheit in the corrosive and oxidizing environments of low-emission, high temperature HSCT engine combustors. Advances in MMC's and IMC's that retain their properties up to 2250 degrees Fahrenheit are needed in order to enable the development of lightweight exhaust nozzle components that will minimize the sound levels of the engine while providing high propulsive efficiency.

Phase II. The second phase of our HSR program emphasizes high-risk, high-leverage technologies essential for economic viability to complement those required for environmental compatibility being developed in Phase I. The $25 million added by Congress to our FY 1993 budget enabled us to start the longest-lead, most critical areas, and our FY 1994 budget request now under consideration provides for full initiation of the remaining technologies necessary to help ensure U.S. industry's competitive position in this future market sector.

Critical Propulsion System Components. Propulsion technology development and validation is crucial to the success of a future HSCT. In addition to large-scale verification of low-emission combustors and low-noise nozzles incorporating the earlier-noted materials, mixed-compression inlets and high-flow fans will be developed and evaluated in combination with the nozzle using an existing slave engine. The goal is to ensure that propulsion technology is in place for stable operation over the full range of power, while reducing supersonic and subsonic cruise fuel consumption by 4% and 10%, respectively.

Airframe Materials and Structures. Advanced materials and structures technology could provide a 30 to 40 percent weight savings while meeting the HSCT requirements of 60,000 hour durability at up to 350 degree Fahrenheit operating temperature. The planned program addresses development, scale-up, and verification of high temperature polymer matrix composites and aluminum alloys, including fabrication and combined load testing of large wing and fuselage structures.

Aerodynamic Performance. Advanced aerodynamic concepts offer the promise of a 33% increase in aircraft range through subsonic, transonic, as well as supersonic drag reduction. In addition, wing leading/trailing edge high-lift devices combined with advanced takeoff and landing procedures could reduce the noise footprint of the aircraft by 50% relative to the Concorde. Planned development efforts include both wind tunnel model testing and the use of one of NASA's F16-XL test bed aircraft.

Flight Deck Systems. Safe and efficient operation in the international air transportation system is key to any future HSCT. The use of synthetic vision sensors could provide all-site Category 3 operational capability and also negate weight penalties associated with nose droop during takeoff and landing, the system employed on the Concorde. Plans for developing advanced information-management cockpit displays include air traffic control simulations with airline pilots using NASA's Transport System Research Vehicle.

Technology Integration. The high level of interdependency among all the technologies being developed requires careful tracking and system-level integration of progress in each specific area to guide all technology efforts to the best overall conclusion. For example, advances in composite and light alloy materials technologies will result in reduced airframe weight, which in turn will lead to reduced engine performance requirements with potentially lower takeoff noise. High-lift aerodynamic concepts being evaluated could also significantly improve the subsonic lift-to-drag efficiency of the airplane, thereby lowering engine takeoff noise reduction requirements while providing greater flexibility in optimum design of the propulsion system for cruise operation. Similarly, supersonic laminar-flow-control concepts offer promise of significant reductions in cruise drag, but integration of the required wing surface suction system with the primary wing structure may limit the choice of advanced wing materials and structural concepts.

The need to address certification, operation and in-service maintenance considerations, along with affordable manufacturing issues, from the very beginning of this integration process cannot be understated. As a result, we have already had early discussions with the FAA, and have established a clear interface for continuous dialogue between NASA, industry and the FAA throughout the technology development and subsequent product development stages.

CONCLUSION

Mr. Chairman, as you can see, NASA has aggressive technology development underway to support the needs of U.S. aviation today and well into the future. I hope I have conveyed to you the importance of our partnerships with FAA, other government agencies and U.S. industry in designing and carrying out our programs. Working together, we can meet our goals of improving U.S. competitiveness in civil aviation and safely enhancing the capacity of the National Aviation System.

That concludes my statement, Mr. Chairman. I would be happy to answer any questions you or other Members of the Subcommittee may have.

United States General Accounting Office

GAO

Testimony

Before the Subcommittee on Aviation, Committee on Public Works and Transportation, House of Representatives

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AIRCRAFT CERTIFICATION

FAA Can Better Meet Challenges Posed by Advances in Aircraft Technologies

Statement of Kenneth M. Mead,
Director, Transportation Issues,
Resources, Community, and Economic Development Division

GAO/T-RCED-94-53

Mr. Chairman and Members of the Subcommittee:

We appreciate the opportunity to testify on the Federal Aviation Administration's (FAA) aircraft certification program. Over the past 2 years, we have reported on FAA's domestic and international certification activities for large commercial airplanes at the request of this Subcommittee.[1] FAA's certification program has a key role to play in promoting aviation safety. Our testimony today will focus on long-standing problems that affect the certification program, FAA's ability to meet the challenges of new technology, and actions that FAA can take to make a generally safe system even safer.

In summary, we found that:

-- FAA has not provided its staff with the guidance, technical assistance, and training needed to improve their technical competence. As a result, the staff's ability to effectively oversee or add value to the certification process as well as understand new technologies has been questioned by internal FAA reviews as well as by some manufacturing officials. Our findings are similar to those of the National Academy of Sciences, which in 1980 warned that FAA's certification staff were falling far behind industry in technical competency.

-- The current certification process generally results in safe aircraft designs because of the efforts of the manufacturers and expertise of their FAA-designated employees, who perform tests and carry out other activities

[1] Aircraft Certification: New FAA Approach Needed to Meet Challenges of Advanced Technology (GAO/RCED-93-155, Sept. 16, 1993) and Aircraft Certification: Limited Progress on Developing International Design Standards (GAO/RCED-92-179, Aug. 20, 1992).

for FAA staff during the typical 5-year process.[2] However, the technical competence of FAA staff has been limited because FAA has not (1) established meaningful guidance to ensure that its staff are effectively involved in a process that delegates up to 95 percent of all activities to manufacturing designees, (2) fully staffed a program established in 1979 for in-house experts to assist staff, (3) ensured that these experts are involved early and at key junctures in the process, (4) provided staff adequate technical training, and (5) addressed the high level of turnover among staff. We have made recommendations to address these problems.

Acknowledging that it needs to improve the competency of its certification staff, FAA has recently initiated efforts to improve its training and reduce the level of turnover among its staff. We support both of these efforts. However, current challenges posed by the certification of Boeing's 777 aircraft, which may be the most advanced commercial airplane ever produced, as well as future challenges posed by the certification of a potential high-speed civil transport, make it imperative that FAA address each of the problems facing its certification program, many of which were identified by the Academy 13 years ago.

We would now like to discuss FAA's certification process and our findings in more detail.

BACKGROUND

Before introducing a new aircraft into commercial service, a manufacturer must obtain from FAA a certificate signifying that the

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[2]The Federal Aviation Act of 1958 authorizes FAA to delegate certification activities, as necessary, to designated, FAA-approved employees of manufacturers.

basic design and systems meet minimum safety standards. To obtain such a certificate, the manufacturer must, usually over a 5-year period, supply FAA with detailed plans, drawings, test reports, and analyses demonstrating the aircraft's compliance with FAA's design requirements and produce a prototype of the new aircraft for both ground and flight tests. FAA employs approximately 120 engineers and test pilots to certify new transport airplane designs. In carrying out their functions, these staff also rely on--and must oversee--approximately 1,300 manufacturer designees who act as surrogates of FAA in approving certification tests and analyses.

After a 1979 accident that resulted in 273 fatalities, the Secretary of Transportation established a "blue-ribbon" committee to assess the adequacy of FAA's certification program. Under the direction of the National Academy of Sciences, the committee reported in 1980 that FAA's system of delegation was sound but warned that the technical competence of FAA's staff was falling far behind that of manufacturers' designees, to the point that the agency's oversight was becoming superficial.[3] The committee recommended that FAA develop a more systematic approach to the certification process, hire 20 to 30 experts to assist staff in understanding the more complex technologies, and improve staff competency by hiring, retaining, and training highly competent engineers.

Since the Academy's review, the two domestic producers of large commercial airplanes--the Boeing Company and Douglas Aircraft Company--and their subcontractors have developed increasingly complex designs and systems. Dramatic advances have occurred, for example, in the use of software-based systems to monitor and control aircraft functions traditionally performed by cockpit crews and in the use of composite structural materials to increase

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[3]Improving Aircraft Safety: FAA Certification of Commercial Passenger Aircraft, National Academy of Sciences (June 1980).

aircraft performance. In many cases, software-based systems have virtually replaced the hydraulic and mechanical control systems used on earlier generations of transport airplanes. For example, pilots of Douglas's MD-11 aircraft--certified in 1990--depend on complex software systems to continuously monitor and adjust the hydraulic, electrical, and fuel systems without action by the crew, thereby reducing the number of cockpit personnel needed from three to two. Unlike its predecessor--the DC-10, certified in 1971, which has almost no software--the MD-11 uses complex software to control many critical functions previously handled by a flight engineer.

PROCESS HAS GENERALLY RESULTED IN SAFE AIRCRAFT, BUT FAA STAFF'S COMPETENCE IS LIMITED BY SEVERAL FACTORS

The certification process has generally resulted in safe transport airplane designs, largely because of the efforts and expertise of the aircraft manufacturers. The extent to which FAA staff materially add to this level of safety is unclear, however, because FAA has not addressed several key problems, some of which were identified by the Academy in 1980. These problems are (1) the lack of adequate guidance to ensure a minimum effective staff role in the certification process, (2) an insufficient number of in-house experts to assist staff, (3) the lack of adequate guidance to ensure that the experts are involved early and at key junctures in the process, (4) inadequate technical training for FAA staff, and (5) high staff turnover. Combined with a diminishing role in the certification process for FAA staff, these problems have limited the staff's ability to understand the advanced systems they are asked to certify. Acknowledging that the technical competency of its staff needs to be improved, FAA has recently initiated efforts to improve its training and reduce the level of turnover.

Manufacturers Have Kept the Number of Design-Related Problems Relatively Low

Because of the manufacturers' expertise and high commitment to safety, design problems have accounted for relatively few commercial transport airplane accidents over the last decade. Between 1983 and 1992, 173 "hull loss" accidents occurred; for 122 of these, causes have been officially identified.[4] Of these 122 accidents, 16, or 13.1 percent, were caused by a failure of the aircraft's design, systems, or structure. By comparison, 84 hull loss accidents, or 68.9 percent, were caused by errors made by the flight crew. Several of the "new generation" transport airplanes designed and manufactured domestically in the 1980s--the Boeing 757, Boeing 747-400, and Douglas MD-11--have not had a hull loss accident.

By Not Changing Its Approach, FAA Has Limited Its Staff's Technical Competence

In 1980, the Academy also noted the positive safety record achieved by aircraft manufacturers but warned that FAA was falling far behind industry in technical competence, in part because of its ad hoc approach to certification. Despite the Academy's warnings, FAA has not fundamentally changed its approach to certification. Instead, FAA has responded to the increasing complexity and the consequent increase in workload by delegating even more certification activities to manufacturing designees. Much of this increased use of designees has occurred because today's certification projects involve many more detailed analyses and tests of more complex systems than past projects.

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[4]"Hull loss" accidents, commonly cited in discussions about aviation safety, are those in which the aircraft is damaged beyond economic repair. See Boeing Commercial Airplane Group, Statistical Summary of Commercial Jet Aircraft Accidents, Worldwide Operations, 1959-1992 (Apr. 1993).

Boeing officials estimated that the overall workload involved in certifying a new aircraft design has increased by as much as fivefold since the beginning of the jet aviation age in the late 1950s. Similarly, they projected that the number of test reports and analyses submitted to FAA for the current certification of the Boeing 777 aircraft will be double the number for the certification of the 747-400 aircraft in 1989.[5] In addition, FAA certification staff must increasingly rely on designees to conduct certification work because the staff's workload has increased in their two other areas of responsibility, which FAA defines as having higher priority. These staff, besides certifying airplane designs, must continuously monitor already certified aircraft and issue airworthiness directives to ensure continued safety and assist in developing new regulations and policies. Increased demands in these areas have limited the amount of time staff can spend on lower-priority work involving certification.

For example, an internal FAA study found that the agency delegated 95 percent of the certification activities for the Boeing 747-400 aircraft--certified in 1989. By comparison, FAA staff estimated that they delegated between 70 and 75 percent of certification activities in the early 1980s. Likewise, the number of designees involved in certifying new transport aircraft designs rose from 299 to 1,287 (330 percent) between 1980 and 1992. At the same time, the number of FAA engineers and test pilots responsible for certifying new transport airplane designs rose from 89 to 117

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[5]FAA expects to certify Boeing's 777 aircraft, which will use highly complex software systems to control such critical components as the aircraft's rudders and wings, in May 1995.

(31 percent).[6] (App. I shows a comparison of the number of FAA staff and designees.)

Despite the increasing demands on its staff and their declining role in the certification process, FAA has not taken steps to ensure that they remain effectively involved in the process. As a result, FAA staff have sometimes not understood the new technologies that they have been asked to certify. For example, an internal study by FAA's Transport Airplane Directorate found that during the certification of the Boeing 747-400 aircraft in the late 1980s, FAA engineers did not understand the complex flight management system, which operates the navigational system and monitors the performance of other systems; hence, they delegated to Boeing designees the approval of the entire system. The study noted that FAA staff "were not sufficiently familiar with the system to provide meaningful inputs to the testing requirements or to verify compliance with the regulatory standards." Similarly, the study found that because FAA engineers had minimal knowledge of 10 other systems, including the aircraft's braking system, the agency delegated to designees key analyses of those systems--analyses that on previous certification projects FAA had reserved for its own staff.

Likewise, FAA and manufacturing officials told us that FAA needs to improve its understanding of new technologies to adequately verify regulatory compliance. Moreover, a 1989 internal FAA review concluded that the amount of work delegated to designees had reached the maximum for properly managing the certification process and that further delegation would reduce FAA's ability to effectively understand and monitor the highly complex technical

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[6]FAA engineers and test pilots responsible for certifying transport category airplane designs are located in FAA's Seattle and Los Angeles Aircraft Certification Offices. These two offices are overseen by FAA's Transport Airplane Directorate in Renton, Washington.

work being done by designees. The review identified a need for better defining FAA's role in the process and recommended that FAA establish uniform "monitoring requirements" for overseeing designees. We found, however, that the amount of delegation has increased since 1989 and that FAA has not taken any action to address the review's concerns. The number of designees involved in certifying transport aircraft, for example, increased over the last 3-1/2 years by an average of 90 per year; meanwhile, the number of FAA certification staff increased by an average of 3 per year.

FAA's Program to Meet Deficiencies in Technical Competence Is Only Partially Staffed and Is Limited in Effectiveness

Recognizing in 1979 that it needed to improve its staff's competence, FAA established the National Resource Specialist (NRS) Program, through which in-house experts in such subjects as crash dynamics, composite materials, and advanced avionics would assist certification staff. The Academy in 1980 noted that FAA's hiring of in-house experts was a good idea and said that FAA needed approximately 20 to 30 experts. However, the program is much smaller than originally envisioned: Only 11 positions are authorized, even though FAA identified a need for 23, and only 8 of the 11 positions are actually filled. FAA cites an inability to attract qualified experts as the reason for its not fully staffing the program or filling the three vacant positions. According to certification staff and experts in the NRS Program, FAA's not fully staffing the program has caused staff to fall further behind in some areas of expertise. In addition, some experts are stretched increasingly thin, in part because they must (1) perform duties originally intended for another NRS position that was never authorized and (2) develop expertise to cover additional areas because of technological advancements.

A lack of direction from management has also limited the program's potential. FAA's guidance is silent on when and to what extent experts should be involved in the certification process. The experts are not required to involve themselves in the process, and certification staff are not required to use them, even though the experts are full-time FAA employees. As a result, the experts are sometimes not sought for advice or are often involved in the process too late for them to make the most effective use of their expertise. For example, one expert told us that he intervened in the process when he learned from an industry source that Boeing's proposed design for the 777 excluded "crack stoppers"--devices installed on the fuselage skin to prevent cracks from growing to unsafe sizes. As a result of his actions, he said, Boeing is reviewing its testing procedures in this area. According to the certification engineer, she did not request expert involvement because she believed no problems existed and no guidance defines when experts should be consulted.

FAA's Certification Training Has Been Inadequate

FAA has provided its staff with little training in new technologies since 1980. In 1987, FAA released a study called "Project Smart," which examined the entire certification program, including training. Like the Academy's 1980 study, FAA found that the certification workforce was 3 to 5 years behind the developments in industry. The study recommended that FAA develop and implement a more formal, structured program with specific annual training requirements. This program was to include a system for identifying, developing, and evaluating training opportunities both inside and outside FAA. Agency officials stated that budget constraints kept them from responding to these recommendations.

In the face of little progress in improving training, FAA hired a contractor in 1990 to survey the certification workforce and document training needs. In February 1991, the contractor reported that all levels of the certification organization were dissatisfied with the state of technical training.[7] The contractor noted that certification staff had no comprehensive, up-to-date program that (1) described the training courses needed, (2) related these courses to job performance, (3) established the sequence in which the courses should be taken, and (4) ensured that the courses were available. It also identified a need for training in over 100 different areas, including such technical subjects as composite materials and software.

We found that the amount of technical training available is not adequate to ensure the staff's competence. For example, FAA continues to provide little training in the sophisticated computer systems being deployed on current aircraft. We found that between fiscal years 1990 and 1992, only 1 of the 12 engineers responsible for approving and certifying aircraft software in the Los Angeles and Seattle Aircraft Certification Offices had attended a software-related training course. Acknowledging that the agency's technical training needs to be improved, FAA officials have initiated a major effort to improve certification training and expect to have a strategic plan for this effort by the end of the year.

High Turnover Has Complicated FAA's Efforts to Ensure Staff Competence

FAA has also had difficulty keeping up with advanced technologies because of the increasing inexperience of its staff. For example, in 1987, 58 percent of the Seattle Aircraft Certification Office's systems and equipment branch engineers--responsible for certifying electrical, mechanical, and software-related systems--had at least 6 years of FAA certification experience. However, as of April 30, 1993, the percentage of staff with 6 years or more of experience had decreased to about 17

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[7]Human Technology, Inc., Description of the Current Training System Within the Aircraft Certification Service (Feb. 1991).

percent. Likewise, over half of the engineers with primary responsibility for certifying the 777 have never participated in a major certification project.

FAA officials attributed this declining experience level to a high turnover among staff, which is caused largely by the lack of a technical career path within the certification unit. Certification staff seeking promotion must either move to positions outside the unit or leave FAA. As a result, nearly one-half of the nonsupervisory engineers at the Seattle and Los Angeles Aircraft Certification Offices joined these offices within the last 4 years. Boeing officials told us that as a result of this high turnover, each certification project brings with it a new set of FAA staff that need to be "educated" in advanced technologies. To help reduce the level of turnover within the certification offices, FAA has initiated efforts to retain competent engineers by attempting to create a technical career path within these offices. A GS-14 "senior engineering series" would be created between the GS-13 engineer and GS-15 NRS positions. FAA expects to have such a career path in place by October 1994.

ISOLATED SAFETY PROBLEMS, FUTURE CHALLENGES HIGHLIGHT NEED FOR MORE VALUE ADDED BY FAA STAFF

Although relatively few design-related accidents have occurred over the last decade, one tragedy and future technological advances highlight the need for FAA staff to keep up to date on new technologies so that they can provide an effective check on the manufacturer's activities. In May 1991, a Boeing 767, whose design was certified in 1982, crashed in Thailand after an engine thrust reverser accidently activated in flight; 223 people were killed. Thai investigators--assisted by the National Transportation Safety Board (NTSB)--concluded that "the consideration given to high-speed in-flight thrust reverser deployment during design and certification was not verified by flight and wind tunnel testing and appears to be inadequate." NTSB's representative in the Thai government's investigation of the accident told us that he believed that FAA had added little value to the process in this instance.

In addition to the challenges of today, further dramatic technological changes will be incorporated in the next generation of large commercial airplanes. Douglas officials estimate, for example, that the next aircraft the company may develop--the MD-12--will use twice as much software as the MD-11. By 2005, according to National Aeronautics and Space Administration officials, pilots of a high-speed civil transport aircraft will likely navigate using sensors and satellite systems, while traveling at three times the speed of current aircraft. Instead of looking out the cockpit window, pilots will view a video screen that will display an enhanced image of the outside generated by these systems.

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In summary, the aviation industry has witnessed rapid changes in aircraft technology since the 1980s. The future will bring more changes, such as the further development of electronic systems for sensing the environment and controlling the aircraft and more advanced uses of composite materials in aircraft structures. Such advances will present significant challenges to FAA in terms of certifying these technologies and ensuring safety. FAA engineers and test pilots must be up to date to carry out their certification and regulatory tasks.

In 1980, the National Academy of Sciences found that the competency of FAA's certification staff was falling far behind that of the engineers in the industry they regulated. Since 1980, FAA has not provided its staff with the guidance, expert assistance, and training needed to improve the staff's competence. Combined with the staff's decreasing role in the certification process and increasing inexperience, these problems have led several FAA internal reviews, as well as some manufacturing officials, to question the extent to which FAA staff understand new technologies or add value to the certification process.

We recognize that the demands on FAA's resources and the complexity and size of certification projects make it unreasonable to expect FAA engineers to review all certification data. Likewise, we recognize that FAA is taking some actions to improve its training program and reduce the high level of turnover among its staff. However, we believe that FAA needs to go further than the current initiatives. By (1) better defining its role in the process, (2) improving its use of in-house experts, (3) establishing specific training requirements, and (4) keeping its training as current as possible, FAA can more effectively meet the challenges posed by advanced technologies and add more value to the certification process.

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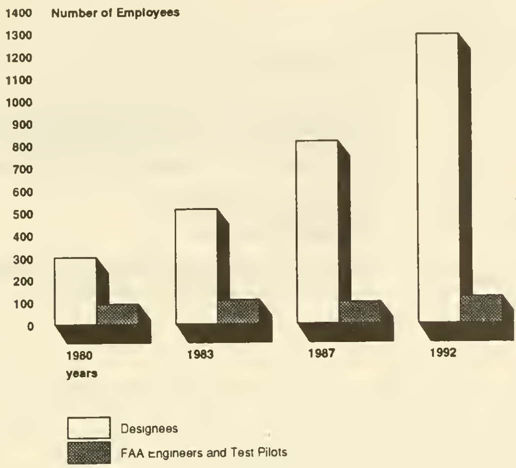
This concludes our testimony. We would be happy to respond to any questions you may have.

(341417)

COMPARISON OF THE NUMBER OF DESIGNEES WITH THE NUMBER OF FAA ENGINEERS AND TEST PILOTS RESPONSIBLE FOR CERTIFYING NEW TRANSPORT AIRPLANE DESIGNS, 1980-92



Note: Figures for 1980 are from March 1980. All other data are as of the end of the fiscal year.

Source: GAO's analysis of data from FAA and the National Academy of Sciences.

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Statement of Robert E. Robeson, Jr.

Vice President
Civil Aviation

Aerospace Industries Association of America

on

Advanced Aircraft Technology and
Federal Aviation Administration Aircraft Certification

Before the House Subcommittee
on Aviation

October 20, 1993

Good Morning. I am Bob Robeson, vice president, civil aviation, of the Aerospace Industries Association of America. As you know, Mr. Chairman, AIA represents the nation's manufacturers of aerospace equipment, including civil aircraft, engines and components. We appreciate this opportunity to address the issues raised in the GAO report which is the subject of this hearing.

Appearing with me today are Gerald R. Mack, Director, Certification and Technical Liaison, Engineering Division for the Boeing Commercial Airplane Group, and Webster C. Heath, Chief Technical Engineer, Airworthiness, Douglas Aircraft Company. In the next few minutes, I would like to give you some general observations concerning what we see as major issues raised by the GAO. Mr. Mack and Mr. Heath have extensive experience in aircraft certification and dealing with the FAA, and are available to answer any questions you may have following my statement.

AIA is committed to working with the FAA in its mission to ensure continued improvement in the safety and efficiency of civil aviation as mandated in the legislation that created the FAA. Our manufacturers view themselves as partners with the FAA in pursuit of safety, and this of course includes the certification of our products.

In this context of partnership, I would like to address the following principal issues raised by the report: The introduction of new technologies; The role of FAA in the certification process and the designee system; and FAA technical competence.

New Technologies

Mr. Swihart's testimony on new technologies that we see coming on line, provides the context for my remarks. However, through the rest of my statement, I would like you to keep a key point in mind. The application of technology in civil aviation tends to be evolutionary rather than revolutionary The reason for this is straightforward. In the environment of airline economics, affordability becomes paramount for success. The challenge of the research and engineering community is to provide value-added technology. This means that technology should be added only when it results in improved safety and/or lower costs to the operator.

The cost of a totally new technology can by quite high. It is driven both by the costs of research, engineering and development as well as by the need for extensive validation to demonstrate that the application of the new technology is safe. This leads to a long lead time between the birth of an idea and the introduction of a resulting product into service.

When speaking of new technologies in the context of aircraft certification, therefore, it is important to remember that this gradual introduction of technology usually means that the FAA already has a foundation of knowledge which it can apply to its analysis of a type design. When we speak of "dramatic technological changes" we are not normally speaking of a sudden introduction of technologies that are unfamiliar. Even in those unusual cases where new technologies are introduced rapidly, the FAA works closely with the private sector to ensure that the application is properly certified.

The aircraft certification process is a "closed loop" process. New aircraft designs and derivative versions evolve as the market dictates. The level of new technology incorporated into these designs depends on the proven benefits in terms of cost and efficiency and safety. One example of technology that has been around for some time but has slowly found its way into aircraft is advanced composite structure.

The aircraft certification process is a "closed-loop" process because it includes not only certification of the design but monitoring the design in the operational phase. This later phase provides the feedback to correct, first of all, the specific design if an unsafe condition exists and secondly to update the Federal Aviation Regulations if the requirements were deficient. History shows that this process has worked extremely well over the past 30 years. But as with any process we can always do better. We must all ensure that changes aren't being made for the sake of change, but for the right reasons.

The transport airplane has become more complex over the years. Most of the developments have come from digital data systems area. The safety and cost benefits that derived from these advancements are phenomenal; it is an accepted fact that these advancements, such as map displays, are largely the contributors to the low accident rate of the new generation airplanes. Applications of advancements in other technical disciplines have been more limited. Airlines want airplanes to be as simple as possible to operate and maintain. Non-safety related advances must result in lower life-cycle costs. This simple fact drives the evolutionary approach to new technologies in civil aviation.

Certification and the Designee System

In order to understand the role of the FAA as the certifying authority, it is important to understand the development of the rules. FAA's rulemaking involvement in this business is to develop certification requirements and standards that will ensure the safety of the traveling public. An important part of this regulatory development is the issuance of pertinent guidance or advisory material that tells both FAA and industry engineers and pilots how to apply the requirements to a specific design. The Aviation Rulemaking Advisory Committee activity has provided the mechanism for all interested parties to participate in the regulatory development process, prior to FAA entering into the final stages of rulemaking. We believe that this ARAC process will result in much more effective requirements.

The FAA's role in the actual certification process (where the requirements are applied) must be carefully managed to ensure resources are being used where the maximum benefit can be realized. The delegation process (Designated Engineering Representatives, Designated Manufacturing Inspection Representatives, and company delegation programs) has proven to be a viable and effective means for certificating aircraft products. The delegation concept has been studied by numerous organizations. This includes studies performed at the request of Congress. The delegation system has consistently received positive endorsements, due to the overwhelming successful track record. These endorsements are a tribute to the men and women of both FAA and industry who operate the delegation/designee system.

The designee system is very comprehensive, Candidates are screened and trained prior the appointment, then a given progressive responsibility and authority by FAA as confidence is acquired. The number of designees has risen significantly the past 10 years, primarily due to the increased use of digital systems. However, the DERs are more limited in scope in these areas due to specialties. So although the FAA workload has increased in handling appointments, the workload due to supervision of DERs has not increased proportionately. The amount of delegation given to a specific DER is based on the experience and working relationship developed between the FAA engineers and the DER. This is similar to the way any employee is given increasing responsibility as the employee develops the capability. In the case of a DER, this consists of developing a capability of applying the FAA requirements. Fortunately, given the nature of the rulemaking process many DERs have had a significant role in assisting with the development of the requirements themselves. Thus, they are already very knowledgeable about the requirements.

AIA is concerned about a possible ambivalence in the GAO report in its discussions of the designee system. We firmly believe that the delegation program works well precisely because the FAA and the manufacturers are in close contact from the beginning of the application for the type certification basis through the service life of the aircraft type.

For this reason, we were somewhat puzzled by the GAO recommendation on page 27 that the FAA should identify "critical activities requiring the agency's involvement or oversight..." We are not clear as to the meaning of this recommendation, since we believe that this involvement is precisely what happens for each product that requires a type certificate.

We certainly agree that there is always room for improvement. After all, that is what total quality management is all about. But it must be recognized that up front cooperation between the applicant and the FAA in concert with the DER system enables the agency to focus its resources where they are needed most and where they will contribute to the highest level of safety.

As new technologies evolve from initial concept reaching the point of being viable for civil aircraft, many individuals with differing interests and expertise are involved. The FAA certification staff should not waste valuable time and resources in research and development activities of a technology that will never get on an aircraft. The National Resource Specialist role is somewhat different. The NRS for a particular specialty should maintain general oversight of a technology and as it approaches a maturing stage, the NRS should begin to lead the development of reasonable standards for certifying designs with the new technology. Also, the NRS should take a significant role of bringing the FAA certification staff "up to speed" using a combination of formal and on-the-job training. We believe that the FAA has partially implemented this approach but further refinement would ensure full implementation. A true NRS/Certification staff team is mandatory to an effective program.

FAA Technical Competence

Finally, we wish to address questions raised concerning the technical competence of FAA staff. Any meaningful discussion of this question must be based on a clear understanding of the mission of the Aircraft Certification Service. While this may appear to be stating the obvious, we must recognize that their job is to certify the design of the product and the quality systems under which the product is built. Their job is not to design the product or to specify a particular quality system. In other words, of the many roads which lead to Rome, the certifier ensures that the road you have chosen is one of them. It is not his or her job to tell you which of the acceptable roads you must take.

In order to perform the job of certifier, the FAA official must be able to understand the information presented to the agency. This is not the same as having the ability to develop the information in the first place. Today's aircraft and systems are so complex that we have become an industry of specialties and specialists down to a micro level. That is why we have so many more DER's, who often have very limited areas of authority. To be the best at aircraft design in any of these specialties, you have to work in your specialty constantly. It is not reasonable, nor fair, nor necessary to expect a certifying official to be an expert at every level of design.

Certainly, training is an important tool in ensuring a qualified certification team. But we must be realistic as to goals of such training and what can be accomplished. In particular, we urge this committee to support funding for the certification service with a focus on near term needs. Training directed toward technologies that will not be incorporated into the fleet for another 10 years will be a waste of scarce resources. Training that is sharply focused on meeting the current needs of the certification service and is grounded on a clear understanding of the distinction between the aircraft designer and the aircraft certifier would help improve the efficiency of the certification process.

Statement of John M. Swihart

Vice Chairman of the Board
National Center for Advanced Technologies

on behalf of

Aerospace Industries Association of America

on

Advanced Aircraft Technology and Federal Aviation
Aircraft Certification

Before the House Subcommittee on Aviation

October 20, 1993

Mr. Chairman, I thank you for this opportunity to appear before the subcommittee today. This hearing on advanced aviation technology gives me a chance to gaze into industry's crystal ball and provide you with a glimpse at the types of technologies that industry is hoping to bring on-line in the coming years.

I am John M. Swihart, the vice chairman of the board of the National Center for Advanced Technologies (NCAT), a non-profit foundation established by the Aerospace Industries Association (AIA) in 1989 to identify the "key" technologies most critical to the continued leadership of our nation in aerospace and to devise a roadmap and a development plan for the development of each technology. Today, I am appearing on behalf of the AIA membership -- the U.S. manufacturers of aircraft, engines, missiles, spacecraft and related components and equipment.

Before I address some of the new technologies for the subcommittee, I thought you may be interested in learning how industry, the government and academia have been working together toward the advancement of technology. The strategic plan on airbreathing propulsion systems developed by AIA and NCAT in February 1992 is a good example of the cooperative efforts being undertaken by industry.

AIA member companies, GE Aircraft Engines, Teledyne/CAE, UTC/Pratt and Whitney, ASAC/Garrett, Textron/Lycoming, GM/Allison and Rockwell International prepared the plan with the assistance of a review panel comprised of leaders from industry, government and universities. The objective of this "Airbreathing Propulsion Technology Team" was to establish a strategic plan based on roadmaps. Their goal is to provide a national plan to improve engine performance, reliability and fuel efficiency, as well as reduce weight and volume, acquisition and operating (life-cycle) costs.

Eleven essential subordinate technologies were identified. Technology development/verification strategies were included in the plan, as well as an emphasis on the importance of manufacturing processes that meet new material systems needs, drive down costs and improve quality. The roadmaps developed by the team include discussions of issues such as efficiently transitioning new technology into production, development of high risk, high payoff research and techniques for addressing multidisiplinary analysis methods. The plan covered both civilian and military aircraft since any advances in technology would be mutually beneficial.

This plan is only one example. Over the years, NCAT has developed similar roadmaps for the development of additional new technologies such as advanced sensors, rocket propulsion, and advanced composites.

NCAT is currently working on Demonstrations of Engineering and Manufacturing Operations (DEMO), which are technology demonstrations that are very close to a product when they are finished. These will include Integrated Product and Process Development (IPPD) and are a systems view of demonstrations which integrate several technologies and manufacturing and process technologies to both improve productivity and reduce cycle time. This is a new approach to technology demonstrations and requires an educational effort to make it work. NCAT, with Georgia Institute of Technology and the National Technological University, is providing a video series on IPPD and how industry, government and academia are approaching it. We are trying to change the culture of serial activity to concurrent activity.

These kinds of new technologies, Mr. Chairman, are what will keep U.S. aerospace manufacturers competitive in the growing world market. Our manufacturers work closely with the FAA and NASA to advance technical know-how. Increasingly, aerospace companies are working together as partners, rather than solely as competitors. Cost and risk-sharing in the R&D phase of development permits U.S. companies to remain competitive in the international marketplace.

A rational investment strategy, for either a company or a nation, is to first maintain existing markets by providing for the technology upon which to base improved products for the established markets; and then invest in technologies and product process innovations for new fields of opportunity. The first element of this strategy is essential; it provides the base to support the greater, and higher-risk investment required in the second element. Applied to aeronautics, this means that our attention must at first be turned to the subsonic flight regime which encompasses all but a minuscule fraction of current civilian operations.

Subsonic Aircraft

In the subsonic arena, the key technical challenge is to provide improvements in safety and efficiency, along with capacity of the national air transportation system. These areas of concern apply to all sizes and types of aircraft and associated propulsion systems. International competition is intense for the global market in each of these areas.

While transport aircraft have not visibly changed much to the casual observer, technology has moved aviation forward. However, aside from the introduction of jet power to commercial aviation, the introduction of new commercial aircraft technologies has been evolutionary, not revolutionary. This is because new technologies must be justified on the basis of safety and cost. Thus, although advancements may appear to be incremental, collectively they add up to very measurable improvements in aircraft safety and efficiency.

In the subsonic aircraft we see continuous improvement in a number of areas. Advancements in engine technology are focused on making the engines quieter and more fuel efficient. Pratt and Whitney, General Electric and Allison have worked with NASA's Lewis Research Center on advanced core engine technology. They found that thermal efficiency can be improved, increasing core performance 60 percent. Studies done at Lewis predict that overall fuel consumption can be reduced 20-30 percent, possibly reducing operating costs by 6-14 percent.

Noise reduction technology is a major effort for industry. Theoretically, engineers know how to reduce engine noise, but they encounter design problems when putting the theories to work. Regardless, a quieter, more fuel efficient engine will be developed. In addition, research is being conducted to reduce airframe noise, particularly when the aircraft is on approach.

Reduced weight is a high priority for commercial aircraft. Industry is working to continue the advances made in recent years in the development and use of composite and new metallic materials. In addition to weight reduction, composites resist corrosion better than other materials. New developments in this area may replace metal wings and fuselages with epoxy-type resins and high-strength carbon fiber. Maintainability and cost are typical of the challenges in increasing the use of composites on commercial aircraft.

Continued investments in rotorcraft are needed to keep the U.S. helicopter industry competitive. Advancements are needed to yield dividends in cost, reliability, and maintainability, external and internal noise, vibration control, reduction in weight and improvements in performance. In addition, work is being done by industry and NASA to research the acoustic, structural and performance characteristics of commercial tilt-rotor aircraft.

High Speed Civil Transport

Possibly the most exciting high-technology project is the High Speed Civil Transport, or HSCT. The aircraft itself is not a "new technology." In fact, I started working on an advanced SST in 1958 and was chief engineer of Boeing's SST product development in 1971. This project, however, will be different, in that it incorporates a combination of many new technologies. Not long after the turn of the century, thousands of passengers a year could be flying from Los Angeles to Tokyo in four hours, instead of the twelve hours it takes to travel on subsonic aircraft. A safe, profitable, reliable, and environmentally friendly, HSCT would drastically change international travel, just as the first subsonic jet transports did 35 years ago.

The challenges facing the development of HSCT are daunting, but we believe that the challenges can be overcome. In late 1989, NASA asked Boeing and McDonnell Douglas to "define the potential market for a next-generation supersonic airliner and consider the engineering advances that would make it financially successful and environmentally safe." Both firms predicted that transpacific travel will increase 400 percent by the year 2000 and that transatlantic trips will double. According to the study, by the mid-2000s, there could be 600,000 passengers per day travelling on more than 1000 HSCTs at more than 2.4 times the speed of sound.

There are a number of difficult design problems that must be solved before aircraft development can begin. For economic reasons, an HSCT must use the same airports as conventional subsonic aircraft. This means it must meet the current Stage 3 noise rules -- one-tenth the noise level of the supersonic Concorde. In addition, the engine emissions of the HSCT must not harm the Earth's ozone layer. The last, and perhaps most difficult requirement is that all the new technology in the HSCT must be combined in such a way that it is cost competitive with the best subsonic jet transports.

HSCT engine research during the past two years has focused on the reduction of oxides of nitrogen (NOx) emissions from aircraft engines. Two promising designs are being studied that either one could reduce NOx emissions by the goal of 90 percent.

To resolve the noise issue, Pratt and Whitney and General Electric are working with NASA to evaluate engine choices for the HSCT. The designers want an engine that has low exhaust velocity at takeoff, like the current high-bypass turbofans used today. However, the engine must also have good supersonic cruise performance, which requires a high-velocity, turbojet like cycle -- the exact opposite of the characteristics that reduce noise. It appears that a mixed flow, turbofan with a mixer/ejector nozzle is the best option to provide the supersonic performance and low take-off noise needed.

Engineers are also working to reduce sonic boom levels of the HSCT. Although the plane is envisioned to fly supersonically only over the ocean, wing and fuselage designs are being investigated to minimize any impact on the marine environment and perhaps permit flight over sparsely populated areas of the world.

As in subsonic design, new material research for the HSCT focuses on increased strength and reduced weight. Study focuses on ceramic matrix composites that could function without surface cooling in the high temperatures of low-emissions jet engines. Another area of research is developing new intermetallic matrix composites for the exhaust nozzles that would reduce their weight by 30 percent over current metal alloys. In addition, the composites being developed for the HSCT must be low-cost, able to operate at over 400 degrees Fahrenheit, and be able to operate for a lifetime goal of at least 18,000 hours. This will save 90,000 lbs. (11.6%) of take-off gross weight.

An additional area of research in the HSCT program involves the reduction of aerodynamic drag caused by air friction. One way to reduce drag and to increase fuel efficiency is to reduce the turbulent airflow over the wings, leaving a smooth or "laminar" flow. Initial tests, using NASA research aircraft have provided a good basis for reduction of drag. The goal is to achieve laminar flow over 45-60 percent of the wing surface. This will save an additional 8% of take-off gross weight.

If progress on the program continues at its current rate, predictions are that the first high speed civil transport could roll off the production line in 2005. The technology developed for the program will advance aviation, and will create a multi-billion dollar market (estimated to be $300 billion in 1993 dollars) for U.S. manufacturers and air carriers.

Mr. Chairman, this concludes my prepared remarks. I would be pleased to answer any questions you and members of the subcommittee have.

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