SPEAKERS   CONTENTS   INSERTS

Page 1   TOP OF DOC

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2001

A REVIEW OF VERTICAL TAKEOFF AND LANDING TECHNOLOGY IN THE NATIONAL AIRSPACE SYSTEM

HEARING

BEFORE THE

SUBCOMMITTEE ON SPACE AND AERONAUTICS
COMMITTEE ON SCIENCE
HOUSE OF REPRESENTATIVES

ONE HUNDRED SEVENTH CONGRESS

FIRST SESSION

MAY 9, 2001

Serial No. 107–9

Printed for the use of the Committee on Science

Available via the World Wide Web: http://www.house.gov/science

Page 2   PREV PAGE   TOP OF DOC

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Page 3 PREV PAGE TOP OF DOC

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Page 4 PREV PAGE TOP OF DOC

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Page 5 PREV PAGE TOP OF DOC

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C O N T E N T S

Page 6 PREV PAGE TOP OF DOC

Page 7 PREV PAGE TOP OF DOC

A REVIEW OF VERTICAL TAKEOFF AND LANDING TECHNOLOGY IN THE NATIONAL AIRSPACE SYSTEM

WEDNESDAY, MAY 9, 2001

Page 8 PREV PAGE TOP OF DOC

House of Representatives,

Subcommittee on Space and Aeronautics,

Committee on Science,

Washington, DC.

The Subcommittee met, pursuant to call, at 2:10 p.m., in Room 2318 of the Rayburn House Office Building, Hon. Dana Rohrabacher [Chairman of the Subcommittee] presiding.

Chairman **ROHRABACHER.** I hereby call this meeting of the Space and Aeronautics Subcommittee to order. Without objection, the Chair will be granted authority to recess the Committee at any time. Hearing no objection, so ordered.

When I was elected to Congress back in 1988, I was a big fan of vertical takeoff/vertical landing technology, and I have continued to be a supporter of that technology. It offered a vital new military capability. On the civilian side, I thought that if we could build and operate aircraft independent of big airports, we could change the nature of commercial air travel in the United States, making it more efficient, more flexible, and more enjoyable.

Our current problems with the National Airspace System make getting away from chokepoints represented by hub and spoke systems even more critical today than it was when we embarked on a major vertical takeoff/vertical landing technology over a decade ago.

Page 9 PREV PAGE TOP OF DOC

In 1988, the leading technology for widespread commercial vertical takeoff/vertical landing aircraft was the tiltrotor, and I backed that program. As I say, I backed that program for most of my career in Congress. Indeed, NASA did some exceptional technology R&D in the XV–15 program, and I don't regret supporting the agency's work. We have examined that technology and moved forward in it as it should have been examined and should have been developed and researched.

But in recent months, we have learned that something is fundamentally wrong with tiltrotors as they are scaled up for routine military use. It may not be wrong with it at a smaller level, but it appears that there are some fundamental problems when the tiltrotor technology is scaled up. A series of crashes and lives lost convinced me we need to take another look at solving our airspace congestion with vertical takeoff and landing aircraft but maybe with a different approach.

Fundamentally, none of us who have supported this program should be spending our time with our heels dug in and saying if we made a mistake, we aren't going to admit a mistake. That is the very worst thing we can do. If we have made a mistake and this isn't the right direction to go, we owe it to the people who are flying the aircraft, we owe it to the public, the taxpayers, we owe it to our Marines to make sure we admit a mistake and correct it, or move on, and just admit a mistake and go in a direction that we can succeed in.

Fortunately, technology keeps changing, and there are new capabilities that are becoming evident and possible everyday, and that changes the possibilities and the alternatives we have when it comes to vertical takeoff and vertical landing aircraft. Where large turbine tiltrotors have failed, entrepreneurs and innovators have stepped in with, basically, jet technology. In recent years, the Office of Naval Research has been funding a small technology demonstration program to see how jet engines using vector thrust could serve American aviation needs, which includes an enormous commercial application.

Page 10 PREV PAGE TOP OF DOC

Today, we have a prototype for an operational vertical takeoff/vertical landing aircraft known as the DP–2. When I was first introduced to this jet as a military program, I was immediately reminded of the civil and commercial benefits of this vertical takeoff and landing aircraft, which is, of course, what attracted me originally to the Osprey.

So that is why we are here today. We are going to take a fresh look at vertical takeoff/vertical landing technology, and we are going to talk about its role in solving our nation's and our national airspace needs, the potential for keeping our country free, and keeping our country at peace, and keeping our country prosperous and ahead of the competition.

Experts at NASA and the FAA are going to explain how vertical takeoff and landing fits into our national airspace system. Representatives from duPont Aerospace and the Office of Naval Research are going to review the state of vertical takeoff and landing jet technology. And I expect that at the end of the hearing, we will be in a better position to pursue the right technologies for our future in aviation.

Mr. Gordon is not with us today, the Ranking Member, but taking his place, Mr. Lampson, a very active member from Texas, takes this job very seriously. We are very happy to have you with us, and you may proceed with your opening statement.

[Statement of background memorandum follows:]

HEARING CHARTER

Page 11 PREV PAGE TOP OF DOC

A REVIEW OF VERTICAL TAKEOFF AND LANDING TECHNOLOGY

IN THE NATIONAL AIRSPACE SYSTEM

Wednesday, May 9, 2001

2:00–4:00 pm

Room 2318, Rayburn House Office Building

1. PURPOSE

The hearing will examine Vertical-Takeoff-and-Landing (VTOL) technology, how VTOL could mitigate airport congestion, and federal and industry efforts to more fully integrate VTOL into the National Airspace System. The hearing will also focus on a developmental VTOL aircraft concept, the DP–2.

The panel will include:

Mr. Anthony A. duPont, founder and President of duPont Aerospace Company, El Cajon, CA, holds an undergraduate degree from Yale and an MS in Aeronautics from the California Institute of Technology. He flew as a navigator and copilot for Pan Am World Airways; worked as an engineer at the Douglas Aircraft Company on projects including design of the Saturn Rocket upper stage; and as Chief, Aerospace Advanced Design, for Douglas' aerospace plane development program. He also worked for the Garrett Corporation as Director of Product Planning (turbofan engines), and managed the company's NASA Hypersonic Research Engine program. duPont Aerospace was founded in 1969.

Page 12 PREV PAGE TOP OF DOC

Mr. William H. Wallace, National Resource Specialist for Rotorcraft Operations, Federal Aviation Administration, holds a BS in Aeronautical Science from Embry-Riddle Aeronautical University. He holds an Air Transport Pilot rating—and Flight and Ground Instructor ratings—for both fixed-wing and helicopter, and has flown more than 11,000 accident-free hours. He is Chairman of the FAA's Vertical Flight Committee, which oversees all FAA rotorcraft and tiltrotor programs including R&D, aircraft certification, flight standards, airports, air traffic, and safety. For the past nine years he has served as the FAA representative to the European Joint Aviation Helicopter Subcommittee. He is retired from the U.S. Army Reserve as a Chief Warrant Officer, Instructor Pilot and Flight Examiner, after 31 years of service.

Dr. John Zuk, Chief of the Advanced Tiltrotor Technology Office, NASA Ames Research Center, holds a BSME from Ohio State University, MS in Mechanical and Aerospace Sciences from the Univ. of Rochester and a Ph.D. in Aerospace Engineering from Case Western Reserve Univ. His career at NASA spans research in aeronautics and space propulsion, Aircraft Energy Efficiency Program management, and technical management in both rotary and fixed wing aircraft systems. He has participated in a number of systems analyses and studies of aircraft concepts including tiltrotor, Vertical/Short Takeoff and Landing systems, Advanced Subsonic, High Speed Civil Transport, and single-stage to orbit. Dr. Zuk has contributed to a number of national studies at the Office of Science and Technology Policy, National Academy of Engineering, and the Transportation Research Board, and has won honors and awards based on his work.

Dr. Thomas D. Taylor, Chief Scientist and Program Manager of Naval Expeditionary Warfare Science and Technology, Office of Naval Research, holds a Ph.D. from the University of California, Berkeley, in Chemical Engineering. He began his career in the Aeronutronic division of Ford Corporation engaged in reentry physics research, worked at Northrop Corporation in aircraft development, and at the Aerospace Corporation. He later moved to the Applied Physics Laboratory (Johns Hopkins Univ.) working on submarine detection concepts, then to the Defense Advanced Research Projects Agency (DARPA) as director of the Submarine Technology Program and then as Deputy Director of the Naval Technology Office. Dr. Taylor next joined the Center for Naval Analysis as a senior fellow, leading major projects on the future of aircraft carriers and the FAA air traffic control system. Thereafter, he joined Office of Naval Research.

Page 13 PREV PAGE TOP OF DOC

2. BACKGROUND

The National Airspace System

The National Airspace System (NAS) is the collection of airports (commercial, military, and private), airways, air traffic control facilities, and communications and navigation systems that safely move commercial, general aviation, government, and military aircraft throughout the country. The Federal Aviation Administration (FAA) is responsible for managing this system.

In the air traffic control arena, FAA has established a nationwide network of jetways. These can be likened to "highways in the sky." By routing aircraft through this system FAA controllers insure that airplanes are safely separated from nearby traffic. While the pattern of jetways is spread in a fairly uniform manner over the country—making it relatively easy to disperse traffic—operations begin to be constrained as aircraft converge on busy hub airports.

As a consequence of sustained economic growth during the 1980s and 1990s, many more people are traveling today than ever before. Increased demand spawned a record number of new scheduled flights—and the purchase of large fleets of aircraft—by the commercial air carriers. In addition, because of industry reliance on the hub-and-spoke system, congestion has evolved from an occasional nuisance ten years ago to a national problem that faces travelers on an almost daily basis.

Page 14 PREV PAGE TOP OF DOC

FAA, airports, and carriers have initiated several cooperative measures—such as redesigning approach and departure paths, establishing a national "flow control" facility, and reducing the number of flight operations during the busiest hours of the day—in an effort to mitigate congestion, but virtually all studies suggest that major improvements must be implemented to achieve meaningful relief. The fact is that the NAS is congested now, and even modest rates of growth in the years ahead will impose huge new burdens on airports, carriers, and ultimately on travelers.

The latest edition of *FAA Aerospace Forecasts* (published March 2001) notes that since 1993 the number of passengers carried on U.S. air carriers (majors and regionals) increased at an average annual rate of 4.3%, growing from 515.6 million in 1993 to 693.5 million in 2000. Expressed another way, overall growth between 1993 and 2000 was 34%. Looking forward, FAA predicts that for domestic markets, large U.S. air carriers and commuters will experience an average growth rate of 3.6% or more between now and the year 2012, growing from 709.8 million enplanements(see footnote 1) this year to 1,080.3 million in 2012. Expressed in absolute terms, domestic traffic will increase by 52%. International routes flown by U.S. carriers are predicted to experience a rate of growth of 6.1% during the same period, rising from 58.1 million enplanements in 2001 to 111.0 million in 2012, an absolute increase of 91%.

One solution promoted by many in the industry is to build more runways, but recent experience has proven they are very expensive and take years to gain necessary environmental clearances. Since 1991 only 6 new runways have been constructed at hub airports. On average it takes ten years from time of application to complete a new runway. At this writing 15 runway applications are in process. Industry advocates are urging the new Administration to develop an expedited procedure to approve runway construction applications.

Page 15 PREV PAGE TOP OF DOC

Another development in the offing is FAA's commissioning of an advanced navigation system based on the Global Positioning System (GPS), now predicted to begin limited operation in late 2003. Today, aircraft flying under instrument flight rules must use existing jetways and instrument landing systems (ILS) to runways equipped with ILS guidance devices. GPS-based navigation systems will be free of any reliance on groundbased systems(see footnote 2) and, once commissioned, will provide access to all domestic airports in (virtually) all weather conditions. FAA would only need to chart approach and departure paths based on GPS signals. These could be straight-in or curved depending on factors such as noise, terrain avoidance, and conflicting traffic. Importantly, GPS will give FAA the ability to chart approach and departure routes for VTOL aircraft separate and apart from those used by fixed wing aircraft, for the first time allowing sequential, noninterfering airport operations, even during periods of poor weather.

Vertical Takeoff and Landing Aircraft (VTOL)

Unlike fixed-wing aircraft, VTOL aircraft (including helicopters, the Harrier AV–8B attack jet flown by the Marines, a proposed civil tiltrotor, and a proposed turbojet-powered transport discussed below) need no or little runway to execute a landing or takeoff. Modern turbine-powered helicopters can fly at commuter airplane-like speeds, are capable of hovering, and can maneuver in confined airspace. At the current level of technology, most VTOL aircraft (the term "runway independent aircraft" is gaining greater use in the aviation community to describe this class) have relatively short range compared to fixed wing aircraft of similar carrying capacity.

FAA estimates that today's civil fleet of helicopters numbers about 8,000(see footnote 3) and will grow at an annual rate of 1.9% between now and 2012.(see footnote 4)

Page 16 PREV PAGE TOP OF DOC

The duPont Aerospace DP–2 aircraft, now under early development, is a VTOL turbojet designed to carry a payload of 10,500 pounds transcontinental distances. In appearance (see pictures of scale-model on back page) it closely resembles a conventional commercial jet aircraft, but relies on two turbojet engines mounted in the forward section of the fuselage for both lift and forward thrust, and will cruise at speeds identical to those achieved by conventional fixed-wing turbojet transports (i.e., Mach 0.8 and higher). A fifty-three percent scale model, called the DP–1, will shortly begin its first series of hover tests and is being developed under the auspices of the Office of Naval Research (ONR). Witnesses from duPont and ONR will make presentations about this aircraft.

Bell Helicopter, in collaboration with Agusta Aerospace, will fly the first-ever version of a civil tiltrotor aircraft (the BA–609) at the end of this year. It will be able to take off and land like a helicopter, transition its engines for forward flight, and cruise at altitudes and speeds similar to those attained by corporate turboprop aircraft. It is designed to carry up to nine passengers in a pressurized cabin. Bell reports to have received 80 firm orders.

While VTOL aircraft are capable of landing at airports without relying on runways, a common complaint voiced by VTOL proponents is that FAA tends to treat them the same as conventional airplanes at large hub airports, requiring helicopters to queue up with fixed-wing aircraft on approaches to—or departures from—busy runways.(see footnote 5) Two factors immediately come into play. First, large fixed-wing transports fly faster approaches than VTOL, requiring air traffic controllers to build in bigger separations behind the VTOL aircraft, creating system delays. This becomes an operational headache, especially during bad weather. Second, VTOL aircraft are forced to fly unnecessarily long approaches, resulting in a greater fuel burn and longer flight time, thereby diminishing many of VTOL's operational advantages.

Page 17 PREV PAGE TOP OF DOC

It has long been the industry's desire for FAA to develop separate instrument approaches to and from busy hub airports that are designed specifically for runway-independent aircraft. Doing so would produce several advantages: it reduces delays now caused by mixing VTOL aircraft with faster fixed-wing jets; it optimizes the operational advantages offered by VTOL aircraft, including shorter, more direct flights into congested hub airports in less time and with less fuel burn; and it creates opportunities for VTOL aircraft to be substituted for short-haul, fixed wing commuters. This latter point, proponents argue, is especially important.

Fully optimized in the NAS, VTOL aircraft could fly from (and between) locations other than airports, relying instead on vertiports/heliports to enplane passengers. As examples, VTOL could carry passengers from an urban vertiport to a hub airport; from one urban vertiport to a vertiport in a nearby city (e.g., from Tysons Corner to downtown Baltimore); or from an inexpensively-constructed vertiport serving a rural community to a regional hub airport.

By redirecting traffic away from congested airports, VTOL aircraft could mitigate congestion by offloading travelers flying through hub airports. This effect would be greatly enhanced in the case of the DP–2, as travelers could be carried long distances without reliance on an airport at either end.

The American Helicopter Society has developed data—based on research performed by NASA Ames Research Center—indicating that flights under 300 miles account for 40% of arrivals and departures at the top 63 hub airports in the country. Replacing half of these flights with VTOL aircraft (having 20 seats or more) using simultaneous noninterfering (SNI) approaches, system capacity in the NAS would be increased by 30%.(see footnote 6)

Page 18 PREV PAGE TOP OF DOC

3. ISSUES

1. Does the technology exist to permit safe operation of VTOL aircraft at congested hub airports, especially during periods of low-visibility?

2. To what degree will GPS permit simultaneous non-interfering approaches by VTOL into a congested airport, and is FAA currently charting SNI approaches in preparation for GPS?

3. What technical hurdles must be overcome by the DP–2 technology to fly safely and be certified by FAA for operation in the National Airspace System?

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Mr. **LAMPSON.** Thank you, Mr. Chairman. I appreciate that. I can't take the place of Mr. Gordon, but I can occupy the seat.

Good afternoon. And I do, indeed, want to welcome the witnesses to the hearing today. The topic of the hearing is stated to be the application of vertical takeoff and landing (VTOL) technology and the National Airspace System. However, I understand that the main rationale for the hearing is the Chairman's interest in the duPont Aerospace Company's DP–2 military aircraft concept, and I have no problem with that and with that rationale. It is the Chairman's right to hold hearings on subjects that interest him and I look forward to the testimony of Mr. duPont and the other witnesses.

Page 19 PREV PAGE TOP OF DOC

I would note, however, that the Administration's NASA budget request eliminates all funding for VTOL research and development related to rotorcraft. So I hope our witnesses will tell us what they think the cancellation of that research program will mean for the future of military and civilian rotorcraft in the United States. And we need to understand whether that cancellation is a good idea or just an ill considered result of an arbitrary budget cap imposed on NASA.

In addition, since funding for NASA's Aeronautics Program continues to decline in this Administration's budget, I think we will need to hear from a lot more folks before deciding that it makes sense for NASA to earmark $30 million of its remaining funds to help a company develop a new commercial aircraft as proposed by Mr. duPont. As Chairman Rohrabacher noted at the NASA Posture Hearing, we are going to have to set our priorities, and my priority is R&D that will benefit the nation as a whole, rather than promote the interest of a single company.

Finally, since I think we will be hearing a lot about the DP–2 program today, I just ask and just note that the DP–2 program has been funded in a DOD budget solely through Congressional earmarks over the last several years. My understanding is that President Bush has indicated that he does not wish to fund congressional earmarks in the future. If the DP–2 turns out not to be a priority for the Pentagon and doesn't make it into this year's defense budget on its own merits, I imagine those members will have to decide whether to support the president or continue earmarking funds for this program. Fortunately, that is not a decision that we have to make here today.

At this point, I will conclude by again welcoming our witnesses, and I yield back my time.

Page 20 PREV PAGE TOP OF DOC

Chairman **ROHRABACHER.** Thank you very much, Mr. Lampson—well said. Without objection, the opening statements of other members will be put into the written record so we can get right to the testimony. And hearing no objection, so ordered. I also ask unanimous consent to insert at the appropriate place in the record the background memorandum prepared by the Majority Staff for this hearing. Hearing no objection, so ordered.

Today, we have four witnesses who will present testimony examining issues concerning the level of development involving vertical takeoff/vertical landing technology. But before I introduce our witnesses, we have a two-minute tape concerning this new vertical takeoff/vertical landing technology, and I would ask unanimous consent that we show the tape now, and then the testimony. It is two minutes. Hearing none, so ordered. And we have the tape here. You may proceed.

[A videotape was played as follows]

Success in future military conflicts will depend on aircraft that land and takeoff without airfields, delivering troops and equipment to remote and inhospitable locations around the globe. The duPont DP–2 fulfills this requirement. The DP–2 has the ability to take off and land like a helicopter, while carrying 48 fully equipped troops, even a Humvee. It is this carrying capacity that separates the DP–2 from the Harrier, an operational vertical takeoff attack aircraft, and the turboprop powered V–22, which is currently the fastest vertical takeoff transport. The DP–2 is also fast. For example, the DP–2 can fly personnel and support from Fort Bragg, North Carolina to Kosovo, nonstop, in 7 hours and 53 minutes. It also flies other strategic or diplomatic missions in record time. With the exception of the Concorde, the DP–2 is faster than any airliner. What is more, the DP–2 can maintain this speed while flying intercontinental distances. It arrives at its destination 13 percent sooner than the 747 and in less than half the time required of the V–22. The DP–2's exceptional 5,000 nautical mile range also eliminates the need for mid-flight refueling on most missions. Another unique feature of the DP–2 is its ability to land on any ship with a landing platform, and it has the capacity to reach that ship anywhere on the world's oceans. The first of two key elements that contribute to the DP–2's affordability is its non-corroding carbon composite structure, which is cured at low temperature, and is rugged, lightweight, and inexpensive to fabricate. The second is its use of highly efficient airline engines with their proven reliability and low maintenance. The tremendous potential of the DP–2 is currently being demonstrated by the aircraft affordability project sponsored by the Office of Naval Research and currently underway at the duPont Aerospace facility in San Diego. A lot of experimental testing has been done. More needs to be done. The DP–2 needs to be flight tested in an operational environment. This would include hovering over water, snow, sand, and other unprepared surfaces while delivering and picking up combat personnel. When testing is complete, however, the country will have a new capability to deal efficiently with threats far from our shores—the duPont DP–2.

Page 21 PREV PAGE TOP OF DOC

[End of videotape]

Chairman **ROHRABACHER.** All right. Thank you very much. I had a little trouble hearing that myself, but I hope all of you were able to hear it out there. Before we hear any witnesses, let me just note for the record, this is not being built in my Congressional District. I will just let everybody know that. This is not my Congressional District. This is at least two hours away.

So before I introduce our witnesses, I would like to ask you all, if you could, to summarize your points within five minutes, within a five-minute framework. We will put your full written statements in the hearing record.

First, we have Dr. John Zuk, who is the Chief of Advanced Tiltrotor Technology Office at NASA Ames Research Center. His career at NASA spans research in aeronautics and technical management in both rotary and fixed wing aircraft systems. You may proceed, Doctor.

STATEMENTS OF ANTHONY A. DUPONT, FOUNDER AND PRESIDENT OF DUPONT AEROSPACE COMPANY, EL CAJON, CALIFORNIA; ACCOMPANIED BY WILLIAM H. WALLACE, NATIONAL RESOURCE SPECIALIST FOR ROTORCRAFT OPERATIONS, FEDERAL AVIATION ADMINISTRATION; JOHN ZUK, CHIEF OF THE ADVANCED TILTROTOR TECHNOLOGY OFFICE, NASA AMES RESEARCH CENTER; AND THOMAS D. TAYLOR, CHIEF SCIENTIST AND PROGRAM MANAGER OF NAVAL EXPEDITIONARY WARFARE SCIENCE AND TECHNOLOGY, OFFICE OF NAVAL RESEARCH.

STATEMENT OF JOHN ZUK

Page 22 PREV PAGE TOP OF DOC

Mr. **ZUK.** Thank you, Mr. Chairman and members of the Subcommittee. I am very pleased to have this opportunity to testify before you on vertical and short takeoff and landing transport aircraft and their ability to revolutionize short haul air transportation. I call this class of aircraft runway independent aircraft. They offer an alternative to building costly new runways at airports and can be located within many existing large hub airport boundaries.

I define runway independent aircraft as a class of aircraft that can operate on runways less than 3,000 feet. They can be totally vertical, like helicopters, extremely short takeoff and landing like tiltrotor, up to short takeoff and landing aircraft. They have excellent low-speed performance and control capabilities and can operate under instrument meteorological conditions (IMC) independent of conventional jet transports at airports. They can land on stub runways, tarmacs, and vertiports under IMC. Today, these vehicles can only operate this way under visual meteorological conditions. These aircraft would operate in separate approach and departure corridors.

Typically, 40 percent of the aircraft operating at large hub airports are short haul; that is, they travel less than 500 miles and carry less than 100 passengers. If these aircraft could be removed from the long conventional jet runways, airport delays would be reduced and capacity increased. Recent studies have found large benefits to these runway independent aircraft operations.

A 1999 Newark Airport Task Force study showed a big benefit for doing this. In the case of increasing the number of airport operations by 100,000 over today, the civil tiltrotor, a type of runway independent aircraft, provided the greatest benefit next to a new runway. The annual delay reduction costs to the airlines was estimated to be $900 million, compared to a new runway's benefit of $1 billion. In the prepared text, a 64-airport network study also showed the very large benefits for this type of aircraft operation.

Page 23 PREV PAGE TOP OF DOC

These vehicles could also operate to general aviation airports, thus, the air transportation system could readily transform to a more distributed system and, thus, increase national mobility and accessibility. To achieve these great benefits, however, requires the development of new procedures called Simultaneous and Non-Interfering. This procedure would allow productive use of currently unused airspace over the airport. The procedure is possible today because of satellite based communications, navigation, and surveillance. Using, for example, differential global positioning satellites and other new technologies, we are now enabled to fly with the precise navigation, and guidance, and surveillance that will be required for IMC operations by runway independent aircraft at airports.

Also required in order to achieve this capability are some of the technical issues that I have mentioned in the text. Some of these issues that must be addressed include what types of aircraft are best suited for runway independent aircraft operations. What is the relationship of the type of runway independent aircraft performance to the required runway length and the controlled airspace that is required in order to operate independently a long jet aircraft, and how will the aircraft in its operation mitigate its environmental impact;

that is, low noise operations will be critical.

By addressing these technical issues and others mentioned in the text, by developing Simultaneous Non-Interfering procedures, and by implementing the satellite-based communications, navigation, and surveillance systems, these potentially great benefits of runway independent aircraft operations will be realized. In the more distant future, runway independent aircraft could completely bypass conventional airports and operate between very small landing areas, such as vertiports, resulting in faster point-to-point travel that would include easy access to other modes of transportation. We then would have a very efficient totally integrated transportation system in this country.

Page 24 PREV PAGE TOP OF DOC

This concludes my oral remarks.

[The prepared statement of Mr. Zuk follows:]

PREPARED STATEMENT OF JOHN ZUK

Mr. Chairman and Members of the Subcommittee:

I am very pleased to have the opportunity to testify before you today on the subject of vertical and short takeoff and landing transport aircraft and their potential to revolutionize short haul air transportation. This class of vehicle, which would operate independent of conventional jets, could significantly increase airport capacity, reduce airport delays, and increase national mobility and accessibility. I will use NASA's experience and knowledge gained from vertical flight and powered lift research, using tiltrotor technology as a prime example, to inform you of the challenges and opportunities. I will present some quantified benefits from recently conducted studies.

An alternative to building costly new runways at airports is desired. One such way is Runway Independent Aircraft Operations (RIA Ops). If key challenges are met, RIA Ops could be expeditiously implemented at a low cost and become a practical way of meeting a class of the future air travel demand. RIA are defined to be types of aircraft that can operate on runways less than 3000 feet. These aircraft are characterized by excellent low-speed performance and control capabilities and capable of full-spectrum operations under Instrument Meteorological Conditions (IMC). They would use approach and departure corridors that are separate from conventional jets. RIA Ops could expand hub airport capacity and reduce delays without enlarging the airport physical boundaries or increasing the noise impact from these additional operations. Runway Independent Aircraft could operate independent of jet transports at hub/spoke airports, by using stub runways, tarmac, and vertiports under IMC. Today, short takeoff and landing (STOL) aircraft, such as the deHavilland Dash 7, operate on stub runways at some airports, such as Washington Reagan. These aircraft may operate independent of the fixed wing jet transports in Visual Meteorological Conditions (VMC). However, these types of aircraft cannot operate independently in all conditions due to the lack of aircraft capability, approved flight procedures, and airspace/airport operations infrastructure. Under IMC, this class of vehicle, as well as helicopters, must be sequenced into conventional fixed wing traffic flows.

Page 25 PREV PAGE TOP OF DOC

Typically, short-haul aircraft at large, hub airports comprise 40% of the total aircraft operations and are responsible for only 20% of the passengers. For each short-haul operation moved from the long runways to the RIA Ops landing and takeoff areas, one long-haul, large, jet transport could be added to the long runways. To enable RIA Ops, a new terminal procedure, called "Simultaneous Non-Interfering" (SNI), must be developed. The SNI procedures will also allow productive use of currently unused airspace over the airport. Two recently completed studies showed potentially large benefits of RIA Ops.

The NASA Intercenter Systems Analysis Team (ISAT) sponsored a FY 2000 study, conducted by Logistics Management Institute (LMI), to determine the impact of RIA replacing short-haul aircraft. Using LMINET, a 64-airport queuing model of the National Airspace System, the relative throughput improvement for CY 1997 would have been approximately 10% increase in operations without extreme short takeoff and landing (ESTOL) operations and up to 26% with ESTOL operations.

The LMI study also estimated the flight delay based on the FAA unconstrained demand forecasts for 2007 and 2022. All planned additional runways that have completed their environmental impact studies were included in the LMINET analysis. RIA were constrained to operate only at airports that could accommodate an independent RIA landing area at least 5000 feet from existing operational runways. RIA replaced both turboprop and regional jet revenue flights on flight segments of less than 500 miles. Results showed that RIA Ops could reduce the 2022 predicted delay by over 80%.

A 1999 Newark Airport Task Force study was undertaken to find ways of reducing delays and increasing Newark Airport capacity. The Task Force examined almost every conceivable possibility, from new technologies, equipment, and procedures, to a new runway. A future state was examined where there would be 100,000 more annual operations than today. Except for a new runway, a runway independent aircraft provided the greatest benefit. In terms of annual delay reduction costs, the tiltrotor benefit was estimated to be $900M, compared to a new runway benefit of $1.2B.

Page 26 PREV PAGE TOP OF DOC

In addition to operating among hub/spoke airports, these vehicles could operate to general aviation (GA) airports. This would enable a rapid expansion of airline service to areas that are not currently served. Hence, the air transportation system could readily transform to a more distributed system. A rapid, more efficient service would be realized by landing closer to the terminal, thereby minimizing aircraft taxi time, noise and emissions. Thus RIA could increase national mobility and accessibility, with minimum environmental impact.

In order to operate IMC, successful RIA must satisfy a variety of vehicle requirements. Based on knowledge gained from NASA tiltrotor technology program, I will now review some of the most important of these requirements. Recognizing the potential of the tiltrotor for airport congestion relief, beginning in FY 1994, NASA embarked on an eight-year Short Haul Civil Tiltrotor (SHCT) project, which ends this year. The project goal is to overcome the principal inhibitors to enabling civil tiltrotor operations in the National Air Transportation System. Goal achievement would enable low-noise, safe operations for a fortypassenger commuter aircraft. V–22 technology was chosen as the baseline.

I am pleased to say that the SHCT noise reduction goal of 12–dB from the baseline has been significantly exceeded. The combination of a Higher Harmonic Control source noise reduction and two segmented noise abatement flight procedures, has a potential total noise reduction of 20–dB, which is equivalent to a factor of four reduction in perceived loudness.

A future SHCT must fly in adverse weather, while maintaining airline levels of safety and minimizing noise impact. This means that Level I handling qualities (low workload) for normal flight operations under adverse weather and low-noise flight condition must be achieved. Also, acceptable (Level II) handling qualities with safe recovery must also be achieved under emergency conditions. This is critical for all RIA Ops. Much was learned from the SHCT project activity, which primarily used piloted simulations. The biggest challenge was to overcome the high-workload landing phase, where, in the tiltrotor's case, a steep 9-deg. noise abatement approach is flown, under adverse weather conditions, into a tight landing area, and a loss of an engine occurs at the critical decision height. To make flying easier under these conditions, technologies such as controls, displays and procedures were developed. The combination of these technologies with new landing procedures, found in piloted simulations, resulted in achieving the specific goal of Level I Handling Qualities for normal operations under adverse weather conditions, and acceptable (Level II) Handling Qualities with safe recovery under emergency conditions. Much of what was learned in the tiltrotor case can be applied to other RIA.

Page 27 PREV PAGE TOP OF DOC

Now I will address specific RIA landing and take-off performance characteristics. Runway Independent Aircraft range from vertical takeoff and landing (VTOL) to STOL. These include VTOL (e.g., helicopters—vertical take off), ESTOL (e.g., tiltrotors—runway length less than 500 ft), super STOL (civil variants of the Air Force's Advanced Tactical Transport—runway length less than 1000 ft), and STOL (runway length less than 1500 ft) aircraft. Although the passenger capacity of RIA aircraft would range from less than 20 to over a hundred, the operational niche is expected to take advantage of airports with runway lengths ranging from zero to 3000 feet. For example, the NASA/Boeing Quiet Short Haul Research (QSRA) Aircraft, flown in the 1980's, required only a 1500-foot runway. The QSRA had excellent low-speed handling qualities and was relatively quiet. Jet engine exhaust was directed over the wing, effectively shielding the ground from jet noise during takeoff.

RIA Ops are possible today due to advances in communications, navigation, and surveillance, especially differential GPS and display technologies. Low installation and infrastructure cost combined with wide-area availability enables an expansion of precision instrument navigation and guidance. As I have previously mentioned, in order to enable RIA Ops, Simultaneous Non-Interfering procedures must be developed. To achieve this capability, I will mention some technical issues that must be resolved.

1) What types of aircraft are best suited for RIA Ops?

2) What are the relationships between the performance of runway independent aircraft, including low-speed control capability, and the amount of controlled airspace required for independent Category IIIA operations in high air-traffic density?

Page 28 PREV PAGE TOP OF DOC

3) How will environmental impact be mitigated?

4) What is the impact of RIA Ops on the future Air Traffic Management System?

By addressing these issues, the large benefits of Runway Independent Aircraft Operations could be achieved.

In conclusion, Runway Independent Aircraft Operations are a potentially revolutionary way of operating at hub airports, offering an alternative to building new runways while providing needed community access from underutilized community airports. If key challenges are met, RIA Ops could be expeditiously implemented at a low cost and may represent a practical way to substantially address the future air travel demand and rapidly expand airline service to areas that are not currently served. In the more distant future, Runway Independent Aircraft could completely by-pass conventional large airports and operate between very small landing areas. These landing areas could be located much closer to travel demand centers and enable easy access to other modes of transportation.

Chairman **ROHRABACHER.** Thank you very much, Doctor. Next we have Mr. William H. Wallace, who is a National Resource Specialist for Rotorcraft Operations at the Federal Aviation Administration, and for the past nine years has served as the FAA representative to the European Joint Aviation Helicopter Subcommittee. You just don't happen to have the name William Wallace—I mean, this is not Braveheart in front of us, but I am sure he has heard that many times before. You may proceed. Thank you very much.

Page 29 PREV PAGE TOP OF DOC

STATEMENT OF WILLIAM H. WALLACE

Mr. **WALLACE.** Chairman Rohrabacher, Members of the Subcommittee, it is a pleasure to be here today to discuss the FAA's activities with regard to integrating modern vertical flight aircraft into the National Airspace System (NAS) and the benefits new technology might provide for the system's capacity. With me today is my colleague, Benjamin Hooper Harris, Chairman of our agency's Vertical Flight Working Group.

On behalf of Administrator Garvey, I would like to thank the Committee for providing this opportunity to briefly outline the FAA's efforts to accommodate modern vertical flight technology, including advanced rotorcraft as well as powered lift tiltrotor aircraft, into the NAS. This hearing is both timely and useful given the challenges our aviation system is facing. With the demand of air travel going up about 3.5 percent annually, all of us in the aviation community are concerned about the growing demand in air traffic and the need for additional capacity through conventional means.

There are no easy answers to congestion and capacity limitations in the NAS. It is a complex situation that demands strategic planning and efforts from all segments of the aviation community. The FAA is working on a number of fronts to address these challenges, including modernization of the air traffic system, improved air traffic procedures through collaborative decision making with the users of our system, our chokepoints initiative to address particularly challenging areas of congestion, redesign of the airspace, and development of free flight technologies. As you know, the current air transportation system is almost exclusively centered on fixed wing airplanes supported by an infrastructure that accommodates these operations.

Page 30 PREV PAGE TOP OF DOC

Can vertical flight technology be a part of this equation? A definite answer must wait current development of a commercially feasible enterprise. But I can tell you that we believe that the technology holds promise for increasing capacity of the NAS and improved transportation services to the public. It is only prudent for us to begin to lay the groundwork for enabling efficient operations for both fixed-wing and vertical flight aircraft. I can assure you that the FAA is prepared to integrate modern vertical flight aircraft into the system.

Both civil and military aviation are introducing new technology vertical flight aircraft with performance characteristics that are significantly different from existing airplanes. The tiltrotor concept, for example, takes advantage of the combined ability of vertical takeoff of a helicopter while cruising at the speed of a turboprop. Proponents of this advanced technology cite improved performance, range, and in particular, operational flexibility—meaning, the ability to function independent of a standard runway—as its advantages. The theory is that a runway independent aircraft would have the effect of reducing short range fixed-wing operations on an airport's main runways, allowing for more large aircraft operations and increasing total capacity. The FAA is conducting research to make this happen. However, the ultimate benefits to capacity will be tied to the aviation industry's business decisions on how to best take advantage of the new capacity.

Our colleagues at the National Aeronautics and Space Administration and the Department of Defense have performed extensive study and research to support the development of new vertical flight technology. The FAA has been directly involved in sponsoring and improving research programs to ensure that they will be applicable to civil or commercial aviation needs. The FAA, NASA, DOD, industry, and academia have entered into a funded agreement to provide strategic guidance and joint funding for research projects through the National Rotorcraft Technology Center, thus, enabling industry and academia wide access to government facilities and capabilities. This agreement will support the vertical flight community in meeting both global transportation and military superiority needs in the next decade while increasing U.S. market share.

Page 31 PREV PAGE TOP OF DOC

It is the FAA's responsibility to ensure that regulatory and operational standards that govern the NAS enhance the safety of the public and do not impede integration of viable advanced vertical flight aircraft into the aviation system. In this regard, we are already at work on the development of certification standards for both aircraft and airmen to accommodate powered lift vertical flight operations within the NAS. For example, we are working with a manufacturer of a civil tiltrotor to develop proposed certification standards of the new aircraft, the Bell Agusta 609. We are consolidating appropriate proven safety certification standards from both transport airplanes and helicopters, as well as developing new standards for those unique aspects of tiltrotor design. We have completed most of the certification standards and the manufacturer has accepted these requirements. The remaining standards involve performance and handling characteristics of this unique aircraft and will be developed during test flight. The first flight is scheduled for late 2001, with full certification scheduled in 2003.

With regard to the pilot qualifications for powered lift vertical flight, the FAA has already developed the requirements for pilot certification, and in 1997, incorporated them into our regulations. We also have a rulemaking project underway to develop the airworthiness and operational flight rules. And finally, we are currently working with the International Civil Aviation Organization (ICAO) and the European Joint Aviation Authorities towards establishment of international pilot certification and operational standards for advanced vertical flight operations. Work is underway with regard to the standards of airport and vertiport infrastructure to service rotorcraft operations using a model developed by NASA, but significant progress awaits the final development of the aircraft itself.

The FAA is also responsible for conducting research into air navigation and air traffic control procedures and to implement those services where needed. We believe that modern vertical flight aircraft, when coupled with advances in the NAS, offer unprecedented opportunities for aviation system efficiency improvement that will enable safe, all-weather transportation and emergency services. For example, satellite based helicopter instrument procedures implemented over the past few years have resulted in significant benefits to helicopter emergency services and to the Gulf of Mexico energy resource extraction operations.

Page 32 PREV PAGE TOP OF DOC

Our research program is targeted at developing better standards and operating procedures to take maximum advantage of the superior flight characteristics of modern vertical flight aircraft. We are exploring the feasibility of safely reducing separation standards and optimizing landing and takeoff profiles based upon aircraft performance and noise characteristics.

In our history, the FAA and its predecessor agencies have successfully transitioned many new and revolutionary aircraft types and systems into the NAS. Beginning in the late 1930's, we completed the U.S. certification of the first large scale production airliner, the DC–3, then went on to certify the first pressurized airliner, the Boeing 307 in 1940, the first civil helicopter in 1946, the first turboprop in 1955, the first turbojet in 1958, as well as the supersonic Concorde in 1979, and the advanced wide-body jets of today such as the Boeing 747 in 1989. It seems appropriate that as we begin a new century and millennium, advances in aviation technology present us with another promising addition to the fleet, the tiltrotor aircraft.

Mr. Chairman, the FAA is prepared to meet that challenge. We will continue to work closely with our partners in the industry, the airport community, and Congress to ensure that the National Airspace System has the ability to take maximum advantage of the unique capabilities of vertical flight aircraft.

That concludes my prepared remarks. My colleague and I will be happy to answer any questions.

Page 33 PREV PAGE TOP OF DOC

[The prepared statement of Mr. Wallace follows:]

PREPARED STATEMENT OF WILLIAM H. WALLACE

Chairman Rohrabacher, Congressman Gordon, Members of the Subcommittee:

It is a pleasure to be here today to discuss the Federal Aviation Administration's (FAA) activities with regard to integrating modern vertical flight aircraft into the National Airspace System (NAS) and the benefits new technology might provide for the System's capacity. With me today is my colleague, Benjamin Hooper Harris, Chairman of our agency's Vertical Flight Working Group.

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There are no easy answers to congestion and capacity limitations in the NAS. It is a complex situation that demands strategic planning and effort from all segments of the aviation community. The FAA is working on a number of fronts to address these challenges including modernization of the air traffic control system, improved air traffic procedures through collaborative decision making with the users of the system, our "chokepoints" initiative to address particularly challenging areas of congestion, redesign of the airspace, and development of free flight technologies. As you know, the current air transportation system is almost exclusively centered on fixed wing airplanes, supported by infrastructure that accommodates those operations.

Page 34 PREV PAGE TOP OF DOC

Can vertical flight technology be part of this equation? A definitive answer must await development of a commercially feasible enterprise. But I can tell you that we believe that the technology holds promise for increasing the capacity of the NAS and improved transportation services to the public. It is only prudent for us to begin to lay the groundwork for enabling efficient operations for both fixed-wing and vertical flight aircraft. I can assure you that the FAA is prepared to integrate modern vertical flight aircraft into the system.

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Our colleagues at that National Aeronautical and Space Administration (NASA) and the Department of Defense (DOD) have performed extensive study and research in support of the development of new vertical flight technology. The FAA has been directly involved in sponsoring, and approving research programs to insure that they will be applicable to civil (or commercial) aviation needs. The FAA, NASA, DOD, industry, and academia have entered into a funded agreement to provide strategic guidance and joint funding for research projects through the National Rotorcraft Technology Center, thus enabling industry and academia wide access to government facilities and capabilities. This agreement will support the vertical flight community in meeting both global transportation and military superiority needs in the next decade, while increasing U.S. market share.

Page 35 PREV PAGE TOP OF DOC

It is the FAA's responsibility to ensure that regulatory and operational standards that govern the NAS enhance the safety of the public and do not impede integration of viable advanced vertical flight aircraft into the aviation system. In this regard, we are already at work on development of certification standards for both aircraft and airmen to accommodate powered lift vertical flight operations within the NAS. For example, we are working with a manufacturer of a civil tiltrotor aircraft (CTR), to develop proposed certification standards for a new aircraft, the Bell Agusta BA 609. We are consolidating appropriate proven safety certification standards—from both transport category airplanes and rotorcraft—as well as developing new standards for those unique aspects of the tiltrotor design. The process involves developing and modifying proposed standards as the aircraft is under development, so that the certification standards can be finalized as the aircraft undergoes final certification. We have completed most of the certification standards, and the manufacturer has accepted these requirements. The remaining standards involve performance and handling characteristics of this unique aircraft and will be developed during flight test. The first flight is scheduled for late 2001, with full certification scheduled for 2003.

With regard to pilot qualifications for powered lift vertical flight, the FAA has already developed the requirements for pilot certification and, in 1997, incorporated them into our regulations (see 14 C.F.R Part 61). The Practical Test Standards—standards that FAA inspectors and designated flight examiners will use during the conduct of the practical test portion of pilot certification—are all in draft form. They will be finalized upon completion of the initial powered lift aircraft certification. Integral to that certification is an evaluation of aircraft operational requirements by our Flight Standardization Board, composed of experienced FAA flight operations specialists. We also have a rulemaking project underway to develop the airworthiness and operational flight rules. And finally, we are currently working with the International Civil Aviation Organization (ICAO) and the European Joint Aviation Authorities (JAA) towards establishment of international pilot certification and operational standards for advanced vertical flight operations.

Page 36 PREV PAGE TOP OF DOC

Work is also underway with regard to standards for airport or vertiport infrastructure to service rotorcraft operations using a model developed by NASA, but significant progress awaits final development of the aircraft itself.

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Page 37 PREV PAGE TOP OF DOC

Mr. Chairman, the FAA is prepared to meet that challenge. We will continue to work closely with our partners in industry, the airport community, and Congress to ensure that the National Airspace System has the ability to take maximum advantage of the unique capabilities of vertical flight aircraft.

That concludes my prepared remarks. My colleague and I will be happy to answer any questions you may have.

Chairman **ROHRABACHER.** Thank you very much, and we will come back to you in the question and answer period. Next we have Mr. Anthony duPont. He is founder and President of duPont Aerospace Company, located in El Cajon, California, which as I say, is not in my Congressional District. He holds an undergraduate degree from Yale and a MS in Aeronautics from the California Institute of Technology. He has an extensive background in the aerospace industry. I first met Tony when I worked in the White House and he was working on some incredibly important high technology and top secret programs for the government during the Reagan years. We welcome you, Tony, and you may proceed with your testimony.

STATEMENT OF ANTHONY A. DUPONT

Mr. **DUPONT.** Good afternoon. I am very honored to have this opportunity to talk about our DP–2 aircraft and how it can fit into the traffic problems the previous witnesses have discussed. To address the problem of runway saturation at the large metropolitan airports, duPont Aerospace is developing a high performance vertical and short field takeoff and landing airplane, the DP–2.

Page 38 PREV PAGE TOP OF DOC

Technology to produce this aircraft is available and well proven. As you saw in the movie, two of the key features are the composite structure and the well proven airline engines. Together with that, we have a simple mechanical control system that is powered by the pilot's hand. If you want help in hover to reduce the pilot's workload, you can clutch in on autopilot, and of course, it works like an ordinary autopilot, and up and away flight. A highly swept wing having a supercritical airfoil permits efficient cruise near sonic speeds, and the result is an aircraft that combines vertical takeoff with a high cruise efficiency.

The DP–2 was originally designed to deliver and retrieve troops and equipment in a hostile environment. It was designed to fly with 10,500 pounds of payload in and out over a 1,000 nautical mile radius at sea level, which is below the radar horizon. The same payload could be carried 5,000 nautical miles if the aircraft were flown at optimum cruising altitudes, starting at 32,000 feet at the beginning of the mission and ending at 42,000.

A full-scale thrust vectoring system has been successfully tested with a 30,000-pound thrust V2500 turbofan engine at Pratt and Whitney's Florida facility. A 53 percent scale aircraft has been ground tested and is being prepared for hover and flight testing under the Office of Naval Research (ONR) sponsorship. The results of the full-scale and half-scale testing verify the performance predicted from testing previously conducted in the NASA Ames 7 by 10-foot tunnel.

The DP–2 has short FAA runway requirements when operated with a conventional takeoff and vectored thrust to reduce the landing distance. A 3,000-foot FAA field length permits the DP–2 to use special landing patterns at major airports, saving taxi time and avoiding interference with the other aircraft traffic. VTOL permits operation away from airports to service more locations and further relieve traffic congestion.

Page 39 PREV PAGE TOP OF DOC

As you saw in the movie, the DP–2 cruises somewhat faster than conventional airliners, and this difference in block speed makes the 50-seat size competitive in cost, measured in cents per seat mile, with the current larger airliners. The 50-seat capacity allows the DP–2 to operate nonstop over routes that will not support frequent nonstop service with 150-seat aircraft, such as San Diego to Washington, something that I took yesterday. The nonstop service is not only more convenient for the passenger, but is also more economical for the airlines. The net result is faster nonstop service at the same or lower fare.

Within the Government procurement process, a prototype of the DP–2 can be available for testing 36 months after contract funding. Prototype flight testing would explore the full capability of the DP–2 concept and develop and evaluate new concepts of operations for the commercial and military users. Estimated cost is around $160 million for a three-aircraft program.

If you want to look at the production cost, airliners or business jet versions of the DP–2 would have direct delivery to customers within 3.5 years after receiving enough firm orders to justify a production program. Preliminary price estimate is about $25 million.

The technology can be scaled up or down. It can be scaled up for 200 passengers, using engines currently in airline service on the Boeing 777. The 53 percent scale airplane that duPont is currently building under ONR sponsorship could be developed into a transcontinental six place business aircraft capable of cruising at altitudes of up to 55,000 feet.

Page 40 PREV PAGE TOP OF DOC

Specific NASA contributions that could move the DP–2 into the commercial area are wind tunnel testing in the National Transonic Facility, spin testing in the spin tunnel, purchase of two 53 percent scale X aircraft similar to the one that ONR has built with up-rated Pratt and Whitney engines, flight test of these two X aircraft to establish minimum airport space required, unconventional takeoff and approach patterns and procedures to minimize community noise. These are the features that Dr. Zuk was talking about. A longer range research objective would be to develop engines optimized for VTOL aircraft. These would be quiet engines with a higher thrust to weight ratio and lower fuel consumption at reduced power settings. The VTOL airplane, the engines have a lot more thrust than is required for cruise at altitude that can be taken advantage of.

The estimated funding to accomplish the first four items listed is $10 million a year for three years. Development of the DP–2 and follow on aircraft would once again put the United States in the forefront in aeronautics.

Thank you.

[The prepared statement of Mr. duPont follows:]

PREPARED STATEMENT OF ANTHONY A. DUPONT

To address the problem of runway saturation at the large metropolitan airports, the duPont Aerospace Company is developing a high performance, vertical and short field takeoff and landing (VSTOL) airplane, the DP–2. The 50-passenger aircraft has both commercial and military applications. Technology to produce this aircraft is available and well proven. Modern turbofan engines currently in worldwide airline service combined with the capabilities of new composite materials provide a vectored thrust propulsion system. A simple mechanical control system powered by the pilot's hand controls the aircraft in both hover and up and away flight. An autopilot can be clutched in to greatly reduce the pilot workload in hover or for conventional flight autopilot functions. A highly swept wing having a supercritical airfoil section permits efficient cruise at near sonic speeds. The result is an aircraft that combines vertical take off with high cruise efficiency.

Page 41 PREV PAGE TOP OF DOC

The DP–2 was originally designed to deliver and retrieve troops and equipment into a hostile environment. It was designed to fly with 10,500-pound payload in and out over a 1,000 nautical mile radius at sea level, below the radar horizon. The same payload could be carried 5,000 nautical miles if the aircraft were flown at optimum cruising altitudes from 32,000 to 42,000 feet.

A full-scale thrust vectoring system has been successfully tested with a 30,000-pound thrust V2500 turbofan engine. A 53 percent scale aircraft has been ground tested and is being prepared for hover and flight-testing under Office of Naval Research, ONR, sponsorship. The results of the full-scale and half-scale testing verify the performance predicted from testing previously conducted in the NASA Ames 7 foot by 10-foot tunnel.

The DP-2 has short FAA runway requirements when operated with a conventional take off and vectored thrust to reduce the landing distance. A 3,000-foot FAA field length permits the DP–2 to use special landing patterns at major airports saving taxi time and avoiding interference with other aircraft traffic. The runway is reduced to a pad for vertical take off operation. VTOL permits operation away from airports to service more locations and relieve traffic congestion. The aircraft can be at cruising altitude less than five minutes after a vertical take off. A sea level cabin is provided for passenger comfort.

The DP–2 cruises at over 500 knots (575 miles per hour) for minimum fuel consumption. This high cruise speed combined with fast climb and special traffic patterns makes the DP–2 block speed considerably better than current 150-seat aircraft. Higher block speed makes the 50-seat DP–2 competitive on cost (cents per seat mile) with the current larger airliners.

Page 42 PREV PAGE TOP OF DOC

The 50-seat capacity allows the DP–2 to operate non-stop over routes that will not support frequent non-stop service with 150-seat aircraft, such as San Diego to Washington. Non-stop service is not only more convenient for the passenger but is also more economical for the airline. The net result is faster non-stop service at the same or lower fares.

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Specific NASA contributions to move the DP–2 into the commercial arena are:

1. Wind tunnel testing in the National Transonic Facility.

Page 43 PREV PAGE TOP OF DOC

2. Spin testing in the spin tunnel.

3. Purchase of two 53 percent scale X aircraft with uprated Pratt and Whitney engines.

4. Flight test of these two X aircraft to establish minimum airport space required, unconventional take off and approach patterns and procedures to minimize community noise.

5. Longer range research to develop engines optimized for VTOL aircraft. These are quiet engines with a higher thrust to weight and lower fuel consumption at reduced power settings.

The estimated funding to accomplish the first four items listed is $10 million a year for three years.

Development of the DP–2 and follow on aircraft will once again put the United States in the lead in aeronautics.

Chairman **ROHRABACHER.** Thank you very much, Tony. And finally, we have Dr. Thomas Taylor, Chief Scientist and Program Manager of Naval Expeditionary Warfare Science and Technology, Office of Naval Research. Dr. Taylor was formerly a senior fellow at the Center of Naval Analysis and has been working closely with the FAA. Dr. Taylor, you may proceed.

STATEMENT OF THOMAS D. TAYLOR

Page 44 PREV PAGE TOP OF DOC

Mr. **TAYLOR.** I would like to thank you for the opportunity to testify here today.

As you mentioned, I managed this program, the DP–2. The DP–2 project is to develop the technology for a vertical takeoff transport aircraft that can be used in both military and civilian roles. The current design of the DP–2, as mentioned earlier, is for 50 to 52 passengers, with a range of about 5,000 miles and a top speed of approximately 500 knots. The possible use of the aircraft includes search and rescue as well as special ops for military. In the commercial world, the aircraft could provide high speed, long range passenger service to airports with short runways or small landing areas.

The project was initiated in the Office of Naval Research in Fiscal Year 1997, with the goal of demonstrating the vertical takeoff system proposed by the duPont Aerospace Corporation. The development plan was first to perform unmanned ground tests with half-scale composite model to understand the thrust vectoring characteristics of the DP–2 aircraft. These tests measure the vertical and horizontal thrust for different settings of the louvered engine exhaust flow deflection system. In addition, they establish the reliability of the composite construction technology for the thrust vectoring system.

The results to date indicate that the thrust vectoring system appears to work as proposed for single engine tests. Next, however, testing must be completed for two engine tests. From these results, one can estimate the system settings for free flight of the aircraft. Tethered tests of the vehicle are planned to understand the stability of the aircraft in vertical flight. This will allow definition of the range of operation of the control system for vertical flight.

Page 45 PREV PAGE TOP OF DOC

Should the vertical hover test prove successful, the next step is to address the full flight characteristics of the aircraft. This requires detailed wind tunnel testing of the vehicle to define the conventional flight operational envelope as well as the flight envelope in transition from hover to conventional flight. This is the most sensitive and critical part of the development. In addition, the full operational control system to deal with hover, transition, and conventional flight needs to be developed and tested.

As the plan and tests have progressed, it has become clear that the risks of manned flight of the half-scale DP–2 are great and the cost of testing to mitigate the risks are going to be greater than the available budget. This led us to use smaller free flight models to reduce risk, minimize cost, and gain understanding of the system performance. This approach has the promise of augmenting major aircraft development to reduce costs. Failures need no longer be a disaster since a crash is not a big loss of equipment, time, or life. The model controls have advanced to the point that fly-by-wire models (unstable models) are now possible. Also, small, low cost, turbo jet engines are now available. As a result, model experiments can be run to examine critical stability and control problems before risking major equipment. This approach, however, will not replace the need for final full scale testing.

At the time, the DP–2 development has not demonstrated any show stoppers. The program has a tethered hover test of the half-scale with two full-scale commercial engines at full power to happen in the next two months. This is critical to the success. This will be an unmanned test for safety reasons. This is a major milestone which will define the future of the development.

Page 46 PREV PAGE TOP OF DOC

This program should be viewed as a proof of principle and not an aircraft development program. The budget for the program has been about $4 to $5 million a year, except for the first year, when it was about $11 million. The budget allows for modest R&D, but it does allow for full-scale aircraft development.

There has been some discussion that this aircraft could be a replacement for existing operational aircraft. This cannot be shown at this time because we are not far enough along in the testing. Assuming success, the timeframe for a finished aircraft is 5 to 15 years, depending on the funding and the development approach used. Because of the uncertainty of this technology, the Navy has not yet indicated a requirement for this aircraft.

That concludes my testimony.

[The prepared statement of Mr. Taylor follows:]

PREPARED STATEMENT OF THOMAS D. TAYLOR

DP–2 PROGRAM STATEMENT

Mr. Chairman and Members of the Subcommittee:

I would like to thank the Subcommittee on Space and Aeronautics for providing me with the opportunity to testify here today.

The DP–2 project is to develop the technology for a vertical take off transport aircraft that can be used in both military and civilian roles. The current design of the DP–2 aircraft is a 52-passenger airplane with a planned range of approximately 5,000 miles and a top speed of approximately 545 knots. The possible uses of the aircraft include search and rescue as well as special operations for the military. In the commercial world the aircraft could provide high speed, long range passenger service to airports with short runways or small landing areas.

Page 47 PREV PAGE TOP OF DOC

The project was initiated in the Office of Naval Research in Fiscal Year 1997 with the goal of demonstrating the vertical take off system proposed by the duPont Aerospace Corporation. The development plan was first to perform unmanned ground tests with a half scale composite model to understand the thrust vectoring characteristics of the DP–2 aircraft. These tests measure the vertical and horizontal thrust for different setting of the louvered, engine exhaust flow deflection system. In addition they establish the reliability of the composite construction technology for the thrust vectoring system. The results to date indicate that the thrust vectoring system appears to work as proposed for single engine tests. Next, however, testing must be completed for two engine tests. From the results one could estimate the systems settings for free flight of the aircraft. Tethered tests of the vehicle are planned to understand the stability of the aircraft in vertical flight. This will allow definition of the range of operation of the control system for vertical flight.

Should the vertical hover test prove successful, the next step is to address the full flight characteristics of the aircraft. This requires detailed wind tunnel tests of the vehicle to define the conventional flight operational envelope as well as the flight envelope in transition from hover to conventional flight. This is the most sensitive and critical part of the development. In addition the full operational control system to deal with hover, transition and conventional flight needs to be developed and tested.

As the plan and tests have progressed, it has become clear that the risks of manned flight of the half scale DP–2 are great and the cost of testing to mitigate the risks was going to be greater than the available budget. This led to using smaller free flight models to reduce risk, minimize cost and gain understanding of the system performance. This approach has the promise of augmenting major aircraft development to reduce costs. Failures need no longer be a disaster since a crash is not a big loss of equipment, time or life. The model controls have advanced to the point that fly-by-wire models (unstable) are now possible. Also small, low cost, turbo jet engines are now available. As a result, model experiments can be run to examine critical stability and control problems before risking major equipment. This approach, however, will not replace the need for final full scale testing.

Page 48 PREV PAGE TOP OF DOC

At this time the DP–2 development has not demonstrated any show stoppers. The program has a tethered hover test of the half scale vehicle with two full scale commercial jet engines operating at full power, in the next two months, that is critical to the success. This will be an unmanned test for safety reasons. This is a major milestone, which will define the future of the development.

This program should be viewed as a proof of principle and not an airplane development program. The budget for the program has been $4 million to $5 million per year except for the first year when it was about $11 million. This budget allows for modest R&D, but does not allow for full-scale aircraft development.

There has been some discussion that this aircraft could be a replacement for existing operational aircraft. This cannot be shown at this time because we are not far enough along in the testing. Assuming success, the time frame for a finished aircraft is five to fifteen years depending on the funding and development approach used. Because of the uncertainty of this technology, the Navy has not yet indicated a requirement for this airplane.

AIR TRAFFIC SYSTEMS FOR VERTICAL FLIGHT

Chairman **ROHRABACHER.** Thank you very much, Doctor, and we will go onto some questions right now.

First of all, let me ask just the panel, in general, the work that has been done, there has been—evidently, from the testimony, there has been a considerable amount of work done by the FAA and others to prepare for a system of vertical takeoff/vertical landing aircraft system, during which this last decade, of course, we believed the V–22 Osprey would be that vehicle, that technology that would be using this. Are many of the systems that have been looked into and researched and developed also applicable to the jet thrust system if Mr. duPont's plane is successful?

Page 49 PREV PAGE TOP OF DOC

Mr. **WALLACE.** Mr. Chairman, the system that we are developing is for a vertical flight aircraft. It doesn't matter what type of propulsion that would be provided to the aircraft. The system would be capable of absorbing, of allowing the aircraft to be utilized within the system

Chairman **ROHRABACHER.** Doctor, do you agree with that assessment?

Mr. **ZUK.** Well, if you recall in my oral and written testimony, I mentioned that one of the issues that has to be resolved is really what is the aircraft performance; particularly, its low speed control. That will determine, you know, how much controlled air space will be required. With a satellite based technology, I believe aircraft of the vectored thrust variety of Mr. duPont's could be accommodated into the system.

TILTROTOR VS. VECTORED THRUST

Chairman **ROHRABACHER.** All right. And Dr. Taylor, do you think a lot of the work that has gone on so far and was aimed at vertical takeoff/vertical landing that has been—first of all, thought would be tiltrotor would be the technology, would that also be applicable for vectored thrust?

Mr. **TAYLOR.** Yes. There has been a big advance in technology over the last ten years in control systems, and the improvement of the thrust to weight ratio for the aircraft engines, and the materials for construction to reduce the weight. And things that might not have been possible ten years ago in this technology, or this thrust vectoring system, are on the edge of being possible. I can't say until we have done the test that we have done it all. But I can say the technology has advanced sufficiently to make an aircraft that is, basically unstable, flyable with a computer, and the thrust to weight ratio engines are such that you can within the 777 engines, you can, basically fly a building around. So you really have the ability to do a lot you couldn't do ten years ago.

Page 50 PREV PAGE TOP OF DOC

COST OF VECTORED-THRUST AIRCRAFT

Chairman **ROHRABACHER.** Let us note that what I seem to be hearing is that even though there are serious questions being looked into about the Osprey program, that even if that technology proves that the margin of safety is not wide enough to justify a full fledged program, that much of the work that has gone into vertical takeoff/vertical landing technology is applicable to perhaps another approach to vertical takeoff/vertical landing, which is what Mr. duPont is proceeding with.

Our goal is always to push the envelope technologically. That is what this Subcommittee is all about and supposed to be all about. We don't want to develop technology that has already been proven. We want to develop research and develop and expand the capabilities of the United States, both in the commercial world as well as in America's defense. Mr. duPont, what are the cost guesstimates if you were to go into production, if your technology is proven correct, what would be the cost guesstimates and comparing that to what the Osprey cost per unit would be?

Mr. **DUPONT.** We are estimating the airline cost at about $25 million a copy. Now, that context assumes that you are going to produce a lot of airplanes and you are going to amortize the nonrecurring research and development cost as part of that $25 million.

Chairman **ROHRABACHER.** So it is $25 million a copy, but that is if there was a large production?

Mr. **DUPONT.** Yes. That assumes you have a fairly high production program. We have looked specifically at the combat CSAR aircraft. We were asked to respond to the request for information on that last year, and there, as I remember, we were estimating something over $30 million a piece in the military context, where the R&D is paid for separately and you buy the airplanes at this rate, you know, one a month or less. It was a very low production rate.

Page 51 PREV PAGE TOP OF DOC

DP–2 MAINTENANCE COSTS

Chairman **ROHRABACHER.** Okay. One last question and then I will move on. And that is, how about the maintenance costs? My father was a Marine pilot and perhaps that is one of the reasons I take this whole thing so seriously. When I was 10 years old, I remember very well my father was a squadron commander with black arm bands, wearing a black arm band for a few days, and having to see my mother and my father go to other homes nearby to tell families of Marine pilots that their loved one was not going to come home. And that was the price of the cold war; that was the price of freedom, and when I think back on it, I am very proud of my dad, but I know the tragedies to those families of those people who were lost, and I take this very seriously.

But my father told me something once, because I asked him—he had flown DC3's first for a long time. He flew them all over the Pacific during the war, and then he went into jets in the '50s. And I said, well, these jets are so complicated. I mean, you know, they are new technologies and they must be so complicated that they are harder to maintain. And he said, oh, no, it is just the opposite. The jets are the easiest to maintain. All those other types of engines that we used to rely on, you had to have them overhauled all the time and they were always working on them.

Is your technology with this thrust vectoring system less complicated than the alternative approaches and easier to maintain?

Mr. **DUPONT.** Definitely. Your father's statement was quite true, that the turbine powered airplanes are much easier to maintain, much longer intervals before in-flight shutdowns, and shop visits, and all that sort of thing. And it is a very redundant airplane. There is almost nothing on that airplane that you can break and still not get home safely, which means that you can fix it after you get home and it is not a fatal flaw. And that has even been useful in our last year's ground testing. We had enough redundancy in the airplane that if something didn't work, we could keep on testing.

Page 52 PREV PAGE TOP OF DOC

Chairman **ROHRABACHER.** But in terms of actually having a mechanic and mechanical maintenance of the craft, is it less complicated or is it more complicated than the alternatives?

Mr. **DUPONT.** This is going to be competitive as an airliner. It has a very low man hours per flight hour.

Chairman **ROHRABACHER.** Okay. Well, thank you very much. Mr. Lampson.

ROTORCRAFT R&D BUDGET

Mr. **LAMPSON.** Thank you, Mr. Chairman. As you know, the Fiscal Year 2002 NASA budget request would eliminate all funding for rotorcraft research and development, and I would like to know what R&D won't get done as a result. So Dr. Zuk, what rotorcraft R&D challenges still remain to be tackled? And if R&D funding were provided by Congress, how should the money be spent? And I want to ask each of you to also tell me the impact of NASA's decision to terminate R&D, what it might be. Dr. Zuk?

Mr. **ZUK.** Well, NASA, of course, has terminated rotorcraft research beginning in FY 2002 due to budget constraints and to address higher NASA priorities. And the feeling by the Administrator and the

Administration, that we should work on more revolutionary technologies. We have conducted, as you are aware, excellent rotorcraft research. For example, we are ending the short haul civil tiltrotor program this year. It was an eight-year effort. We believe we have been able to show that we could reduce the noise by 20 DB; that is & the loudness level of the V–22. We have showed that to meet the transport category of safe airline operations, to meet the transport category certification requirement, that that is doable, that there are ways of flying the tiltrotor very easily.

Page 53 PREV PAGE TOP OF DOC

Of course, there is much research that could be done, but the Administration has chosen to address other priorities.

ROTORCRAFT RESEARCH PRIORITIES

Mr. **LAMPSON.** As a technical person, what would your priorities be?

Mr. **ZUK.** Well, there are many areas that still require—like transport aircraft, there is still research being done in advancements. And as technology, generic technology, advances, it helps vertical flight aircraft. And so there are many things we could do, and to make the rotorcraft safer, more reliable, and lower noise. There are many promising new technologies in their infancy that we would mature more than they are today.

Mr. **LAMPSON.** I would love to have the benefit of some of that. If you wouldn't mind later providing some of it to my office, I would appreciate it.

Mr. **ZUK.** I will respond.

Mr. **LAMPSON.** Thank you very much. Do others of you want to make a short comment, because I have a couple of other questions that I want to—Mr. Wallace, do you want to tell me what you think?

Mr. **WALLACE.** I would just like to further expand upon a question the Chairman asked earlier about the system being able to accommodate a vehicle such as the one Mr. duPont has talked about. I would like to reiterate the fact that the efforts that we have put forth so far have been based upon a tiltrotor type vehicle. All the performance work that has been done, the development of vertiports, are all based upon a tiltrotor vehicle. So if there was a vehicle like this, if it was proposed to the FAA, we would have to study it through the certification process and see how we could apply it into the system.

Page 54 PREV PAGE TOP OF DOC

Mr. **LAMPSON.** Well, I have a question about that, to follow that up, in a second. So keep that thought, but do you have a comment on this, as far as this other research is concerned?

Mr. **WALLACE.** Regarding NASA's budget, that was an internal decision made within the agency, and I really don't have any comment on that.

Mr. **LAMPSON.** Okay. Mr. duPont?

Mr. **DUPONT.** I am not qualified to comment on the rotor research programs. The first time I heard about it is when I read in the papers it was canceled.

Mr. **LAMPSON.** Okay. Dr. Taylor?

Mr. **TAYLOR.** My only observation is that the thrust to weight ratio of the jet engines has progressed, you know, from the first days they started the Harrier program to now, to where you have enough thrust to weight ratio that you can really consider using jet engines for vertical takeoff. Where really, before your only option was tiltrotors that really you could make work. So I would say, based on technology, not on the political considerations, that work that pushed into using high powered thrust to weight ratio jet engines is really the thing to do.

SKY CAR

Page 55 PREV PAGE TOP OF DOC

Mr. **LAMPSON.** Thank you. Mr. Wallace, are you familiar with any other projects other than rotorcraft, other types of projects that are being done privately within our sector, within the United States, that could fit within this, and is FAA working with them to develop the parameters within which they might operate? I am thinking of one in particular, the one called Sky Car; it is a hovercraft, a VTOL.

Mr. **WALLACE.** I have read some articles about some other vehicles. As far as I know, they haven't been —I believe that is a home built aircraft, the one you are talking about?

Mr. **LAMPSON.** Well, I don't know what you mean by home built.

Mr. **WALLACE.** It is one of a kind aircraft. There has been no aircraft that I know of, other than the aircraft that we are talking about today, that have been submitted to the FAA for any certification.

DP–2 AND NASA R&D FUNDING

Mr. **LAMPSON.** That is, I think, in the process of being submitted. But my point is that I wanted to make in that, there is about $150 million invested in that particular activity so far, privately, and I understand that there has been—this work has been done along with the FAA, so that the FAA is kept knowledgeable. But I wanted to bring it over to Mr. duPont. In your testimony about the DP–2, you state that the technology to produce this aircraft is available and well proven, and then you go on to describe tasks that NASA could undertake to help your company make the DP–2 into a commercial aircraft at maybe a cost of as much as $30 million. Why should we spend any of NASA's shrinking aeronautics R&D budget to help your company do product development, and would you consider that corporate welfare?

Page 56 PREV PAGE TOP OF DOC

Mr. **DUPONT.** No, sir.

Mr. **LAMPSON.** Tell me why.

Mr. **DUPONT.** Because if you do something like this, that is technology that is available to anybody, unfortunately, but that is the way it would be. If we take the Government's dollar to do it, that is———

Mr. **LAMPSON.** And how do we pick, or prioritize, which projects are going to get the money? Why shouldn't the man who spent $150 million developing something similar to what you are talking about not get some kind of help from us as well?

Mr. **DUPONT.** Well, I can't speak to that, because I am not familiar with the project, but the justification for funding this one is that it is a good answer to the problem that was posed about the airport congestion and the lack of runways preventing the growth of air travel. You are going to have to go VSTOL or vertical to get out of that box, it seems to me.

Mr. **LAMPSON.** I am taking way longer. Let's go to Dana. And if you don't mind, maybe we can catch up. Thank you, Mr. Chairman.

Chairman **ROHRABACHER.** Second round, gentlemen. Dr. Weldon, representing, of course, Florida, who has a keen interest not only in space, but in aerospace technology. Dr. Weldon, you may proceed.

Page 57 PREV PAGE TOP OF DOC

DP–2 PERFORMANCE

Mr. **WELDON.** Thank you, Mr. Chairman. I want to thank all the witnesses for your very interesting testimony, and I want to thank you, Mr. Chairman, for calling this hearing.

I am not an aeronautical engineer. I am just kind of curious about the high speeds, Mr. duPont, that you are able to achieve. Is that because you are doing vertical takeoff and landing—I guess my real question is if you designed a conventional aircraft with wings like this, that had a shape like this, that could go this fast, it would be unstable at conventional takeoff and landing speeds. Is that why you are able to achieve the high speed?

Mr. **DUPONT.** No. This is a stable airplane. The reason we are able to achieve the high speed, in addition to, you know, highly swept wings and all that, is because we have more thrust than is conventionally put into an airliner, so we can get out in that corner of speed and altitude, where the range factor is high and you get your best fuel consumption at a considerably higher speed. This is something I believe———

Mr. **WELDON.** So you could come in and land on a regular runway———

Mr. **DUPONT.** Yes.

Mr. **WELDON.**—using that infrastructure?

Page 58 PREV PAGE TOP OF DOC

Mr. **DUPONT.** Yeah. It is a 3,000 foot airplane if you operate it like a conventional airplane. The only thing you are using vectored thrust for in that case is just to slow down your landing speed so you can stay within the 3,000 feet.

AIRCRAFT COMPOSITES

Mr. **WELDON.** Why are you using composites? Most commercial airliners today, aren't they all made with aluminum? And I would ask some of the other witnesses to comment on this. Does that pose some certification concerns and stability of the airframe concerns? I will let you go first, Mr. duPont.

Mr. **DUPONT.** Okay. It just hasn't crept into the main load bearing structure of airliners yet, but I would like to point out the horizontal tail of the 777 is all composite. So it is getting there. The reason we used it was that it is a lot easier to develop an airplane using composite structure than aluminum.

Mr. **WELDON.** Do you mean just the research and development tooling costs?

Mr. **DUPONT.** Tooling is a lot cheaper, but aside from that, if you do it right, the material is lighter, and then when we use it in the thrust vectoring system, it doesn't change shape as it gets hot, so this was a problem with other previous schemes that used metal elements in the vector control system.

Page 59 PREV PAGE TOP OF DOC

Mr. **WELDON.** So the composites are critical for your thrust vectoring system as it is currently designed to work, and to do that using conventional metals, aluminum or whatever, presents problems?

Mr. **DUPONT.** It would be a lot heavier and a lot more difficult because of the change in shape when it gets warm.

Mr. **WELDON.** Mr. Wallace, did you want to comment on safety certification of an aircraft that was made entirely of composites, issues or concerns?

Mr. **WALLACE.** As Mr. duPont has stated, there are a number of aircraft, transport airliners, that have composite features to them. The Boeing 777 is one, as he said, and we have certified one airplane that is completely composite.

Mr. **WELDON.** What airplane is that?

Mr. **WALLACE.** It is the Beech Starship.

Mr. **WELDON.** Okay. So this is not that revolutionary, using composites?

Mr. **WALLACE.** No. We also use composites on a number of rotorcraft. The new Sikorsky S92, I believe, will be mostly composite. A lot of the rotor systems are all composite.

Page 60 PREV PAGE TOP OF DOC

INDUSTRY R&D SUPPORT OF THE DP–2

Mr. **WELDON.** I just want to follow on, Mr. duPont, with sort of the direction Mr. Lampson was going in. You laid out in your testimony some dollar figures on what it would cost to develop an airplane, and I know there are some Boeing representatives sitting out there in the audience. Why doesn't industry just come along and fund you if this is really—because it sounds great. I mean, it sounds like a dream come true, actually. We have got all these concerns in this Committee and in the Transportation Committee about our overcrowded airline infrastructure, and to have the capability to bring a system like this on board could solve a heck of a lot of problems, and to shorten the time duration to get from place to place certainly appeals to everybody; particularly, U.S. Congressmen. But why doesn't industry just pile on and fund this? I mean, if I were the chairman of Boeing or Airbus, I would be looking very closely at your little company and what you are doing. I mean, what is the problem here?

Mr. **DUPONT.** Well, I think the problem is the uncertainty, whether it would work or not. I can remember an interview with the Vice President of American Airlines. He says, Tony, don't tell me why the airplane is good, I will tell you why it is good, and he did. And then he said, now, you tell me it is real. And I had a hard time answering that question. I am in a lot better shape today because of the ONR project, but I think it was—and we have talked to Boeing and we have talked to Lockheed, and we have talked to Grumman, and we have talked to, in one way or another, almost everybody in the industry years ago about doing exactly what you said, why don't you invest in this great idea and get rich. And nobody was willing to do it, and I think it was, primarily, because of skepticism that you could actually accomplish it.

Page 61 PREV PAGE TOP OF DOC

Mr. **WELDON.** So the only investor remaining out there is Uncle Sam, I guess is what you are saying?

Mr. **DUPONT.** No. duPont Aerospace.

Mr. **WELDON.** Well, thank you, Mr. Chairman. Fascinating.

Chairman **ROHRABACHER.** Thank you very much. And you are not looking for production, you are looking for just research and development? You don't expect the Government just to manufacture all these things.

Mr. **DUPONT.** No. I expect when it is proven, hopefully, the Government will buy a bunch of them.

Chairman **ROHRABACHER.** Okay. Ms. Jackson Lee?

DOD VS. NASA FUNDING FOR AERONAUTICS R&D

Ms. **JACKSON LEE.** I thank the witnesses for their testimony and I think this is an important hearing because it is important for those of us who are concerned with technology in the 21st century to be engaged in the discussion. However, I have always raised issues of safety as it relates to NASA programs, the international space station, and I would like to do so here for those of you who have presented your testimony. Particularly, if I am correct, this vertical takeoff follows somewhat the V–22 program. This is what we have come to know as the Osprey somewhat, I assume, that is being used by the military.

Page 62 PREV PAGE TOP OF DOC

And if that is the case, then let me say to you that I am looking at a report of the panel to review the V–22 program, which is a vertical takeoff that has been utilized by the Marines, of which we realize that we have had a number of unfortunate incidents with that. And I would like to read into the record this language. Based on its findings, the panel recommends that the Department proceed with the V–22 program, but temporarily, reduce production to a minimum sustaining level to provide funds for a developmental maturity phase. Various operational restrictions should be imposed until the development maturity phase has progressed to the point where known risk issues have been properly addressed and confidence in aircraft reliability, and maintainability, and logistics supportability have returned.

This was to former Secretary Cohen of the Department of Defense. I imagine this report is on the desk of the new Secretary of Defense, and I guess I am, as I said, tracking some of the line of questioning of my colleagues. Why shouldn't we allow that process to take its will at the DOD with its funding and its review? Certainly, we want our men and women in the military to have safe travel, as opposed to having us engage in what is at best a shaky production and shaky research. And I am certainly one that believes that we can use the Government for innovative technologies and research; that is how we got the Internet, but why don't we let them finish their work before we begin to utilize civilian dollars in NASA when NASA is in need of so many additional dollars for human space flight and other research areas. And I would hope that each of the gentlemen would answer the question.

Mr. **ZUK.** If I may begin, I would just like to quickly relate our experience with the XV–15 tiltrotor research aircraft. The first flight took place back in May 1977, and one of the two aircraft is still flying in Arlington. The tiltrotor itself has many safe features, including a wide conversion corridor; that is, you can convert from vertical to horizontal flight over a wide speed range. That is an excellent feature. Because it is what we call a low disk loading vehicle, it moves a large amount of air. It doesn't have to exhaust at a high velocity. And this minimizes the downwash and any type of ingestion into the engine.

Page 63 PREV PAGE TOP OF DOC

For civilian applications, we will not have the demands that the military puts on vehicles. NASA itself carries the technology through the technology development stage, and the research aircraft so that the technology is demonstrated. Then whoever develops the vehicle is involved in the details of the design and the user determines how it will be operated. The manufacturer determines how it will be maintained. That is really out of our hands.

In the tiltrotor's case, I feel that the extensive database we have for the XV–15 indicates that it is a very safe vehicle. The same can be true for other concepts. And our experience through NASA, and actually begin in 1950, 1960, 1970, and early 1980's, showed that many other short takeoff and landing concepts are viable, can be safe. We have also———

Ms. **JACKSON LEE.** Dr. Zuk, let me just try to get the other members in. What I am trying to find out is I understand the budget for R&D aviation is zeroed out for NASA, and I want to, certainly, correct that. You happen to be a particular project manager. I am trying to find out whether we should let the Defense Department continue to do its work in research, as opposed to taking needed funds for general aviation research out of NASA to do this kind of work when it has already been proven that this doesn't seem to be a very safe vehicle. If the other gentlemen could proceed with that so that my question could be answered, I would appreciate it.

Mr. **WALLACE.** Yes. I cannot address the military side, the V–22 issue. What I can address is the civil aircraft that we are in the process of certifying right now. With the civil tiltrotor, power lift vehicle, the Bell Agusta 609, the way we are certifying it is through transport category standards. Now, what I mean by that is, when you go back to Texas, and you go out here to Ronald Reagan National Airport, and climb on the Airbus, or whatever airplane it is, we are using the same transport category safety standards for that aircraft, as for the new civil aircraft. It has to meet the same civil transport airplane and rotorcraft standards. Now, there is a certain portion of the standards, approximately 15 percent, that are unique for tiltrotor aircraft. What we are doing is we are addressing special conditions for tiltrotor aircraft. But again, those aircraft have to meet the highest standards equivalent to the transport standards.

Page 64 PREV PAGE TOP OF DOC

Ms. **JACKSON LEE.** Mr. duPont?

Mr. **DUPONT.** I am not sure I am answering the question you posed.

Ms. **JACKSON LEE.** Should we let DOD do this work and get them to refine it to the point that they use their dollars as opposed to attempting to do this research in collaboration with NASA?

Mr. **DUPONT.** Now, are you talking about the rotorcraft program that was zeroed out or are you talking about the DP–2?

Ms. **JACKSON LEE.** I am talking about the vertical takeoff technology, which I assume you are involved in.

Mr. **DUPONT.** Okay. Well, I think the reason that NASA would be a great participant is that they would focus on the civilian needs and the civilian applications and some of the things that Dr. Zuk was talking about, how you operate this airplane to minimize the noise contours and still have a safe area around the airplane, and the military has a different set of requirements. They would only be incidentally addressed at a military program where they would be directly confronted by a NASA program.

Ms. **JACKSON LEE.** Thank you. And I thank the Chairman's indulgence. If Dr. Taylor could finish my question, I would appreciate it very much.

Page 65 PREV PAGE TOP OF DOC

Mr. **TAYLOR.** Being a technologist, I will come at this from a technology side.

Ms. **JACKSON LEE.** Thank you.

Mr. **TAYLOR.** Again, I think you have to hearken back to the days of the vertical takeoff airplane for the Harrier or the other ideas that were 15 or 20 years ago. Everybody was all for this, and they found out that they didn't have enough power. And the long and short of it is, as we have advanced, we now have a whole lot of power in the jet engines. And we now have great control systems for flying airplanes that we just didn't have before. So I would say, based on my knowledge base and what I know, is that the safety factor of the vertical takeoff airplane has improved greatly over even the last three or four years. So I am not here to judge existing aircraft or the technology in those aircraft, but I can tell you that we certainly have the ability to build a safe vertical takeoff airplane.

Ms. **JACKSON LEE.** Thank you very much, Mr. Chairman.

Chairman **ROHRABACHER.** Thank you very much. If we could have a second round here, seeing as there are only a couple of us left. Let me just start out by saying we are talking about a $300 million investment that we have had, and from NASA in these last ten years, $30 million a year for ten years on tiltrotor technology R&D. Dan Goldin suggested to me that very little was achieved for that actual $300 million investment and that when you have to prioritize your spending, that that was an easy decision for him to make because we had come to the point where very little was coming out of that $30 million investment a year. Although, I can say that that is tiltrotor; again, we are not talking about vertical takeoff/ vertical landing, we are talking about, specifically, tiltrotor approach to vertical takeoff/vertical landing. Mr. duPont has testified that for a few years of $30 million a year investment he could come up with, actually, several experimental craft that could be used, experimental craft that would be available to totally test the technology, and test this vectoring thrust system, and come up with some working models which might well be a very good investment for $30 million, as compared to, as I say, Dan suggested that they weren't getting much out of that $30 million a year now.

Page 66 PREV PAGE TOP OF DOC

PREDICTING DP–2 PERFORMANCE

Tony, let me ask you something. You have made some claims here, and you have got a lot of people listening here, and you are on the record now. How can you project that a plane that hasn't flown yet is going to be able to go as fast as it goes, and is going to be able to have the stability that you claim it has, and such as that? I mean, look, I am not an engineer. How can you make a claim that it is going to be able to have a 5,000 mile range, for example?

Mr. **DUPONT.** Okay. Well, three things go into the range calculation. You have the empty weight of the airplane, and we have compared the empty weight projected for the DP–2 against some past airplanes. In the airline world, let us take the DC–9–30; in the military world, take an airplane that has a lot of fuel in it, namely, the KC–135. Our empty weight fraction as a percent of takeoff gross weight lies in between those two airplanes. So the anti-weight fraction is reasonably expected that it will make it. This has been checked by some other outside companies, including Sikorsky, who we were a partner with at one time. And then the aerodynamic data that gives you your stability, and your drag, and so forth, most of that was obtained in the NASA 7 by 10 wind tunnel with one of these power scale models that Dr. Taylor was talking about.

Chairman **ROHRABACHER.** Well, let me just put it this way. This hearing isn't to approve or disapprove your craft. I wanted to make sure that the word got out that there was a possible alternative here, and that because of the problems with the V–22, that people should not just say that vertical takeoff/vertical landing concepts are either going to live or die based on whether or not the Osprey was the right decision. I think everyone would be excited and everybody could understand the commercial application of having a plane that can take off and land like a helicopter, but it can go 500–600 miles an hour for a 5,000 mile range. I mean, it is clear this has not only military application, but a tremendous commercial potential as well. So we are going to be watching this. I, personally, think this is what NASA should be doing. NASA should be pushing the envelope, and as you said, that you would expect a lot of other airliners in the future, not only just from your company, but from many companies, to be utilizing this technology that you are pioneering.

Page 67 PREV PAGE TOP OF DOC

And with that said, I am just going to let Mr. Lampson move forward with his questions.

DOD FUNDING FOR THE DP–2

Mr. **LAMPSON.** Thank you, sir. Let me go to Dr. Taylor. I understand that the Office of Naval Research, ONR, DARPA, and perhaps some others, may have spent as much as $50 million to date on the DP–2 in its earlier incarnation, the vectored thrust technology project. Is this correct?

Mr. **TAYLOR.** I think it is a bit high. I think the number is in the 20's.

Mr. **LAMPSON.** There has been a lot of confusion presented to us, because we have asked this of some different agencies, and we have gotten different answers from different folks. Would you mind giving us the correct information, please?

Mr. **TAYLOR.** Well, I don't have it all.

Mr. **LAMPSON.** No, not now. Just send it to us at your convenience.

Mr. **TAYLOR.** Sure. We have a total account of this.

Page 68 PREV PAGE TOP OF DOC

AERONAUTICS R&D SPENDING CUTS

Mr. **LAMPSON.** I think that would be helpful to have. An article in the April 16th issue of Aviation Week and Space Technology quotes industry officials as saying that NASA's announced plans to cut R&D have started an exodus of skilled workers from NASA Ames and Langley Research Centers. The one official goes on to state that, "The damage in the area of personnel is already so large that it will take a long time to repair" even if funding is restored. This Committee has already expressed its concerns about the need to attract skilled men and women into aerospace if our nation is to remain competitive.

So Dr. Zuk, what is the impact of aeronautics R&D cuts on the Government's and the industry's ability to attract good people into aerospace careers and how concerned should we be about this?

Mr. **ZUK.** Well, living in the Silicon Valley, we have had a long time concern, really, this past decade of attracting the best students to lead our future in aerospace. And the cutback in funding in aeronautics research is, of course, will harm that some more. And we also have an impact of contractor personnel that help that are really key to operating our facilities, the wind tunnels and the simulators. And we have already seen the beginning of an exodus. To my knowledge, I don't think we have reached the critical point yet, but I am sure we will soon, where we won't have the capability to operate it sufficiently as we have in the past.

Mr. **LAMPSON.** I appreciate you telling us that. That really concerns me a great deal, as it has this Committee, I know, for sometime. And perhaps we can spend some effort in the future, Mr. Chairman, to explore that particular point to a greater extent. Actually, I find this fascinating, and the technology, I truly love. And the work that you all are doing in these areas, no question about it, it is going to make life better for us all, and I think it is fantastic.

Page 69 PREV PAGE TOP OF DOC

NATIONAL ROTORCRAFT TECHNOLOGY CENTER

With that being said, let me just end, I guess. I have one more question of Dr. Zuk, if I can, and then I will be quiet and let you have this thing back, and we will go on about our business. The NASA budget cuts will result in the elimination of the National Rotorcraft Technology Center, which is located at the NASA Ames Research Center. What is the mission of the National Rotorcraft Technology Center, and who is a member or are members?

Mr. **ZUK.** Okay. Well, I am, I guess, peripherally involved with the National Rotorcraft Technology Center, so I can give you a better answer in writing. But just in general, I think it has been in operation now for over five years. Its members are the Government funds 50 percent and the Rotorcraft Industry Technology Association funds the other 50 percent. The Government side, it has been primarily NASA and the Army, with some FAA and Navy involvement. And they have been addressing relatively near term technology. It has been the pre-competitive type of technology. I attended the last yearly review and it has really been impressive, the work that NRTC has performed. But I will be happy to provide more information.

Mr. **LAMPSON.** Thank you. I appreciate that. Just the overall impact if it goes away—big?

Mr. **ZUK.** Well, I think a lot of people would be disappointed.

Mr. **LAMPSON.** Thank you very much. Thank you, Mr. Chairman. I thank all of you.

Page 70 PREV PAGE TOP OF DOC

Chairman **ROHRABACHER.** Ms. Jackson Lee?

ROTORCRAFT R&D FUNDING

Ms. **JACKSON LEE.** Thank you very much, Mr. Chairman. Let me first of all say that the work of scientists should always be held in very high esteem. I think the responsibilities that we have in this Committee, as we would have if we were in the appropriations process, is prioritization. And so I am certainly concerned that aviation R&D, as I understand the numbers—and someone should correct me—I believe we have gone from $36 million down to zero in terms of funding; it is zeroed out, if I am correct. And I certainly oppose that and want to see dollars utilized for aviation research.

Dr. Zuk, what I am trying to find out with your particular program, how many dollars—what are you utilizing and what did you utilize last fiscal year for your program?

Mr. **ZUK.** Okay. Again, I am the project manager for the short haul civil tiltrotor program.

Ms. **JACKSON LEE.** I understand.

Mr. **ZUK.** That was $3 million last year. It, actually, ends this year. Now, the rotorcraft program was, I believe, $30 million a year, and I might just add that even though rotorcraft itself is the name of the research, but there is a lot of generic research that applies to other concepts as well. In other words, it just doesn't apply to helicopters. There is certainly a percent that applies to all vertical and short haul aircraft.

Page 71 PREV PAGE TOP OF DOC

DP–2 DEVELOPMENT REQUIREMENTS

Ms. **JACKSON LEE.** My position would be to ensure that aviation R&D is funded, but before I conclude on what the other aspect of my position, and Mr. duPont, what are you trying to get the Government to do in cooperation, collaboration, with your research?

Mr. **DUPONT.** The specific things I mentioned are what I think are the most important things to do, is we would like to have a thorough wind tunnel program in the National Transonic Facility, which we would pay for ourselves if we could afford it. As I mentioned earlier, that data one way or another will be made available to everybody, so it is not like corporate welfare.

Ms. **JACKSON LEE.** And the cost of that would be?

Mr. **DUPONT.** I don't really know, but that is a pretty expensive facility. And the other wind tunnel facilities we have priced out come at thousands of dollars an hour, so it is a fairly healthy bill. The other thing that would contribute a lot to safety, one of the problems that we could address in a spin tunnel with one of the scale models is spin capabilities, how do you get into it, how do you get out of it. It is not an expensive program, but it is something very important to do. And then most important of all, if this thing is going to really make it into the commercial airline arena, we have to do that flight testing that Dr. Zuk has been doing for some of the other airplanes, other types of airplanes, to find out how you can get this into the smallest space safely and quietly. And to that end, we would like NASA to acquire a couple of these 53 percent scale airplanes that they could use for that purpose.

Page 72 PREV PAGE TOP OF DOC

Ms. **JACKSON LEE.** Thank you very much. As I said, the work that you do is to be applauded. I think that, as I indicated before, we have responsibilities to prioritization. I would like to see Dr. Zuk continue his work and to have funding in R&D on aviation go from zero to the amount that we can adequately support. I still maintain my position as it relates to research that is being done by the Department of Defense. I would like to see them even though it is defense and military based, spend some of those dollars and refine some of the issues that you have just mentioned, because I am concerned that in prioritizing what we have monies to spend, I think that there is some remaining work to be done, for example, on the space station, that has now been cut because of choices that have been made.

And so I encourage the work, but my concern would be in the spending of dollars in technology that has been questioned as it relates to safety, and I would be more inclined to be supportive of the Department of Defense pursuing it to its ultimate, and then, of course, it translates and can be utilized prospectively for commercial use or civilian use.

So I thank the gentlemen very much for their work and I hope that out of this hearing we all have one common perspective and that is to re-fund or to fund this fiscal year the R&D for aviation under NASA, and I think that is a worthy cause to do. I yield back.

Chairman **ROHRABACHER.** Thank you very much, Ms. Jackson Lee, and this Subcommittee prides itself on the bipartisan nature of our work and we try to work together. And to the degree that there is some competition between the two parties is a good thing. I mean, it keeps everybody honest, makes sure everybody is watching out for everything.

Page 73 PREV PAGE TOP OF DOC

I just would like to thank the witnesses. We are proud of the research. We listened real carefully to what Mr. duPont had to say. Some of the NASA research that we have supported over these last 10 and 15 years have made it possible for his aircraft, which was impossible 20 years ago, through materials research, and computer research, and such. A lot of the work that is done by NASA now is making his craft a possibility when it was an impossibility before; especially, in terms of the materials research that NASA has been doing with National Aerospace Plane and our space program. I am sure that is where a lot of this composite research was done, which now makes his breakthrough possible.

I believe that the $30 million a year that we were spending on tiltrotor research perhaps should be redesignated just research for vertical takeoff/vertical landing rather than just tiltrotor research. If it is going to be spent, it should be spent in a way that examines all the alternatives, rather than just the one alternative. But indeed, the helicopter industry, just as in all industries that are status quo, have a lot of power and interest in keeping the status quo, but that is not what this body should be about. This body should be about pushing the potential and the possibilities, creating a new status quo by funding not what the people are currently in power. You know, there are big guys who run big businesses and big government, and there are little guys like Tony duPont. And quite often in our history, the little guys have been the ones who have come up with the big breakthroughs. And if Mr. duPont is successful, I believe what he has in mind will change the world. It will certainly keep America—again, it will thrust America to the lead in commercial aviation and will have important, significant contributions to make to our national security.

And finally, let me just say that I wish we didn't have to even look for a new craft. I wish that the $12 billion that have been spent on the V–22 program, the Osprey, which I supported all these years, I wish it would have been successful. We have got 30 bodies that have been laying on the ground and these are very brave men and women who are defending their country. And if we are wrong, as I said in the beginning, let us have the courage to admit it if we are wrong and go in another direction. And I know that it is very difficult to do in corporate America, to do that, but we owe it to those people who are risking their lives to be honest about it. And if there is an alternative that could be safer and be better for our country, let us go in that direction.

Page 74 PREV PAGE TOP OF DOC

With that said, vertical takeoff and vertical landing, I think, is still a major option, and perhaps we have got some alternatives here in front of us today that we should take a look at. This hearing will be adjourned as soon as I say the last important legal words. The witnesses are thanked, and please be advised that members of the Subcommittee may request additional information for the record, and I would ask other members who are going to submit written questions to do so within one week of this hearing. So that concludes the hearing and we are now adjourned.

[Whereupon, at 3:40 p.m., the Subcommittee was adjourned.]

APPENDIX 1: Biographies

BIOGRAPHY FOR WILLIAM H. WALLACE

Page 75 PREV PAGE TOP OF DOC

Mr. Wallace is the federal Aviation Administration's National Resource Specialist for Rotorcraft Operations. An Air Transport Pilot, and a Flight and Ground Instructor for airplane and helicopter, he has flown more than 11,000 accident-free hours. He is an expert in aviation safety, with more than 30 years of experience in management, safety, and flying positions. While serving in the Army, Mr. Wallace completed two tours in Vietnam and was awarded the Silver Star, Bronze Star, Vietnamese Cross of Gallantry with Silver Star, Purple Heart with Oak Leaf Cluster, and the Air Medal with 14 Oak Leaf Clusters. He retired from the U.S. Army Reserve as a Chief Warrant Officer, Standardization Instructor Pilot and Instrument Flight Examiner, after 31 years service.

While serving as the Aviation Safety Program Manager, U.S. Department of Energy, he was responsible for managing a worldwide aviation safety and training program which has been adopted by domestic and foreign military and civilian organizations. He was a founding member of the U.S. Government Interagency Committee for Aviation Policy.

As the National Resource Specialist for Rotorcraft Operations, he is responsible for providing the operational and technical expertise necessary for the development of national policy and regulations and coordinating the development, operational testing, evaluation, and implementation of national standards, programs and procedures for helicopter and tiltrotor operations. Mr. Wallace is the Chairman of the FAA Vertical Flight Committee, which oversees all FAA rotorcraft and tiltrotor programs including research and development, aircraft certification, flight standards, airports, air traffic, and safety.

He is a member of NASA's AeroSpace Technology Advisory Committee Rotorcraft Sub-Committee. He has participated in the development of international standards while serving as the rotorcraft technical advisor to the US Mission, International Civil Aviation Organization (ICAO) and a member of the Air Navigation Commission Helicopter/Tiltrotor Study Group, and NAFTA's Trinational Technical Safety and Security Helicopter Work Group. For the past nine years he has served as the FAA representative to the European Joint Aviation Authorities Helicopter Operations Sub-Committee and is a primary member of the Performance and Night Vision Goggle Working Groups.

Page 76 PREV PAGE TOP OF DOC

He also serves as Chairman of the FAA Rotorcraft Task Force, is a member of the National Rotorcraft Technology Center's Rotorcraft Center of Excellence Management Advisory Board, and is a member of the Rotorcraft Industry Technology Association's Technical Advisory Committee. Mr. Wallace is a former Manager of the FAA's Vertical Flight Program Office and was Technical Advisor to the Congressional Civil Tiltrotor Development Advisory Committee. He is also a member of the SAE G–10 Human Factors Vertical Flight Committee and RTCA Special Committee on Night Vision Goggle Appliances and Equipment.

He has a BS in Aeronautical Science from Embry-Riddle Aeronautical University, and completed the Rotary Wing Technology Course at Pennsylvania State University, the Aircraft Accident Investigation Program at the School of Engineering, Arizona State University, the U.S. Army Aviation Safety Officer's Course at the Safety Center, University of Southern California, and the FAA Transportation Safety Institute's Rotorcraft Safety and Accident Investigation Course.

Mr. Wallace was awarded the American Helicopter Society's 1999 Frederick L. Fienberg Award, presented to the helicopter pilot who accomplished the most outstanding achievement during the preceding year. He has been a guest lecturer at the U.S. Army Safety Center and the invited speaker at the American

Institute of Aeronautics and Astronautics Powered Lift Conference, the National Academies Transportation Research Board, the International Air Medical Conference, the Helicopter Association International's "Heli-Expo", and numerous other industry meetings and safety symposia. He has also been interviewed for featured articles in national and international aviation publications.

Page 77 PREV PAGE TOP OF DOC

BIOGRAPHY FOR THOMAS D. TAYLOR

Dr. Taylor received his Ph.D. from the University of California at Berkeley and his BS from the University of Oklahoma. Both degrees were in Chemical Engineering.

Dr. Taylor has worked in the Aerospace Defense area during his Career. He began his work at the Aeronutronic division of Ford Corporation, where he was engaged in re-entry physics research. He continued this work at Northrop Corporation and the Aerospace Corporation. He was also involved in aircraft development at Northrop. He later moved to the Johns Hopkins Applied Physics Laboratory where he worked on submarine detection concepts. This work took him to Defense Advanced Research Projects Agency (DARPA), where he was director of the congressionally mandated Submarine Technology Program and also served as the Deputy Director of the Naval Technology Office. After his stay at DARPA, Dr. Taylor joined the center for Naval Analysis as a senior fellow. There he led major studies on the future of aircraft carriers and the FAA air traffic control system.

Dr. Taylor then joined the Office of Naval Research where he has served in a variety of positions. He currently is Chief Scientist and Program Manager in the Expeditionary Warfare department. Dr. Taylor is Internationally recognized for his research in computational fluid dynamics. He has published over fifty papers and a book in the field. He has served on three International committees in the area.

Page 78 PREV PAGE TOP OF DOC

APPENDIX 2: Material for the Record

FAA Responses to Questions for the Record

Submitted by Chairman Rohrabacher following the hearing on "A Review of Vertical Takeoff and Landing

Technology in the National Airspace System," held May 9, 2001

1. Based on your knowledge of the marketplace, what operating and performance improvements will the next generation of runway-independent aircraft incorporate? Will they be of such a degree that the cost to operate these aircraft will be driven down? Will they be quieter? Faster?

R**ESPONSE**: Noise has been identified as a major barrier to the further utilization of vertical flight aircraft as an integral element in an integrated air transportation system. Millions of dollars have been spent on R&D by industry, DOD, and NASA in the quest to reduce the noise of rotors, transmissions, and engines, and for development of specialized operational techniques to avoid conditions that generate high ambient noise. These aircraft will have higher payload, higher gross weight, lower fuel consumption, lighter weight transmissions, lighter weight engines with higher engine performance to allow for steeper approaches, lower airspeeds, and lower instrument approach minimums, increased speed, and longer range. To the extent which new technology improvements are incorporated into these aircraft will depend upon how commercially feasible they become.

Page 79 PREV PAGE TOP OF DOC

2. Does modern airport design make it feasible to build vertiports within the airport boundary area with sufficient separation from existing runways and convenient access to terminal buildings? Would this airport design effectively utilize the advantages of runway-independent aircraft?

R**ESPONSE**: Given a new sheet of paper, it is extremely feasible to design an airport that can accommodate both fixed wing aircraft and runway independent aircraft. However, the issue becomes more challenging when considering adding a vertiport at an existing airport. At existing airports throughout the National Airspace System (NAS), infrastructure improvements, to varying degrees, may need to be made to take advantage of the unique capabilities of runway independent aircraft, in addition to providing support (passenger movement, refueling, general servicing) for the aircraft. The assumption is that runway independent aircraft would not utilize the same facilities as fixed wing aircraft due to differences in physical and ground movement characteristics.

While these aircraft would not use a runway, approach procedures would need to be developed to ensure adequate separation of fixed-wing and rotary aircraft. Given the available airspace for maneuvering in the terminal area, independent procedures may be limited. The speed and operational capability of the various aircraft will determine the separations required between aircraft operations.

3. Would it be expensive for airports to modify their system of terminals, taxiways, ramps and associated infrastructure to integrate runway-independent aircraft operations?

Page 80 PREV PAGE TOP OF DOC

R**ESPONSE**: As mentioned in question 2, general infrastructure improvements would most likely be needed to accommodate runway independent aircraft. Whether those improvements are extensive and/or expensive would greatly depend on the number of operations the airport is trying to handle and the physical details of the airport relating to the sitting of the vertiport.

4. How difficult is it to design and build a new vertiport in a suburban location? Are these facilities likely to draw opposition from nearby businesses and homeowners? Is gaining an environmental clearance an onerous process that is likely to result in failure? What has been the industry's experience?

R**ESPONSE**: Construction of vertiports in suburban locations would be a difficult undertaking for a number of reasons. First, the physical size of a vertical takeoff and landing (VTOL) facility is larger than one associated with a helicopter, mainly due to aircraft size, but also due to airspace that would be needed to support low visibility minimums.

The expansion of existing airport facilities typically draws opposition from nearby homeowners, particularly if the development would result in an increase in operations. Community awareness that an airport/vertiport construction brings accompanying air traffic noise will be an issue. This has become a highly publicized and emotional issue that many residential organizations have rallied against. Local businesses may not be as opposed to such development, especially if they directly benefit from the improvements. Of course, the sensitivity of potential noise impacts plays a large role in the ability to promote airport development.

The environmental process must be completed in order to gain necessary project approvals. The time required to gain the approvals depends on the type and extent of the environmental impacts. The environmental review process ensures that the public and government agencies understand the environmental impacts of a particular action, but the process itself would not prevent the action. In such case the agencies involved would need to decide whether the benefits outweighed the costs. Failure is more likely to occur for highly unusual and unrecognized circumstances regarding safety.

Page 81 PREV PAGE TOP OF DOC

From an airspace perspective with environmental noise covered under land use planning guidance, Stage 2 helicopters are typically within the 65 DNL noise guidance specified and would be unrestricted. However, the industry is challenged by community opposition that is normally channeled through their local political representatives. It is this negative sentiment from the communities that is usually a factor in zoning decisions that will ultimately dictate a vertiport consideration.

5. Is it possible to design suburban vertiports to operate in Instrument Meteorological Conditions?

R**ESPONSE**: It is possible to locate and develop a suburban vertiport to operate in IMC conditions, however as mentioned in response 4, there are a number of obstacles that will make that task very, very challenging.

6. How difficult and time-consuming is it for FAA to chart a new VTOL approach route to an urban hub airport? Would it take a matter of years to resolve environmental and operational issues, much as it does to satisfy similar requirements for a new runway?

R**ESPONSE**: Charting a VTOL approach to an urban hub airport is no more difficult than charting any other approach. The procedure would be placed in the track along with other procedures. No special charting issues would affect the time or effort required to chart such procedures.

The process is initiated by identifying a requirement for a new procedure. A procedure package is processed by the Regional Airspace Procedures Team (RAPT), then by the Office of Aviation Standards (AVN), for development, quality control and flight check.

Page 82 PREV PAGE TOP OF DOC

The process of final publication begins with the publishing of that procedure (with an effective date) by the FAA's National Flight Data Center (NFDC). A Transmittal Letter provides the procedure to the National Aeronautical Charting Office (NACO). NACO processes the data, develops and distributes the chart so as to meet a target charting cycle date. NACO introduces new procedures on an established 56 day charting cycle. Currently NACO is processing around 75 new area navigation (RNAV) procedures per cycle.

For a federally funded airport/vertiport development, the average environmental and operational assessment can take approximately six months to two and one-half years, depending on the specifics of the existing airspace. The Environmental Assessment (ES) procedures for FAA actions are outlined under DOT Order 1050.1D "Policies and Procedures for Considering Environmental Assessments."

7. How will the Global Positioning System change FAA's ability to chart simultaneous non-interfering approaches to congested hub airports? Does this navigation system present new capabilities not currently available? Will FAA attempt to exploit this new capability to the benefit of VTOL users?

R**ESPONSE**: The Global Positioning System (GPS) will provide the navigation solution for area navigation routes independent of ground navigation aids, such as the Very High Frequency Omni-Directional Range (VOR) system which currently serves as the basic navigation system in the NAS. This ability to develop routes (including approach and departure routings) will provide the flexibility needed for FAA to develop and chart simultaneous non-interfering approaches, and departures, from congested hub airports.

Page 83 PREV PAGE TOP OF DOC

GPS navigation offers lateral navigation capabilities that are more flexible, and in many cases, more accurate than conventional VOR navigation used today. In addition, GPS can support vertical navigation, as the system can fix an aircraft's position in three dimensions. Ground-based navigation aids, which, with the exception of an Instrument Landing System (ILS) using a glide slope signal combined with a localizer signal to approach a specified runway, can only accomplish two dimensional (no altitude information) navigation. While accuracy of GPS is very high, two other attributes, integrity and availability, require augmentation in order to perform to civil aviation standards.

These augmentations are being developed in two applications; Wide Area Augmentation (WAAS) and Local Area Augmentation (LAAS). WAAS will support the required availability and integrity for very accurate lateral navigation, and will provide augmentation to the vertical navigation capability of GPS to support the development of three-dimensional flight path guidance to near current standard ILS standards. However, instead of servicing only one runway, as an ILS, GPS augmented by WAAS can provide navigation signal to any point, allowing simultaneous non-interfering approach procedures without the requirement to site expensive and maintenance intensive conventional ILS ground systems. In addition, the navigation signal in space can be used to build steep angle approaches, and/or multi-angle procedures to support terrain/obstacle clearance, traffic flow management or noise abatement requirements.

LAAS offers the ability to develop these same types of optimized flight paths for approaches and landing as WAAS, however, LAAS provides the signal in space to support such operations to much lower landing minima (ceiling and visibility). In fact, the target capability for LAAS is to provide service equivalent to the best ILS service currently available. The great advantage of LAAS is that these services will be available to more than just the single ILS runway, but to other runways and to runway independent landing sites, such as vertiports and heliports, located in the service volume of the LAAS ground station, called a pseudolite.

Page 84 PREV PAGE TOP OF DOC

The FAA is currently engaged, and actively committed to developing GPS capabilities for the benefit of VTOL users. The Satellite Operational Implementation Team (SOIT) chartered a separate working group in 1998, the Vertical Flight Working Group (VFWG) to implement GPS services and capabilities for the vertical flight (helicopter and tiltrotor) community.

The VFWG is unique in the SOIT, as all other working groups concern themselves with an operational aspect of GPS implementation, such as the WAAS and LAAS programs, signal interference, or international harmonization. The VFWG focuses instead on the needs of a distinct GPS user group. It was determined that the vertical flight community had specific operational requirements and applications for GPS that were not addressed in the mainstream airline and general aviation implementation.

The VFWG is dealing with GPS implementation requirements for avionics, infrastructure, air traffic procedures, aircraft certification and flight operations procedures and standards, both for Visual Flight Rules (VFR) and Instrument Flight Rules (IFR) operations. The group works these issues in collaboration with industry through the Helicopter Association International (HAI), the American Helicopter Society (AHS) and direct contact with manufacturers and operators. The group also includes other government agencies, including international participation.

The incorporation of GPS and the accommodation of new technology vertical flight aircraft are part of the FAA effort in modernizing the NAS. Modern vertical flight aircraft technology, including advanced rotorcraft as well as tiltrotor aircraft, when coupled with advances in the NAS, offer unprecedented opportunities for aviation system efficiency improvement and will enable safe all-weather transportation and emergency services. It is the policy of the FAA to support the development and use within the NAS of these new technologies.

Page 85 PREV PAGE TOP OF DOC

8. Can the latest generation of VTOL aircraft fly in weather conditions comparable to those in which fixed-wing aircraft operate, ensuring reliable operation in all weather conditions?

R**ESPONSE**: The latest generation of VTOL aircraft are capable of flying in comparable weather conditions in which fixed-wing aircraft operate, with the exception of flight in icing conditions in most cases. Some civil VTOL aircraft have been certificated for flight into known icing conditions, however the majority have not. Current project aircraft, such as the S–92 helicopter and the BA–609 tilt rotor, are being designed to meet FAA icing operations requirements. These VTOL aircraft will have the ability to operate in the same weather conditions as fixed-wing aircraft.

Some weather hazards, however, such as thunderstorms, large hail, tornadoes, etc. preclude any aircraft from safely flying. Hence, while VTOL aircraft can operate in the same conditions as fixed-wing aircraft, there are no truly all-weather capable aircraft.

Page 86 PREV PAGE TOP OF DOC

In letters dated May 30, 2001, Subcommittee Chairman Rohrabacher submitted additional questions to the National Aeronautics and Space Administration and the Office of Naval Research, with the intent of including their responses in the hearing record. As of September 18, 2001, NASA and ONR have failed to respond.

(Footnote 1 return)

An enplanement is one paying passenger boarding a scheduled flight. The term does not cover general aviation, government or military traffic.

(Footnote 2 return)

One exception does exist. A proposed Local Area Augmentation System (LAAS) is under development to enhance GPS signals. This system would be installed on an airport-by-airport basis, and it's uncertain whether FAA will adopt this technology.

(Footnote 3 return)

This number is subject to some dispute. An FAA advisory group, made up of helicopter industry representatives, believes the number of civil helicopters in active service is on the order of 12,000.

(Footnote 4 return)

FAA Aerospace Forecasts, March 2001.

(Footnote 5 return)

This is especially true when visibility is poor due to storms, low ceilings, rain or snow. Large airports typically have simultaneous non-interfering approaches that can only be flown during Visual Flight Rules procedures. To make a business case for substituting VTOL for fixed-wing commuters, operators insist they must have access to the airport in all weather conditions.

(Footnote 6 return)

An SNI approach is one made by a VTOL aircraft to an airport that does not share the same approach and departure routes used by conventional fixed wing aircraft.

CONTENTS SPEAKERS INSERTS

INSERTS SPEAKERS CONTENTS

NO INSERTS IN THIS HEARING