THE FEDERAL AVIATION ADMINISTRATION'S R&D BUDGET PRIORITIES FOR FISCAL YEAR 2008

HEARING

BEFORE THE

SUBCOMMITTEE ON SPACE AND AERONAUTICS

COMMITTEE ON SCIENCE AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

ONE HUNDRED TENTH CONGRESS

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March 22, 2007

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THE FEDERAL AVIATION ADMINISTRATION'S R&D BUDGET PRIORITIES FOR FISCAL YEAR 2008

THURSDAY, MARCH 22, 2007

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON SPACE AND AERONAUTICS,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
Washington, DC.

The Subcommittee met, pursuant to call, at 10:00 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Mark Udall [Chairman of the Subcommittee] presiding.

COMMITTEE ON SCIENCE
U.S. HOUSE OF REPRESENTATIVES
WASHINGTON, DC 20515

Hearing on

The Federal Aviation Administration's R&D Budgetary Priorities for Fiscal Year 2008

March 22, 2007
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

WITNESS LIST

Ms. Victoria Cox
Vice President for Operations Planning
Air Traffic Organization
Federal Aviation Administration

Dr. R. John Hansman
Co-Chair, FAA Research, Engineering and Development Advisory Committee
Professor of Aeronautics and Astronautics
Director, MIT International Center for Air Transportation

Dr. Donald Wuebbles
Chair, Workshop on the Impacts of Aviation on Climate Change
Department Head and Professor
Department of Atmospheric Sciences
University of Illinois-Urbana Champaign

Mr. Steve Alterman
President, Cargo Airline Association
Chairman, Environment Subcommittee,
FAA Research, Engineering and Development Advisory Committee

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HEARING CHARTER

SUBCOMMITTEE ON SPACE AND AERONAUTICS
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

The Federal Aviation Administration's R&D Budget Priorities for Fiscal Year 2008

THURSDAY, MARCH 22, 2007
10:00 A.M.—12:00 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

Purpose

The purpose of the March 22nd Subcommittee on Space and Aeronautics hearing is to review the FY 2008 budget request for the Federal Aviation Administration's (FAA) research and development (R&D) programs and examine current and potential R&D priorities, including support to the NextGeneration Air Transportation System (NextGen). On March 29th, the Subcommittee will examine the NextGen initiative, which is being planned and developed by the interagency Joint Planning and Development Office (JPDO).

Witnesses:

The witnesses scheduled to testify at the hearing include the following:

Ms. Victoria Cox, Vice President for Operations Planning, Air Traffic Organization, Federal Aviation Administration

Dr. R. John Hansman, Co-Chair, FAA Research, Engineering and Development Advisory Committee; Professor of Aeronautics and Astronautics; Director, MIT International Center for Air Transportation

Dr. Donald Wuebbles, Chair, Workshop on the Impacts of Aviation on Climate Change; Department Head and Professor, Department of Atmospheric Sciences, University of Illinois-Urbana Champaign

Mr. Steve Alterman, President, Cargo Airline Association; Chairman, Environment Subcommittee, FAA Research, Engineering and Development Advisory Committee

Background

Potential Issues

The following are some of the issues that could be raised at the hearing:

- Are the content and priorities of FAA's R&D program appropriate, and have adequate resources been allocated to the program?
- Has FAA's R&D program been appropriately aligned with the needs of the next generation air transportation system (NextGen) initiative?
- What impact is NASA's restructuring of its aeronautics program having on FAA's R&D program?
- What has been the impact of FAA's R&D program on the aviation industry's operations?
- What role, if any, should FAA play in addressing the R&D challenges associated with the impact of aviation on climate change?
- Since FAA certification has become more difficult as new technologies and systems become more complex, is there any R&D that could improve the certification process?

Overview

Aviation is a vital national resource for the United States. It supports commerce, economic development, law enforcement, emergency response, and personal travel

and leisure. It attracts investment to local communities and opens up new domestic and international markets and supply chains. Aviation and aerospace activities make up as much as nine percent of America's Gross Domestic Product and also represent the fastest growing source for technological exports.

Research and development (R&D) is central to maintaining and improving the Nation's aviation system so that it can respond to changing and expanding transportation needs. Civil aviation research and development is carried out both by NASA and by the FAA.

FAA R&D Activities

FAA has undertaken a wide range of aviation-related R&D, including such categories as the following:

- R&D in support of the next generation air transportation system (NextGen) initiative
- R&D to improve airport capacity and safety
- R&D on aviation-related environmental concerns, such as noise and emissions
- R&D on aviation weather (aviation weather is a major source of delays in the Nation's air transportation system)
- R&D on wake turbulence (wake turbulence has a major impact on the spacing/separation of aircraft, which has an impact on the efficiency of operations)
- R&D on air traffic control and flight deck human factors
- R&D on aging aircraft, fire safety, safety risk analysis
- R&D on General Aviation (GA) directed at reducing GA accidents
- R&D on Unmanned Aircraft Systems and their integration into the national airspace

As can be seen from the above list, the R&D portfolio at FAA is broad. However, two caveats should be noted. First, the R&D at FAA tends to be near-term and more operationally focused than the aeronautics R&D conducted at NASA—they are intended to be complementary efforts. Up until NASA restructured its aeronautics program over the past year, NASA had typically carried its aviation-related R&D to a level of technical maturity that enabled the FAA to pick it up, complete its development, and implement it in the national airspace system. Second, FAA's research budget for individual research areas can be very small—on the order of several millions of dollars in some cases—with the total R&D being on the order of $260 million in the FY 2008 budget request.

Mechanisms for Conducting FAA R&D

FAA R&D is carried out by means of a variety of mechanisms. For example, the FAA maintains a Technical Center in Atlantic City, NJ where a range of R&D activities and test facilities are located. In addition, the FAA has maintained a contractual relationship with the Center for Advanced Aviation Systems Development (CAASD) at MITRE Corporation, a Federally Funded R&D Center (FFRDC) where a variety of R&D efforts related to air traffic management are carried out.

The FAA has also entered into a number of partnerships with other federal agencies, most notably with NASA and DOD—and it has formal cooperative agreements with both agencies. FAA also participates with a number of other federal agencies on various interagency initiatives.

Other research mechanisms include the following:

- Cooperative Research and Development Agreements (CRDAs) with industry
- Small Business Innovation Research (SBIR) Grants
- Joint University Program for Air Transportation Research (Ohio University, MIT, and Princeton)
- Aviation Research Grants to Universities
- Air Transportation Centers of Excellence (involving 70 academic institutions throughout the U.S.)
- Airport Cooperative Research Program
- Technology Demonstrations with industry

Relationship to NASA's Aeronautics R&D Program

As noted above, FAA and NASA's R&D programs are intended to be complementary, not duplicative. The FAA describes NASA as *"the FAA's closest R&D partner in the Federal Government."* In a number of key areas, NASA has traditionally conducted both basic research *and* more applied "transitional research," with the latter

R&D having the goal of achieving a level of technological maturity that enables the FAA to pick it up and implement it in the national airspace system. As a result, an aeronautics program at NASA that has insufficient resources or that is unable to carry research to the point at which it can be picked up by the FAA will eventually impact the R&D options available to the FAA. A number of organizations have raised concerns about that potential outcome. For example, in the area of aviation safety, the REDAC (FAA's R&D advisory committee) stated in its June 20, 2006 review of the FY 2008 FAA R&D program plans:

> *"The FAA needs to make an assessment of the impact of the budget cuts in NASA's aeronautics R&D. Subcommittee on Aircraft Safety is concerned that there may be inadequate resources in the FAA's budget for taking on safety-related research that NASA used to perform in the past but won't be funded to cover in the future."*

The Government Accountability Office (GAO) made the following statement in its November 2006 report on the Next Generation Air Transportation System (NGATS):

> *". . .The Joint Planning and Development Office [JPDO] faces challenges with some planning and expertise gaps. For example, NASA is moving toward a focus on fundamental research and away from demonstration projects. Many experts told us that this creates a gap in technology development."*

Recommendations of External Advisory Committees

REDAC

The FAA has an advisory committee called the Research, Engineering and Development Advisory Committee (REDAC) that is tasked with monitoring the agency's R&D activities. One of the witnesses, Dr. Hansman, has been a long-time member and leader of the REDAC, and he will be able to outline the concerns and recommendations of that advisory committee. Some of its most recent recommendations include the following:

- *"Research should be conducted on advanced materials and joining processes being introduced on new aircraft; on new wiring technologies and on large bypass engines. Also on aircraft modifications designed to mitigate the risk of MANPADS, on fires due to non-HAZMAT-declared shipments, on expanding operational deployment of unmanned aerial vehicles [UAVs] and on reversing the trend toward a dwindling pool of qualified Aviation Maintenance Technicians [AMTs]."*
- *"[REDAC Environment and Energy] subcommittee members expressed widespread concern that we need to be proactive in addressing fuel availability/energy independence [and] recommend that the Administrator. . .work with DOE, DOD, and NASA to identify commercial needs and leverage research to commonly address this challenge."*
- *"We need an R&D program that assesses the impact of integrating unmanned aircraft systems into the national airspace system. The funding for RE&D related to unmanned aircraft systems in FY08 and beyond does not reflect the complexity of the technical and operational issues associated with their routine integration into civil airspace."*
- *"In anticipation of the acceleration of technology deployments required to realize [the next generation air transportation system] the committee recommends that FAA assess the costs of [next generation system] deployments and apply sufficient funds to accelerate the technology transfer and implementation."*
- *"[The FAA needs to] establish an R&D program that will lead to consistent and safe reduction of [aircraft] separation standards. . ."*

National Academies' Decadal Survey

In 2006, the National Academies completed a "Decadal Survey" of civil aeronautics and aviation research priorities. One of the research priorities identified in the Survey related to the certification process:

> *"Certification is the demonstration of a design's compliance with regulations. For example, before it can be operated by U.S. airlines, a new aircraft must be shown to comply with U.S. federal aviation regulations. As systems become more complex and non-deterministic, methods to certify new technologies become more difficult to validate. . .NASA, in cooperation with the Federal Aviation Administration (FAA), should anticipate the need to certify new technology before its in-*

troduction, and it should conduct research on methods to improve both confidence in and the timeliness of certification."

Aircraft Energy and Emissions Issues

With respect to energy, in the last year or so there has been increased interest by both the military and by commercial users in securing a stable supply of fuel. That has led to efforts to develop alternative fuels for aviation. Those alternative fuels would at first be used to supplement petroleum-based products and eventually potentially replace them. The FAA has convened workshops to look at alternative fuels and has been developing an "alternative fuels roadmap," but it is unclear how far FAA intends to proceed on alternative fuels R&D.

With respect to emissions, an announcement late last year by the European Union that it intended to impose penalties in 2012 on non-European air carriers that pollute too much has focused increased attention on the issue of aircraft emissions—particularly of greenhouse gases. The European move has been criticized and moves are underway to attempt to block it, but there is growing consensus that aviation operations will be a growing source of greenhouse gases and other undesirable compounds unless technological or operational fixes are made. Both NASA and FAA have undertaken research on aircraft emissions and mitigation technologies in the past, but more needs to be done. One of the witnesses, Dr. Wuebbles, last year chaired an FAA-sponsored workshop on the impact of aviation on climate change, and he will discuss some of the research needs identified by that workshop. Mr. Alterman of the Cargo Airline Association is serving as the current chairman of the REDAC's Environment Subcommittee and can also discuss these issues.

Budgetary Information

In FY 2008, the FAA plans to invest a total of $259,194,000 in R&D. This investment spans multiple appropriations for the FAA and includes: $140,000,000 in Research, Engineering and Development; $90,354,000 in ATO Capital; $128,000 in Safety and Operations; and $28,712,000 in the Airport Improvement Program.

In general, the R,E&D account funds R&D programs that improve the national airspace system (NAS) by increasing its safety, security, productivity, capacity, and environmental compatibility to meet the air traffic demands of the future. The AIP account generally funds airport improvement grants, including those emphasizing capacity development, and safety and security needs; and funds grants for aircraft noise compatibility planning and programs and low emissions airport equipment. It also funds administrative and technical support costs to support airport programs. The ATO capital account and the Safety and Operations account are new account designations in the FY 2008 budget request. They replace the former Facilities and Equipment (F&E) and Operations accounts.

A breakdown of 2008 R&D project funding is presented in Table 1, with applied research projects listed first, followed by development projects.

Table 1
FAA R&D Program Budget by Research and Development Category

Program	Account	2007 President's ($000)	2008 President's ($000)	2009 Planned ($000)	2010 Planned ($000)	2011 Planned ($000)	2012 Planned ($000)
Applied Research							
Fire Research and Safety	R,E&D[1]	6,638	7,350	8,457	8,546	8,815	8,957
Propulsion and Fuel Systems	R,E&D	4,048	4,086	4,050	4,075	4,150	4,201
Advanced Materials/Structural Safety	R,E&D	2,843	2,713	2,686	2,700	2,747	2,780
Atmospheric Hazards/Digital System Safety	R,E&D	3,848	3,574	3,568	3,608	3,687	3,749
Aging Aircraft	R,E&D	18,621	14,931	14,683	14,688	14,903	15,013
Aircraft Catastrophic Failure Prevention Research	R,E&D	1,512	2,202	2,158	2,153	2,181	2,192
Flightdeck /Maintenance/System Integration Human Factors	R,E&D	7,999	9,651	37,499	36,967	39,245	39,869
Aviation Safety Risk Analysis	R,E&D	5,292	9,517	8,349	8,334	8,446	8,493
Air Traffic Control/Technical Operations Human Factors	R,E&D	9,654	10,254	10,323	10,471	10,715	10,919
Acromedical Research	R,E&D	6,962	6,780	6,932	7,149	7,390	7,630
Weather Program	R,E&D	19,545	16,888	19,336	19,286	19,638	19,643
Unmanned Aircraft Systems Research	R,E&D	1,200	3,310	4,238	4,236	4,295	4,323
Joint Planning and Development Office	R,E&D	18,100	14,321	13,979	13,844	13,961	13,945
Wake Turbulence	R,E&D	3,066	10,755	10,560	10,412	10,471	10,418
Environment and Energy	R,E&D	16,008	15,469	35,039	34,678	34,811	34,926
System Planning and Resource Management	R,E&D	1,234	1,184	1,847	1,827	1,836	1,759
William J. Hughes Technical Center Laboratory Facility	R,E&D	3,430	3,415	3,548	3,644	3,758	3,868
Subtotal R,E&D		130,000	136,400	187,252	186,618	191,049	192,685

Center for Advanced Aviation System Development	ATO Capital[2]	30,100	22,854	26,180	27,720	35,112	36,652
Subtotal ATO Capital		30,100	22,854	26,180	27,720	35,112	36,652
Airport Cooperative Research Program – Capacity	AIP[3]	5,000	2,000	5,000	5,000	5,000	5,000
Airport Cooperative Research Program – Environment	AIP	0	3,000	5,000	5,000	5,000	5,000
Airport Cooperative Research Program – Environment	AIP	5,000	5,000	5,000	5,000	5,000	5,000
Subtotal ATO AIP		10,000	10,000	15,000	15,000	15,000	15,000
Commercial Space Transportation Safety	S&O[4]	63	64	64	64	64	64
Subtotal S&O		63	64	64	64	64	64
Applied Research		170,163	169,318	228,496	229,402	241,225	244,401
Percent Applied Research		71.9%	65.3%	56.0%	56.1%	57.3%	59.2%
Development							
GPS Civil Requirements	R,E&D	0	3,600	3,469	3,416	3,432	3,411
Subtotal R,E&D		0	3,600	3,469	3,416	3,432	3,411
Runway Incursion Reduction	ATO Capital	8,000	5,000	5,000	5,000	2,000	0
System Capacity, Planning and Improvement	ATO Capital	5,500	6,500	6,500	6,500	6,500	6,500
Operations Concept Validation	ATO Capital	3,000	3,000	3,000	3,000	3,000	3,000
General Aviation and Vertical Flight Technology	--	2,000	0	0	0	0	0
Safer Skies	--	3,600	0	0	0	0	0
NAS Weather Requirements	ATO Capital	800	1,000	1,000	1,000	1,000	1,000
Airspace Management Lab	ATO Capital	4,000	4,000	4,000	4,000	4,000	0
Airspace Redesign	ATO Capital	2,800	5,000	3,000	3,000	3,000	3,000
Wind Profiling and Weather Research Juneau	ATO Capital	1,100	4,000	0	0	0	0
Wake Turbulence	ATO Capital	1,000	3,000	1,000	1,000	1,000	1,000
Local Area	ATO	0	1,000	0	0	0	0

Augmentation System (LAAS)	Capital						
Safe Flight 21 – Alaska Capstone	ATO Capital	16,800	15,000	20,000	20,000	20,000	13,300
NextGen Demonstration	ATO Capital	0	20,000	12,000	12,000	12,000	12,000
NextGen System Development	ATO Capital	0	0	102,000	102,000	105,000	106,700
Subtotal ATO Capital		48,600	67,500	157,500	157,500	157,500	146,500
Airports Technology Research – Capacity	AIP	8,503	8,907	8,907	8,907	8,907	8,907
Airports Technology Research - Safety	AIP	9,367	9,805	9,805	9,805	9,805	9,805
Subtotal AIP		17,870	18,712	18,712	18,712	18,712	18,712
Commercial Space Transportation Safety	S&O	63	64	64	64	64	64
Subtotal S&O		63	64	64	64	64	64
Development		66,533	89,876	179,745	179,692	179,708	168,687
Percent Development		28.1%	34.7%	44.0%	43.9%	42.7%	40.8%
TOTALS		$236,695	$259,194	$408,241	$409,094	$420,933	$413,088

1 R,E&D: Research, Engineering and Development
2 ATO: Air Traffic Organization Capital
3 AIP: Airport Improvement Program
4 S&O: Safety and Operations
NB: FY 2007 levels refer to the President's request for FY 2007.

Chairman UDALL. This hearing will come to order.

Good morning to everybody. With this being our first subcommittee hearing of the 110th Congress, I would like to go ahead and introduce several new Members of the Space and Aeronautics Subcommittee before we get to our opening statements.

Mr. Lampson, who is returning after a brief absence, has joined the Committee, as has Mr. Rothman of New Jersey, the 9th district, Mr. Ross of Arkansas, the 4th district, and Mr. Chandler of Kentucky from the 6th district. I do know that Mr. Rothman will be joining us later. I know Mr. Ross and Mr. Chandler and Mr. Lampson are all trying to make time to join us today as well.

At this point, I would like to recognize Mr. Calvert to introduce his new Members. I did want to thank Chairman Calvert. He is my Chairman from the last—the 109th Subcommittee days, and I have enjoyed working with him on the past, and I know we are looking forward to working together again.

Mr. Calvert.

Mr. CALVERT. Well, I am getting used to sitting over here on the—this side of the dais, so—but congratulations, Mr. Chairman. I know you are going to do a great job. And I am equally represented by my Members as you are today. Dana Rohrabacher, who also chaired this subcommittee, comes from my home State of California, and Frank Lucas from the great State of Oklahoma, who is a farmer and rancher who has served a long time on this committee, also, Joe Bonner from Alabama from the good old port city of Mobile, Alabama, he is going to be with us a bit later, and, of course, Tom Feeney from Florida, who, like, Mr. Rohrabacher, won in his first elected—try at elected office, so he is going to be with us I think a bit later, also.

So with that, that is my add to the Committee here.

Chairman UDALL. We have got a great team of Republicans and Democrats alike, and I know we are going to have a productive 110th Congress.

At this time, I would like to provide my opening statement, and then I will turn to Mr. Calvert for his.

Good morning. Thank you to the witnesses. We have a distinguished panel today before us, and I want to extend my appreciation to all of you for your participation.

As I did earlier, I wanted to welcome my colleagues, and in particular, Ranking Member Calvert, to the first hearing of the Space and Aeronautics Subcommittee of the 110th Congress. We have a good mix of returning veterans and thoughtful newcomers on this subcommittee. I don't know whether that means that the veterans aren't thoughtful, but certainly, the veterans bring a wealth of experience and wisdom to the Subcommittee's work.

There are—is no lack of important issues for us to consider this year, and one of those issues is the outlook for the FAA's R&D program. A review of the FAA's R&D program is especially appropriate now, given that Congress will be reauthorizing the FAA this year, and we need to be sure that the FAA has a healthy and effective research capability.

As our FAA witness will, no doubt, remind us, FAA carries out a wide range of R&D activities, including research related to such things as developing the NextGeneration Air Transportation Sys-

tem, incorporating UABs into the national airspace, understanding the impact of wake turbulence on aircraft separation standards, reducing general aviation accident rates and the list goes on.

Yet, it needs to be noted that the FAA's research is intended to complement the aeronautics research carried out by NASA, not substitute for it.

As I have said in the past, I am concerned that the changes NASA is making to its aeronautics program are ill advised, both in terms of the reduced funding commitment and in retreating from R&D that has direct relevance to the public good and to our economic well-being.

In particular, I am concerned that the FAA's options for future technologies and systems are going to be negatively impacted by the cutbacks underway at NASA, and I intend to explore that issue at today's hearing.

Another issue I would like to have our witnesses address is how well aligned FAA's R&D program is to the needs of the NextGeneration Air Transportation System Initiative. Is it focused on the right priorities? Does it have the right resource commitments?

Finally, the issue of the impact of aviation on climate change is receiving increasing attention due, in part, to proposed European Union emissions penalties on aircraft operations. I think it is in our strong interest to know what the state of research is in this country, both on the scientific questions surrounding the aviation impacts and on the technological options for mitigating those impacts.

Well, we have a lot to discuss today. Again, I want to welcome our witnesses, and I look forward to your testimony.

[The prepared statement of Chairman Udall follows:]

PREPARED STATEMENT OF CHAIRMAN MARK UDALL

Good morning, and welcome to today's hearing.

We have a distinguished panel of witnesses before us today, and I want to extend my appreciation for your participation.

I'd also like to take a moment to welcome my colleagues—and in particular Ranking Member Ken Calvert—to this, the first hearing of the Space and Aeronautics Subcommittee in the 110th Congress.

We have a good mix of returning veterans and thoughtful newcomers on the Subcommittee, and I'm really looking forward to an active and productive year ahead.

Of course, there are no lack of important issues for us to consider this year, and one of those issues is the outlook for FAA's R&D program.

A review of FAA's R&D program is especially appropriate now, given that Congress will be reauthorizing the FAA this year, and we need to be sure that FAA has a healthy and effective research capability.

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Yet it needs to be noted that FAA's research is intended to *complement* the aeronautics research carried out by NASA—not *substitute* for it.

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Well, we have a lot to discuss today.

Again, I want to welcome our witnesses, and I look forward to your testimony.

Chairman UDALL. The Chair now recognizes Mr. Calvert for his opening statement.

Mr. CALVERT. Thank you, Mr. Chairman. Again, congratulations on your first hearing and calling this important hearing to examine the Federal Aviation Administration's R&D budget for fiscal year 2008.

The FAA plays a unique federal role. Not only does it regulate air carriers, pilots, airports, air traffic design and operation, it operates the Nation's air traffic control system 24/7. A huge part of our economy, including the commercial air carrier system, is dependent on the FAA to provide navigation and air separation services to ensure delivery of goods and services to every corner of our nation.

Against this backdrop, the FAA's budget request for fiscal year 2008 is $14.1 billion, yet, its request for research, engineering and development is $140 million, or about one percent of its overall budget. Looking more broadly at R&D activities within the agency, its investment ticks up to $260 million, not quite two percent.

For an entity that relies on a nationwide, state-of-the-art network for communications, tracking, guidance systems, this is a startling low level of funding. Yet, it is possible because, historically, over the last 40 years, FAA has relied on the National Aeronautics and Space Administration to perform a large R&D role, especially in the area of air traffic control. The relationship between the FAA and NASA is changing, but more about that in a moment.

FAA's research, engineering, and development program emphasizes a research agenda that focuses largely on air traffic design, materials, human factors, weather, environment, fuel, and others. The technologies they developed have led to important breakthrough products, examples being: fuel-inerting systems, flame-retardant systems, aircraft deicing systems. This brief list does not do justice to their work, but it gives an indication of the many types of valuable technologies they have brought to this marketplace.

There is plenty more research to be done, especially as new aircraft and materials are being introduced. Consider, for instance, the number of very light jet models under development and Boeing's new 787 with the first all-composite fuselage. The technologies incorporated in these designs and their operation and behavior must be fully understood if the FAA is to maintain an enviable safety record. And FAA, together with other federal agencies, continues to do important weather-prediction research.

I am concerned, however, with the FAA's R&D budget is going forward, especially with regard to taking on a greater role of re-

searching and developing air traffic control technologies. As I mentioned a moment ago, NASA has traditionally done much of the basic research related to our nation's air traffic control system. But the relationship appears to be changing as NASA reduces its expenditures for air traffic—excuse me, aerospace systems research.

NASA has also stated it will no longer develop technologies to the level of maturity enabling quick adoption without huge additional investment and years of research, a capability that FAA does not possess today.

I am interested to hear from our witnesses how they describe FAA's challenges and whether, in their view, sufficient budgetary resources are being brought to bear on solving them, as well as to offer their assessment about the content and scope of FAA's R&D portfolio.

Commercial aviation is here to stay, and roles connecting the world's markets is growing dramatically, both in the number of people carried and the amounts and value of cargo delivered. There is no substitute for the services aviation provides. So it is incumbent on government and industry to research and develop safer, more efficient, environmentally-benign aircraft to ensure uninterrupted growth in our economy.

So I thank you again, Mr. Chairman, and look forward to listening to our witnesses today.

[The prepared statement of Mr. Calvert follows:]

PREPARED STATEMENT OF REPRESENTATIVE KEN CALVERT

Thank you, Mr. Chairman, for calling today's hearing to examine the Federal Aviation Administration's R&D budget request for Fiscal Year 2008.

The FAA plays a unique federal role. Not only does it regulate air carriers, pilots, airports, and aircraft design and operations, it also operates the Nation's air traffic control system 24/7. A huge part of our economy, including the commercial air carrier system, is dependent on FAA to provide navigation and air separation services to ensure delivery of goods and services to every corner of our nation.

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For an entity that relies on a nationwide state-of-the-art network of communications, tracking, and guidance systems, this is a startlingly low level of funding, yet it's possible because historically—over the last forty plus years—FAA has relied on the National Aeronautics and Space Administration to perform a large R&D role, especially in the area of air traffic control. The relationship between FAA and NASA is changing, but more on that in a moment.

FAA's Research, Engineering and Development (R,E&D) program emphasizes a research agenda that focuses largely on aircraft safety design, materials, human factors, weather, environment, and fuels, among others. The technologies they've developed have led to important breakthrough products, examples being fuel inerting systems, flame retardant materials, and aircraft de-icing systems. This brief list doesn't do justice to their work, but it gives an indication of the many types of valuable technologies they've brought to marketplace.

There is plenty more research still to be done, especially as new aircraft and materials are introduced. Consider, for instance, the number of very light jet models under development, and Boeing's new 787 with the first all-composite fuselage. The technologies incorporated in these designs, and their operation and behavior, must be fully understood if FAA is to maintain an enviable safety record. And FAA, together with other federal agencies, continues important weather prediction research.

I am concerned, however, about FAA's R&D budget going forward, especially with regard to taking on a greater role researching and developing new air traffic control technologies. As I mentioned a moment ago, NASA has traditionally done much of the basic research related to our nation's air traffic control system. But the relationship appears to be changing as NASA reduces its expenditures for airspace systems

research. NASA has also stated that it will no longer develop technologies to a level of maturity enabling quick adoption without huge additional investment and years of research, a capability that FAA may not possess today.

I'm interested to hear our witnesses describe FAA's challenges, and whether, in their view, sufficient budgetary resources being brought to bear on solving them, as well as offer their assessment about the content and scope of FAA's R&D portfolio.

Commercial aviation is here to stay, and its role connecting the world's markets is growing dramatically, both in the number of people carried and the amounts and value of cargo delivered. There is no substitute for the services aviation provides, so it is incumbent on government and industry to research and develop safer, more efficient and environmentally benign aircraft to ensure uninterrupted growth in our economy.

Thank you, Mr. Chairman, and my thanks to our witnesses for taking time from the busy schedules to join us today.

Chairman UDALL. Thank you, Mr. Calvert.

If there are Members who wish to submit additional opening statements, those statements will be added to the record.

At this time, I would like to introduce our excellent panel of witnesses. I am going to start with Ms. Victoria Cox. She is the Air Traffic Organization Vice President for Operations Planning in the Federal Aviation Administration. Next to her is Dr. John Hansman. He is the Co-Chair for the FAA's Research, Engineering, and Development Advisory Committee and is currently the Director of MIT's International Center for Air Transportation. Next to Dr. Hansman is Dr. Donald Wuebbles, who is the Chair—I guess was the Chair for the Workshop on the Impacts of Aviation on Climate Change and is presently the head of the University of Illinois' Department of Atmospheric Sciences. And to his left, we have Mr. Steve Alterman, the President of the Cargo Airline Association and Chairman of the Environment Subcommittee of the FAA's Research, Engineering, and Development Advisory Committee.

You will each have, I think, as you know, five minutes for your spoken testimony, after which the Members of the Subcommittee will each have five minutes to ask questions in each round of questioning.

So, Ms. Cox, we will start with you. Thank you for being here today.

STATEMENT OF MS. VICTORIA COX, VICE PRESIDENT FOR OPERATIONS PLANNING SERVICES, AIR TRAFFIC ORGANIZATION, FEDERAL AVIATION ADMINISTRATION

Ms. COX. Good morning, Chairman Udall, Congressman Calvert.

I am Victoria Cox, Vice President for Operations Planning Services in the Air Traffic Organization of the Federal Aviation Administration.

I would like to request that my written statement be included for the record.

Chairman UDALL. So ordered.

Ms. COX. Thank you.

I am honored to be here this morning to testify on the FAA's fiscal year 2008 budget request for research and development activities.

Because of the enormous economic benefits afforded by aviation, the United States must have an aviation system that is second to none, a system that can respond quickly to changing and expanding transportation needs. We have the most effective, efficient, and

safest aviation system in the world today, but today's system is at capacity, and demand for air services is growing. Future congestion can only be alleviated by transforming the system we have today. Our current system just isn't scalable to handle future demand.

We are a partner in the development of the NextGeneration Air Transportation System, or NextGen, envisioned by the Joint Planning and Development Office. NextGen includes performance targets that will reduce congestion by providing far greater capacity than our current system allows. It will deliver initial capabilities by 2015 that will accommodate the demand for forecasted—demand forecasted for that timeframe. The NextGen of 2025 will be capable of supporting a three-fold increase in demand.

The Operational Evolution Partnership, or OEP, is the mechanism by which the FAA will assess R&D requirements for supporting NextGen. It will lay out a path from concept development to implementation, ensuring that our R&D is indeed focused on the NextGen vision. OEP version one will be published in June of 2007.

Critical to FAA operations today and for NextGen are our research programs. The FAA has recognized this fact by proposing funding increases in research, engineering, and development totaling $280 million over the next five years. In fiscal year 2008, the FAA plans to invest a total of approximately $260 million in overall research and development.

As the tempo of operations at our airports continues to rise, our research projects include the development of technologies that ensures safe transit of aircraft on taxiways and runways. We are continuing research on aviation safety issues. Aviation safety research is essential to meeting FAA flight plans, safety objectives, and NextGen performance targets. The potential of the NextGen system to handle tremendous growth in air traffic compels us to maintain our vigilance in safety research.

As we look at the NextGen system, we are working hard to ensure that we meet the increasing demand for flying in an environmentally-sound manner. The focus of the Environment and Energy Research Program is making aviation quieter, cleaner, and more energy-efficient, which has added—which has the added benefit of reducing climate impact.

The FAA is also planning wake turbulence research, the results of which will help us increase capacity while maintaining safety. It will help us to safely reduce separation distances between aircraft, support the efficient use of closely-spaced parallel runways, and allow airports to operate closer to their design capacity.

In addition, FAA is requesting funds for further research on unmanned aircraft systems. The program ensures the safe integration of these vehicles into our system. NextGen will dramatically alter the roles and responsibilities of key players. Human factors research is needed to define the changing responsibilities of humans in the system to allocate the functions to people or to automation and to design automation so it serves the needs of the people who are accountable for system performance.

To succeed in maintaining safety and ensuring sufficient capacity in the future, we do need a stable funding stream that will enable the FAA to launch the NextGen system. Secretary Peters has said that it is critical to deploy state-of-the-art technology that can safe-

ly handle the dramatic increases in the number and type of aircraft using our skies. Continued collaboration and success in research and development will make this statement a reality.

We are enthusiastic about and we are focused on the opportunity to direct our R&D efforts toward the realization of the NextGeneration Air Transportation System, and I look forward to working with you to making the NextGen system a reality.

This concludes my testimony, and I thank you for the opportunity to appear before the Subcommittee, and I would be happy to answer any questions you have.

[The prepared statement of Ms. Cox follows:]

PREPARED STATEMENT OF VICTORIA COX

Good morning, Chairman Udall, Congressman Calvert and Members of the Subcommittee. I am Victoria Cox, Vice President for Operations Planning Services in the Air Traffic Organization of the Federal Aviation Administration. I am honored to be here this morning to testify on the FAA's FY08 budget request for Research and Development (R&D) activities.

Aviation is a vital national resource for the United States. It provides support for business, jobs, economic development, law enforcement, emergency response, and personal travel and leisure. It attracts investment to local communities, and opens up new domestic and international markets and supply chains. As a result, the United States must have an aviation system that is second to none—a system that can respond quickly to its changing and expanding transportation needs. This can only be achieved through the introduction of new technologies and procedures, innovative policies, and advanced management practices.

Our nation's air transportation system has become a victim of its own success. We created the most effective, efficient and safest system in the world. But we now face a serious and impending problem: today's system is at capacity and demand for air services is growing rapidly.

The FAA is committed to reducing congestion in our nation's air transportation system and thereby maintaining and facilitating increases in the economic benefits afforded by the system. Future congestion can only be alleviated by transforming the system we have today—our current system is not capable of being "scaled up" to meet future demand. We must transform the current system to the system envisioned by the Joint Planning and Development Office (JPDO)—the Next Generation Air Transportation System or NextGen. NextGen includes performance targets for the year 2025 that, if achieved, will reduce congestion by providing far greater capacity than our current system with higher efficiency levels than we have today, while maintaining safety.

The FAA is integrating NextGen into its planning activities, including its five-year strategic Flight Plan. In addition, the FAA is using the Operational Evolution Partnership, the new OEP, to guide our transformation to NextGen. In the past the Operational Evolution Plan successfully provided a mid-term strategic roadmap for the FAA that extended ten years into the future. The new OEP will include strategic milestones through 2025, and its participants will include representatives from JPDO.

OEP is the FAA's way to plan, execute and implement NextGen in partnership with private industry. Through OEP we are seeking stakeholder input, evaluating available technologies, defining and prioritizing research and development requirements, establishing milestones and commitments, and providing status, context and guidance for initiatives related to NextGen.

OEP will provide a single entry point for new NextGen initiatives to enter the FAA capital budget portfolio. It ties these initiatives directly to our budget process, and it is the way that the FAA will implement the JPDO's vision of the future system. It will provide an integrated view of the programs, systems and procedures that are critical to transforming the system; and it will let us see them in the framework of the steps that must be taken by all FAA lines of business in order to achieve timely implementation. It also allows us to understand the near-term steps and mid-term goals that we must accomplish to sustain and improve the National Airspace System (NAS) on our way to the NextGen system of 2025.

Research is absolutely critical to FAA operations today and for NextGen. FAA has recognized this fact by proposing funding increases in R&D totaling $280 million over the next five years. These funding increases are enabled by the financing re-

forms contained in the Administration's proposal to reauthorize the FAA. Among other reforms, H.R. 1356, the *NextGen Financing Reform Act of 2007,* adopts cost-based user fees (or offsetting collections) for the costs of air traffic control services for commercial aviation users. FAA's annual spending of these user fees would be fully offset by the user fee collections. Therefore, FAA's spending would rise or fall based on FAA's costs and would not compete with any other discretionary budget priorities (as spending Trust Fund revenues do today).

The FAA uses R&D to achieve its near- and long-term goals and objectives. In the past, the R&D program was driven by the near-term operational needs of the aviation system, and a large share of the agency's R&D was focused on specific near-term safety and capacity issues. The FAA's R&D program is being adapted to be more flexible, balanced, and dynamic so we can respond simultaneously to the critical near-term needs of the system while providing for the NextGen system. The OEP is the mechanism by which the FAA will assess R&D requirements for supporting NextGen, and new initiatives will be reviewed and prioritized before inclusion in Agency budget planning.

Research and Development will help FAA achieve NextGen by identifying challenges, understanding barriers, and developing solutions across the parameters of safety, environment, air traffic management, human factors, systems integration and self-separation. To better manage our R&D program, we have developed the *National Aviation Research Plan (NARP),* which describes the FAA R&D programs that support both the day-to-day operations of the National Airspace System and the vision for NextGen. The projects identified in the NARP enable the FAA to address the current challenges of operating the safest, most efficient air transportation system in the world while building a foundation for NextGen. Research makes known the unknown. It identifies constraints and barriers, separates solutions that are effective from those that are not, and will help transform our nation's air transportation system.

Even before NextGen and the new OEP, we have not been developing our R&D goals and portfolio in a vacuum. We continually assess our research program in conjunction with our stakeholders and customers to ensure we keep our R&D resources focused on the most critical tasks. The R&D program receives expert advice and guidance from the Research, Engineering and Development Advisory Committee (REDAC). Established by Congress in 1989, the REDAC reports to the FAA Administrator on research and development issues, and provides a liaison between our R&D program and industry, academia, and other government agencies. The R&D program benefits significantly from the recommendations provided by the REDAC. The committee, its subcommittees and working groups work hand-in-hand with us to develop our R&D program. As our advisory committee members will probably tell you, one of our greatest challenges is our ability to define what the future system will look like. Of what technologies will it be comprised? JPDO has just within the last few weeks released the NextGen Concept of Operations, and in the next few months will publish the NextGen Enterprise Architecture. The significance of these documents should not be understated. They are essential to understanding the transformed operational environment; will allow us to more precisely develop a plan for achieving it; and will provide the basis for architecture-based, quantitative resource planning.

In fiscal year 2008, the FAA plans to invest a total of approximately $259 million in Research and Development. $140 million of this total is for Research, Engineering and Development (RED), which breaks down as $123 million from the Airport and Airways Trust Fund, and $17 million from the General Fund.

The RED budget request includes $91.3 million in RED for continued research on aviation safety issues. This request supports critical safety research in the areas of: continued airworthiness of aging aircraft, fire safety, advanced aircraft materials and structural safety, catastrophic failure prevention, atmospheric hazards, propulsion and fuel systems, and weather. Aviation safety research is essential to meeting FAA Flight Plan safety objectives and NextGen performance targets. The potential of the NextGen system to handle tremendous growth in air traffic compels us to maintain our vigilance in safety research. We must continue to invest in aircraft safety to reduce accident rates to insure that an increase in accidents does not accompany the increase in traffic.

An investment in safety R&D has and will continue to result in critical safety improvements for the flying public. Our scientists and engineers, for example, are developing a fire proof airline cabin, improving aviation maintenance programs, developing better weather forecasts, ensuring the safety of composite aircraft components, reducing runway incursions, and creating new, more effective ways to train pilots, controllers, dispatchers, and crews.

In addition to safety programs, RED funding includes environmental issues, wake turbulence projects, unmanned aircraft systems, and human factors studies.

As we look at the NextGen system we are working hard to ensure that we meet the increasing demand for flying in an environmentally sound manner. The focus of the environment and energy research program is making aviation quieter, cleaner, and more energy efficient—which has the added benefit of reducing climate impact. We are investing in research and development, and demonstration projects that will help us better understand aviation's environmental health and welfare impacts and bring new technologies, operational innovations, and other capabilities on line to address and reduce these impacts. In FY08 we are requesting $15.5 million in environment and energy research as well as $3 million for environment projects under the Airports Cooperative Research Program, funded under the Airport Improvement Program.

The FAA is also requesting funds to support wake turbulence research, the results of which will help us increase capacity while maintaining safety. This program provides a better understanding of the swirling air masses, or wakes, trailing downstream from aircraft wingtips. It will help us to safely reduce separation distances between aircraft, support the efficient use of closely spaced parallel runways, and allow airports to operate closer to their design capacity. FAA is requesting an increase in funding for wake turbulence research from $4 million in fiscal year 2007 to $13.7 million in fiscal year 2008, including $3 million in the ATO Capital request.

In addition, FAA is requesting funds to further research on unmanned aircraft systems. The program ensures the safe integration of unmanned aircraft systems into the National Airspace System. This research provides information to support certification procedures, airworthiness standards, operational requirements, maintenance procedures, and safety oversight activities of unmanned aircraft system civil applications and operations. FAA is requesting an increase in funds for unmanned aircraft systems research to $3.3 million for fiscal year 2008.

Human Factors projects will develop procedures, training and decision support approaches that mitigate human error while exploiting the innovation and problem-solving capacity that is the hallmark of human behavior. We will also develop system performance metrics that include people as critical elements of system performance while evaluating the impact of new technologies and procedures on human decision-making through integrated demonstrations. In fiscal year 2008, FAA is requesting $19.9M for human factors research and engineering efforts.

The R&D request includes $18 million to continue supporting the JPDO ($14.3M in RED and $3.5M in ATO Capital). As the unit that spearheads NextGen for the Federal Government, JPDO will continue defining the future operating environment, identifying demonstration opportunities, and working with the relevant agencies who will implement the JPDO vision.

$90 million in the ATO Capital account request is intended for research and development work. This includes $23 million for the R&D work at the MITRE Center for Advanced Aviation System Development (CAASD). Other requests for Capital funding include the NextGen demonstration projects. We are requesting $20 million to stage NextGen Demonstration projects that will be used to lower risk; identify early implementation opportunities; refine longer-term objectives; demonstrate compatibility with other JPDO agencies; and, if results dictate, eliminate certain concepts from further consideration.

We are requesting $28 million for research and development under the Airport Improvement Program. The two key elements of the AIP program are increasing the capacity of our nation's airports and improving the safety of aircraft operating from these airports. As the tempo of operations at our airports continues to rise, AIP research projects include the development of technologies that insure safe transit of aircraft on taxiways and runways, improved runway designs that insure the safe control of aircraft landing in ice and snow conditions, and the development of state-of-the-art crash and rescue equipment to minimize the loss of life and injury in the event of an accident. In addition to our in-house airport research, the Airport Cooperative Research Program, funded through AIP, helps us leverage outside R&D expertise by providing grants to research institutions to help us solve real-world airport safety and capacity issues.

Given expected demand growth, it is important to improve operations well in advance of 2025 so we can avoid gridlock, especially since we expect one billion passengers per year traveling in the system by 2015. With that in mind, we are conducting research to support mid-term capabilities that must be in place to address demand forecasted for that time frame. The OEP is helping us to define projects that deliver mid-term results and also provide the stepping stones to NextGen.

We believe that a timely and efficient transition to NextGen requires us to participate in concept development and validation, prototyping and field demonstrations.

Such involvement will give us in-depth understanding of required NextGen operational improvements and hasten our ability to implement NextGen systems in the National Airspace System. The President's budget request for FY08 includes an estimated $4.6 billion for NextGen investments over the next five years. That number includes increases in funding for SWIM from $21 million to approximately $52 million, while funding for NAS-wide implementation of ADS–B goes from $86 million in FY08 to an estimated $156 million in FY12.

We have been working closely with the JPDO on defining mid and long-term R&D activities that support seven solution sets that are key to NextGen: initiation of trajectory-based operations; increased arrivals/departures at high density airports; increased flexibility in the terminal environment; improved collaborative air traffic management; reduced weather impact; increased safety, security and environmental performance; and transformed/networked facilities.

Trajectory-based operations, or management by trajectory, will allow aircraft to fly trajectories negotiated with air traffic control as opposed to today's practice of managing aircraft sector by sector and requiring them to fly routes specified by air traffic control. NextGen demonstrations in fiscal year 2008 will test various aspects of trajectory-based management in the oceanic environment and demonstrate how oceanic flights using tailored routes can avoid congestion and take advantage of shorter routes.

High density airports are those where demand for runway capacity is high, there are multiple runways with airspace and taxiing interactions, or there are other airports in close proximity that create the potential for airspace interference. Airspace redesign coupled with new concept validation work will support this solution set.

Flexible terminals and airports will apply technologies that enhance both pilot and controller situation awareness and improve service on the ground. Wake turbulence research will support reduced separation standards that will contribute to this theme.

Collaborative air traffic management will consist of strategic and tactical interactions between air traffic controllers and customers. It will include flow programs as well as collaboration on procedures to shift demand to other routings, altitudes, times, etc.

Enhanced weather forecasts as well as improved use of forecasts will contribute to a reduction in weather impacts. Weather plays a critical role in air traffic congestion and delays in today's system. As much as sixty percent of today's delays and cancellations for weather stem from potentially avoidable weather situations. For fiscal year 2008 and beyond, FAA is focusing on capabilities to help stakeholders at all levels make better decisions and better react to avoidable weather situations thus minimizing their impact.

Safety, security and environment enhancements will result from deployment of new procedures and systems that support NextGen objectives. The Runway Status Lights program, for example, under our Runway Incursion Reduction funding supports this safety theme. R&D funded environment and energy programs also contribute significantly here. The estimated $4.6 billion in NextGen investments over the next five years also includes several initiatives to deal with aviation environmental issues. Historically, new technology accounts for 90 percent of environmental footprint reduction. Our prototype Continuous Descent Approach (CDA) has the double benefit of reducing noise and emissions. We are seeking to expand on this work in fiscal year 2008 and beyond to develop and prototype air traffic and ground procedures to reduce aircraft noise and fuel burn and emissions. And we are seeking to advance Environmental Management Systems by developing noise, local air quality and climate impacts metrics and decision support tools that will allow us to dynamically manage the environmental impacts of the NextGen system.

Human Factors considerations overlie all of these themes. NextGen systems will dramatically alter the roles and responsibilities of key players in the National Airspace System: pilots will take on more separation responsibilities; automation will enable air traffic controllers to manage larger numbers of aircraft while improving safety; network-enabled operations will provide broader situation awareness to stakeholders throughout the system and enable a new level of air-ground cooperation. Human factors research is needed to define the changing responsibilities of humans in the system, to allocate function to people or automation and to design automation so it serves the information needs of the people who are accountable for system performance. We are requesting funding increases in fiscal years 2008–2012 for human factors R&D in both the RE&D and ATO capital programs.

Proposed Research and Development in support of the seven NextGen solution sets will be outlined in the publication of OEP Version One in June 2007. The OEP will lay out the path from concept development to implementation in the National

Airspace System, ensuring that our R&D is indeed focused on achieving NextGen capabilities.

Our planning is also in line with the Administration's National Aeronautics Research and Development Policy published in December 2006. As outlined earlier in this testimony, we propose to conduct research in areas that support safety, the environment and air traffic management; we plan to conduct research to support certification of safety and environmental performance of aircraft systems; we are working and plan to continue to work to bring our requirements in line with NextGen; and through the OEP, we are aligning our efforts with NextGen.

To succeed in maintaining safety and ensuring sufficient capacity in the future, we do need a stable funding stream that will enable the FAA to launch the NextGen system. This is critical, as Secretary Peters stated "if we are to deploy the state-of-the-art technology that can safely handle the dramatic increases in the number and type of aircraft using our skies." As outlined in the H.R. 1356, the *NextGen Financing Reform Act of 2007,* research will be funded to allow critical safety and capacity R&D to continue at a pace necessary to field NextGen technologies by 2025. These increases in research funding are linked to and dependent on this proposal. We are enthusiastic about and focused on the opportunity to direct our R&D efforts toward the realization of the Next Generation Air Transportation System, and look forward to working with this committee to make the NextGen vision a reality.

This concludes my testimony, and I thank you for the opportunity to appear before the Committee. I would be happy to answer any questions the Committee may have.

Chairman UDALL. Thank you, Ms. Cox.

Dr. Hansman, the floor is yours.

STATEMENT OF DR. R. JOHN HANSMAN, JR., CO-CHAIR, FAA RESEARCH, ENGINEERING, AND DEVELOPMENT ADVISORY COMMITTEE; T. WILSON PROFESSOR OF AERONAUTICS AND ASTRONAUTICS AND ENGINEERING SYSTEMS; DIRECTOR, MIT INTERNATIONAL CENTER FOR AIR TRANSPORTATION, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Dr. HANSMAN. Yes. I also submitted written testimony, which I hope will go in the record.

But as a Professor, I have to have slides. So the United States has, as Ms. Cox said, the best and most efficient air transportation system in the world. This is a complex, adapted system that has evolved over the past seven years. This shows you the traffic in one day over the system.

[Slide.]

The system is being stressed by demand on the system. The blue line here shows you the North American revenue passenger kilometer trends. You can see that the demand is increasing and is expected to increase in the future.

The stress is starting to show in a couple of places. One is delays. This shows you the delay patterns over time. You can see that the delays have been building in the system. They were moderated somewhat by the attacks, the drop in traffic after September 11. The demand is back up in the system, but the other thing is, if you look at this carefully, the blue line is the month-by-month data. You can see that, starting in 1998, the system started to become marginally stable, and you can see volatility in the delays due to weather impacts and other demands on the system.

In addition, you have issues, such as fuel price, so this shows you the jet fuel price as a function of time, and you can see, over the past several years, we are at extremely high levels of fuel. Not only fuel is an issue, but also environmental. This is an example of an analysis done by the SAGE tool. One of my colleagues, Professor

Ian Wates, who is part of the partner program. This actually shows you the carbon emissions, carbon dioxide emissions from aircraft over the world. And you can see the two hotspots in the world are the United States and Europe. So there is significant concern there.

I want to go to the questions that I was asked to address.

First, is what concerns, if any, does the REDAC have about the content priorities of the FAA's R&D programs, what we would recommend to be done? In general, the REDAC has been generally supportive of the content of the programs evaluated by a number of the subcommittees. There is, as been noted earlier, concern about the declining support for the national support for aeronautics research and development both the FAA and R&D, the concern that this resulted in decline in the national capability in aeronautics and air transportation. We are also concerned about the FAA's ability to attract and retain people in emerging technology areas. Some of the examples are safety-critical software, systems engineering, data mining.

Another question was: what impact does NASA's restructuring of its aeronautics program have on the FAA's R&D program? To the extent we know, NASA's program is transition—in transition, so it is a little bit difficult to address—assess, but there is clearly a shift to more fundamental, long-term research, which is probably appropriate, but it is unclear where that is going to go, and also a shift to lower, what we call, technology-readiness levels.

So there is going to be some need to cover the short-term gap and also applied aeronautics issues, and the FAA may have to pick these up. The particular concerns in this technology maturity gap for technologies that NASA develops, they won't be taking them far enough to really field, so someone is going to have to come into the gap and figure out how to mature these technologies to the point that they are ready to go into the system. There is also concern about things that have been historical areas of excellence for NASA, such as human factors. And there are a number of databases that NASA has been particularly managing that will have to be taken over. And again, this general concern about loss of national capability in applied aeronautics. And finally, the human resources pipeline. If we are not supporting aeronautics research, it is hard to motivate faculty and students to move into these areas that are going to be critical for us in the future.

To what extent has the FAA's R&D programs been integrated? NextGen is—with the NextGen and JPDO, NextGen is still a work-in-progress. It is influencing the R&D requirements, and there have been initial implementation efforts, but there is a concern about the balance between the near-term and long-term issues.

Finally, in terms of major challenges, there are a number, but the one I really want to get to is the difficulty of us for—to actually implement technologies into the system. This is a simple model one of my students developed, looking at how technologies come into the system. The challenge we have now is these take a long time. It is typically decades to get new technologies in the system. Another thing is we have actually lost some of the national capability to do major changes in the system, because the NAS, the National Aeronautics System, has been stable for the past 40 or 50 years.

So as we contemplate major changes from the JPDO, it is not really clear that we have the safety and environmental approval process capability to rapidly implement these systems, so this is a major area of concern, and I would be happy to talk about it more later.

[The prepared statement of Dr. Hansman follows:]

PREPARED STATEMENT OF R. JOHN HANSMAN, JR.

Chairman Udall and Members of the Subcommittee:

Thank you for the opportunity to comment on the Federal Aviation Administration's research and development capability. I am a Professor of Aeronautics and Astronautics at the Massachusetts Institute of Technology and the Co-Chair of the FAA Research and Development Advisory Committee (REDAC). The REDAC is a Congressionally mandated committee which advises the FAA Administrator on research and development.

The roll of research and development in the FAA is to support current and future operational requirements as well as the agency's mission of providing a safe, secure, and efficient global aerospace system. The U.S. has the best and highest performance Air Transportation System in the world. There are, however, increasing signs that the system is under stress. Let me highlight a few examples.

The system is approaching its capacity limits at key points. As a result, due to increasing demand (Figure 1) and the highly integrated nature of the network (Figure 2), nominal interruptions, such as weather problems, result in a nonlinear increase in system delay. This can be seen in the national data shown in Figure 3 where summer delays began to amplify in 1998. Delays were subsequently moderated due to traffic reduction following the attacks of September 11, 2001. As traffic levels have returned, the overall delays have grown to record levels and expected to grow in the future. The FAA and airlines have actually done a remarkable job of minimizing delays given the limited airport and system capacity, but major weather related delay events, such as those at Denver, New York, and the problems last weekend on the east coast are further indications of system vulnerability.

Other factors stressing the system are emerging requirements for increased fuel and environmental efficiency. Aviation fuel prices (Figure 4) have, like other fuel sources, increased markedly in recent years and are likely to remain high. Environmental issues are becoming increasingly prominent internationally and at home. Concern over aviation noise continues to limit our ability to expand operations at key airports and the increased attention on global warming is driving requirements on aircraft emissions.

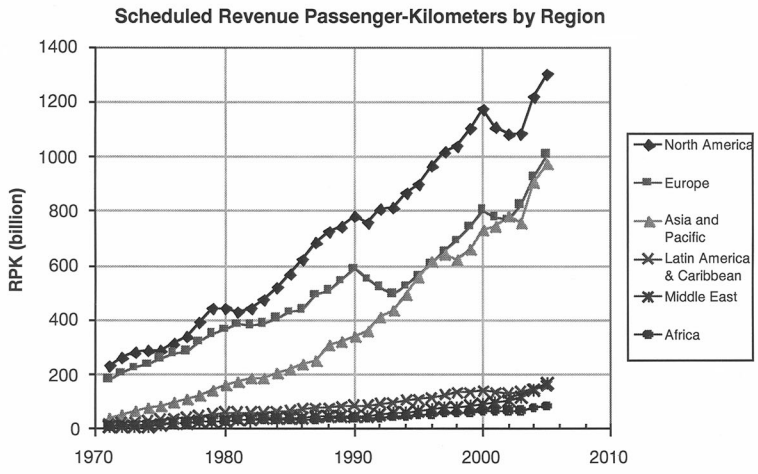

Figure 1. Passenger Demand Trends (Data Source: ICAO)

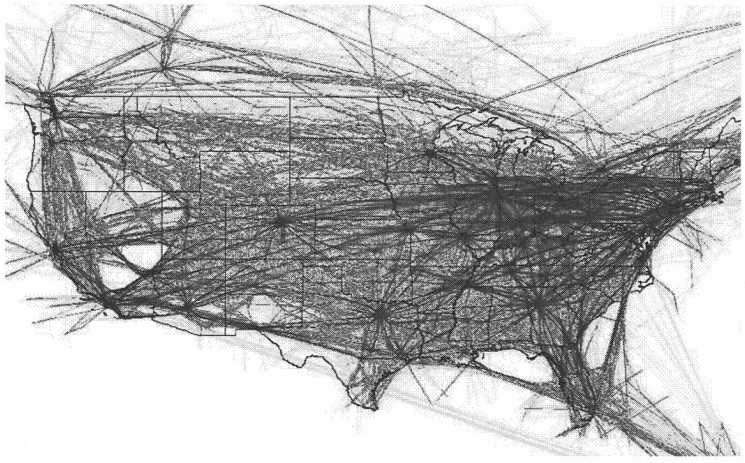

Figure 2. U.S. Air Traffic Density (Source: FAA ETMS Data)

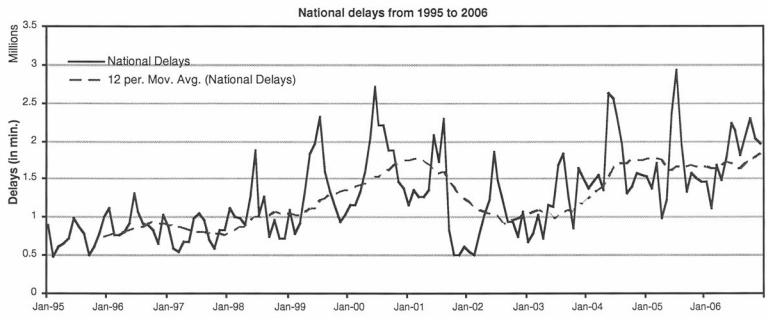

Figure 3. U.S. Delay Data (Source: P. Bonnefoy analysis FAA OPSNET)

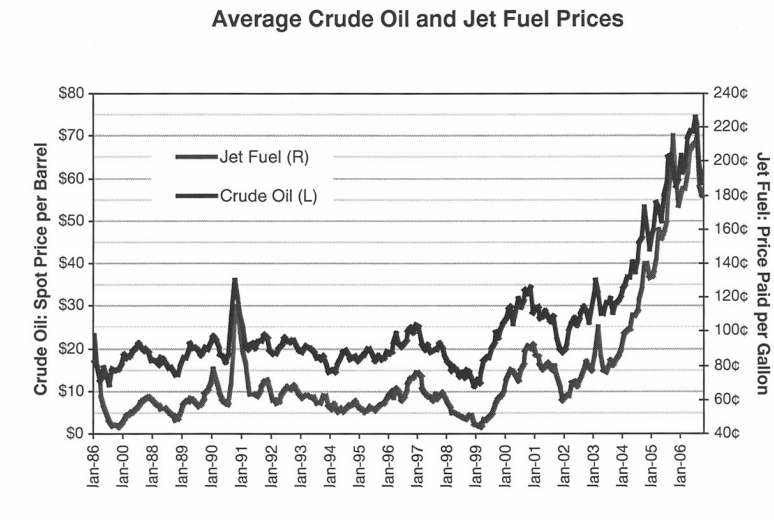

Figure 4. Fuel Price Trends (Source: ATA)

I will comment briefly on the specific questions which you have asked me to address.

What concerns, if any, does the REDAC have about the content and priorities of the FAA's R&D program, and what would the REDAC recommend be done?

The REDAC has been generally supportive of the specific content of the FAA's R&D programs given the limited resources allocated to R&D and system development. The REDAC subcommittees review the R&D programs in the areas of Airports, National Airspace System Operations, Human Factors, Environment & Energy, and Safety and generally have concurred with the FAA's R&D plans.

The REDAC has been concerned for a number of years that the declining support for aeronautics R&D both at the FAA and NASA have resulted in the decline of national aeronautics capability. In some important areas research efforts are below critical mass and others are not supported at all.

The REDAC is also concerned about the ability of the FAA to attract and retain highly skilled personnel in emerging technology areas which are important to the FAA R&D mission. Important efforts such as the Safety Management System are not as effective as they should be due to lack of intellectual capital. The REDAC has recommended the FAA increase its capability in key emerging areas such as; complex safety critical software, system engineering, and safety data mining.

What impact is NASA's restructuring of its aeronautics program having on FAA's R&D program?

The restructuring of the NASA aeronautics program has significant implications on the FAA R&D program. Over the past decade, as aeronautics research support in the U.S. has declined, the FAA and NASA have worked to integrated their research programs to avoid duplication and to cover key topics in the areas of aviation safety, aircraft technology, and air traffic control. NASA has shifted its focus to longer-term and more fundamental aeronautics research and developing a core knowledge base. While this is a reasonable strategy given their limited resources it will be incumbent for the FAA or some other agency to cover shorter-term and applied civil aeronautics issues which NASA had previously addressed. It should be noted that this has been a difficult area to assess as the NASA program has been in transition and it is still not fully clear what the full content of the NASA's program will be and it's consequent impact on the FAA.

There are, however, several areas of concern. One is the technology maturity gap problem. As NASA has limited its focus on lower Technology Readiness Levels (basic research and technology feasibility) the FAA will have to pick up more responsibility for moving key technologies for the NAS through the mid TRL levels (development and demonstration). This will be in addition to the FAA's normal efforts at high TRL level system integration. The REDAC, among others, have highlighted this issue and the FAA has proposed several efforts to address the TRL gap. In some areas (e.g., Environmental) the technologies will benefit both industry and government so the FAA has been able to propose cooperative agreements with industry such as the Research Consortium for Lower Energy, Emission, and Noise Technology Partnership. In other areas (e.g., Air Traffic Management and Safety Analysis) the FAA will be the primary technology user and will have to manage the higher TRL level efforts. This will require resources and will likely be a significant challenge for the FAA.

Another area of concern is the maintenance of aviation safety and human factors databases developed through long-term NASA efforts. Through the Aviation Safety and Reporting System (ASRS) and several human factors field studies, NASA has developed several databases which are national assets and relied on by the FAA and other aviation safety researchers. If NASA does not continue to support these databases it will be necessary to protect these resources.

Finally there is the issue of nurturing and maintaining the national capability in applied aeronautics. It is important for the FAA and NASA to work together to encourage and enable the next generation who will move the system forward. There are some notable successes such as the FAA Centers of Excellence and the recent NASA NRA program. However, the general decay in aeronautics research coupled with re-structuring uncertainty has had an adverse impact on university programs and the pipeline of young talent attracted to solving the challenges which the FAA will face.

To what extent has FAA's R&D program been integrated with the needs of the JPDO, and is that an appropriate level of integration?

To the extent that the JPDO has been able to define near-term operational and R&D requirements the FAA has begun to integrate them into its plans. Examples include the initial implementation of ADS–B and System Wide Information Management (SWIM) as well as increased FAA support for environmental programs. However, the NextGen system is still a work in progress and is not sufficiently defined to drive a majority of the FAA R&D programs. In addition, as the JPDO is focused on longer-term transformational concepts, there is a tension between those needs and the R&D required to address nearer-term issues and to manage the system.

What are the major challenges facing the FAA's R&D program over the next five years?

Building and maintaining the intellectual capability in the FAA as well as supporting R&D organizations, balancing both near-term and long-term (NextGen) issues, and finding the resources to excel will be challenges.

However, I believe that the major challenge for the FAA R&D program and the agency as a whole will be to find ways to efficiently and quickly implement the tech-

nologies, and new operational concepts into the NAS while maintaining or increasing level of safety and minimizing environmental impact. This will be necessary to support both near-term and NextGen system transitions. It is unclear if we have the strategic core competency to effectively implement the new concepts in the NAS and we must develop approaches to enable effective transition.

Figure 5 depicts a simple model of change and system transition in the NAS (developed by one of my students Aleksandra Mozdzanowska) which illustrates this point. Change can be motivated by safety, capacity, efficiency, environmental or other concerns and we often focus R&D on the technology or operational concept aspects indicated on the right side of the figure. However, success will be determined by how well we can implement and develop system capability as indicated on the left side of Figure 5. The time constant for implementation can be very long and most major system changes have historically taken decades.

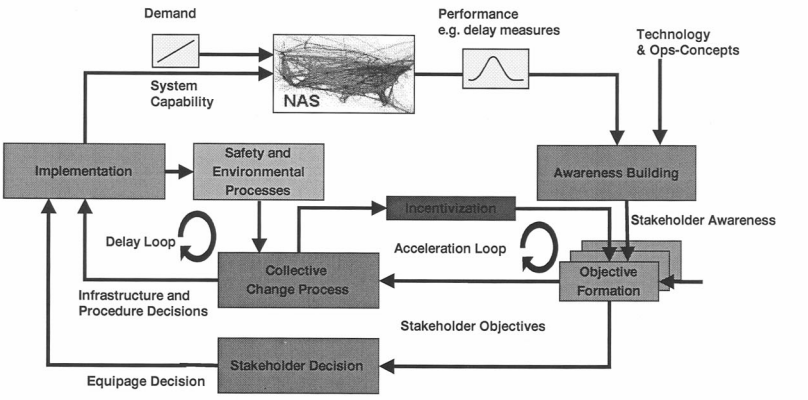

Figure 5. Simple Model of NAS System Transition.

As our expectations for safety and environmental impact have increased, the safety and environmental standards have risen and these can be significant barriers to implementation. Many of the standards post date the basic technical and operational structure of the NAS which has been fairly stable for the past 30 to 50 years. As a consequence there is very little experience in making the type of major system changes envisioned in the NextGen operational concepts, procedures, and capabilities, particularly those which simultaneously require air and ground system changes.

Given the number and complexity of expected operational capabilities envisioned over the next five to 10 years the FAA will need to develop new approaches to program management, safety and environmental analysis, as well as efficient processes for operational approval which ensure that safety, environmental, schedule, and cost goals are met.

Chairman UDALL. Thank you, Doctor.

Dr. Wuebbles, the floor is yours.

STATEMENT OF DR. DONALD J. WUEBBLES, CHAIR, WORKSHOP ON THE IMPACTS OF AVIATION ON CLIMATE CHANGE; DEPARTMENT HEAD AND PROFESSOR, DEPARTMENT OF ATMOSPHERIC SCIENCES; EXECUTIVE COORDINATOR, SCHOOL OF EARTH, SOCIETY, AND ENVIRONMENT, UNIVERSITY OF ILLINOIS AT URBANA–CHAMPAIGN

Dr. WUEBBLES. Thank you, Mr. Chairman.

Let me first start by—I have a written statement, but even though I am a professor, I am going to actually read my statement instead of using slides.

Chairman UDALL. Doctor, you should turn on your mike or bring it closer.

Dr. WUEBBLES. Okay. Thank you.

Good morning, Mr. Chairman, and Members of the Committee. My name is Don Wuebbles. I am a professor of atmospheric sciences and Director of the School of Earth, Society, and Environment at the University of Illinois-Urbana Champaign.

Thank you for the invitation to testify in support of a new research agenda in the United States for understanding the impact of aviation on the Earth's climate.

In June 2006, I organized and chaired a workshop on the impacts of aviation on climate change that was developed in coordination with the Federal Aviation Administration. The findings from the international panel of experts participating in that workshop are the basis for my statement.

The 2004 report to Congress from the Partner Center for Excellence at MIT indicated that the most serious, long-term environmental issue facing the aviation industry may be the effect of aviation emissions on climate, both because of potential impacts, and also because of the lack of understanding of the issues.

Projections from industry and from governmental organizations, including the FAA, suggested that over the next two decades, the demand for aviation could grow to three times its present level. This projected growth will likely result in increased impacts from aviation on the environment. One important concern is aircraft influence released at cruise altitudes that interact with background atmosphere and undergo complex processes, resulting in potential impacts on climate.

Our workshop examined the current state of scientific knowledge about the effects of aviation on climate, identified key uncertainties and gaps, and determined further research needs.

I will describe some of the findings and what is still unclear, but the bottom line is that because of potentially serious implications of aviation influence on our planet, further research, and funding for that research, are imperative.

Aviation contributes about two percent of the global human-related emissions of carbon dioxide. As a result of policies to reduce other human-related emissions, this percentage could increase in the future. The climate effects from the emissions of carbon dioxide are much better known than the effects from other aviation emissions, particularly the effects resulting from nitrogen oxide emissions on atmospheric ozone and methane, the effects from emitted aerosols and aerosol pre-cursors, and the climate effects associated with contrail and cirrus cloud formation. The scientific understanding of those effects range from fair to poor, very poor.

The estimates of climate impacts due to contrail and contrail-induced high-altitude cirrus clouds are especially uncertain. Contrails form if ambient air along the flight track is colder and moister than the threshold based on known thermodynamic grandeurs that are currently not well characterized at cruise altitudes. In high, supersaturated air masses, contrails can organize themselves in clusters that add significantly to the natural high cloud cover that can affect climate. The workshop recommended new, carefully-coordinated, regional-scale measurement campaigns along with proc-

ess studies and laboratory studies towards understanding the factors affecting the growth, decay, and trajectories of contrail ice particles and determine resulting effects on cirrus, including the role of aerosols.

The workshop also found much better—that much better approaches are needed for comparing relative effects of all aviation emissions on climate, particularly to place those effects on a common scale for assessing the overall climate impact and to quantify the potential trade-offs on the climate impact due to aircraft technology, aircraft operations, and various policy scenarios. For example, should the aviation community emphasize increased energy efficiency, thus reducing emissions of carbon dioxide, are policies to reduce formation of contrails and effects on cirrus clouds.

This is an important consideration for national and international policy. Some in Europe are advocating action without adequate analysis, which could lead to bad, unintended consequences.

As a key conclusion, the workshop participants acknowledged an urgent need for aviation-focused research activities to provide better science-based understanding of the impacts of aviation emissions on climate change. We need improved metrics, measurement techniques, and modeling capabilities to quantify and predict impacts and to understand the interrelationships of aviation and environmental factors.

This effort will entail coordination with existing and planned climate research programs within government agencies and could be organized through expansion of such programs or by totally new activities. The workshop participants indicated that such efforts should include strong and continued interactions among the science and aviation communities as well as among policymakers to develop well-informed decisions.

The next steps required include further ranking and prioritizing of identified research needs, creating a research roadmap with associated roles and responsibilities of various participating agencies and stakeholders, and identifying resources needed to implement the roadmap.

The FAA has already taken some steps to make resources available. There is funding allocated to these efforts in the fiscal year 2008 President's budget starting in fiscal year 2009; however, one agency cannot do it alone. This should be a focus of the U.S. Climate Change Science Program. The need is immediate. We need scientific focus and resources in the United States to pursue aviation climate impact research to put us in a position to make smart decisions for the NextGen aviation system and to allow us to shape the international debate with the International Civil Aviation Organization and other forums.

Thank you.

[The prepared statement of Dr. Wuebbles follows:]

PREPARED STATEMENT OF DONALD J. WUEBBLES

The Need for New Research to Address the Impacts of Aviation on Climate Change

Good morning Mr. Chairman and Members of the Committee.

My name is Don Wuebbles. I am a Professor of Atmospheric Sciences and Director of the School of Earth, Society, and Environment at the University of Illinois at Urbana-Champaign.

Thank you for the invitation to testify today about the need for a new research agenda in the U.S. for understanding the impacts of aviation on the Earths' climate system. In June 2006, I organized and chaired a workshop on the impacts of aviation on climate change that was developed in particular coordination with the Federal Aviation Administration. This workshop was sponsored jointly by the U.S. Next Generation Air Transportation System (NGATS) Joint Planning and Development Office Environmental Integrated Product Team JPDO/EIPT and Partnership for AiR Transportation Noise and Emissions Reduction (PARTNER) Center of Excellence. The resulting findings from the international panel of experts participating in that workshop are the basis for my statement.

A 2004 report to Congress from the PARTNER Center for Excellence at MIT indicated that the most serious long-term environmental issue facing the aviation industry may be the effects of aircraft emissions on climate—both because of potential impacts and also the lack of understanding of the issues. Projections from industry and from governmental organizations, including the FAA, suggest that over the next two decades, the demand for aviation could grow to about three times its present level. This projected growth will likely result in [higher aviation emissions of various pollutants and associated] increased impacts from aviation on the environment, and human health and welfare. [These effects are dependent upon a variety of factors (such as the size and mix of the operational fleet necessary to meet the stated demand as well as mitigation steps such as new technological advances, more efficient operational procedures, market based options and regulatory intervention).] One of the most important concerns is the potential impact of emissions on the climate. Once released at cruise altitudes [within the upper troposphere and lower stratosphere], the aircraft effluents interact with the background atmosphere and undergo complex processes, resulting in potential impacts on the Earth's climate system.

Our workshop examined the current state of scientific knowledge about the effects of aviation on climate, identified key uncertainties and gaps, and determined further research needs. I will describe some of our findings and what is still unclear. *But the bottom line is that because of the potentially serious implications of aviation effluents on our planet, further research and funding for that research are imperative.*

In agreement with earlier studies [e.g., the 1999 assessment by the international science community through the Intergovernmental Panel on Climate Change (IPCC)], the workshop concluded that the major ways that aviation can affect climate are the direct effects from aircraft emissions of the important greenhouse gas carbon dioxide (CO_2) (and, to a much lesser extent, water vapor), the indirect forcing on climate resulting from changes in the atmospheric distributions and concentrations of ozone and methane as a primary consequence of aircraft nitrogen oxide emissions, the direct effects (and indirect effects on clouds) from emitted aerosols and aerosol precursors, and the climate effects associated with contrails and cirrus cloud formation.

Aviation contributes about two percent of the global human-related emissions of carbon dioxide. As a result of policies to reduce other human-related emissions, this percentage could increase in the future. The climate effects from aviation emissions of carbon dioxide are much better known than the effects from other emissions. This workshop agreed with prior assessments that the level of scientific understanding to estimate climate response due to aviation emissions other than carbon dioxide ranges from fair to very poor.

The potential importance of aircraft nitrogen oxide emissions on the atmospheric concentrations of ozone is well recognized. Aviation perturbed ozone levels can also affect the amounts of methane, another important greenhouse gas. However, the workshop determined that important uncertainties remain in our understanding of these effects. The workshop recommended new detailed inter-comparisons of current models of atmospheric physics and chemistry relative to the existing database of measurements of key atmospheric gases and particles. Also, participants recommended expanding the analysis of the wealth of data already measured from aircraft and satellite platforms with a focus on the atmospheric regions perturbed by impacts of aviation emissions. In the longer-term, there is a need for new field campaigns to better understand the physical and chemical processes in these regions.

The estimates of climate impacts due to contrail and contrail-induced formation of high-altitude cirrus clouds are especially uncertain. Contrails form if ambient air along the flight track is colder and moister than a threshold based on known thermodynamic parameters that are not well characterized at cruise altitudes. Early

contrail evolution depends, in poorly understood ways, on aircraft and engine emission parameters. In ice-supersaturated air masses, contrails can organize themselves in regional-scale clusters that add significantly to the natural high cloud cover and have the potential, albeit with large uncertainties, for a relatively large effect on climate. Factors controlling the climate effects of cirrus clouds and contrail-cirrus (e.g., ice crystal habit, vertical profiles of ice water content, effective radius) are poorly constrained by existing observations. The extent of global distribution of supersaturation at cruise altitudes has not been adequately verified to enable its reliable prediction.

Workshop participants discussed many uncertainties and knowledge gaps related to aircraft emissions of aerosols, their role in plume evolution, interaction with the background atmosphere and the formation of high altitude cirrus clouds. The magnitude of the atmospheric impact depends on details of plume processing and on the relative ability of background aerosol particles to act as ice-forming nuclei. It was also noted that models do not adequately treat the radiative properties of cirrus, thus limiting their abilities to study contrail-cirrus cloud interactions. Large uncertainties also exist as to how properties of ambient aerosols are perturbed in the presence of jet engine emissions under various atmospheric conditions and aircraft configurations.

The workshop recommended new carefully coordinated regional-scale measurement campaigns to measure the factors affecting the growth, decay, and trajectories of contrail ice particle populations, and to define the abundance and properties of ambient aerosols as well as gaseous aerosol precursor concentrations. Process studies that explore the role of emitted aerosol particles, and how volatile aerosols interact with each other and with background aerosols, are required to understand the effect of emitted aerosol particles on cloudiness. Laboratory measurements are also urgently needed to develop improved aerosol-related parameterizations of heterogeneous ice nucleation for use in atmospheric models.

The Workshop also found that much better approaches are needed for comparing relative effects of all aviation emissions on climate, particularly to place these effects on a common scale for assessing the overall climate impact, and to quantify the potential trade-offs on the climate impact due to changes in aircraft technology, aircraft operations and various policy scenarios. For example, should aviation emphasize increased energy efficiency, thus reducing emissions of carbon dioxide, or policies to reduce formation of contrails and effects on cirrus clouds? There is no published study that utilizes the current understanding of the impact of aviation emissions on atmospheric composition to examine the possible choices, dependencies, and problems for evaluating aviation trade-offs. This is an important consideration for national and international policy—some in Europe are advocating action without adequate analysis—which could lead to bad unintended consequences.

Conclusions

As a key conclusion, the workshop participants acknowledged an urgent need for aviation-focused research activities to address the uncertainties and gaps in the understanding of current and projected impacts of aviation on climate and to develop metrics to better characterize these impacts. This effort will entail coordination with existing and planned climate research programs within government agencies, and could be organized through expansion of such programs or by totally new activities. The workshop participants indicated that such efforts should include strong and continuing interactions among the science and aviation communities as well as among policy-makers to develop well-informed decisions. The next steps required include further ranking and prioritizing of identified research needs; creating a research roadmap with associated roles and responsibilities of various participating agencies and stakeholders; and identifying resources needed to implement the roadmap.

The FAA has already taken some steps to make resources available—there is funding allocated to these efforts in the FY08 President's Budget starting in FY09. However, one agency cannot do it alone—this should be a focus for the U.S. Climate Change Science Program. We need better science-based understanding of the impacts of aviation emissions on climate change. We need improved metrics, measurement techniques, and modeling capability to quantify and predict impacts and to understand inter-relationships of aviation environmental factors. This is not a "science project"—the need is immediate. Decisions, with broad policy implications, such as the European Emissions Trading Scheme are being made without a firm understanding of the underlying science. We need scientific focus and resources in the U.S. to pursue aviation climate impact research—to put us in a position to make smart decisions for the NextGen aviation system and to allow us to shape the international debate within the International Civil Aviation Organization and other fora.

BIOGRAPHY FOR DONALD J. WUEBBLES

Don Wuebbles is Executive Coordinator (Director) of the new School of Earth, Society, and Environment at the University of Illinois. He is also a Professor in the Department of Atmospheric Sciences as well as in the Department of Electrical and Computer Engineering. Dr. Wuebbles was Head of the Department of Atmospheric Sciences from 1994 until 2006 before accepting the new position. He was also the first Director of the Environmental Council at the University of Illinois, from 1996 until August 1999; as Director, he was responsible for oversight and development of all educational and research programs at the University of Illinois relating to the environment. Don earned his B.S. (1970) and M.S. (1972) degrees in Electrical Engineering from the University of Illinois. He received his Ph.D. in Atmospheric Sciences from the University of California at Davis in 1983. Don spent many years as a research scientist and group leader at the Lawrence Livermore National Laboratory before returning to the University of Illinois in 1994. He is the author of about 400 scientific articles, most of which relate to atmospheric chemistry and global climate change as affected by both human activities and natural phenomena. His research emphasizes the development and use of mathematical models of the atmosphere to study the chemical and physical processes that determine atmospheric structure, aimed primarily towards improving our understanding of the impacts that man-made and natural trace gases may be having on the Earth's climate and on tropospheric and stratospheric chemistry. He has been a lead author on various national and international assessments related to these issues, including chairing a recent international workshop on the potential impacts of aviation on climate.

Chairman UDALL. Thank you, Dr. Wuebbles.

And now we turn to Mr. Alterman. The floor is yours for five minutes.

STATEMENT OF MR. STEPHEN A. ALTERMAN, PRESIDENT, CARGO AIRLINE ASSOCIATION; CHAIRMAN, ENVIRONMENT SUBCOMMITTEE, FAA RESEARCH, ENGINEERING, AND DEVELOPMENT ADVISORY COMMITTEE

Mr. ALTERMAN. Thank you very much, Mr. Chairman and Members of the Committee.

My name is Steve Alterman, and I am the President of the Cargo Airline Association, the association that represents those carriers that fly only freight. I also have the honor as serving as the Chairman of the Environmental Subcommittee of the FAA's REDAC Committee. Thanks for the opportunity to be here today.

Initially, I think it is important for everyone in Congress to understand the critical importance of research and development to the industry as we move toward a new paradigm in aerospace management. As a practical matter, today's R&D forms the basis for tomorrow's operational products, and any delay in this element of work has significant negative long-term effects. All too often, this component of the modernization equation is overlooked in the contentious debate over financing. It should not be.

Over the past decade, our industry segment has worked closely with the FAA and various portions of the research and development portfolio, from the development of Automatic Dependent Surveillance Broadcast, it is a terrible acronym, but it is a wonderful product, it is called ADSB, to the balancing of environmental sensitivity to—with the needs of the traveling and shipping public. If we were to learn one thing from these efforts, it is that there must be a firm commitment from both industry and government to the necessary research and the transition from the research mode to one of implementation. I couldn't agree with John Hansman more about the challenge of implementing once we get the research done. I think it is a key point.

Put somewhat differently, the FAA research and development effort must be a true partnership with each participant being willing to support the other. From an industry perspective, we need to do not only the scientific elements of the project, but we need to understand both the cost and benefits to the industry and the government as we do this.

I am not going to go into the NASA funding debate other than to tell you that industry has as much concern over it as Congress seems to have and the rest of the panelists have. we think it is very unfortunate, the reprioritization of their efforts, and we need to figure out—either get that back on track or work around so that we can get the necessary research done.

I would like to concentrate this morning, in my time left, on three separate issues. One is the—our involvement with the ADSB technology that the FAA has identified as the building block of future surveillance in the NextGen system. We started working on this about 11 years ago, trying to develop a new collision-avoidance system to replace TCAS. We were ahead of our time, and haven't succeeded in that yet, but we realized, in working with the technology, that it had much broader application. And we think that providing better and more timely information to both cockpit crews and controllers, we can move forward with the modernization effort. It is an essential building block. We work closely with the FAA Safe Flight 21 office in this effort, both with surface management systems to try to work on the safety on the ground and potentially airborne applications, using the ADSB technologies. Our members, Fed-Ex and UPS have been involved at both Memphis and Louisville with trials and working together with the FAA.

In addition, a companion project in the State of Alaska was demonstrating the benefits of ADSB technology to the general aviation community. And I think all of us in the industry, and I think I can speak for all of us, absolutely support those efforts.

The FAA has recognized this by actually making that announcement and forming a program office within the agency to implement ADSB.

What have we learned in this process? Well, first, we wanted to—things take too long. I think that Mr. Hansman is correct. I hate to keep agreeing with him, but things take too long. To a large extent, delays are inherent in any process that requires the involvement of a massive bureaucracy, but there must be ways to accelerate R&D efforts that are for the potential for significant improvements.

Second, you know, research and development may, in fact, be the easy part. As a colleague from Federal Express noted early in the project, "This ain't no science project." Our industry has invested over $100 million of our own money in the ADSB technology effort alone. We need to see it implemented, not just studied.

The second area of research in which the cargo industry has participated involves the development of new operational procedures. I think this is important, because, as we talk about the complicated technology challenges of the future, there are certain low-tech cousins of those technologies that could help in the near-term. Operational procedures is one of those, and we have been working closely with the FAA on a program called Continuous Descent Arrivals,

with UPS being the demonstrating company, which has showed that we get not only operational benefits: less fuel burn, environmental benefits, and safety benefits, and we are in the process now of figuring out how to take what we learn in Louisville and migrate that to the rest of the country.

Finally, perhaps the most aggressive area of FAA research and development is in the environmental area. We absolutely support what is being done there, and I know my time is up, but I will just simply say that I know you are studying the fiscal year 2008 budget. Those funds are necessary, but they are necessary, in large part, as a basis for the efforts that are contained in the FAA's reauthorization proposal. As an industry, we absolutely support the section 600 provisions in those—in that bill that would do more environmental research and provide environmental demonstration programs and research programs.

That concludes my oral statement. I would be happy to answer any questions.

Thank you.

[The prepared statement of Mr. Alterman follows:]

PREPARED STATEMENT OF STEPHEN A. ALTERMAN

Good morning. My name is Steve Alterman and I am the President of the Cargo Airline Association, the nationwide organization representing the interests of the all-cargo air carrier industry, as well as other businesses and entities with a stake in the all-cargo supply chain. (A list of current members is attached). I also have the honor of serving as the current Chairman of the Environmental Subcommittee of the FAA's Research, Engineering and Development Advisory Committee (REDAC). Thank you for the opportunity today to present some industry thoughts on FAA R&D efforts.

Initially, I think it is important for Congress to understand the critical importance of research and development as we move toward a new paradigm in airspace management. As a practical matter, today's R&D forms the basis for tomorrow's operational products, and any delay in this element of work has significant negative long-term effects. All too often, this component of the modernization equation is overlooked in the contentious debate over future system funding. It should not be.

Over the past decade, our industry segment has worked closely with the FAA on various portions of the research and development portfolio, from the development of Automatic Dependent Surveillance–Broadcast (ADS–B) capabilities to the balancing of environmental sensitivity with the needs of the traveling and shipping public. If we have learned one thing from these efforts, it is that there must be a firm commitment from both industry and government to both the necessary research and the transition from the research mode to one of implementation. If either side breaks down, useful projects may be doomed.

Put somewhat differently, the FAA research and development effort must be a true partnership—with each participant willing to support the other. From the industry perspective, the research should include, not only the scientific elements of the project, but also an analysis of the benefits and costs to both government and industry.

Another preliminary point worth noting is that recent "re-prioritizing" of NASA research to concentrate on space missions, and downgrade aeronautics activities, has seriously affected the FAA research effort. In order to compensate for the decrease in NASA activity, it is vitally important that the FAA R&D budget be increased to permit needed research to be undertaken in a timely fashion.[1]

Moving to more specific aspects of the FAA R&D program, I would like to concentrate on three separate areas of activity, all of which contain valuable lessons.

- The Cargo Airline Association's involvement with ADS–B technology began over 11 years ago when member companies were searching for a collision avoidance alternative to the radar-based TCAS system. While we were not successful in developing this new capability (I think we were ahead of our

[1] In the alternative, NASA aeronautics research funding should be restored to former levels, with specific Congressional guidance on how the money should be spent.

time), we soon realized that the technology held promise for projects over and above airborne collision avoidance. Providing better and more timely information to both cockpit crews and controllers, both in the air and on the ground, appeared to be a realistic goal. Working with the newly-formed FAA Safe Flight 21 Office, all-cargo airlines developed both new Surface Management Systems and potential airborne applications using ADS–B technology, with test-beds established both in Louisville, Kentucky and Memphis, Tennessee. In addition, a companion project in the State of Alaska, Project Capstone, demonstrated the operational and safety benefits of ADS–B technology to the General Aviation community.

Over the years, it became obvious to all those involved in these research and development efforts that ADS–B would have a central place in any modernized air traffic system. And the FAA agreed. In December 2005, the agency announced that ADS–B would form the basis for future system surveillance. To facilitate this transition, the FAA also announced that a new ADS–B Program Office would be formed to provide the implementation vehicle. Today, this Office is in the process of laying the groundwork for the purchasing and installing the ground stations necessary for initial ADS–B applications.

While this progress is certainly encouraging, we cannot stop there. Plans must be made for future improvements involving air-to-air ADS–B applications—applications that will provide significant benefits to commercial aviation users. The research necessary for such improvements must be done now if we expect implementation in a timely manner. The House of Representatives recognized this need in its proposed Fiscal Year 2007 Appropriations package wherein it added $20 million to the Administration's $80 million budget request for ADS–B development and specified that the extra $20 million be spent on air-to-air application development.[2]

What have learned in the course of this process? First, things take too long. To a large extent, delays are inherent in any process that requires the involvement of a massive bureaucracy, but there should be ways to accelerate R&D efforts that have the potential for significant airspace improvements. Second, research and development may in fact be the easy part. As a colleague from Federal Express noted early in the ADS–B development process, "This ain't no science project!" Indeed, we must have the resources and leadership to transform the research into products for the National Airspace System. We cannot let either industry or government inertia overwhelm these efforts.

- The second area of research in which the all-cargo industry has participated involves the development of new operational procedures. These procedures are the low-tech cousins of technological improvements and possess the promise to provide near-term benefits while longer-term solutions to problems are being developed. Specifically, one of our members, UPS Airlines, has been working cooperatively with the FAA on the concept of Continuous Descent Arrivals (CDAs), an operational procedure that provides more efficient vertical profiles in the landing process. To test the viability of such arrivals, nighttime operations at Louisville were selected since UPS provides the overwhelming majority of operations. The results have been encouraging, with the airline experiencing more efficient operations and significant fuel savings and the public enjoying the measurable environmental benefits of less noise and aircraft engine emissions. The challenge now is to migrate the Louisville experience into "mixed environments" where many different airlines operate in high density airspace. These tests are currently in the planning stages. Of course, after all the research is completed, and all the necessary data collected, the ultimate goal will be to incorporate these procedures into the national airspace system. Again, this effort will require both industry and government involvement and cooperation. The major challenge for the airline community is to adequately quantify and understand both the costs and benefits of the modified flight procedures and then to work cooperatively with the agency and controller communities to ensure a smooth, safe transition to the new flight procedures.[3]

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[2] These funds were never actually appropriated since no Transportation Budget was ever enacted for FY 2007 and we are now operating under a Continuing Resolution.

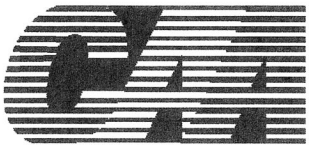
[3] In order to give the Subcommittee more detail on this initiative, attached hereto is the testimony of Captain Karen Lee of UPS Airlines before the Senate Aviation Operations, Safety and Security Subcommittee on March 22, 2007.

- Perhaps the most aggressive area of FAA research and development is in the area of environmental issues confronting the industry and the Nation. To put this challenge in perspective, the FAA, in the context of the ongoing JPDO activity, has established a goal of reducing noise and emissions in absolute terms, by the year 2025, notwithstanding an expected major leap in air traffic. This ambitious program depends on a robust research and development effort and we are encouraged by, and support, the initiatives set forth in sections 601 *et seq.* of the FAA's proposed *Next Generation Air Transportation System Financing Reform Act of 2007.* These proposals include environmental mitigation demonstration pilot programs (section 604); airport grant eligibility for assessment of advanced flight procedures to mitigate noise (section 605); and the establishment of a research consortium within the existing PARTNER Center of Excellence to address advanced engine and airframe technology.

  Finally, with respect to the specific issue of how to address the issue of aviation's impact on climate change, we respectfully suggest that R&D challenges be funneled through the existing PARTNER Center of Excellence. This university-based consortium is the best forum for analyzing the complicated issues inherent in any discussion of climate change and aviation's contribution to it.

In summary, it is clear to the all-cargo industry that a robust FAA research and development program is absolutely essential if we are to meet the future goals of modernizing the airspace system and providing the capacity needed to serve passengers and shippers worldwide. We believe that the agency has established a strong track record in this area and we are committed to working with all parties to this process in the coming years. If there is any word of caution, it is that we cannot let the bureaucracy delay the implementation of those projects that prove, in the research and development phase, to be beneficial.

Thank you very much.



THE CARGO AIRLINE ASSOCIATION
The Voice of the Air Cargo Industry

MEMBERSHIP LIST

ALL-CARGO AIR CARRIERS

* ABX Air, Inc.	Wilmington, OH
* Atlas Air, Inc.	Purchase, NY
* FedEx Express	Memphis, TN
* United Parcel Service	Louisville, KY
* Air Transport International	Little Rock AR
Capital Cargo International	Orlando, FL
DHL Express	Miami, FL
First Air	Gloucester, Canada
Kalitta Air	Ypsilanti, MI
Kitty Hawk Inc.	Dallas, TX
USA Jet Airlines, Inc.	Belleville, MI

AIRPORT ASSOCIATE MEMBERS

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Louisville International Airport	Louisville, KY
Memphis-Shelby County Airport Authority	Memphis, TN
New Orleans International Airport	New Orleans, LA

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HEARING BEFORE THE SENATE COMMERCE COMMITTEE

SUBCOMMITTEE ON AVIATION

FEDERAL AVIATION ADMINISTRATION (FAA) MODERNIZATION

MARCH 22, 2007

TESTIMONY OF KAREN LEE

DIRECTOR OF OPERATIONS, UPS AIRLINES

Chairman Rockefeller, Senator Lott and Members of the Committee, my name is Karen Lee and I am Director of Operations at UPS Airlines. Thank you for the opportunity to testify this morning on air traffic modernization and what we at UPS have been doing over the last 10 years with Automatic Dependent Surveillance-Broadcast (ADS–B). We believe that modernization of our current aviation system should be the major priority in the FAA Reauthorization this year. Our efforts on ADS–B demonstrate the benefits that modernization will provide.

UPS has been committed to the development and implementation of ADS–B systems and applications for over 10 years. ADS–B is a satellite-based surveillance technology that allows each aircraft to broadcast information about itself such as position, speed and altitude. It does this continuously, as often as once per second, and this surveillance information is available to any user equipped to receive and display it.

UPS, along with the Cargo Airline Association, first became involved with ADS–B in 1996 as a potential means of meeting collision avoidance requirements. Although we ultimately installed T–CAS in order to meet those requirements, our early work with ADS–B demonstrated many potential benefits, such as improved efficiency and safety, as well as environmental benefits. As a result, UPS continued its work on the technology.

Use of ADS–B technology creates a new level of safety and redundancy in our airspace system since pilots will now be able to see the traffic around them and controllers will have surveillance data that is much more accurate and timely than they have today. There are many applications that are enabled when aircraft are equipped to see other aircraft. Many of those applications create opportunities to make aircraft operations safer and more efficient while reducing noise and emissions.

ADS–B is now recognized as the foundation of the Next Generation Air Traffic System. Administrator Blakey has been a strong proponent of ADS–B and has been very supportive of the efforts we have undertaken at our international air hub in Louisville, Kentucky.

There are two basic scenarios in which ADS–B surveillance can be very beneficial. The first is in geographic areas that do not have radar surveillance. ADS–B surveillance information can be provided from the aircraft to air traffic controllers through inexpensive ground receiving stations and shown on a display that looks exactly like a radar display. Controllers use the ADS–B surveillance data exactly the same way they would use radar information; it just comes to them directly from the aircraft.

You are probably familiar with the FAA Capstone project in Alaska where more than 250 light aircraft are equipped to broadcast ADS–B position information. Using ADS–B, Alaska has reduced its accident rate by 47 percent and has done so in areas that radar could not be installed because of rugged terrain.

The second scenario is in high density airspace. Let's use Louisville as an example. During the UPS rush hour, from 11:00 at night until 1:30 in the morning, we can land 47–52 aircraft per hour. We should be able to land 60–62 aircraft per hour in most weather conditions. Our inability to do so represents a loss of capacity and efficiency that costs us millions of dollars every year.

Our traffic arrives somewhat randomly and the flow and sequence of arriving aircraft is unpredictable. The enroute center directs our aircraft into the terminal area as they arrive from all directions and the approach controllers then must organize and sequence the aircraft to line up for final approach. Our flights end up "driving" around at low, highly inefficient altitudes while waiting for their turn for landing—sometimes flying 60 or 70 miles to travel the last 40 miles of flight.

In addition, due to high controller workload and lack of shared traffic information with our pilots, our flights arrive at the runways with very uneven spacing. If you were to stand at the end of the runway and measure the time between landing aircraft, you would find a high level of variation—90 seconds, then 105 seconds, then 80 seconds, then 180 seconds and so on. What we really need is 95 seconds, 95 seconds, 95 seconds (or the appropriate time interval for the night's conditions—it is variable). Anything more than that interval is loss of capacity. And because our air-

craft arrive somewhat randomly and unpredictably and all under radar vectors, they are scattered over a wide area as they enter the terminal area—making the controller's job that much more difficult to get us organized and lined up.

This is very similar to every busy airport in the world. Some are worse than others, but all capacity and efficiency losses are driven by the same factors: less than perfect surveillance information, each aircraft handled individually by a controller to be sequenced, each aircraft spaced and vectored to final approach and pilots who are blind to traffic around them. This results in wide variations in spacing on final approach and much higher fuel burns.

We are on the verge of a major milestone in the effort to become more efficient and to optimize the airspace capacity available to us. There is a wonderful convergence of emerging technologies and procedures that have created the dawn of a new era in aviation—indeed created the dawn of the next generation air transportation system.

In July we will fly the world's first NextGen RNAV Continuous Descent Arrival procedures using an ADS–B application called merging and spacing. This will mark the first time that pilots will be given responsibility for spacing their aircraft, at very accurate time intervals, using ADS–B surveillance information in the cockpit from cruise altitude all the way to the runway. The goal is to accurately, consistently and precisely deliver our aircraft to the end of the runways, in the most efficient way possible, in almost all weather conditions, night after night. When we accomplish this, we anticipate we will save over 800,000 gallons of fuel annually, reduce our noise footprint by 30 percent and our emissions by 34 percent below 3000 feet, and increase the capacity of our airport by 15–20 percent or more.

We are confident of our success for several reasons. ADS–B technology is maturing rapidly. In fact, UPS has 107 Boeing 757 and 767 aircraft equipped with a first generation system and has accumulated thousands of hours of experience using the simple, but powerful application of Enhanced See and Avoid. We have seen significant improvements in our operations at Louisville as a result of this implementation and have gathered enough experience to validate our next implementation this year.

Our air traffic controllers are willing partners in our ADS–B work and have enjoyed benefits by working with us. We have a wide base of industry support and have worked closely with FAA and others throughout this project. Our pilots have enjoyed the early benefits of enhanced situational awareness and traffic displays in the cockpit for several years now and are actively involved in the preparation for the next steps in 2007. And, as I have mentioned, Administrator Blakey and the FAA are moving forward with ADS–B plans in the United States and are a strong ally in this effort.

Although aircraft equipage is always seen as an obstacle to progress, we believe that the architecture we are implementing is very practical. We are using one set of hardware to house several different applications. The electronic flight bag provided by Boeing will allow us to provide electronic charts and manuals for our pilots, electronic logbooks for maintenance, graphic satellite weather for in-flight use, and a display for CPDLC for data link communications with ATC in the future. The same display used for all of those applications will also be used for ADS–B applications, the first of which is the Continuous Descent Arrivals using merging and spacing.

It will also house a very important safety enhancement: a moving surface map with traffic for ground operations. Studies show that the threat of most runway incursions and potential ground collisions will be solved by using the surface map with traffic.

We all have a major challenge ahead in transforming and modernizing the best aviation system in the world. We must do this in order to provide the capacity needed to accommodate future growth, to provide an additional margin of safety and to achieve the environmental improvement that is required. We believe that ADS–B will be the foundation for the modernized system.

Thank you and I am pleased to answer any questions you may have.

BIOGRAPHY FOR STEPHEN A. ALTERMAN

CURRENT POSITIONS

President, Cargo Airline Association, a nationwide (U.S.) trade organization that promotes the use of air freight and represents the United States all-cargo industry before Congress, State and local governments and the Courts.

Senior Partner, Meyers & Alterman, a Washington, D.C. law firm specializing in air transportation law.

FORMER POSITIONS

Chief of the Legal Division, Bureau of Enforcement, U.S. Civil Aeronautics Board, and, before that, Trial Attorney for the Bureau of Enforcement (1968–1975).

EDUCATION

Educational experience includes a law degree from Boston University School of Law (1968) and an undergraduate degree in Political Science from Brown University, Providence, Rhode Island (1965).

Other past and present positions include:

- Chairman, Environment Subcommittee, FAA Research, Engineering and Development Advisory Committee, 2003–Present.
- Member, Steering Group, Environmental Integrated Product Team (JPDO), 2005–Present.
- Member, Aviation Security Advisory Committee, 1996–Present.
- Member, Federal Advisory Panel on Land Use Planning, 1993–1995.
- Member, FAA Aviation Rule-making Advisory Committee, 1991–Present.
- Member, Federal Airport Noise Working Group, 1987–1991.
- Member, Federal Advisory Committee on Fuel Savings, 1991.
- Member, Federal Advisory Committee on Passenger Facility Charges, 1990.

March 15, 2007

The Honorable Mark Udall
Chairman, Subcommittee on Space and Aeronautics
Committee on Science and Technology
United States House of Representatives
2320 Rayburn House Office Building
Washington, DC 20515-6301

CARGO AIRLINE ASSOCIATION

1220 19th Street, NW
Suite 400
Washington, DC 20036
TEL 202 · 293 · 1030
FAX 202 · 293 · 4377

Re: Financial Disclosure

Dear Mr. Udall:

This is to certify that, other than compensation as President of the Cargo Airline Association, I have no financial interests whatsoever that may be relevant to any testimony given before the Subcommittee on Space and Aeronautics on March 22, 2007.

Thank you very much.

Sincerely yours,

Stephen A. Alterman

DISCUSSION

Chairman UDALL. Thank you, Mr. Alterman.

Let me thank the panel, again, for a very informative and very succinct testimony.

At this point, we will open the first round of questions, and I will recognize myself for five minutes. And I want to direct my first question to Ms. Cox, but to notify the three other panel members I would like to think about your response as well, and then we will move down the line.

SUGGESTED ADDITIONAL R&D FUNDING PRIORITIES

I know, as an FAA employee, you, of course, support the President's budget request, but I would like to know what your top-three R&D funding priorities would be if Congress were to provide additional funding for your R&D programs and why you would make those your three additional priorities.

Ms. COX. Yeah. I think that we are in an unusual situation this year. We are, first, starting to take a serious look at the research and development that will be required to support the NextGen system, so obviously, the support of the NextGen system is a priority. And the reauthorization has afforded us the opportunity this year to do an in-depth study of the requirements that we believe we need to make this happen over the next five years so that the fiscal year 2008 budget that we presented reflects serious increase in the RE&D budget and increases in overall NextGen support through all of the appropriations that represent R&D.

So I think you see there, in the budget, some of our key priorities.

As the rest of the panel members have indicated, environment is a key issue as we move forward, and I think that our budget request in the fiscal year 2008 budget and for the years beyond certainly reflect that indication.

We need to focus on our air traffic system and issues that will help us to increase capacity by reducing separation in the systems.

And we need to look at overall effects of human factors. As I mentioned in my oral testimony, the way people behave in the system of tomorrow will be very different from today, and we can't just put that in place immediately. We have to do a lot of studying about how we do that most appropriately as we look at the shifts in responsibilities.

Chairman UDALL. Thanks, Ms. Cox.

Dr. Hansman.

Dr. HANSMAN. Yeah, I have three. The first is approaches to accelerating the operational approval of new technologies and procedures. We really don't know how to do that right, and we need ways to do the safety analysis. And we have to make that more efficient.

The second is the environmental concerns, which are emerging and becoming more significant, both on global warming and also the contrail problem.

And then the third is pushing the transition in the system and the NextGen, and as Ms. Cox mentioned, I think human factors,

because humans will be a "part of the system" and will be very important here.

Chairman UDALL. Thank you.

Dr. Wuebbles.

Dr. WUEBBLES. As I said in my testimony, I have expressed an urgency for support to look at the effects of aviation on climate. We need to prepare ourselves, particularly, I think, over the next several years for the next major international look at policy that will happen in 2009. And we don't really want to go into that kind of situation without being much better aware of where we stand in terms of our understanding of effects while others are trying to promote various international regulations.

Chairman UDALL. Mr. Alterman.

Mr. ALTERMAN. Yes, I agree with everybody. I think they are right on. And from a purely parochial standpoint, we believe that we should continue funding the ADSB program and accelerate that funding. Congress, for fiscal year 2007—the House of Representatives for fiscal year 2007 recommended $100 million for ADSB development, which was $20 million more than the President's budget, with the extra $20 million going to research and development for future air-to-air applications. The Senate, in its bill, had $80 million. Of course, none of those were actually implemented, because we are operating under a CR for 2007, but we urge you to continue funding the ADSB development program.

As a practical matter, it is a two-stage effort. The FAA is doing a very good job now on stage one, which is putting ground stations in. We need to continue the research on future air-to-air applications. And I can't stress enough the need for environmental funding for funding environmental research. It is a major issue, and I think if there is one thing I can leave with you, the industry thinks it is an issue, too. It is not something that is simply in the scientific community or with the agency. We feel that we have an obligation, as we go forward, to enhance the environment to the extent possible. We need to do that, because we think environmental constraints will actually beat capacity constraints in limiting our growth.

With respect to the fiscal year 2008 budget, the money there, I think, from our perspective is fine. You will note that the proposal from the agency for fiscal year 2009 and forward has a major jump in environmental funding, and we support that.

Chairman UDALL. Thank you, Mr. Alterman. It is obvious the industry sees the environmental concerns that have been expressed and have been surfaced as an opportunity and the actions you are taking in the form of enlightened self-interest, so thank the leadership in the industry, if you would.

At this point, I would like to recognize the Ranking Member, my good friend from California, Mr. Calvert, for five minutes.

Mr. CALVERT. Thank you, Mr. Chairman.

Ms. Cox, you pointed out your top-three priorities. I want to just, for the record, point out, I came here 15 years ago, and I remember we were talking about reviewing the air traffic control and I don't know if we are that much further along than we were 15 years ago, but I just thought I would point that out. But hopefully, we can

make a lot more progress in the next few years since we, obviously, on the record, have increasing air traffic, and changing air traffic.

IMPACT OF ADMINISTRATION'S FINANCING REFORM PACKAGE ON FAA BUDGET

Part of, as I understand it, your R&D budget is going to be if Congress enacts the Administration's proposed financing reform package, including ticket taxes and aviation fuel taxes. How important is that in the new authorization for you to fund your R&D efforts?

Ms. COX. Obviously, a stable and predictable funding stream is important for our R&D efforts, and we believe that the Administration's plan will provide that. This is a particularly unique situation that we have with NextGen in that, in the past, we have looked at programs as standing as individual projects that we would put forward to support the modernization of a system. Today, the individual projects that we are putting forth, such as ADSB, such as data communications, our wake work that supports reduced separation are all inextricably linked together, so what we have is an integrated system of capabilities, a portfolio, if you will, of capabilities that is required to produce the desired outcome. And that, in particular, requires a stable funding stream, and not one that funds one program but not the other, but that—so that we are really hopeful that we can get our programs funded as a portfolio of projects, and that is a little different from what we have expected in the past.

Mr. CALVERT. So you see this as a dedicated fund for your R&D budget, and the appropriators are going to agree to that, that that is not going to be made part of the general fund and be appropriated from year to year?

Ms. COX. Well, the 2008 budget, and past budgets, have been a split, I believe, between the general fund and the airports and the airways trust fund. And for the RE&D budget, the 2008 budget, requests the same thing.

STATUS OF RESEARCH EFFORTS IN SPECIFIC IMPORTANT AREAS

Mr. CALVERT. Next, for Dr. Hansman, you state that some of the important areas, research efforts are below critical mass and others are not supported at all. Can you elaborate on that? What areas are we being underserved in?

Dr. HANSMAN. These are comments that have come out of some of the subcommittee—REDAC Subcommittee reviews, so for example, in the safety area, because of the importance of doing safety management system, which is a data-based approach to addressing safety concerns, the amount of funds that were available to do safety research prevented funding of other things, such as work on aircraft icing, some worked on fire protection, terminal area safety. So there is a trade-off, and some things are being uncovered. And then the other areas are things like safety-critical software. Software is becoming a more urgent part of the system. So we are sort of below intellectual critical mass in the agency to really move forward and anticipate the problems of the future.

Mr. CALVERT. Would you agree with that, Ms. Cox, that—Dr. Hansman's assessment of these gaps?

Ms. COX. You know, I think that we have gaps that we need to address, and particularly in getting to NextGen. One of the things that we need to do in order to—I believe that Mr. Alterman reflected the fact that we move too slowly. In order to speed up the way that we go forward in implementing the results of our technology is for the implementing organization, and in the case of the NAS, it is the FAA, for the implementing organization to become involved in these efforts at a lower technology-readiness level, perhaps, than we have in the past so that we have an in-depth understanding of the capabilities and a better understanding of how to implement the system.

We have shown great success as we take over NASA technologies at the stage where we begin the technology maturation and in moving those forward. In cases where we haven't stepped in as early with NASA and co-worked with them, we have not done as well. So I think in the future, and the 2008 budget request reflects this desire to become involved at an earlier level in most of these technology areas so that we can advance the implementation.

Mr. CALVERT. I thank you. I will just catch on the next round.

Chairman UDALL. I thank the gentleman from California.

It is now my privilege to yield five minutes to the gentleman from New Jersey. I mentioned Mr. Rothman earlier. He comes from a district in New Jersey where the dependence on the modern air traffic system is important, but he also has a wide range in constituency that is concerned about new generation engines, noise reduction.

And Mr. Rothman, it is great to have you as a Member of the Subcommittee, and you now have five minutes to ask questions of the panel.

Mr. ROTHMAN. Thank you, Mr. Chairman. Thank you for that very kind introduction.

I think the FAA is familiar with me, not everyone, perhaps, but I have had the great privilege of representing the 9th Congressional district in New Jersey. Now I am in my 11th year, and we have an airport in our district called Teterboro Airport. And we have had some issues over the years.

I thank each and every one of you for your service and for your scholarship and all your years devoted to these matters.

I have got a whole lot of questions. I will probably get to them in the second or third round, but let me start with a couple of points, which is sometimes it seems to me that those involved in the airline industry or in the FAA haven't addressed this fundamental issue. Let us assume that we have the science and technology that would allow planes to fly in our skies perfectly safely without any emissions or any noise, and they could fly wing-to-wing, thus blotting out the sun. Is that the goal here? Or is it something different, some balance between a quality of life that regards the open sky, or some parts of it open and the sun as things to be pleasant to look at now and then?

That is one issue. Have we thought about that? Or are we just racing down this track of pure science and technology without figuring out, you know, reducing it out to its absurd or its extreme?

Do we want the Jetsons? Perhaps some of you remember the image in the Jetsons. I don't. I don't think my constituents want it. I don't think most Americans want it. But that is my view. But I am going to represent that view strongly until someone persuades me that it is unreasonable.

NOISE REDUCTION FUNDING

I do—I did note, with great interest, and everyone is addressing the environmental issues. And start with Ms. Cox. The focus of the environment and energy research program is making aviation quieter, cleaner, and more energy-efficient. I—that is great to hear. And I was just curious. I noted that, if I am reading the budget correctly, $15.4 million of the budget is being spent on the environment and energy. That is about 11 or 12 percent of the budget. And of the $15.4 million going to the environment and energy, how much, if you know, is just going towards noise mitigation, noise reduction?

Ms. COX. I am not the expert to break out the split versus emissions versus noise reduction. I know that our funding addresses both. And in fact, it is a little bit more in 2008 than $15.4 million. In 2008, we are also requesting that the airports cooperative research program add a third area to address. They now address safety and capacity. We are adding environment to that and requesting an additional $3 million in that program to work on the environment, on issues such as emissions and noise reduction. And I will be happy to get back to you with that breakout.

Mr. ROTHMAN. Thank you. I appreciate that.

Can I just ask the panel my general little question?

Dr. HANSMAN. Yeah, I would say two things. First, actually, on the mitigation, I believe you were just talking the research part of mitigation. There is also a significant amount of money that is spent on sound, you know, insulation mitigation. That is on the order of about $300 million a year, I believe.

Mr. ROTHMAN. Yeah. Unless they are going to do the houses as well as——

Dr. HANSMAN. Yeah.

Mr. ROTHMAN.—the schools——

Dr. HANSMAN. Yeah.

Mr. ROTHMAN.—you know, waking up the residents at 5:00 in the morning, it——

Dr. HANSMAN. So I—but I want to address the first comment that you made, which is what is the appropriate balance of air transportation. We thought about this a lot. The U.S. economy—and our quality of life actually presumes air transportation, so you have to think about this from the overall context. So it was actually interesting to me, after September 11, when the traffic died in the system and people stopped flying, it turns out that the first people to start flying were not the business travelers. It turns out that they were people on personal travel, because our society in the United States has distributed in a way that we have spread out. So when your grandmother or your mother is in Florida and sick, you presume you can get on an airplane and go to Florida.

ECONOMIC EFFECTS OF CAPACITY

Mr. ROTHMAN. My question is: at what point do we say the theater is filled, it is sold out, you can't stand in the aisles. The restaurant you want to go to is sold out. You will have to come back another day. We don't allow you to eat in the aisle.

Dr. HANSMAN. So here is what happens with that. So when capacity—when you get local constraints on capacity, what happens is it will become expensive and difficult to travel to that location. And you know in New Jersey that this happens. Then what will happen is economic activity in people's where they will go will move to other locations. So if you think about it, it becomes a dynamic on sort of competitive economic regional economics.

Mr. ROTHMAN. I note that my time is up, but if you are successful in your technological efforts, it may be really cheap for a very long time to fly, and the sky will be nearly completely blotted out before it gets too expensive. So I don't want to gamble on the market. That is why they invented the government to look into these things to regulate——

Dr. HANSMAN. And we have a lot of sky.

Mr. ROTHMAN. Yeah.

Chairman UDALL. I thank the gentleman from New Jersey. I am going to have to step out temporarily. I am going to ask Mr. Rothman to assume the chairmanship, but before I do that, I wanted to recognize the gentleman from California, who, on the heels of Vice President Gore's presentation yesterday on climate change, I am sure has some interesting things to say today.

And the gentleman from California is recognized for five minutes.

Mr. ROHRABACHER. Well, thank you, Mr. Chairman.

And with all respect to Mr. Rothman, I do think there is still the friendly skies to—as United Airlines has described them, and will be for a long time.

My father was a pilot for 23 years, and in the Marine Corps and later worked flying Tigers Airline. I think the airline industry is a commendable and very responsible part of our society. When you talk about the pursuit of happiness as being an important right of the American people, I think the airline industry has played a significant part in providing people an avenue to pursue happiness, which of course is an important thing for a free society. It can never be underestimated.

AIRPORT AND AIRLINE IMPACTS ON HUMAN HEALTH

A couple questions here. Dr. Wuebbles, I am sorry that our Chairman had to leave for this, you mentioned about the studies that you were doing on how the pollution level from airlines, contrails, et cetera, affect the environment. How much percentage of money are we spending here in terms of—as compared to determining the affect of airlines on the health of human beings? For example, people who live near airports, of course, as planes are coming in, I am sure there is a pollution factor there as well, is there not?

Dr. WUEBBLES. There certainly is. Let me look at your question. The—we can essentially say, in terms of effects of aviation on cli-

mate, analysis that are going on right now, as far as I know, that is—the amount of funding is essentially zero. There is none in FAA. There is none in NASA or at other agencies that I know of. So——

Mr. ROHRABACHER. Well, they had to pay for that study that you were talking about. I mean, everybody got together and went to great——

Dr. WUEBBLES. The only——

Mr. ROHRABACHER.—events and restaurants, I am sure, and——

Dr. WUEBBLES. We met outside the Boston Airport at a hotel. Everybody flew in. We have—we were not provided—we—the only thing that was provided was some expenses for travel. So that was it. Everybody donated their time, otherwise. So, you know, if you want to say, you know, it is that little amount, it is basically what we are spending in the United States right now. And we can contrast that with—to programs in Europe where they are spending a fairly significant amount on research to look at some of these issues.

I am not really aware of how much money we are spending in terms of looking at air quality from airports. I know that there was some money in the FAA budget, I just don't know the amount.

Mr. ROHRABACHER. Well, I know people have studied noise, which noise is a major factor, and I take it from what you have said, we have made some progress in that in the last 20 years. But the actual pollution that comes out of an airplane when it is landing and that effect on the health of the people who live near that airport I think should be something that is at least as important to us as whether or not traveling at high altitudes is going to affect the climate of the Earth.

Dr. WUEBBLES. I think both issues are very important, and on that—you know, I don't disagree with the fact that we need to be spending more on looking at air quality issues, and particularly particulates and effects on ozone.

Mr. ROHRABACHER. If I disagree with the former Vice President who was testifying here yesterday, if I disagree with him on anything, it would be that if we—let me put it this way. If we are going to go at this issue of pollution, I believe that we should be going at it in order—focus our efforts on trying to make sure that people's lives are healthy, that my children don't breathe in contaminated air and thus have heart or lung problems versus the idea of setting the pollution problem and focusing on whether or not the Earth is one degree warmer now, after 150 years of advancing industrialization of humankind. And——

Dr. WUEBBLES. Congressman, I agree with your concern about the air quality effects, however, I will also say that, having looked greatly at the issues related to climate, that that also is an extremely important issue and potentially have great—many impacts on our children and grandchildren, and it is something we ought to be seriously——

Mr. ROHRABACHER. Does a——

Dr. WUEBBLES.—paying attention to.

Mr. ROHRABACHER. Do you believe that the—you said two percent of the CO2 that is man-caused comes from the airline industry?

Dr. WUEBBLES. Yes, roughly.

Mr. ROHRABACHER. And the—of the that is being poured into the atmosphere——

Mr. ROTHMAN. The gentleman's time is——

Mr. ROHRABACHER. Well, thank you very much, and I think I made——

Mr. ROTHMAN. Would you like to finish your question or——

Mr. ROHRABACHER. Well, you know what? I——

Mr. ROTHMAN. We will get it on the next round.

Mr. ROHRABACHER. I think we made the point, and——

Mr. ROTHMAN. Okay.

Mr. ROHRABACHER.—I hope that we do research that is not just the trendy research as to what climate change is all about but research aimed at trying to protect people's health.

Dr. WUEBBLES. I think both are important, yes.

Mr. ROHRABACHER. Okay. Thank you very much.

Mr. ROTHMAN. I thank the gentleman from California.

I am going to begin my five minutes now, another one. It is a great privilege of being in the chair with nobody on my side, but it did take me 11 years to get here, in the minority, most of them.

QUALITY OF LIFE ISSUES

I wanted to note—I don't know if the other gentlemen had any comment on my Jetsons blocking off the sun thing and about the balancing of quality of life interests. And by the way, I do want to second my friend, Mr. Rohrabacher's, interest in the inability of our kids to breathe as we also enjoy air travel.

Mr. ALTERMAN. We endorse breathing. We think that is good. I think that, you know, when we look at this, everything in life is balanced—is an attempt to balance competing interests and trade-offs. I mean, even within the environmental community, we discover, scientifically, that if we address one issue, we may—and solve that issue, we may adversely affect other issues. It is all a trade-off, and I don't think any one of us wants blackened skies. I am a photographer. I don't like them. But, you know, it is a balancing, as Dr. Hansman said, of the economic needs of the country, the mobility of the country, against the environmental sensitivity. I think, as I stated in my written statement, this is one of the major challenges to the aviation industry. How do we balance the needs of the economy, the needs of the people for mobility, against the absolute need for environmental sensitivity, to the extent possible? So all of the issues that have been mentioned by the committee here are very important. Those are balanced against other interests.

Mr. ROTHMAN. Mr. Alterman, if I may, we have experienced in our history, the history of civilization, perhaps, where one technology is replaced with another technology and other modes—one mode of transportation is replaced with another. For example, when a highway gets clogged and you can't widen the highway anymore, we have to find another way to move people and goods, and there—you know, whether it is trains or planes or who knows what, but the marketplace, hopefully with government either not getting in the way or assisting will provide that alternative.

But I did want to ask, Mr. Alterman, you had said in your testimony that you were looking forward to a reduction in noise in absolute terms by 2025 on page 5 of your testimony. And I wondered, the FAA, in the context of ongoing JPDO activity, has established a goal of reducing noise and emissions in absolute terms by the 2025, notwithstanding an expected major leap in air traffic. What did you mean by that, "absolute terms"?

Mr. ALTERMAN. Well, those weren't my words. Those were the FAA words.

Mr. ROTHMAN. Ms. Cox, what did you mean by that?

Ms. COX. Again, sir, I will have to defer to my technical experts on the environment to tell me what that means.

Mr. ALTERMAN. Well, I am not sure I am a technical expert. I am a dumb lawyer, but what it means, to me, as Chairman of the Environmental Subcommittee of the REDAC is we want—it is not a percentage. In other words, if aviation expands, doubles, let us say, that doesn't mean we are going to—our goal is not to simply have less than doubling of the pollutants. It is to actually reduce them at the same time to less noise, less people impacted by noise in 2025 than are impacted today, less people impacted by air quality issues in 2025 than today. It is an ambitious goal. I am not sure, to be honest with you, whether we can do it, but it is the goal we have established, and I think it is a laudable one, and we need to work toward it.

Mr. ROTHMAN. With all due respect, I wanted to get to Dr. Hansman, who looks like he is ready to make a comment, also. I may be wrong, but I think that there is a growing interest amongst the American people to—a grown sensitivity to noise and emissions from aircraft, and they are kind of fed up. And there will be a revolt, at least that is—you know, again, I have a little airport in my district, but people outside of my district, Republicans, conservative folks, are telling me they are fed up. They bought a house in a nice part of the state, and all of a sudden, at 5:00 in the morning or 11:00 in the morning, there is this screeching of the brakes from the 747 over their head or the 747s are lined up, 25, 30 miles out from New York City. And it just is really not what they bargained for.

Dr. Hansman, did you have a thought? I know you mentioned in your testimony that internal and domestic concern, the environmental issues are becoming a bigger and bigger part of the challenges for aviation.

Dr. HANSMAN. Yeah. I think you have addressed one of them, which is the noise concern. It is a significant concern, and it limits the capacity of the system, because, you know, people near New York don't want to have more airplanes coming over their house. On the other hand, people want to be able to fly to different locations. So we have this trade-off that we have to deal with. And in fact, the real benefit of the research is to really try to get mitigation. And there is—you know, there is progress being made, particularly on the noise side, some of the things that were talked about, the CDA approaches. There is a project going on at MIT right now called the Silent Aircraft Initiative, where the objective is to see whether it is possible to design an airplane where the

noise outside of the airport contour is at or below the background noise level. So you know, I think that there is some hope.

Mr. ROTHMAN. Great. Thank you.

My time is up.

Mr. Calvert.

Mr. CALVERT. I thank the gentleman.

I have several airports in my district, so noise is—the Chairman is correct. It is not a Democrat or a Republican issue, but I think that a point should be made that the technology that has been developed over the last number of years have developed much quieter engines. The problem, it seems to me, is the inventory of older aircraft that is flying today. You take a DC–9, for instance. It is a relatively small aircraft. It puts out a noise contour that is significantly higher than, say, a 747 with a newer engine design. So you know, maybe a mutual thing that we could do is figure out a way to change over that inventory at a quicker rate in order to get new aircraft that has quieter noise contours that would satisfy the Chairman's interests as well as my own in developing quieter aircraft at a rapid rate. I—as a matter of fact, I have an industry, Mr. Alterman may want to comment, told me that if you could change the inventory relatively quickly and some of these older aircraft that are still flying, you could actually reduce significantly, and much quicker, the noise issue throughout the United States, especially in major airports. Is that an accurate comment, Mr. Alterman?

Mr. ALTERMAN. Yeah. Again, it is a matter of balance. I mean, if you put all new equipment into the fleets, yes, you would get noise benefits, clearly. The problem is that this is not an industry where you can go to the drug store and say I am going to buy a new piece of—you know, a new toothpaste today. There is——

Mr. CALVERT. But I am thinking of—and this also applies to emissions, because some of the engines are, obviously, a lot more efficient than the engines that were developed 30 years ago. And I am a believer in the carrot approach rather than the stick approach in governance and the regulatory environment, is to give incentives to re-engine some of these aircraft or new aircraft, because the aircraft were designed that—at the time that they were designed, not thinking about the noise problem. Would the industry, do you think, have a positive reaction to an incentive, such as a tax incentive to depreciate that equipment over a rapid period of time?

Mr. ALTERMAN. Knowing our industry, they would be more than happy to consider any financial benefits for doing that, sure. And I think that—I think the—to be honest, you know, we would all like to accelerate it. I think we are—we have made great strides, I mean, as you have mentioned. I am not sure I remember the exact numbers, but I think since the 1970 era, we have had a reduction of approximately 90 percent in the number of people affected by noise, as defined by the FAA in the 65 LDN. That number may be wrong. I can probably turn to the FAA to get the right number.

Mr. CALVERT. Maybe, you know, we can have others comment. Ms. Cox, I know, wants to comment on this. but I know that the gentleman's difficulties, as well as my own, is really applicable to

when I get a complaint on noise, I can almost tell them what aircraft flew over, you know, I—because I know the aircraft.

Would you like to comment on that, Ms. Cox?

Ms. COX. Well, I was going to elaborate on the number. 700 million people, 30 years ago, were impacted by noise, and it is 500,000 today. But if you are one of that 500,000, then you are not concerned about the people who are relieved of that. And so we are conducting research to address that issue. And particularly, in the particulates and emissions area, we are conducting a great deal of research and have had some success. The fuel consumption in the United States has been reduced by five percent since 2000 with the commensurate benefits in the number of carbon emissions that there are in the air.

Mr. CALVERT. Obviously, airlines make decisions, and the air cargo industry makes decisions based on economics. The DC–10 was a great aircraft, but it burnt a lot of fuel and put out a lot of emissions. The cargo industry has gone to the DC–10, because they can offset their costs more effectively on moving parcels versus people. They can more equitably move those costs over.

How do we—you know, it seems to me that the industry—the new aircraft that is coming across, the 777, the 787 Dreamliner, if you take a look at the emissions that are coming out of these new engine designs from all the major engine companies, much , much better. Tremendous. The same thing with the automobile industry. If we could take the old cars off the road, you would have a relatively dramatic increase in air quality just by removing the inventory of old cars. The same thing applies with the air carrier industry, it seems to me. That is just—of course, outside our jurisdiction, but something that is of interest to me.

How do we do that? How do we give an incentive to the industry, because I think you can see dramatic improvement, both in noise and emissions, both have an environmental plus, plus a—noise reduction? How do we do that in a rapid period of time? And it seems to me, you solve a lot of problems and, at the same time, do the technology for down the road, but there is some immediacy to these issues to keep the American people engaged in this subject. They would like to see this thing resolved sooner, rather than later.

Anybody like to comment on that? My time has expired, but maybe he will—the Chairman will let me the indulgence of the committee.

Dr. HANSMAN. There are historical precedence. The noise thresholds we use now have actually come—have been reduced over time, so we are now at stage three. There is discussion about what stage four is. One of the important parts of the research is the threshold for the next noise stage, stage four noise, will be what is technically feasible, so it is not useful to propose this noise target that you can't get to. And I think it is a very interesting idea to figure out how you would incentivize behavior in—both in terms of noise and emissions, you know, over the short-term and the long-term.

Chairman UDALL. Anyone else care to comment? I think it is a very important question that the Ranking Member has asked.

The Chairman will yield himself five minutes at this time.

I would tell the panel, we have votes scheduled for 11:15 to 11:30. I am going to ask another round of questions, and then I

know Mr. Rothman would like another five minutes, but we will begin to draw down the hearing and aim to close the hearing at—between 11:15 and 11:30.

FURTHER CLARIFICATION OF DECREASED FUNDING IN IMPORTANT AREAS

As for, Dr. Hansman, in your testimony, you stated that the REDAC has been concerned for a number of years the declining support for the R&D functions at both the FAA and NASA have resulted in the decline of national aeronautics capabilities. In some important areas—and this is a quote, I think, from the testimony you gave. "In some important areas, research efforts are below critical mass, and others are not supported at all." What do you consider to be the most damaging consequences of the declining support of both the FAA and NASA? And can—would you be able to elaborate on some of the specific research areas that are either being shortchanged or not supported at all? And why are they important? And then they rest of the panel, if you want to comment after Dr. Hansman, I would look to your comments as well.

Dr. HANSMAN. I will give a few examples. I am not sure I have the comprehensive list in front of me.

One area of concern, for example, is human factors area work, and it is, historically, a great strength in NASA. We have the best aviation human factors capability in the world. The level of support for human factors in NASA has degraded significantly on, particularly, applied human factors to aviation problems. This is going to be critical for many of these NextGen concepts as we determine what is the appropriate role of automation and human performance.

Another area that we are not as strong as we should be is on some aviation weather issues. That is an area of concern. Deicing procedures, fire protection, terminal area safety, things like that are all areas of concern.

Chairman UDALL. Other panelists? Dr. Wuebbles.

Dr. WUEBBLES. I was at the REDAC Environment and Energy Subcommittee meeting the last two days, and it was clear that climate, actually, has been rising as a new major issue within that committee in terms of its recommendations to the FAA. So it is being recognized there as an important issue.

Chairman UDALL. Mr. Alterman, if I could move in a similar way to your testimony, you pointed out that NASA's recent downgrading of its aeronautics activities "has seriously affected the FAA research effort". And then you go on to say that if Congress decides to restore NASA aeronautics funding to former levels, there should be "specific Congressional guidance on how the money should be spent". Would you elaborate on what that guidance would consist of, and what would you recommend that any restored NASA aeronautics funding be spent on——

Mr. ALTERMAN. Well, I—it is probably presumptuous of me to say that, but I—what we have discovered, when people get a pot of money with no direction, I am not talking about earmarks, I am talking about direction on where you—we should spend it, as you have heard from the panel, there are a whole range of activities that NASA has traditionally been involved in, and we always need

to prioritize. We never have the money we absolutely need, so there need to be priorities on how you are going to spend money. So my thought was that if , in fact, you are going to give any agency a pot of money, it would help, I believe, to prioritize how that money—I am not saying spend this dollar here and that dollar there, but if the feeling of Congress is that climate change is important or noise mitigation or whatever NASA might be doing, it—those things need to be prioritized, and the agency that gets the money needs to know how you feel about the priorities and how you spend it.

The other comment that I might make, although I am sure it is true of all bureaucracies, is, you know, we all get letters requesting contributions from charitable contributions all of the time, and the first question I ask is who is going to get the money if I give $100 to this organization. And I am always looking for organizations that actually flows the money to the intended recipients and not spent on a bureaucracy where people are making a whole bunch of money. I think the same thing is true when we get to pots of money that the government hands out to other agencies. We need to be sure that we are not simply funding a bureaucracy with nothing at the other end of it.

Chairman UDALL. A point well made, Mr. Alterman.

RECOMMENDATIONS REGARDING NASA FUNDING

The rest of the panel, do any of you have recommendations on how any NASA money—aeronautics money that was restored might be spent? And Ms. Cox, I know that NASA is perhaps a sibling, perhaps a cousin, and I am sometimes reluctant to give my siblings or my cousins advice. On the other hand, there are days when I want to give them advice, so I turn to you to see if you have any further thoughts.

Ms. COX. Well, one thing that we are looking into, NASA is one of the partner agencies of the Joint Planning and Development Office. So we don't have as much clarity as we would like to have now around future planning from the agency, so we are looking to the JPDO to work with their partner agency to identify what these issues are and what research might or might not be done in the future so that we can take the recommendations from the JPDO and proceed accordingly.

Chairman UDALL. If I might clarify, you look to the JPDO at playing a key role here as a convener and as an organization that can help get to what is really important?

Ms. COX. Right, because they do—they have the vision for the NextGen. They provide guidance toward our budgetary planning. They have oversight to our R&D program. And because NASA is a partner agency and contributes to those recommendations, I would expect that to come from them.

Chairman UDALL. Dr. Hansman.

Dr. HANSMAN. The one area I have real concern over is innovation. It turns out, as things have been declining and we have been trying to focus around very specific things, there is actually very little in the NASA budget or process where someone with a brilliant new idea, so when finally we—some undergraduate invents the gravity drive that will enable the George Jetson car, there is

actually not that much of an opportunity for those ideas to actually flow in and be funded in the system. So right now, it is very specifically targeted research efforts, they way they are doing it.

Chairman UDALL. Dr. Wuebbles, do you have any further comment? You have got the last word here.

Dr. WUEBBLES. In relationship to NASA, I think that a strong coordination between NASA and FAA towards looking at the climate issue would make a lot of sense. If we go back to—throughout most of the 1990s, NASA had a major program looking at the environmental effects of aviation, and—that I was part, in fact. And I would, you know, like to see those capabilities certainly restored within the agency.

Chairman UDALL. Thank you.

I would recognize the gentleman from New Jersey for five minutes.

Mr. Rothman.

Mr. ROTHMAN. I thank the Chairman.

Allow me just to say it is a pleasure and a privilege to serve with you, Mr. Chairman, and your grace and your generosity and wisdom are much appreciated, as always, and it is a pleasure to be serving on your committee.

To our Ranking Member, who—our former Chairman, I look forward to working with you on a whole host of things, including that great idea about—although several great ideas, about the inventorying of the older aircraft and how we can incentivize as opposed to punish those who would be better off, from our point of view, not being in the sky in their planes.

I was wondering, I know next week there is going to be a hearing of our subcommittee of NextGeneration air—the NextGen project, and I was wondering, respectfully, if the FAA could send over folks who are mindful or have at their fingertips these noise-mitigation figures and goals for the air—for the FAA.

Ms. COX. Sir, I believe I have someone just behind me who passed me a note on your last question, but I would leave it to him to interpret it.

Carl Burleson, could you——

Mr. ROTHMAN. Well, maybe, since I only have a few more minutes, and we are going to have a whole other hearing on that, perhaps this person could join us next time as well, or whoever you suggest——

Ms. COX. And there are many people in his organizations who are far better qualified than I to address those questions.

Mr. ROTHMAN. Well, on that issue, maybe, but—and I wanted, also, to invite the panel members, I hope I am not saying anything improper, to recommend to the Subcommittee, at least in my area of particular interest. I am mindful of the great value to humanity, civilization, our economy, our quality of life, of air travel, so that is the given, okay. But I do—I want to focus on reducing, if not eliminating, air noise as an ideal goal. Are there projects, like at MIT, programs in other places around the world that we should be funding? If it is a project-by-project kind of a thing that this government does, do you have any ideas? Are there any projects that deserve funding? In this area, I would be most welcome to hear about them. And I just am going to rattle these off, and then if

there is 10 seconds left, a response, but—I would also be interested to know the percentage of noise related to the older inventoried aircraft. You know. How does that break down? Did 95 percent of the noise used to come from stage one and stage two now that they are kind of being phased out? And by the way, I introduced legislation to do that voluntarily, but—and invited industry to join me. I said, "How long will it take you to phase them out? Five years? Ten years? What can we work out? I am a reasonable guy." They told me to go jump in the lake. That is when the carrot sort of dropped and the hammer came into my hand. But I would be interested in that inventory.

Also, on airspace redesign, I am concerned. Let us assume we get to zero noise from aircraft but there is this constant flow over the head of, you said, half a million people. I believe it is more than that, but I would be interested to know how that figure came—comes about.

Ms. COX. It is 500 million.

Mr. ROTHMAN. Oh, 500 million. Okay. Well, that is quite a lot, then. Enough for us to care about.

In airspace redesign, even if it is quiet, can we relocate it so that the sky isn't blotted out for any one segment or have to, you know, during the soccer game, see this stream overhead? Dr. Hansman is jumping at the——

Dr. HANSMAN. The only thing I want to say is that you have got to get to the airport. So you can move the trajectory some, but, you know, if you have a limited number of airports, and we are not really building any new ones in the United States, you have got to get to and from the airports, so that is a fundamental constraint.

Mr. ROTHMAN. You know, and again, it is all in the balancing of the equities and where we have to spend more on noise-proofing everybody's home or building railroads in the middle of our high turnpikes and throughways to get to the airport. There are lots of choices that—cost is an issue, too, but—Mr. Alterman?

Mr. ALTERMAN. I just want to remind everybody that we take seriously this challenge. But one of the things that we have to remember is, as Mr. Rohrabacher said, he is concerned about the health impacts. When—one of the problems we have is the interrelationship of the various pollutants. And we could solve your noise problem, perhaps, but the results of solving the noise problem might be much unhealthier air. And——

Mr. ROTHMAN. Mr. Alterman, please accept this as a given. I would never want one to be at the expense of the other, so it would have to be——

Mr. ALTERMAN. Well——

Mr. ROTHMAN.—together——

Mr. ALTERMAN. Yeah, well, that is my point.

Mr. ROTHMAN.—and it is not a zero-sum game, if that is the right use of that phrase. I would want to—I would want noise reduced. I would also want environmental health issues addressed, as well. I want neither to suffer at the hands of the other.

Mr. ALTERMAN. Yeah, and that is our goal, too. I only raised the issue, because we have been concentrating in the last few minutes on the noise, and I just want—I don't want any misunderstanding

that we have to treat this as an issue that relates to all the pollutants, and not just noise.

Mr. ROTHMAN. As a father of two teenagers with asthma in Northern New Jersey, I feel your pain.

Thank you, Mr. Chairman.

Chairman UDALL. Thank you, Mr. Rothman.

I wanted to see if Mr. Calvert had any additional questions.

Mr. CALVERT. No, I just wanted to thank the witnesses and congratulate the Chairman for his first successful hearing.

Chairman UDALL. Don't get ahead of yourself. We haven't finished yet, Mr. Calvert.

Mr. CALVERT. But I have.

CHANGES TO THE FAA'S R&D PROGRAM IN THE CONTEXT OF THE 2007 OPERATING PLAN

Chairman UDALL. I would—as I bring the hearing to a close, I want to direct a question to Ms. Cox, perhaps, for the record or for a short answer. And it focuses, that is, my question, on what changes have been made, if any, to the FAA's R&D program in the context of the 2007 operating plan as a result of joint resolution, in other words, the continuing resolution.

Ms. COX. As you know, we are fortunate to have our budget in hand now, and we are proceeding with that plan at a slower pace than, obviously, we would have, had we had more clarity about our budget initially. But with the funding that we have now, we are able to implement the operating plan that we have in place.

Chairman UDALL. Would you provide details, for the record?

Ms. COX. Absolutely.

Chairman UDALL. And then as a follow-on, do you anticipate any adjustments to the fiscal year 2008 R&D plan and funding as a result in the year now identified fiscal year 2007 operating plan? And if you want to take that, for the record, as well, I would be happy to let you do so.

Ms. COX. I will, because there are specific areas that we will need to address with that that I don't have at my hand.

Chairman UDALL. Thank you.

I want to bring the hearing to a close, but before we do, I want to thank all of the witnesses. You have been an excellent panel. Thank you.

Mr. Alterman, in particular, you shared with me that you come to the Hill about every 10 years to testify, and I think we may bring you back annually or maybe every six months, because you are, clearly, adept and comfortable here. And I thank you for your presentation, along with the rest of the panel.

If there is no objection, the record will remain open for additional statements from the Members and for answers to any follow-up questions the Committee may ask of witnesses. Without objection, so ordered.

The hearing is now adjourned.

Thank you.

[Whereupon, at 11:28 a.m., the Subcommittee was adjourned.]

Appendix:

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

Responses by Victoria Cox, Vice President for Operations Planning Services, Air Traffic Organization, Federal Aviation Administration

Questions submitted by Chairman Mark Udall

Q1. What changes, if any, have been made to FAA's R&D program in the FAA's FY 2007 Operating Plan as a result of the Joint Resolution? Do you anticipate any adjustments to the FY08 R&D plan and funding allocations as a result of the FY07 Operating Plan?

A1. No changes have been made to the FY 2007 Operating Plan. As a result of the FY 2007 Operating Plan, we do not anticipate any adjustments to the FY 2008 R&D Plan. However, an analysis using JPDO budget guidance identified research and development programs, projects and funding supporting NextGen. The FY 2008 plan includes an additional $10M request for NextGen research involving wake vortex and human factors.

Q2. Aircraft noise is a significant concern for communities across the United States.

Q2a. Do you believe FAA's FY08 request for noise research is sufficient?

A2a. The FAA is currently investing $15 million dollars per year under RE&D and about $3 million per year under Airports Cooperative Research Program (ACRP) on noise and emissions mitigation research. Of those amounts, about 95 is spent on noise research geared toward developing analytical tools to better understand the relationship between noise and emissions and different types of emissions, better identifying and measuring the issues and impacts associated with aircraft noise, and generating improved solutions to mitigate these problems, and assessing the impact and advance implementation of operation procedures to reduce noise. However, as noise and emissions are interrelated, 90% of the noise investment also supports emissions mitigation. The vast majority of FAA's resources are spent on near-term mitigation as we invest about $300 million in insulation and land purchases to mitigate noise. However, the Administration NextGen Finance Reform bill proposes a number of R&D initiatives and investments that will provide opportunities to accelerate maturity of noise and emissions technologies (the Consortium for Low Emissions, Energy and Noise (CLEEN) program under section 606). We are also seeking new flexibilities in the use of mitigation funds to include development and implementation of operational procedures.

Q2b. What have been the FAA's accomplishments to date in this area?

A2b. Over the last thirty years the population significantly impacted by aircraft noise was reduced from seven million to 500 thousand by improvements in source reduction technologies, operations and other mitigation measures. These technology improvements were generated by research undertaken by NASA, DOD, and industry. Specific outputs of the FAA research program had a greater regulatory and policy focus including:

- Developed highly influential advanced computer models for airport and heliport noise analysis—over 600 copies of the models have been sold around the world and used in over 160 U.S. airport studies involving more than $1.8 billion in airport noise compatibility grants; they have also provided the basis for an aircraft overflight noise exposure prediction model for Grand Canyon National Park.
- Conceptualized and developed a new generation of analytical tools which will revolutionize approaches to aviation environmental assessment and regulation by enabling a comprehensive approach that assesses interdependencies and optimizes solutions based on cost-benefit analyses of impacts and mitigation. The tools will provide significant cost savings and other benefits to users.

However, in recent years, the FAA has taken a more aggressive role in maturing nearer-term technology and operational solutions including:

- Developed a clean and quiet new procedure—Continuous Descent Arrival (CDA). By landing using a continuous decent, lower power approach CDAs enable reducing community noise by 3–6 dB as well as fuel burn and emissions. We are in the process of transitioning CDA into the NAS.
- In collaboration with Industry and NASA under the Quiet Aircraft Technology (QAT) Program demonstrated a number of quiet aircraft technologies,

including inlet acoustic treatments, low noise landing gear, and chevron nozzles for community noise reductions.

Q2c. What do you think are the most promising research opportunities in aircraft noise reduction—and what should be FAA's role in the research? NASA's role?

A2c. The vast majority of promising opportunities involve either new engine/airframe technology or innovation in air traffic management procedures. Ninety percent of the environmental improvements (noise and emissions reductions) in the aviation system in the last 30 years have come from improved technology. Without a pipeline of near-term (5–10 years) technology improvements, we cannot achieve the absolute reduction of significant noise and air quality impacts that we believe are necessary to enable NextGen growth. We need robust research and development to accelerate technology solutions to manage and mitigate environmental constraints. The goal is to have a fleet of quieter, cleaner aircraft that operate more efficiently with less energy.

To that effect, the FAA is seeking to establish a Consortium for Low Emissions, Energy and Noise (CLEEN) technology (Section 606). The program is focused on collaboratively (50/50 private sector/federal funding) demonstrating aircraft and engine technologies that reduce noise and local air quality and greenhouse gas emissions at the source to a developmental level that will allow quicker industry uptake of these new environmental technologies in order to produce a more efficient, cleaner and quieter fleet. We believe it is feasible to reduce noise levels by 10 dB at each of the three certification points relative to 1997 subsonic jet aircraft technology.

Aside from cleaner and quieter technologies, FAA has a crucial role to play in collaboration with airlines and airports in advances in reducing community noise exposure by leveraging advances in Communication, Navigation and Surveillance technology in the short- to medium-term to optimize aircraft arrival and departure procedures, sequencing and timing on the surface, in the terminal area and enroute, thereby increasing airport and airspace throughput and reducing noise, fuel burn and emissions. Provisions in Section 604 would facilitate these endeavors.

There are also promising research opportunities advancing analytical tools to help us assess environmental impacts to make sure that we can assess the issues and solutions—so we target the right problem and solve it in the most cost-effective manner.

Regarding research role, industry focuses on developing near-term technology (B787). NASA is focusing on long-term technology. Between the two, there is a gap where we need to bring to maturation the next generation of technology (e.g., quieter, cleaner versions of B787) that would make a difference in the next 5+ years and we believe this is the role of FAA can play under CLEEN.

Q2d. Please provide noise research funding numbers for FY06 through FY12.

A2d. Aerospace systems have historically been designed—and regulations for their certification and use have been written—as though aviation noise and various emissions had nothing to do with one another. However, aviation noise and emissions are highly interdependent phenomena. Our environment and energy research investments are based on a new, interdisciplinary approach. Consequently, the majority of our investment benefits both noise and emissions. Our research investments that will help us understand and mitigate aircraft noise and emissions impacts are shown in Table 1.

$1000s	RE&D	Capital Activity-1	ACRP*
FY06	$13,500		
FY07	$14,300		$500
FY08	$14,100		$1,000***
FY09**	$31,000	$15,000	$1,500***
FY10**	$31,000	$15,000	$1,500***
FY11**	$31,000	$15,000	$1,500***
FY12**	$31,000	$15,000	$1,500***

* Airports Cooperative Research Program
**Based on 2007 National Aviation Research Plan
***Projections; actual investments subject to ACRP Board Discretion

Q2e. What specifically does the goal of "reducing noise and emissions in absolute terms by 2025" mean?

A2e. Our goal is to reduce the significant impacts of aircraft noise and local air quality emissions on a net basis. For example, if half a million people are impacted by significant noise today, as defined as exposed to 65 DNL, the target is less than half a million people would be exposed, despite a here fold capacity growth, to the appropriate noise metric for 2025. We are also working on developing sufficient understanding of the science and impacts to develop appropriate metrics for greenhouse gas emissions.

Q3. How does the Federal Interagency Committee on Aviation Noise function? What is FAA's role? Does the Committee produce an interagency research plan? If not, why not? If so, please provide a copy. What specifically has this Committee accomplished to date?

A3. The Federal Interagency Committee on Aviation Noise (FICAN) was formed in 1993 to provide a forum for a coordinated Federal Government approach over future research needs to better understand, predict and control the effects of aviation noise, to encourage new technical development efforts in these areas, and set technical policy with respect to aircraft noise. It does not produce research plans, but seeks to foster coordination of efforts among relevant agencies.

The Committee is currently composed of representatives of the departments of Transportation (Office of the Secretary and the Federal Aviation Administration), Defense (all three branches), Interior (National Park Service), Housing and Urban Development; the agencies of Environmental Protection, National Aeronautics and Space. Each of these federal agencies either conducts significant research on aviation noise or has broad policy roles with respect to aviation noise issues (such as HUD, NPS and EPA). In the past FAA or the Defense Department representatives have led the committee since their work is directly related to aviation. Currently, the Chair is from the Navy.

The most widely recognized product of the FICAN (published by a proceeding committee in 1992) is the report "Federal Agency Review of selected Airport Noise Analysis Issues" which has findings, conclusions and recommendations for the aircraft noise policy issues. The FICAN has also published findings and reports on extensive array of aircraft noise issues such as low-frequency noise, supplemental metrics, effects of aircraft noise on learning, noise in national parks, etc.

Additional information on FICAN can be found at: *http://www.fican.org/*

Q4. In his testimony Dr. Hansman stated that ". . .the NASA program has been in transition, and it is still not fully clear what the full content of the NASA program will be and its consequent impact on the FAA."

a. Has NASA given you a clear and complete description of its restructured program yet, and has it identified those areas of research that supported FAA in the past that will be cut back or eliminated? If so, what are those areas?

b. Has NASA told you how far (in terms of technological maturity) it will take the research that it is planning to do?

c. What is the impact of NASA's redirected aeronautics program on the FAA, and when will that impact be felt?

A4. The FAA has program documentation from NASA for its aeronautics research. The documentation does provide a clear, top-level description of its research thrusts and milestones. However, we are waiting for the completion of detailed project plans to better understand the details of the research and to what level of maturity the research will be brought. Currently, JPDO, NASA and FAA are working together on the general requirements for technology transfer from NASA to FAA to ensure that we understand and have plans to ensure that NASA's research efficiently transitions to FAA for further development and systems engineering in preparation for implementation investment decision making. Furthermore, the JPDO has a requirement to deliver an R&D plan to OMB this fall. As a part of that process, JPDO will document the research requirements for NextGen and the responsibilities of each agency in addressing those requirements. In summary, we do have general documentation from NASA that demonstrates alignment to NextGen requirements and we are working together and with the JPDO to work through the details to ensure we can transition NASA research into FAA implementation.

Because of lengthy lead times, research required to support NextGen implementation through FY 2015 has been completed with a provision for supporting technology transition of this research. However, because of these lengthy lead times, the research required for products to be implemented in FY 2016 and beyond must be started soon. As previously stated, the FAA is working with the JPDO and NASA to understand what research will be delivered so potential "gaps" can be defined.

Q5. Dr. Hansman discusses the "technology maturity gap" that is emerging as a result of NASA's planned cutbacks. Others, including the GAO, have raised the same concern.

a. What are the most important research areas that are projected to face a "technology gap?"

b. Does your FAA R&D budget for FY08 with its five-year runout assume that FAA will fund all of the technology maturation tasks that you had been counting on NASA to do? If not, how much additional funding will you require for FAA to do all of the technology maturation?

A5. We are depending on NASA for the longer-term, transformational elements of the transition to NextGen that we expect to begin implementing after 2015. Up to that point, the research, much of which was originally pioneered by NASA, has largely been completed or is at a more advanced stage of development. Therefore, for the next several years, we do not expect that there will be any significant technology gaps. The FAA's reauthorization that is currently with Congress reflects our expanded requirements for R&D to meet the mid-term needs of the transition to NextGen (up to 2015). In the long-term, we are looking to NASA to answer challenging transformational questions, such as the relative roles of humans and automation in NextGen, how to implement automated, fault-tolerant gate-to-gate 4D trajectory management within the NAS. As previously discussed in response to Question 4, we are actively working with NASA and JPDO to understand the details of the research that is required and to ensure we have a technology transition pathway.

Q6. Dr. Hansman in his testimony raises a concern about whether or not NASA intends to continue supporting the aviation safety and human factors data bases that have been built up over the long-term by NASA. What has NASA told you—does NASA intend to maintain and support these important data bases?

A6. The aviation safety data bases from the NASA Voluntary Aviation Safety Information Sharing Program (VASIP) are being transitioned to the FAA for implementation as part of the Aviation Safety Information Analysis and Sharing System (ASIAS). NASA responsibilities consist of supporting transition of Voluntary Aviation Safety Information Sharing (VASIS) technologies to ASIAS by the end of FY 2007. NASA will continue development of data mining analytical tools that could be applied to systems such as ASIAS. The NASA-managed Aviation Safety Reporting System (ASRS) will continue to be supported by the FAA as new electronic reporting procedures are implemented. The NASA National Aviation Operations Monitoring Service (NAOMS) has been picked up and sponsored by the Air Line Pilots Association (ALPA).

Q7. Has the interagency Joint Planning and Development Office (JPDO) given you a clear set of research requirements yet?

a. If so, would you please provide them to the Committee?

b. If not, why hasn't the JPDO done so, and when do they intend to provide them?

c. You have outyear funding set aside in your budget for "Next Gen" research. What specifically is that funding intended to be used for?

d. Do you consider JPDO research requirements "guidelines" for FAA's R&D program to consider, or do you consider them to be mandatory requirements that will have to be addressed completely in FAA's R&D plan?

A7. JPDO provided R&D needs to the partner agencies in January of this year based on the NextGen Concept of Operations and the transitional Operational Improvements. This was a starting point for FAA/JPDO collaborative planning. Within the FAA, we have used the Operational Evolution Partnership (OEP) as the mechanism for incorporating NextGen requirements into our R&D plan. The JPDO has been a full partner in the OEP process to ensure that NextGen R&D needs are appropriately reflected in FAA's plan. Furthermore, the JPDO will publish an Integrated Work Plan late this summer and, as a part of that, is developing a multi-agency R&D plan that it will submit to OMB this fall. FAA is fully participating in this effort as well, and we will ensure that the OEP and multi-agency R&D plan are synchronized. We will use the outyear funding set aside for NextGen R&D to carry out the FAA's portion of the multi-agency R&D plan.

Q8. General aviation operations are an important part of the Nation's aviation system. What specific research do you have underway or planned related to general aviation, and how much do you plan to spend on that research?

A8. A significant component of general aviation research addresses human factors issues associated with getting better weather information into the cockpit to improve pilot decision making and reduce accidents. Reducing visual flight rules (VFR) flight into instrument meteorological conditions (IMC), which is the leading cause of general aviation fatalities, is a primary focus. Developing better training and testing of weather knowledge and its application is another component along with identifying proactive methods for general aviation data collection that could be used for risk assessment and accident prevention. Non-weather related human factors research includes development of the technical information needed to publish proficiency standards for very light jets. Total funding is $1.15M.

Q9. Do the technology demonstrations come out of the agency's overall R&D budget, and if so, how do you prioritize between R&D and carrying out technology demonstrations?

A9. The demonstrations are part of the overall R&D budget. They are a key part of the R&D development which includes, per OMB Circular A–11, "design and development of prototypes and processes," and are included in the FAA's 2007 National Aviation Research Plan (NARP).

The demonstrations have been prioritized among all developmental activities. They are included in the R&D portfolio since these demonstration leverage research that has identified opportunities to move air traffic control towards NextGen trajectory based operations through new algorithms for decision support systems, new flight deck systems, and new procedures. They were given their priority among developmental activities because successful results will lead to NextGen midterm implementations.

Q10. What is the timetable for certifying Unmanned Aircraft Systems for operations in the national airspace system?

A10. The development of guidance and regulations for Unmanned Aircraft Systems (UASs) will be an evolving process, and is crucial to the safe integration of UASs into the National Airspace System (NAS). To support these activities, the Aviation Safety Organization established the FAA Unmanned Aircraft Program Office in early 2006 to specifically consider and address required activities to support the safe establishment and growth of the UAS Industry. The level of effort for related efforts requires significant resources from the FAA's Air Traffic and Aviation Safety organizations.

In 2004, the FAA requested that RTCA, a government-industry consensus standards development forum, initiate an effort to develop civil standards for UASs. In response, RTCA established Special Committee 203 (SC–203) to develop and recommend UAS standards, specifically for Detect Sense and Avoid (DSA) and Com-

mand, Control standards, and Communication (C3) technology. Since its inception, SC–203 has met 10 times, making significant progress in defining UAS operational concepts, as well as serving as a liaison with the international community in effort harmonization the developing standards. The committee's current schedule reflects a timeline to deliver recommendations for UAS technical standards to the FAA in 2011. Approval of these technical standards is largely dependent upon the successful parallel effort of industry to develop DSA and C3 technologies. In the interim, the FAA is evaluating various alternatives to accelerate limited operations of UASs in the NAS. The desired goal is to implement streamlined processes to enable UAS access to the NAS, based on the level of maturity of UAS technology. Appropriate levels of funding and resources will be needed to accomplish this task. If resources are available and the industry wishes to pursue civil, commercial applications for UASs, the FAA has an enabling strategy to facilitate routine UAS "file and fly" access to the NAS within the 2012–2015 timeframe.

Q11. The REDAC had recommended that "When the decision occurs to implement research results, funding must be identified for the transition process. . ." *The FAA responded that it is working with the Agency's Research Project Description process to create a line item to support Technology Development and transfer of technology. Is that line item included in the FY08 budget request?*

A11. The FAA's reauthorization that is currently with Congress reflects our expanded requirements in fiscal years 2008–2012 to support transition of research. Our Capital Investment Plan for fiscal years 2008–2012 carries a "Future NextGen Air Transportation System—System Development line (Budget Line Item Number 1A 14X) beginning in fiscal year 2009.

Questions submitted by Representative Ken Calvert

Q1. Historically NASA has played a major role performing research and development on behalf of FAA, especially with respect to air traffic control technologies, but that relationship appears to be changing. NASA's aeronautics research budget has been reduced by more than half over the last few years, and NASA is no longer developing new technologies to a high level of technical maturity. Looking to the future, how would you characterize NASA's role with respect to FAA? Will it continue to diminish? How detrimental is that to the overall effort?

A1. NASA has and will continue to play a critical role in ATC research. Without their continued foundational research, the longer-term, higher-risk elements of the NextGen transformation will likely go unrealized. Their policy decision to not pursue higher levels of technical readiness will ultimately require FAA to accept technologies earlier in the pipeline. We are working closely with NASA and the JPDO to develop general requirements for technology transition which we will use to work specific plans between the agencies. FAA's reauthorization bill, which is with Congress, specifies the funding requirements for FAA to deliver on development and implementation of NextGen over the next five years. As we work the details of transitioning technology between NASA and FAA, we will update our budget projections to cover those outyear requirements.

Q2. Traditionally NASA has developed promising technologies to a high maturity level enabling FAA to incorporate them into its air traffic control system without too much additional development. Now that NASA is confining its development work to a basic level of technical maturity, does FAA have the resources and capability to fill this void? Where will it get the personnel?

A2. Timely and efficient transition of research products will require the FAA to engage at a lower technical maturity levels. Past successful transitions of NASA technologies have taken longer to fully implement in the National Airspace System than we can allow if we are to realize the NextGen system in time to meet forecasted demand.

The FAA's reauthorization request reflects our expanded requirements for R&D to meet the mid-term needs of the transition to NextGen. The requested funding will allow this transition. We will focus internal resources on NextGen research and technology development and will use attrition to hire technical and program management expertise. We will use the Operational Evolution Partnership to focus MITRE CAASD research on NextGen requirements; we are assessing resources available at Volpe to supplement FAA capabilities, and we may look to industry for assistance.

We are in the process of seeking outside expertise in the form of a "blue ribbon panel" to explore strategies to strengthen our technical and contract management expertise.

Q3. NASA, the Defense Department, and other federal agencies have demonstrated that Unmanned Aerial Vehicles can be flown safely in the national airspace system and have the potential to serve useful civil and emergency services roles. Many industry experts envision UAVs playing more prominent roles in the U.S. airspace, but FAA requirements to fly them are complex and it can take weeks to gain permission to fly.

Q3a. What is the current state of research on operating UAVs in controlled airspace?

A3a. The introduction of Unmanned Aircraft Systems (UASs) into the National Airspace System (NAS) continues to present many challenges to the aviation community, including the Federal Aviation Administration (FAA). Although NASA, the Department of Defense (DOD), and other federal agencies have safely flown UASs in the NAS, the FAA works with these organizations to develop conditions and limitations for UAS operations to ensure they do not jeopardize the safety of other aviation operations or harm the general public. Typically these operations are flown in segregated airspace, or require the use of visual observers to mitigate identified risks.

Several Research activities are ongoing in support of UAS operations and are in various levels of maturity. Many of these efforts are multi-year activities, and will require continued finding, often competing with other safety related R&D activities, and include investigating the following areas:

- UAS Regulatory Studies;
- UAS Airframe Technology Survey;
- System Safety Management;
- Compression Ignition Engines;
- Propulsion System Technologies;
- Ground Observer Requirements for UAS Operations;
- Design and Development of Visibility Analysis Tool;
- Vision Model to Predict Target Detection and Recognition;
- Sensory Deficiency Assessment Program;
- UAS Maintenance and Repair; and
- Ground Control Station Radio Frequency Interference.

To resolve the complex issues surrounding UAS–NAS integration, FAA is collaborating extensively with the DOD Joint Integrated Product Team, representatives from the DOD Policy Board on Federal Aviation, as well as various other U.S. Government agencies, including Department of Homeland Security, Department of Commerce, Department of Justice, and NASA.

To further international harmonization associated with UAS-airspace integration, FAA is actively engaged with counterparts from both the European and international aviation authorities. For example, FAA actively co-chairs the European counterpart organization to RTCA SC–203, EUROCAE Working Group #73, for UAS technical standards development. FAA closely collaborates with EUROCONTROL annual work plans for research and development activities to help mitigate UAS-airspace impacts, which includes the study of human factors.

Q3b. By what date does FAA anticipate UAVs having routine and convenient access into the national airspace system?

A3b. The development of guidance and regulations for Unmanned Aircraft Systems (UASs) will be an evolving process, and is crucial to the safe integration of UASs into the National Airspace System (NAS). To support these activities, the Aviation Safety Organization established the FAA Unmanned Aircraft Program Office in early 2006 to specifically consider and address required activities to support the safe establishment and growth of the UAS Industry. The level of effort for related efforts requires significant resources from the FAA's Air Traffic and Aviation Safety organizations.

In 2004, the FAA requested that RTCA, a government-industry consensus standards development forum, initiate an effort to develop civil standards for UASs. In response, RTCA established Special Committee 203 (SC–203) to develop and recommend UAS standards, specifically for Detect Sense and Avoid (DSA) and Command, Control standards, and Communication (C3) technology. Since its inception, SC–203 has met 10 times, making significant progress in defining UAS operational

concepts, as well as serving as a liaison with the international community in effort harmonization the developing standards. The committee's current schedule reflects a timeline to deliver recommendations for UAS technical standards to the FAA in 2011. Approval of these technical standards is largely dependent upon the successful parallel effort of industry to develop DSA and C3 technologies. In the interim, the FAA is evaluating various alternatives to accelerate limited operations of UASs in the NAS. The desired goal is to implement streamlined processes to enable UAS access to the NAS, based on the level of maturity of UAS technology. Appropriate levels of funding and resources will be needed to accomplish this task. If resources are available and the industry wishes to pursue civil, commercial applications for UASs, the FAA has an enabling strategy to facilitate routine UAS "file and fly" access to the NAS within the 2012–2015 timeframe.

Q4. How does FAA coordinate its weather research programs (FY08 request is $16.8M; five year request totals $84M) with those of other federal agencies (e.g., National Weather Service) to ensure that research efforts aren't duplicated, and that research products are being widely disseminated?

A4. The Aviation Weather Research Program is highly leveraged with other government agency work including the Department of Commerce, the Naval Research Laboratory, National Aeronautics and Space Administration and, recently, with several of the Department of Energy's programs as well as several Federally Funded Research and Development Centers (FFRDCs). Within the Department of Commerce collaborative work on aviation weather extends to several National Oceanic and Atmospheric Administration laboratories including the Earth Sciences Research Laboratory and the National Severe Storms Laboratory, along with the National Weather Service's National Centers for Environmental Prediction. In addition to interagency outreach the program also coordinates science activities with several countries including Canada, Great Britain, and China.

In FY 2007 the program manager began participating in the Joint Program Development Office's (JPDO) Weather Executive Council. The JDPO includes membership from seven agencies, including Department of Transportation, Federal Aviation Administration, National Aeronautics and Space Administration, Department of Homeland Security, Department of Commerce, Department of Defense and Office of Science and Technology Policy. In FY 2006, the JPDO Executive Council reviewed aviation weather activities at several agencies, including the FAA's Aviation Weather Research Program. The JPDO Weather Executive Council also includes representatives from industry to enhance outreach.

Additionally, as part of the FAA's Research, Engineering and Development portfolio, the program is reviewed both by internal management and by the Research, Engineering and Development Advisory Council.

ANSWERS TO POST-HEARING QUESTIONS

Responses by R. John Hansman, Jr., Co-Chair, FAA Research, Engineering, and Development Advisory Committee; T. Wilson Professor of Aeronautics and Astronautics and Engineering Systems; Director, MIT International Center for Air Transportation, Massachusetts Institute of Technology

Questions submitted by Chairman Mark Udall

Q1. A concern that has been raised is the potential impact of the cutback in NASA's human factors research program. How important is human factors research to the success of FAA's system development initiatives, and how concerned is the REDAC about the NASA cutbacks?

A1. Human factors issues are critical in terms of the safety and capacity performance of the NAS. Human error remains a primary cause factor in 60–70 percent of fatal accidents. Controller cognitive and workload limits are one of the major constraints on the capacity of the NAS. Many of the proposed NextGen concepts will change the roles of the humans in the system but humans will remain in key supervisory roles for the foreseeable future. It is very important to understand the human-automation integration issues associated with implementing NextGen. These issues should be addressed early in the system development process to avoid unintended safety issues or expensive late stage redesign efforts. when human factors concerns emerge late in system development.

The REDAC has expressed significant concern about the national capability in aviation human factors. This concern precedes the recent NASA cutbacks.

Q2. In your testimony you state that "as the JPDO is focused on longer-term transformation concepts, there is a tension between those needs and the R&D required to address nearer-term issues and to manage the system."

Q2a. What does the REDAC think the appropriate balance should be between funding for transformational R&D and R&D required to address nearer-term issues?

A2a. The REDAC has recommended a portfolio approach with a balance between near-term focused research to address emergent problems, longer-term research for transformational goals such as NextGen, and a small investment in long-term exploratory research to stimulate innovation.

Q2b. Does FAA currently have the right balance between those two kinds of research?

A2b. The FAA has traditionally focused on research to support short-term issues. The forces on the agency, and the research requirements, processes tended to prioritize investment towards current issues. Because of the time required to program and execute the research programs, the results were often too late to be as effective as would be desired. An increase in research towards anticipated needs would be beneficial. The FAA management has recognized this need and is developing processes to define research requirements to support both the mid-term Operational Evaluation Plan and the longer-term NextGen issues. The REDAC would also like to see a small part of the portfolio for investment in innovation and new concepts.

Q3. In your testimony you state that "the major challenge for the FAA R&D program and the agency as a whole will be to find ways to efficiently and quickly implement the technologies, and new operational concepts into the national airspace system while maintaining or increasing level of safety and minimizing environmental impact." *You then conclude that* "it is unclear whether we have the strategic core competency to effectively implement the new concepts in the national airspace system, and we must develop approaches to enable effective transition."

Q3a. Can you elaborate—is it a research problem, a workforce problem, a management problem, a funding problem, or something else?

A3a. While all of the elements above have some role, the key issues are cultural. The current culture has developed over a long period of management and maintenance of the NAS. Most of the changes to the NAS have been adaptations to the current system and there have been very few major changes for the past three decades. There have been no recent changes of the transformational scale proposed in some of the NextGen concepts. Also during this time, there has been an admirable

improvement in the level of safety or the system. There has also been an increase in the safety and environmental analysis required to get operational approval. Finally as the system has grown in scale it has also grown in complexity. These factors combine to make it extremely difficult and time consuming and to make substantial changes in how the NAS operates.

Q3b. What would you recommend be done?

A3b. There are three recommendations. First, developing the capability for efficient operational approval should be a goal for the FAA, the JPDO, as well at the partner agencies. Second, research should be conducted into both the operational approval processes and the techniques (such as lean process, advanced safety analysis, and system trade studies) to improve the efficiency and to enable system transition. Third, several pathfinder programs should be defined for expedited operational approval where the processes are monitored for efficiency, coordination, and effectiveness to identify both best practices and areas where improvements are needed. These programs should provide a template for subsequent programs.

Q4. Unmanned Aircraft Systems (UAS) are likely to play a very significant role in future aviation activities. Is the FAA doing enough to understand the impacts of UAS on the national airspace system and to certify them for operations in the airspace? If not, what would you recommend be done? Should other governmental agencies be involved?

A4. The FAA is struggling to respond to the growing demand for access to the NAS from both military and civil UAS users. Two key demands are military requests for easier "file and fly" access for their large scale vehicles (such as Predator and Global Hawk) and civil or public agency users (e.g. police) who desire to fly small model aircraft scale UAVs for surveillance missions.

Operational approval of UAS in the NAS is an example of the type of transformational system change I discussed in the previous question. Routine UAS operations represent a significant departure from current NAS operations and may require fundamental changes in NAS operations and policy. This is a significant challenge for the FAA. The UAS program office is putting out a significant effort but appears to be under-resourced in terms of staff and funding. The shift in NASA focus away from UAS and other applied areas has also pulled resources away from the UAS programs office in technical areas such as UAV flight dynamics, airspace modeling tools, and UAS frangibility.

The REDAC would recommend increasing support for research related to UAS in the NAS and for the UAS program office with the goal of accelerating operational approval. The DOD and NASA are potential collaborators in these efforts.

Q5. Aircraft noise is a significant concern for communities across the United States.

Q5a. Do you believe FAA's FY08 request for noise research is sufficient?

A5a. Noise has been identified as one of the key focus areas in the FAA FY09 requests due both to the impact on local communities and the ability of the system to expand capacity. Given the importance as well as the time required to ramp up capability, it would be prudent to initiate some of the FY09 efforts in FY08.

Q5b. What have been the FAA's accomplishments to date in this area?

A5b. At the aggregate level there have been significant improvements. For example the number of people exposed to the 65 dbA noise level in the U.S. has decreased from approximately seven million in the mid-1970's to approximately 500,000 today. The FAA has also been supporting the development of new operational approaches such as recent flight tests of low noise Continuous Descent Approaches (CDA) at Louisville, KY.

Q5c. What level of funding would be consistent with its importance and would allow us to exploit opportunities for aircraft noise reduction?

A5c. The proposed FY09 levels of $55 Million plus $5 Million from ACRP funds proposed in the National Aviation Research Plan appear to be appropriate.

Q5d. What do you think are the most promising research opportunities in aircraft noise reduction—and what should be FAA's role in the research? NASA's role?

A5d. In the near-term, operational procedures such as the Continuous Descent Approaches and flight procedure modification will provide the most promising opportunities for aircraft noise reductions. The challenges for these efforts will be in integrating these new procedures into the NAS and the impact on airspace design, procedures, and capacity. NASA and the FAA can collaborate on the airspace and oper-

ational procedures. NASA has also charted a path to develop aircraft with significantly lower noise footprints. This is a commendable effort, but given the slow turn over of the commercial aircraft fleet the operational procedures improvements will be the most important in the short-term.

Q6. How would you characterize FAA's cooperative research with academia and industry? Do you have any recommendations to improve the effectiveness of the cooperative activities?

A6. The FAA has several effective Centers of Excellence (COE) focused on specific topics such as aviation environmental impact, operations research, etc. The COEs typically stimulate cooperative research between academia and participating industry partners. The FAA is less effective at stimulating innovative concepts and bringing in new researchers and students into cooperative activities. It would be desirable to have a small part of the research portfolio dedicated to innovation and the support of students with the goal to stimulate both excitement and opportunities in fields critical to the FAA mission.

Questions submitted by Representative Ken Calvert

FAA/NASA Collaboration

Q1. Historically NASA has played a major role performing research and development on behalf of FAA, especially with respect to air traffic control technologies, but that relationship appears to be changing. NASA's aeronautics research budget has been reduced by more than half over the last few years, and NASA is no longer developing new technologies to a high level of technical maturity. Looking to the future, how would you characterize NASA's role with respect to FAA? Will it continue to diminish? How detrimental is that to the overall effort?

A1. Given the diminished NASA aeronautics research budget, NASA has elected to focus it's efforts toward more fundamental research which has resulted in some cutbacks in areas that have recently supported FAA needs. NASA continues to work in air traffic control systems and technologies but with a longer-term perspective driven by fundamental research issues or NextGen requirements. NASA is also working on safety and environmental research in collaboration with the FAA. NASA will continue to work with the FAA both directly and through the JPDO on longer-term fundamental research but the FAA will have to cover the shorter-term and more applied research efforts.

Q2. Traditionally NASA has developed promising technologies to a high maturity level enabling FAA to incorporate them into its air traffic control system without too much additional development. Now that NASA is confining its development work to a basic level of technical maturity, does FAA have the resources and capability to fill this void? Where will it get the personnel?

A2. In response to the NASA aeronautics program refocusing, the FAA has recognized the need to increase funding and attention to longer-term research and the transition of lower TRL technologies operational maturity. It should be noted that the NASA cutbacks primarily impact NASA developed technologies and the transition "gap" problem has been longstanding for other technologies. The issue is exacerbated by the need to modernize the system reflected in the NextGen concepts. It is unclear if the FAA has the reservoir of personnel and expertise to address the issue.

Transitioning New Technologies

Q3. You state that FAA's ability to implement change into the air traffic management system can take years, if not decades, and you also question whether FAA has the core competency to implement new concepts. What prevents FAA from implementing changes more rapidly, especially if it's their desire? If it's structural, can't FAA change the process to make it more responsive? Are legislative changes needed, and if yes, what are they?

A3. The task of changing a mature, national, safety critical infrastructure, such as the Air Traffic Management (ATM) system, is a major challenge. The system must continue to operate around the clock and across the Nation while maintaining the current high level of safety for each step of the transition path. As the ATM system has evolved it has become more interdependent and includes more stakeholders. As a result, many potential changes will have broad impact and will involve many stakeholders. Proposed changes must also pass through much higher levels of safe-

ty, environmental (NEPA), and financial review than when the ATM system was initially developed.

For example, the high safety standards and complexity of the system make it exceptionally difficult to prove that a fundamentally new technology or concept meets the Target Level of Safety (TLS) for the system. The difficulty is increased because all the interactions with other elements of the system, as well as all failure modes, need to be considered. Often the problem may not be a real safety issue but the lack of data or analysis to prove that the change will meet the safety standard prevents change from occurring. Because safety is the highest priority of the ATM, the FAA cannot give operational approval until is assured that the change is safe. Similar challenges exist for environmental impact reviews as well as the OMB review process for federal investment and the individual stakeholder impact analysis.

Fundamentally, it is a much more difficult problem to change a mature ATM system than the original development of that system. We have not made changes of the order contemplated by NextGen since the development of RADAR based ATC in the late 1950's.

Unmanned Aerial Vehicles

Q4. NASA, the Defense Department, and other federal agencies have demonstrated that Unmanned Aerial Vehicles can be flown safely in the national airspace system and have the potential to serve useful civil and emergency services roles. Many industry experts envision UAVs playing more prominent roles in the U.S. airspace, but FAA requirements to fly them are complex and it can take weeks to gain permission to fly.

Q4a. What is the current state of research on operating UAVs in controlled airspace?

A4a. The problem of approving UAV operations in civil airspace is an example of the difficulty in assuring that changes in the NAS meet the high safety standards the FAA believes it has the responsibility to protect. While it is true that NASA, the DOD and others around the world have flown UAVs in civil airspace these have generally been in fairly restricted conditions and there is some disagreement as to what the appropriate safety standards for UAVs should be. Because the current regulatory structure has assumed human occupants, many of the regulations and safety criteria assume that there is a pilot in the vehicle and these criteria need to be amended or interpreted.

Because of the difficulties of evaluating the projected level of safety of totally new UAS operational systems it is attractive for the FAA to require that the UAS system have the equivalent level of function or safety to manned systems. As an example, one of the major research areas has been to define technologies or procedures which provide the equivalent "sense and avoid" capability to a pilot's visual ability to avoid traffic. This approach is technically challenging and may be appropriate for large, highly capable UAVs, but would be prohibitive for very small model scale UAVs. There is also research into operational procedures and risk analysis.

It should also be noted that the FAA and NASA funding levels for research on operating UAVs in controlled airspace are modest and do not reflect the priority indicated by industry and the Department of Defense.

Q4b. By what date does FAA anticipate UAVs having routine and convenient access into the national airspace system?

A4b. For small scale UAVs operating in visual line of sight of a ground observer, approval for routine access is expected in the next 18 to 24 months. For larger scale UAVs the time frame is longer. The technical standards process for "sense and avoid" avionics is not expected to be complete before 2009 and may not be finished until later. If the FAA retains the requirement for "sense and avoid" capability, routine access would not be expected before 2010–2012. In the interim period, it is likely that the demand for access will spur more efficient processes for limited access through expedited Certificates of Authorization (COA) or other processes.

Future Aeronautics Workforce

Q5. With respect to developing the next generation of aeronautics engineers, you state that uncertainties in federal aeronautics research funding is having an adverse impact on university programs and the pipeline for young talent. Please elaborate: what is the impact and its severity? What are FAA and NASA doing to address this challenge?

A5. The NASA Aeronautics Program has been a core supporter of U.S. academic research in aeronautics over the past 30 years. The significant reduction in the NASA

Aeronautics research budget over the past few years has reduced the opportunity space and made it difficulty to attract young faculty and students to the aeronautical engineering field just at the time when the demographics indicate we should be building in this area. The FAA and NASA are aware of this problem, but it is unclear if they have the resources or focus to turn this tide. It should be noted that NASA is attempting to increase academic participation in it's National Research Announcements program but this is limited to specific topic areas.

Weather Research

Q6. How does FAA coordinate its weather research programs (FY08 request is $16.8M; five year request totals $84M) with those of other federal agencies (e.g., National Weather Service) to ensure that research efforts aren't being duplicated, and that research products are being widely disseminated?

A6. There is some coordination between the FAA weather research programs and the NWS through the JPDO weather focused activities. There is also significant information exchange on research programs through the aviation weather research community.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Donald J. Wuebbles, Chair, Workshop on the Impacts of Aviation on Climate Change; Department Head and Professor, Department of Atmospheric Sciences; Executive Coordinator, School of Earth, Society, and Environment, University of Illinois at Urbana–Champaign

Questions submitted by Chairman Mark Udall

Q1. The 2002 National Research Council report, For Greener Skies: Reducing Environmental Impacts of Aviation, *stated that research to reduce oxides of nitrogen and improve engine efficiency had been significantly reduced at NASA and that the research that is supported does not carry the work far enough so that results can be readily adopted by industry. And in general, the report found that even though large uncertainties remain regarding aviation's effects on the atmosphere, research budgets for examining the issue had been cut by two-thirds in recent years.*

Q1a. Do you know whether the research outlook has improved at NASA since the 2002 report?

A1a. The research support at NASA for evaluating the environmental effects of aviation emissions has not improved at all; in fact, as far as I know, there is currently no support within NASA for aviation impact's studies. NASA had a significant research program in the 1990s called the Atmospheric Effects of Aviation Project (AEAP) that focused on some of the global environmental issues associated with aviation, but that program ended by 2001. A much smaller program then developed out of NASA Glenn Research Center that continued some support for a few special observations (primarily of aerosol emissions on the ground) and some atmospheric modeling, but that program ended in 2005. There has been no support since then for research to study the potential impacts of aviation on climate change. The Workshop I coordinated last June was the first attempt to pull the international science community together to examine where the science stands since the IPCC special assessment on aviation was completed in 1999. Our conclusion was that there was a definite need for a new research program in the U.S. on the impacts of aviation on climate change.

Q1b. In your opinion, does FAA have the right level of investment in this research? What about other government agencies?

A1b. The FAA is currently not spending any money, as far as I know, on basic research to understand the environmental impacts of aviation (however, they may be working with the engine manufacturers on technology to reduce emissions). Nor is there any support for aviation emissions effects coming from other agencies.

Q1c. What should NASA's role in assessing and mitigating the impact of aviation on the environment be? What should FAA's role be?

A1c. I personally think that both NASA and FAA should have a major role in further assessing and in mitigating the impact of aviation on the environment. NASA has played a major role in past assessments of human activities on the global atmosphere, both in terms of global atmospheric chemistry (e.g., the ozone layer) and in climate analyses. As mentioned above, NASA sponsored the research on aviation emissions effects throughout the 1990s and early 2000s. The scientists in that program, including myself, were lead authors on many of the chapters of the IPCC assessment on aviation impacts on the environment in 1999. NASA has also played a strong role in sponsoring technology development towards reducing emissions from aviation. As part of its mission, the FAA has an obligation to determine mitigation strategies and help develop aviation policy. Therefore, a joint program with new money aimed at supporting a research program towards fully understanding the potential impacts of aviation on climate change, that at the same time brings in the concerns of the FAA regarding tradeoff studies to help them consider appropriate policies, would likely be best. The funding request from the FAA to get some efforts going in 2008 would certainly help, but the overall program needs to be much larger.

Q2. In your testimony you noted the importance of data from satellites and airborne platforms for better understanding of the impact of aviation on climate change. That sounds like there is a role for both NOAA and NASA's Earth Science program in the effort. Do NASA and NOAA have programs established to conduct

research in the impact of aviation on climate change? If so, are they adequate? If not, what else is needed?

A2. Both NOAA and NASA are taking important observations and doing important analyses to contribute to the basic understanding of the effects of human activities on our climate system. Neither, however, is currently involved in any research to understand the impact of aviation on climate change. The new research program I have proposed should definitely coordinate with other climate related studies at NASA, NOAA and other agencies. However, this new research program is necessary to meeting the needs of the Federal Government and industry to fully resolve key uncertainties in our understanding of the impacts of aviation on climate change. Improved understanding will be necessary to negotiations with other members in ICAO towards future international policy affecting aviation.

Q3. In your testimony you state that "Decisions with broad policy implications, such as the European Emissions Trading Scheme are being made without a firm understanding of the underlying science." *Would you please elaborate on what the Europeans are doing relative to aviation emissions, and what underlying research is needed to properly support an emissions trading scheme related to aviation?*

A3. There are a number of different messages coming out of Europe that complicates answering this, but I think the key element is that there is an indication they want to include a multiplying factor on the amount of carbon dioxide emitted from aircraft that would account for all of the other effects on climate. Thus, the two percent effect of aviation on total human emissions of carbon dioxide would be treated as anywhere from four to nine percent of the total problem. The multiplier depends on how well we understand the effects of aviation emissions on climate resulting from nitrogen oxide emissions, contrail formation, and from effects on cirrus clouds. These effects all have large uncertainties, and would bring an arbitrariness to any policy developed unless these uncertainties are greatly reduced. Various organizations in Europe have all talked about policies to reduce contrail formation by forcing aircraft to fly at lower altitudes, but this would result in increased carbon dioxide emissions. We need improved metrics for the climate effects from aviation to put the tradeoffs from different emissions on a level playing field—those analyses have not been done yet, and really can't be done effectively until the scientific uncertainties are reduced.

Q4. Your workshop concluded that more research is required to understand aircraft emissions issues and to suggest policy responses. In your testimony you suggest it should be a focus for the U.S. Climate Change Science Program. Have you made this suggestion to the Program? If so, what was the response? Are you confident that results could be available in time to influence the Next Generation Air Transportation System, which is going to be developed and implemented between now and 2025?

A4. I have not talked with CCSP myself, but that is only because I knew that the FAA has already had that discussion with them. CCSP understands the importance of the issues and is interested in the science, but of course has no money itself for supporting the research. With the right size program set in place within the next few years, I am quite confident we, the science community, can have a sizable influence on NextGen. The right size for the research program is to be determined (e.g., through discussions with leaders at NASA and other agencies that are knowledgeable on the resources needed for the measurement campaigns and modeling studies required to meet the program objectives), but my guess is we need $7–15M per year for 5–10 years to largely resolve the major science issues. Interim findings would likely have a significant impact on NextGen.

Q5. How would you characterize FAA's cooperative research with academia? Do you have any recommendations to improve the effectiveness of the cooperative activities?

A5. As far as I understand, FAA has very little cooperative research with academia that is outside of very specific operations related tool development and associated studies. I personally think it would be very useful and highly productive for FAA to develop much stronger interactions with the academic community. Perhaps a new research effort could be developed within FAA that would be aimed at such interactions, particularly at addressing questions and issues of interest to FAA but at a more basic level.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Stephen A. Alterman, President, Cargo Airline Association; Chairman, Environment Subcommittee, FAA Research, Engineering, and Development Advisory Committee

Questions submitted by Chairman Mark Udall

Q1. In your testimony you are emphatic that "there must be a strong commitment from both industry and government to both the necessary research and the transition from the research mode to one of implementation. If either side breaks down, useful projects may be doomed."

Q1a. What specifically needs to be done to ensure that the commitment exists by both industry and government?

A1a. While it is difficult to mandate "commitment," if the government adequately defines the precise technology to be implemented and provides a detailed, credible description of both the costs and benefits, industry buy-in becomes easier. On the industry side, while difficult in an uncertain economic environment, technological improvements must be analyzed for their long-term implications, not in terms of short-term dollars that must be spent. In the end, I expect that the FAA will have to mandate the necessary equipage, with industry input coming during the rulemaking process.

In addition, if possible in the current political climate, industry acceptance could help be ensured if incentives for early equipage were given by the Federal Government. Such incentives might include accelerated depreciation, tax credits or other forms of financial assistance.

Q1b. Who should be in charge of making sure the transition from research mode to implementation takes place?

A1b. With primary responsibility for the National Airspace System, the FAA should be in charge of transitioning from research to implementation. In doing so, it might be helpful to establish a specific position within the agency to work with the Air Traffic Organization (ATO) in such transitioning.

Under no circumstances should the JPDO be put in charge of implementation. As a practical matter, the JPDO has become a massive bureaucracy in itself, with a focus on planning and development. As a multi-agency organization, it cannot focus on the details of air traffic technology implementation and placing any implementation function within the JPDO will only delay necessary improvements.

Q2. In your testimony you discuss the importance of ADS–B demonstrations. In general, how valuable are technology demonstrations or pilot projects to industry acceptance of new technologies? Should the FAA be doing more technology demonstrations, and if so, what kinds?

A2. Technology demonstrations and pilot projects are extremely important in obtaining industry acceptance of new technologies. Such projects provide a "real world" analysis of the technology being advanced and permit industry to experience the benefits first hand. Such pilot programs should be undertaken whenever possible.

In the context of FAA Reauthorization, programs dealing with environmental issues are particularly susceptible to the pilot program process. For example, sections 604 (Environmental Mitigation Demonstration Pilot Program) and 605 (Grant Eligibility for Assessment of Flight Procedures) of the FAA's proposed *Next Generation Air Transportation System Financing Reform Act of 2007* are extremely important and should be enacted by Congress. We urge that they be included in the House version of any reauthorization bill. (We also strongly urge adoption of section 606 of the FAA proposal (Research Consortium for Lower Energy, Emissions and Noise Technology Partnership)).

Q3. How would you characterize FAA's cooperative research with industry? Do you have any recommendations to improve the effectiveness of the cooperative activities?

A3. While speaking only from personal experience, I would say that the FAA and industry cooperate very well in the research area. For example, the industry's ongoing efforts in the ADS–B area began over 11 years ago and have included a constant dialogue with the FAA (specifically the Safe Flight 21 Office). By working cooperatively with the agency, we have been able to reach common understandings on the research to be done to mature the technology. Similarly, the Environmental Subcommittee of the FAA Research, Engineering and Development Advisory Committee

(REDAC) has been especially effective in targeting research to address significant environmental issues. This subcommittee is made up of a broad cross-section of the aviation industry and federal agencies and interfaces well with the FAA's Office of Environment and Energy.

If we have learned anything from these activities, it is that honest and continual communication between the government and industry is essential to mature and implement necessary technologies. Therefore, it is important that the FAA REDAC continue to provide the vehicle for industry input into the research process.

Question submitted by Representative Ken Calvert

FAA/NASA Collaboration

Q1. Traditionally NASA has developed promising technologies to a high maturity level enabling FAA to incorporate them into its air traffic control system without too much additional development. Now that NASA is confining its development work to a basic level of technical maturity, does FAA have the resources and capability to fill this void? Where will it get the personnel?

A1. The FAA, by itself, probably does not currently have the resources to fill the NASA void. To enable the agency to obtain these capabilities, Congress will have to provide the resources necessary to expand the FAA research programs. However, it may not be necessary to directly expand the FAA employee base to accomplish this objective. Rather, it may be possible to leverage the experience of existing research organizations such as MITRE and, in the environmental area, the PARTNER Center of Excellence, by increasing the funding for these organizations and specifying what projects they will address.