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Chairman Gordon and Members of the Committee, thank you for the opportunity to comment on the status of the Next Generation Air Transportation System initiative (NextGen) with regards to the impacts of aviation on the environment. I am the Head of the Department of Aeronautics and Astronautics at the Massachusetts Institute of Technology and Director of the Partnership for AiR Transportation Noise and Emissions Reduction (PARTNER). For 17 years I have conducted research directed towards understanding and reducing the environmental impacts of aviation. This work has spanned climate change, air quality, noise, and economic effects, and has included technological, operational, and policy dimensions. I work closely with the FAA Office of Environment and Energy.

My written testimony is organized in six sections. Section 1 briefly describes PARTNER. Section 2 summarizes the key findings from the 2004 Report to Congress on Aviation and the Environment. Section 3 provides an overview of noise, air quality, and climate change issues related to the national air transportation system. Within this section, I make several comments on current FAA and NASA programs and plans. In Section 4 I draw from the discussions of the Section 3 noise, air quality, and climate change overview and summarize what has changed since the 2004 Report to Congress on Aviation and the Environment. In Section 5 I share my views on the progress of the NextGen initiative and the Joint Planning and Development Office (JPDO). Section 6 concludes with the issues that I feel most urgently need to be addressed.

My main message is that the United States must accelerate efforts to address the environmental impacts of aviation. It is the right thing to do for the health of the public and the planet. It is also the right thing to do for the economy. If we do not achieve significant advances in environmental performance there will be increasing impacts on

health and welfare, and increasing constraints on the national air transportation system—with the attendant negative economic impacts that come with both. The constraints are sufficiently strong that they can impede realizing the potential of the Next Generation Air Transportation System. I therefore strongly support increases in funding for environmental research, development, and demonstration programs, such as those described in the pending FAA and NASA Reauthorizations. The priority must be on appropriating funds to programs that address aviation's environmental impacts starting with the FY09 budget. Thereafter, authorization and appropriation of funding for more significant programs are required.

1. PARTNER

PARTNER is an FAA/NASA/Transport Canada-funded Center of Excellence, founded in 2003, that focuses on improving the scientific understanding of aviation's environmental impacts, and on assessing, developing, and implementing technological, operational, and policy options for mitigating these environmental impacts. Educating future researchers and leaders in aviation and environment is an overarching goal. We have more than fifty graduate students working with leading faculty members at the Georgia Institute of Technology, Harvard University School of Public Health, Massachusetts Institute of Technology, Pennsylvania State University, Purdue University, Stanford University, Missouri University of Science and Technology, University of North Carolina, York University in Canada, and University of Reading and University of Cambridge in the United Kingdom.

One of PARTNER's greatest strengths is our advisory board. More than 50 U.S. and international organizations are represented including aerospace manufacturers, airlines, airports, national, state and local government, professional and trade associations, non-governmental organizations and community groups.

Hundreds of PARTNER investigators, students, and advisory board members have worked collaboratively over the last five years under the sponsorship of the FAA, NASA, Transport Canada, DOD, and the Airports Cooperative Research Council (ACRP) to advance understanding of the relationship between aviation and environment. This work has included:

- designing and testing alternate descent patterns as a no/low-cost means to reduce aircraft landing noise, fuel consumption, and pollutant emissions
- three significant measurement campaigns at U.S. airports to assess and understand the formation of particulate matter from aircraft
- collaborating with NASA and industry studying noise acceptability of supersonic flight over land
- examining land use, noise, and local development dynamics related to airport encroachment
- assessment of the human health and welfare risks of aviation noise, local air quality, and climate change impacts

- analyses of the costs and benefits of alternative fuels for aviation
- development of aircraft and air transportation system simulations to assess policies, technologies and operational options for enabling environmentally responsible air transportation growth
- online resource development to better inform the public about aircraft noise issues

2. 2004 Report to Congress on Aviation and the Environment

One of the first collaborative endeavors undertaken by PARTNER was to draft a report to the United States Congress on behalf of the Secretary of Transportation and the Administrator of NASA. The report, which is titled, *Aviation and the Environment: A National Vision Statement, Framework for Goals, and Recommended Actions*, represents the collective views of a broad range of stakeholders. Thirty-eight organizations participated, spanning the aerospace industry, NASA, FAA, the Environmental Protection Agency, Department of Commerce, Department of Defense, academia, state and local governments, and community activists. It was my privilege to be the lead author of the report (http://mit.edu/aeroastro/partner/reports/congrept_aviation_envirn.pdf).

The report's most important element is a proposal for a National Vision Statement for Aviation and the Environment. This vision statement was supported by every one of the 59 stakeholders who participated in drafting it. The National Vision specifies *absolute reductions* in significant health and welfare impacts from aviation noise and air quality emissions—notwithstanding growth, reduced uncertainty in understanding other impacts, and global leadership for the U.S. aerospace enterprise in addressing aviation mobility and environmental needs.

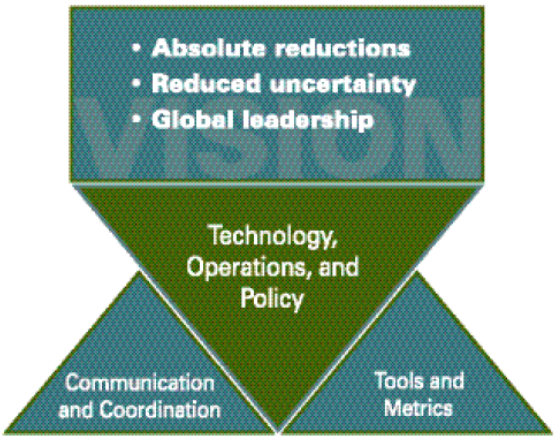

Figure 1: The image depicts the relationship between the recommended actions and the National Vision for Aviation and the Environment. Technology, Operations and Policy represent a balanced approach to addressing aviation mobility and environmental needs. These are placed in an inverted triangle to signify that the balance is dependent on the supporting elements of Communication and Coordination, and Tools and Metrics. It is only with all three of these elements in place that the National Vision of absolute reductions, reduced uncertainty, and global leadership will be achieved.

To achieve this challenging vision, the 2004 Report to Congress on Aviation and the Environment recommends three actions. The first is to promote coordination and communication among stakeholders. This should be interpreted as a call for a structure like the Joint Planning and Development Office. The second is to develop more effective tools and metrics for guiding policy decisions and for planning research investments. This is the area where some of the most important advances are occurring within FAA, but also where further work is required in the area of climate change. The third recommended action is to establish a vigorous program to develop specific technological, operational and policy options that support a balanced approach to long-term environmental improvements. My concerns are greatest with regard to progress on this third action.

This vision and the recommended actions have been adopted as the basis for the environmental objectives and plans of the NextGen Initiative,[1] the FAA's National Aviation Research Plan,[2] and the National Science and Technology Council's National Plan for Aeronautics Research and Development.[3]

I will return to the findings of this report later in my testimony. In particular, as you have requested, I will comment on what has changed since the report's publication (Section 4), share my views on the progress of the NextGen initiative and the JPDO (Section 5), and identify the issues I believe most urgently need to be addressed (Section 6).

3. Aviation, Environment and Mobility

Before commenting specifically on the NextGen initiative, it is useful to describe what we know and do not know about the environmental impacts of the U.S. air transportation system, and to set these impacts in the context of environmental impacts from other sources. I start by sharing two quotes:

> **"Flying — the worst thing to do … The dirtiest industry in the world."**
> B. Sewill, *Fly Now, Grieve Later*, 2005

> **" … unrelenting carbon-efficient improvement is business as usual for commercial airlines … We are the greenest form of mass transportation."**
> J. C. May, ATA President and CEO, Congressional Testimony, 2007

What are we to make of these differences of opinion? In Europe for example, sentiments in the press, and those held by many in the public, are quite negative. It is "common knowledge" for some that aviation is dirty business. This common knowledge is not

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[1] http://www.jpdo.gov/iwp.asp
[2] http://www.faa.gov/about/office_org/headquarters_offices/ato/publications/oep/plans/images/2007NARP.pdf
[3] http://www.ostp.gov/galleries/default-file/Final%20National%20Aero%20RD%20Plan%20HIGH%20RES.pdf

consistent with scientific assessments. There are certainly important impacts on human health, welfare, and ecological systems from aviation that must be addressed (I detail many of these below). However, it is equally true that the air transportation industry has made, and can continue to make, significant improvements. For example, in the last 30 years, there was a 60% reduction in energy intensity in air transportation, a reduction that is larger than that of any other mode of transportation. Indeed, between 2000 and 2007, fuel use and CO_2 emissions from U.S. commercial aviation have decreased by 3% in absolute terms despite 12% more passenger movements and 22% more freight flown.[4]

More importantly, further improvements are possible with new technologies and new fuels—improvements that will enable aviation to remain a small, and possibly even decreasing, contributor to the overall environmental burden of human activities. However, achieving these improvements is dependent on making the right decisions (which requires healthy scientific research programs), and on sufficient, sustained investments in the development of new technologies, operational procedures and alternative fuels. Thus, while it is possible for aviation's impacts on the environment to be reduced in absolute terms, it is more probable at our current levels of investment that aviation environmental impacts will grow—contributing to greater detriments on health and welfare, and further constraints on our air transportation system and the economic growth it enables.

I started with the two quotes, "Flying — the worst thing to do," and "…the greenest form of mass transportation," to focus your attention to the value of knowledge, knowledge that can be used to make rational judgments about what matters, why it matters, and to whom it matters. Aircraft, and the air transportation systems in which they operate are highly optimized complex systems. As such, there are important tradeoffs and interdependencies. For example, if one designs an airplane to minimize noise, impacts on climate and air quality can worsen and vice versa. Further, there are almost always important safety and economic implications that come with design changes. How should one decide what is more or less important?

The issues highlighted by the quotes I shared go well beyond posturing in the press. The public and political views in Europe and the United States, and the policies to which they may lead, will affect us all—for better or for worse. Aviation is a global business, with airplanes designed by a small number of suppliers, largely for a single global market. If policies are imposed in one part of the world that push aircraft design in a certain direction, all of us will fly on those airplanes. Therefore, there is a premium on getting the answer right when assessing tradeoffs and interdependencies. This is especially true because new airplane development times are as long as a decade, and airplane usage in the fleet is as long as three decades. In aviation, when we make decisions, they tend to be expensive, and we must live with them for a long time.

It is in this area, the area of developing the knowledge and tools to make rational decisions about environmental impacts, where the FAA, in particular its Office of Environment and Energy, has been leading the world. The FAA has adopted a rigorous,

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[4] During the same period, CO_2 emissions from aviation in Europe rose approximately 30%.

rational, science-based approach to understanding what matters, why it matters, and to whom it matters. This is the most critical first step to taking action, especially for a system as complex as our national air transportation system. A detailed plan for research aimed at further developing this understanding is contained within the latest draft of the NextGen Integrated Work Plan.[5] I was one of many people who participated in developing the plan, and I strongly support it.

In the next three subsections, I describe in turn issues related to aviation noise, air quality impacts, and climate change. Many of the estimates of impacts I describe come from research programs funded in the last five years by the FAA Office of Environment and Energy. Many of the significant technological advances that I describe were enabled and promoted by NASA Aeronautics research and development programs of the 1970s-1990s.

3.1 Noise

There are approximately one-half million people in the United States who live in regions near airports with high levels of aircraft noise, noise levels such that more than 12% of the impacted population will be highly annoyed.[6] People are awakened at night, housing values are depreciated, learning in schools is reduced. An estimated 5 million people live in areas with moderate airplane noise, but still, where greater than 3% of the population will be highly annoyed.[7] Adding these groups together (those in significant and moderate noise areas), there are perhaps 200,000 people in the United States who are highly annoyed by commercial aircraft noise. Despite the magnitude of the number, it is small compared to the number of people living in homes in city centers, and along all of the highways and railways in the United States, where residents suffer similarly from high noise levels.

Further, we have seen dramatic 95% *reductions* in the number of people impacted by aircraft noise over the last 35 years (while the population impacted by highway and railway noise is estimated to have increased), and this is despite a six-fold growth in aviation passenger-miles traveled. However, most projections suggest that advances in aircraft technology will barely be able to keep up with growth in order to keep aircraft noise impacts in the United States constant. Meanwhile, we spend hundreds of millions of dollars each year on soundproofing homes (which is little more than a band-aid), local authorities continue to make poor land-use decisions (allowing residential development in high noise regions), and we burn extra fuel for some noise abatement procedures at airports (and suffer the associated economic, climate, and air quality detriments). Most importantly, the very valid complaints of residents around airports have almost halted the airport expansion that could be so vital to our economy. The limits on airport expansion lead to further congestion of our airspace, more flight delays, economic losses, and even more environmental impacts. The Chinese are in the process of building some 50 airports, and expanding another 70. In contrast, consider Boston where I live: efforts to

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[5] Working draft version dated August 12, 2008.

[6] 65dB and higher Day-Night Noise levels

[7] 55dB and higher Day-Night Noise levels

add a third runway to Logan Airport started in the 1970s. The runway was only half-completed when community opposition led to a court injunction halting construction. The injunction was not lifted until 2003—30 years of less efficient, less productive operations that to a large extent were due to concerns about aviation noise.

With this as context, it is useful to understand what led to the dramatic reductions in aviation noise impact that occurred in the 1980s and 1990s. These were a direct result of technological advancements (especially the introduction of the high bypass ratio turbofan engine) and policy incentives (accelerated phase-out of older, noisier aircraft—a phase-out that is estimated to have cost the industry between $5 billion and $10 billion). These technological advancements were founded on robust NASA-FAA-industry-university research and development activities.

In the last several years, funding for the NASA Aeronautics Program has been insufficient to support such robust research and development activities. As a result, NASA Aeronautics has shifted its focus relatively more towards long-term, fundamental research, with relatively less emphasis on the more costly, system-level technology acceleration and implementation programs. This is an appropriate strategy given the limited funding—fundamental research is the foundation upon which all the other efforts are built. However, it is not a strategy that is promoting the development and implementation of low noise technology to the degree that is required. While the modest augmentations in recent NASA Aeronautics budgets have been welcome, they have varied from year to year, making it difficult to launch the multi-year programs that are necessary for success. I note that the NASA programs are strongly driven by the NextGen goals, and are explicitly incorporated in the NextGen Integrated Work Plan. The team is well coordinated. The missing element is an increased and sustained funding commitment. The FAA FY09 budget request also includes funds to more rapidly develop and implement low noise technology and procedures (as one component of the Continuous Lower Energy, Emissions, and Noise Program, CLEEN). This program, with a proposed budget of $22M per year (for all objectives, not just noise reduction) can be an important contributor to an effective, vertically-integrated national research and development program. But here too, funds must be appropriated.

Thus, while we underfund the research and development that is the only pathway to long-term improvement, we continue to spend hundreds of millions of dollars each year on the band-aid approach of soundproofing homes and purchasing land around airports. Because we have underinvested in research and development, this band-aid is indeed, the only option for residents near airports, residents who justifiably have had enough with bearing the burden of the high noise environments. The national strategy for addressing aircraft noise is broken. New technology can change the equation and significantly reduce the requirements for soundproofing and the hundreds of millions of dollars it drains from the Airport and Airway Trust Fund through the Airport Improvement Program.[8] We must challenge the nation's government-industry-university research enterprise to do this and we must appropriately fund it. This will break the logjam

[8] *For Greener Skies, Reducing the Environmental Impacts of Aviation*, NRC, 2003.

between aircraft noise and airport expansion, promote economic growth, reduce health and welfare impacts on residents living near airports, and contribute to scientific and technological advancement.

3.2 Air Quality

Commercial aviation is responsible for between 2% and 3% of U.S. energy consumption, almost all of it from petroleum. The competitiveness of the industry and the high fraction of costs related to fuel, have led to a level of penny-pinching for energy efficiency that is unparalleled. Airlines make decisions about seemingly minute items to optimize their financial performance (such as evaluating whether or not to limit the availability of ice cubes as part of the drink service to improve fuel efficiency). The incentives for fuel efficiency are extreme. However, as with other users of fossil fuels, the combustion of these fuels leads to gaseous and particulate matter emissions that can adversely affect human health. Only those emissions emitted below 3000 feet above ground level are traditionally considered in EPA national inventories and in air quality evaluations, although emerging work suggests that emissions at higher altitudes may also be important for surface air quality. The aviation emissions below 3000 feet represent between 0.03% and 0.4% of the total National Emissions Inventory levels depending on the particular pollutant.[9] However, in many U.S. counties the contribution to county-level inventories can be as high as several percent (rising to as high as 20% to 50% for some pollutants in four counties only). Moreover, there are 148 airports located in non-attainment areas that do not meet National Ambient Air Quality Standards for one or more pollutants. So small contributions can still be quite important.

To my knowledge, the FAA is the only organization in the world that is specifically funding research to understand the health impacts that are attributable to these aviation emissions. It should be commended for this. It is another example of the FAA's rational, rigorous approach to understanding what matters and why it matters. It is important to do so, because even within the different pollutant emissions, there are important trade-offs. For example, high temperature engines that reduce carbon dioxide (CO_2) emissions can increase emissions of oxides of nitrogen (NO_x). A second example is related to emissions of hazardous air pollutants. At the time when we wrote the 2004 Report to Congress, we listed these as one of the highest areas of uncertainty for aviation. Four years later, research funded by the FAA and the Airports Cooperative Research Council is showing that hazardous air pollutants from aviation are not a source of significant health impacts.

Of aviation emissions, those that contribute to ambient fine particulate matter ($PM_{2.5}$) are the most significant source of adverse heath consequences. More than 95% of total health impacts attributable to aviation are estimated to come from exposure to increased

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[9] For a one year period in 2005-2006, operations at 325 U.S. airports, including approximately 95% of operations for which flight plans were filed, represent the following percentages of the total 2001 U.S. National Emissions Inventory for anthropogenic sources: 0.17% of carbon monoxide (CO) emissions, 0.40% of oxides of nitrogen (NO_x) emissions, 0.23% of emissions of volatile organic compounds (VOCs), 0.06% of oxides of sulfur (SO_x) emissions, and 0.03% of fine particulate matter ($PM_{2.5}$) emissions.

levels of ambient particulate matter. The emissions that contribute include sulfur oxides, nitrogen oxides, volatile organic emissions (these three groups of emissions are mostly emitted as gases, but later in the atmosphere they lead to secondary formation of particulate matter), and also primary particulate matter emissions (soot). In recent studies, the average contribution of aircraft to ambient levels of $PM_{2.5}$ in the United States was estimated to be less than one-tenth of one percent: 0.08% for all counties and 0.06% for counties in air quality non-attainment areas. The aircraft contributions to county-level ambient $PM_{2.5}$ concentrations ranged from 0% to 0.5%. However, this is likely an underestimate since only emissions below 3000 feet were considered and the geographical resolution of the models was limited.

Although the impacts are quite small relative to all human impacts on air quality, they are important. Using standard health risk assessment approaches, approximately 160 yearly incidences of premature mortality can be attributed to the aviation emissions below 3000 feet. These health impacts of aviation very likely constitute less than 0.6% of the total adverse health impacts due to poor air quality from all anthropogenic emissions sources in the United States—underscoring the overall significance of the health risk associated with poor air quality in the United States which very likely contributes to more than 25,000 premature mortalities each year.

The benefits that NextGen can provide for improving air quality may be significant. Air traffic management inefficiencies, congestion, and delay result in increased fuel burn and emissions. We have all experienced unacceptably long taxi operations, waiting in long lines to take-off, or for an airport gate to become available—all the while with engines running, burning fuel, generating emissions, and wasting time and money.[10] Approximately 10% of the fuel burn and emissions below 3000 feet in today's system are a direct result of delays and inefficient operations. It will only get worse. The air transportation system is a traffic jam waiting to happen. Without the development of an efficient next generation system, small numbers of additional operations (much smaller than the 2x to 3x growth that is anticipated) will increasingly cause gridlock, especially in conditions with poor weather. There is thus, a potential for significant adverse environmental and economic consequences. This is an area where NextGen planning and initiatives are appropriately targeted. Moreover, the modelling and planning tools used by the NextGen program now explicitly incorporate the latest results from air quality health impacts analyses. Although many important scientific questions remain, and it is likely that the estimates of health impacts will change, the research programs have been initiated, and the linkages are in place so that these effects can be appropriately considered in NextGen planning and development.

In addition to NextGen operational improvements, there are also options to reduce air quality impacts through the adoption of low sulfur fuels and alternative fuels. Recognition of the potential role of alternative fuels is one of the key changes since the

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[10] The Joint Economic Committee estimated that flight delays in 2007 cost the U.S. economy $41 billion. *Your Flight Has Been Delayed Again: Flight Delays Cost Passengers, Airlines, and the U.S. Economy Billions in 2007*, JEC, 2008.

writing of the 2004 Report to Congress on Aviation and the Environment. The FAA is moving aggressively to pursue the assessment (including the full life-cycle impacts), testing, and certification of low sulfur and low carbon alternative fuels. It is not yet clear what the costs and benefits of these options will be, but FAA has put in place a thoughtful, effective research program to develop and assess these options. The work is a component of a larger work program within the Commercial Aviation Alternative Fuels Initiative (CAAFI), a broad government-industry-academic consortium.

While the work on operational improvements and new fuels is proceeding well, programs to develop aircraft and engine technologies for mitigating air quality impacts are not well supported. As with the development of low noise technologies, the reduced levels of funding for NASA Aeronautics in the last decade have left the nation without sufficiently strong focused technology programs that are important for bridging fundamental research and industrial development, and thereby promoting more rapid advancement of aircraft and engine technology. Here too, the recent augmentations to the NASA Aeronautics budget have been helpful, but they are not enough—and they are not sustained, therefore making them less effective for contributing to long-term development programs. The FAA can also play an important role in addressing the gap with its Continuous Lower Energy, Emissions, and Noise Program, CLEEN. However, as I noted previously, this program, with a FY09 budget request of $22M per year for all objectives, is not sufficient to promote the technological advances that will be required to reduce air quality impacts simultaneously with the anticipated growth of operations.

3.3 Climate Change

Aircraft emissions contribute to climate change by increasing the levels of greenhouse gases in the atmosphere. Commercial aviation is responsible for approximately 2.7% of U.S. greenhouse gas emissions (roughly 10% of the greenhouse gas emissions from the transportation sector). Because of the altitude at which aircraft fly, the effects on climate are unique among all greenhouse gas emitters. There are effects related to the formation of condensation trails (contrails) and clouds, and positive and negative impacts of NO_x emissions that can be more pronounced than those from surface-level NO_x emissions. These effects cannot simply be added to the effects of the CO_2 emissions; they depend on time of day, time of year, altitude of the emissions, and region of the globe. Although the impacts of aviation CO_2 are well understood, and are the same as those from CO_2 emitted from other sources, many of the other effects are poorly understood. All of them involve complex chemical and atmospheric processes. However, when these effects are taken together, most estimates suggest that the impact of aviation on climate is greater per unit of fuel burn than that from surface-based combustion sources.

As we wrote in the 2004 Report to Congress, this is the area of greatest scientific uncertainty for aviation, and the area with the greatest potential for environmental impacts. It is also an area where there is a vigorous international debate on measures that should be taken to mitigate the impacts—for example, the debate surrounding the European Union plans to include commercial aviation in an emissions trading program. There are also examples closer to home like the petition California and other states filed with the EPA to regulate greenhouse gas emissions from aviation.

Perhaps nowhere in the area of aviation and the environment is there a greater premium on pursuing a rigorous program of scientific study that is closely tied to national and international decision-making needs. This is also the area where the United States most significantly lags our European colleagues. The United States had a robust, vibrant research program (the Atmospheric Effects of Aviation Program). This program was discontinued around the year 2000. Since that time, most of our understanding of the impacts of aviation on climate has come from the excellent programs in Europe. Much of the U.S. academic community has disbanded and gone on to focus on other things. Although work continues, it is not well funded or well connected. Today in the United States, the entire portfolio of funded research focusing on aviation and climate is likely less than $1 million per year—for the most uncertain, and potentially most damaging, environmental impact of aviation. We are now in a position of being insufficiently prepared to contribute to national and international discussions of climate policy for aviation—the latter of which are likely to move ahead with or without us. This is a failure.

To address this critical need, this year the FAA and NASA launched the Aviation Climate Change Research Initiative. With optimistically[11] only $2 million to $3 million of funding per year, this effort must be expanded. Without this, we will be unable to evaluate the complex trade-offs among aviation's climate effects—let alone balance them against other objectives for noise, air quality, safety, and economic performance of the industry. This is a case where engine, aircraft, and operational design trades are quite possible, and industry is asking, "what really matters?" but we do not have an answer for them. All the while, airplanes continue to be built, airplanes with a 30-year lifetime in the fleet. We must change the path we are on, and to do so, we must move more forcefully than we are moving today.

4. What has changed since the 2004 Report to Congress on Aviation and Environment?

I have addressed several points regarding changes since the 2004 Report to Congress in Section 3; I will now summarize them. The report recommended three actions to achieve a National Vision of absolute reductions in significant health and welfare impacts from aviation noise and air quality emissions, reduced uncertainty in understanding other impacts, and global leadership for the U.S. aerospace enterprise in jointly addressing aviation mobility and environmental needs. In the last four years there have been some successes in responding to this vision, and some failures.

[11] It is waiting funding in the FY09 Budget.

Changes relative to recommendation 1: Promoting coordination and communication among stakeholders.

- The National Vision for Aviation and the Environment and Recommended Actions drafted by a broad group of stakeholders was accepted and acted upon by FAA and NASA, and incorporated into the National Plan for Aeronautics Research and Development and Related Infrastructure (January 10, 2008).[12]
- The Environmental Working Group of the JPDO is regarded as one of the most effective groups within the JPDO. This is evidenced in the 2005 National Research Council Report, *Technology Pathways: Assessing the Integrated Plan for a Next Generation Air Transportation System*, where the activities of the group were highlighted and put forward as an exemplar for other components of the JPDO to follow.
- NASA Aeronautics programs and plans are closely aligned with the needs of the NextGen initiative.
- FAA and NASA have cultivated several open, collaborative research enterprises focused on environment and energy including the Partnership for AiR Transportation Noise and Emissions Reduction, the Aviation Climate Change Research Initiative, the Commercial Aviation Alternative Fuels Initiative, the Aviation Emissions Characterization Roadmap, the NASA Fundamental Aeronautics N+1, N+2 and N+3 research programs, and the Research Consortium for Continuous Lower Energy, Emissions, and Noise (CLEEN).

Changes relative to recommendation 2: Developing more effective tools and metrics for guiding policy decisions and for planning research investments.

- The FAA has led the world in supporting research to understand the air quality impacts of aviation resulting in several seminal contributions.
- The FAA and NASA have led the world in developing tools to characterize and quantify the interdependencies among aviation-related noise and emissions, impacts on health and welfare, and industry and consumer costs, under different policy, technology, operational, and market scenarios.
- One of the most significant changes since the 2004 Report to Congress is the greater recognition of the importance of energy efficiency, and the potential value of alternative fuels for reducing the climate change impacts of aviation and reducing our dependence on non-replenishable resources. The FAA and the DOD have excellent programs in place to rigorously evaluate the full life-cycle costs and benefits of alternative fuels for aviation.
- Despite laudable efforts this year to launch the Aviation Climate Change Research Initiative on the part of FAA and NASA, the gap in technical credibility with regard to aviation climate impacts has widened between the United States

[12] The National Plan was developed in response to Executive Order 13419 which implemented the National Aeronautics R&D Policy. The National Plan establishes high priority national aeronautics research and development challenges, goals and supporting objectives to guide the conduct of U.S. aeronautics R&D activities through 2020.

and Europe in the last four years. Most of the significant research findings are coming from Europe.

Changes relative to recommendation 3: Establishing a vigorous program to develop specific technological, operational, and policy options that support a balanced approach to long-term environmental improvements.

- The FAA is well positioned to develop specific operational and policy options (with the notable exception of the aviation climate area) to support long-term environmental improvements. One highlight is its vigorous development and implementation of Continuous Descent Arrival procedures that reduce noise, reduce emissions, and save fuel.
- Since the writing of the 2004 Report, four more years have passed without sufficient funding for the critical NASA-FAA-industry-university technology development programs that will be required to address the environmental impacts of aviation while enabling growth in air service.
- Moreover, even the more modest programs proposed in current FAA plans (such as the Continuous Lower Energy, Emissions, and Noise Program, the Aviation Climate Change Research Initiative, expansion of the environmental work in the Airports Cooperative Research Program, and funding for environmental demonstration programs at airports) will not move forward unless funds are appropriated to support them.

5. What steps should the NextGen initiative be taking to mitigate impacts? How satisfied are you with the JPDO's efforts to date?

I have reviewed a working draft of the environmental section of the latest Integrated Work Plan for NextGen (draft dated Aug. 12th 2008). The plans in the environmental section are impressive—rigorous, science-based, detailed, and well coordinated. The extent to which these will be effectively integrated with the overall JPDO work program is still to be determined, but I commend the Environmental Working Group of the JPDO for its efforts. It has truly aspired to put in place a program that will enable an *absolute reduction* in aviation's environmental impacts *notwithstanding growth* of the aviation system. Quoting from the draft Integrated Work Plan:

> "*Therefore, the NextGen challenge is to reduce aviation's environmental footprint, even with projected aviation growth. This includes reducing the impacts of aviation noise, and air quality and greenhouse gas emissions in a cost-beneficial manner."*

The draft Work Plan further describes their path to achieving this:

> *"NextGen must achieve a balance between aviation's environmental impacts and other societal objectives, both domestically and internationally. NextGen can meet these challenges by eliminating system-induced congestion and delay, accelerating the aircraft technology development/penetration cycle and by advancing alternative fuels to manage aviation's environmental impacts."*

This is a useful framework for summarizing my thoughts on NextGen and JPDO. First, as I have highlighted several times, the rational, rigorous, science-based approach adopted by the FAA to evaluate the costs and benefits of various options is exceptional. Second, the efforts to eliminate system-induced congestion and delay are sorely needed. Even today we see significant environmental impacts from these factors. These impacts will occur to an even greater extent if the number of operations is increased without improving the system. The efforts to carefully assess the full life-cycle costs of alternative fuels are also very appropriate.

However, it is the area of accelerating the aircraft technology development/penetration cycle that most concerns me. The plans and programs developed by FAA and NASA are excellent. They are well coordinated. The national capabilities in government, industry and academia are excellent. However, the current funding levels in this area are insufficient to support the national vision for absolute reductions in impacts notwithstanding the projected growth.

6. The most critical issues

The two most urgent needs are:

1) To accelerate the FAA-NASA Aviation Climate Change Research Initiative. This will enable a careful evaluation of the complex trade-offs among aviation's climate impacts, and a balancing of these impacts against other objectives for noise, air quality, safety, and economic performance of the industry.
2) To significantly increase and accelerate the focused technology, operations, and alternative fuels programs in NASA and FAA that are required to effectively bridge fundamental aeronautics research and industrial development programs. This will have the single greatest leverage on our ability to achieve long-term environmental improvements in the aviation industry. This can start immediately: important programs have been planned and proposed by the FAA and NASA. However, they are on hold waiting FY09 funding. I encourage you to support, and indeed to expand, these programs.

Accelerating efforts to address the environmental impacts of aviation is the right thing to do for the health of the public and the planet. Commercial aviation is estimated to be responsible for 2%-3% of U.S. CO_2 emissions, 160 or more yearly premature mortalities associated with poor air quality, and 200,000 people who are highly annoyed by aircraft noise. While these impacts are small relative to the sum of human environmental impacts, they are nonetheless important. Accelerating efforts to address the environmental impacts of aviation is also the right thing to do for the economy. The constraints on the system are sufficiently strong that they can impede realizing the potential of NextGen. If we do not achieve significant advances in environmental performance there will be increasing impacts on health and welfare, and increasing constraints on the national air transportation system—with the attendant negative economic impacts that come with both.

The priority must be on appropriating funds to programs that address aviation's environmental impacts starting with the FY09 budget. Thereafter, authorization and appropriation of funding for more significant programs are required.

Thank you very much, Mr. Chairman and members of this committee for this opportunity to address you. I will be pleased to respond to your questions.