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

Transforming America's Air Travel

June 11, 2015
9:00 a.m.
2318 Rayburn House Office Building

Purpose

The purpose of this hearing is to review the current state of civil aeronautics research and inform the Committee's consideration of the Federal Aviation Administration (FAA) Reauthorization.

Witnesses

- Dr. Jaiwon Shin, Associate Administrator, Aeronautics Mission Directorate, NASA; and Member FAA Research and Development Advisory Committee.
- Mr. Dennis Filler, Director, William J. Hughes Technical Center, FAA.
- Mr. William Leber, Chair, National Research Council report titled "Transformation in the Air – A Review of the FAA Research Plan;" and Vice President, Air Traffic Innovations, PASSUR Aerospace.
- Dr. R. John Hansman, T. Wilson Professor of Aeronautics & Astronautics; Director, MIT International Center for Air Transportation, Massachusetts Institute of Technology; and Chair, FAA Research and Development Advisory Committee.
- Dr. Greg Hyslop, Senior Member, American Institute for Aeronautics and Astronautics; Vice President and General Manager, Boeing Research & Technology; Chief Engineer, Engineering, Operations & Technology, the Boeing Company.

Background

The FAA and the National Aeronautics and Space Administration (NASA) conduct federal civil aeronautics research and development (R&D). The FAA conducts, coordinates, and supports domestic and international research and development of aviation related products and services, including the Next Generation Air Transportation System (NextGen).[1] NASA conducts fundamental and applied aeronautics research. [2] NASA's current activities are focused in four program areas: advanced air vehicles program (AAVP), airspace operations and safety program (AOSP), integrated aviation systems program (IASP), and the transformative aeronautics concepts program (TACP).

[1] See 49 U.S.C. §40501 et al. Accessed at http://www.gpo.gov/fdsys/pkg/USCODE-2011-title49/html/USCODE-2011-title49.htm
[2] See 51 U.S.C. §40101 et al. Accessed at http://www.gpo.gov/fdsys/pkg/USCODE-2011-title51/html/USCODE-2011-title51.htm

The FAA was last reauthorized in 2012, under the *FAA Modernization and Reform Act of 2012*.[3] This authorization was for fiscal years (FY) 2012-2015. FAA research and development activities are a component of the broader FAA reauthorization effort.

NASA was last authorized in 2010, under the *National Aeronautics and Space Administration Authorization Act of 2010*. This authorization was for FY2011-2013. The House of Representatives authorized NASA aeronautics research as port of the overall NASA authorization in 2014[4] and 2015[5], but the legislation awaits consideration by the Senate.

FAA Research, Engineering, & Development (R,E&D) Budget Request

Budget Authority ($ in millions)	FY15 Enacted	FY16 Request
Safety	**91.019**	**96.623**
Fire Research and Safety	6.000	6.643
Propulsion and Fuel Systems	2.000	3.034
Advanced Materials/Structural Safety	2.909	3.625
Aircraft Icing/Digital System Safety	5.500	6.920
Continued Airworthiness	9.619	8.987
Aircraft Catastrophic Failure Prevention Research	1.500	1.433
Flightdeck/Maintenance/System Integration Human Factors	6.000	9.947
System Safety Management	7.970	6.063
ATC/Technical Operations Human Factors	5.400	5.995
Aeromedical Research	8.300	10.255
Weather Program	14.847	18.253
Unmanned Aircraft Systems (UAS) Research	14.974	9.635
NextGen – Alt Jet Fuel for General Aviation	6.000	5.833
Economic Competitiveness	**22.286**	**24.671**
NextGen - Wake Turbulence	8.541	8.680
NextGen - Air Ground Integration Human Factors	9.697	8.875
NextGen Weather Tech in the Cockpit	4.048	4.116
Commercial Space	--	3.000
Environmental Sustainability	**37.935**	**38.884**
Environment and Energy	14.921	15.061
Environmental Research – Aircraft Tech, Fuels, and Metrics	23.014	23.823
Mission Support	**5.510**	**5.822**
System Planning and Resource Management	2.100	2.377
William J. Hughes Technical Center	3.410	3.445
Total	**156.750**	**166.000**

[3] P.L. 112-95
[4] See http://science.house.gov/press-release/house-passes-bipartisan-nasa-authorization-act
[5] See https://science.house.gov/press-release/house-passes-bipartisan-nasa-bill

The FAA supports a range of research activities from materials and aeromedical research to the development of new products, services, and procedures. FAA's FY16 budget request includes $166 million for research, engineering and development (R,E&D). This is an increase of $9.3 million (6 percent) above the FY2015 enacted level of $156.75 million. FAA's R,E&D research is categorized into four areas: Safety, Economic Competitiveness, Environmental Sustainability, and Mission Support.

Noteworthy changes include an increase in Propulsion and Fuel Systems ($1.034 million); an increase for Aircraft Icing / Digital System Safety ($1.420 million); an increase in Flightdeck / Maintenance / System Integration Human Factors ($3.947 million); a decrease to System Safety Management ($1.907 million); an increase to Aeromedical Research ($1.955 million); an increase to the Weather Program ($3.406 million); a decrease to Unmanned Aircraft Systems Research ($5.339 million); and an increase to Commercial Space ($3 million).

In addition to R,E&D, the FAA FY16 budget request includes $198 million for research and development funding under the Facilities and Equipment (F&E) account and $46 million under the Grants-In-Aid for Airports (AIP).[6]

FAA NextGen R,E&D Budget Request

Budget Authority ($ in millions)	FY15 Enacted	FY16 Request
Alternative Fuel for General Aviation	6.000	5.833
Wake Turbulence	8.541	8.680
Air Ground Integration Human Factors	9.697	8.875
Weather Tech in the Cockpit	4.048	4.116
Environmental Research – Aircraft Tech, Fuels, and Metrics	23.014	23.823
Unmanned Aircraft Systems Research†		9.635
Total	**51.300**	**60.962**

† *Note – FY16 is the first year that UAS has been included into the NextGen program.*

The FY16 R,E&D budget requests $61 million specifically for NextGen, an increase of $9.7 million over FY2015 enacted level. This is largely a result of including UAS research in the NextGen Program for the first time.

Notably, environmental research and alternative fuel research accounts for nearly half of all NextGen R,E&D funding.

[6] These activities are not listed in the following chart.

NASA Aeronautics Research Budget Request

Budget Authority ($ in millions)	Actual 2014	Enacted 2015†	Request 2016
Airspace Operations and Safety Program	-	154	142.4
Advanced Air Vehicles Program	-	248.1	240.9
Integrated Aviation Systems Program	-	150	96.0
Transformative Aeronautics Concepts Program	-	97.4	92.1
Aviation Safety	80.0	-	-
Airspace Systems	91.8	-	-
Fundamental Aeronautics	168.0	-	-
Aeronautics Test	77.0	-	-
Integrated Systems Research	126.5	-	-
Aeronautics Strategy & Management	22.7	-	-
Total	**566.0**	**650.5**	**571.4**

†Reflects FY15 Operations Plan submitted to Congress on March 6, 2015, which reduced the Advanced Air Vehicles program by $500,000 from enacted level.

NASA's Aeronautics Research Mission Directorate (ARMD) conducts aeronautics research to improve aviation safety, efficiency, and air traffic management, and to develop game-changing technology to facilitate the continued growth of the U.S. aviation industry. The FY16 budget request for ARMD is $571.4 million, a 12 percent decrease ($79.6 million) from the $651 million included in the FY15 appropriations act.

In FY16, NASA will focus on six strategic "thrusts." These include:

1) Safe, Efficient Growth in Global Operations
    - Enable full NextGen and develop technologies to substantially reduce aircraft safety risks;
2) Innovation in Commercial Supersonic Aircraft
    - Achieve a low-boom standard;
3) Ultra-Efficient Commercial Vehicles
    - Pioneer technologies for big leaps in efficiency and environmental performance;
4) Transition to Low-Carbon Propulsion
    - Characterize drop-in alternative fuels and pioneer low-carbon propulsion technology;
5) Real-Time System-Wide Safety Assurances
    - Develop an integrated prototype of a real-time safety monitoring and assurance system;
6) Assured Autonomy for Aviation Transformation
    - Develop high impact aviation autonomy applications.

National Research Council

Transformation in the Air—A Review of the FAA's Certification Research Plan

The National Research Council (NRC) issued a report this week titled *Transformation in the Air – A Review of the FAA's Certification Research Plan*. The FAA Modernization and Reform Act

of 2012 required the FAA to develop a research plan for the certification of new technologies into the NAS and have the NRC review that plan. In response to this statutory directive, the NRC empaneled a study to assess the FAA's plan for research on methods and procedures to improve both confidence in and the timeliness of certification of new technologies for their introduction into the National Airspace System (NAS). The NRC determined that "the plan lack detail and specificity and does not provide an effective guide to FAA research of the 5-year term required by the act."[7] The committee concluded "it is more of a high-level task plan for incrementally developing over the next 5 years than the detailed research plan that the FAA will actually need" and that "the plan does not meet the requirements of the authorizing legislation." The report went on to state that, "[w]hereas the plan restates the language from the FAA Modernization and Reform Act of 2012, it lacks the specificity required to generate actionable objectives. It is more of a high-level task plan for incrementally developing over the next 5 years the detailed research plan that the FAA will actually need." [8]

The committee recommended that "in order to improve confidence in and timeliness of the certification of new technologies and the approval new operations they enable in the NAS, the FAA should create a comprehensive research plan that results in a documented approach that provides the full context for its certification and implementation of Next Gen, including both ground and air elements, and the plan's relationship to the other activities and procedures required for certification and implementation into the NAS."[9] The committee concluded that "future FAA research plans, when properly assembled and executed, can play a valuable role in guiding the FAA and stakeholders and explaining progress in certifying new technologies into the NAS. The committee provided a number of recommendations to the FAA."[10]

<u>A Review of the Next Generation Transportation System: Implications and Importance of System Architecture</u>

The NRC issued a report last month titled "A Review of the Next Generation Transportation System: Implications and Importance of System Architecture." This review focused on enterprise architecture, software development approaches, and safety and human factors.

The report found that "The original vision for NextGen is not what is being implemented today. Instead, NextGen today primarily emphasizes replacing and modernizing aging equipment and systems."[11] The NRC continued by stating that "[t]he Federal Aviation Administration (FAA) should create an architecture community that can produce and evolve a system architecture and should also strengthen its workforce in systems engineering and integration, digital communications, and cybersecurity to increase the likelihood it will succeed in developing the architecture and managing the implementation of the systems it describes." Finally, the NRC concluded that "NextGen and its system architecture should be developed to cope with change. Two newly important areas, cybersecurity and unmanned vehicles, make this need particularly resonant. Human factors will also play an important role in NextGen and the NAS as each evolves. Finally, regarding anticipated costs and benefits, airlines are not motivated to spend

[7] *Id.* at 2
[8] *Id.* at 2
[9] *Id.* at 3
[10] *Id.* at 3
[11] *"A Review of the Next Generation Air Transportation System: Implications and Importance of System Architecture,"* National Research Council, May 2015

money on equipment and training for NextGen because they do not receive most of the benefits directly and because of implementation schedule uncertainties. The rest of this summary elaborates these and related observations in more detail and highlights several of the committee's findings and recommendations in bold."

Government Accountability Office

Air Traffic Control: FAA Needs a More Comprehensive Approach to Address Cybersecurity As Agency Transitions to NextGen

GAO issued a report last April that reviewed FAA's cybersecurity efforts. The GAO found that, "[a]s the agency transitions to the Next Generation Air Transportation System (NextGen), the Federal Aviation Administration (FAA) faces cybersecurity challenges in at least three areas: (1) protecting air-traffic control (ATC) information systems, (2) protecting aircraft avionics used to operate and guide aircraft, and (3) clarifying cybersecurity roles and responsibilities among multiple FAA offices.

As GAO reported in January 2015, FAA has taken steps to protect its ATC systems from cyber-based threats; however, significant security-control weaknesses remain that threaten the agency's ability to ensure the safe and uninterrupted operation of the national airspace system. FAA has agreed to address these weaknesses. Nevertheless, FAA will continue to be challenged in protecting ATC systems because it has not developed a cybersecurity threat model. NIST guidance, as well as experts GAO consulted, recommend such modeling to identify potential threats to information systems, and as a basis for aligning cybersecurity efforts and limited resources. While FAA has taken some steps toward developing such a model, it has no plans to produce one and has not assessed the funding or time that would be needed to do so. Without such a model, FAA may not be allocating resources properly to guard against the most significant cybersecurity threats.

Modern aircraft are increasingly connected to the Internet. This interconnectedness can potentially provide unauthorized remote access to aircraft avionics systems. As part of the aircraft certification process, FAA's Office of Safety (AVS) currently certifies new interconnected systems through rules for specific aircraft and has started reviewing rules for certifying the cybersecurity of all new aircraft systems.

FAA is making strides to address the challenge of clarifying cybersecurity roles and responsibilities among multiple FAA offices, such as creating a Cyber Security Steering Committee (the Committee) to oversee information security. However, AVS is not represented on the Committee but can be included on an ad-hoc advisory basis. Not including AVS as a full member could hinder FAA's efforts to develop a coordinated, holistic, agency-wide approach to cybersecurity.

FAA's acquisition management process generally aligned with federal guidelines for incorporating requirements for cybersecurity controls in its acquisition of NextGen programs. For example, the process included the six major information-technology and risk-management activities as described by NIST. Timely implementation of some of these activities could have been improved based on their importance to NextGen, cost, and deployment status. The Surveillance and Broadcast Services Subsystem (SBSS)—which enables satellite guidance of

aircraft and is currently deployed in parts of the nation—has not adopted all of the April 2013 changes to NIST security controls, such as intrusion detection improvements, although the Office of Management and Budget guidance states that deployed systems must adopt changes within one year. Systems with weaknesses that could be exploited by adversaries may be at increased risk if relevant controls are not implemented."[12]

[12] "Aviation Security: FAA Needs a More Comprehensive Approach to Address Cybersecurity As the Agency Transitions to NextGen," Government Accountability Office, April 2015.