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

An Overview of the NASA Aeronautics Research Mission Directorate Budget for Fiscal Year 2013

Thursday, April 26, 2012
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

Purpose

The purpose of the hearing is to review the Fiscal Year 2013 budget request submitted by NASA's Aeronautics Research Mission Directorate (ARMD) and to examine its programs and strategies. ARMD's request was submitted as part of the NASA budget in mid-February, seeking $551.5 million for FY2013, $17.9 million below its FY2012 funding level. The hearing will also discuss a report recently issued by the National Research Council, *Recapturing NASA's Aeronautics Flight Research Capabilities*, that looked into the efficacy and affordability of strengthening the agency's integrated flight research program.

Witnesses

- **Dr. Jaiwon Shin**, Associate Administrator, Aeronautics Research Mission Directorate, National Aeronautics and Space Administration;
- **Ms. Marion Blakey**, Chair, Aeronautics Committee, NASA Advisory Council, and President, Aerospace Industries Association;
- **Dr. Wesley Harris**, Chair, Committee to Assess NASA's Aeronautics Flight Research Capabilities, National Research Council, and Charles Stark Draper Professor of Aeronautics and Astronautics, MIT; and
- **Dr. John Tracy**, Chair, National Research Council's Aeronautics Research and Technology Roundtable, and Chief Technology Officer and Senior Vice President of Engineering, Operations and Technology, The Boeing Company

Background

From 1915 until 1958, the National Advisory Committee for Aeronautics (NACA) conducted much of the aeronautics research and development activities in the United States. From its charter, codified into law in 1915, the NACA mission was to "direct and conduct research and experimentation in aeronautics, with a view to their practical solution." In 1917, the NACA

established the Langley Memorial Aeronautical Laboratory in Virginia, which became the most advanced aeronautical research and development facility in the world.

The NACA was involved in all areas of aeronautics, constructing wind tunnels and conducting airfoil testing to meet military research and development requirements, recommending the inauguration of airmail service, promoting safety in aerial navigation and advising the President on the Air Commerce Act of 1926, the first federal law regulating civil aeronautics. The NACA also established facilities dedicated to aeronautical research such as the Moffett Field Laboratory near San Francisco (renamed the Ames Aeronautical Laboratory), the Lewis Research Center near Cleveland Ohio, and the Wallops Flight Center on the eastern shore of Virginia.

During WWII, the NACA focused on military research such as high speed flight utilizing rocket powered aircraft and advanced supersonic wind tunnels. By the 1950s the NACA was already researching high altitude hypersonic flight, spaceflight, and reentry into the Earth's atmosphere. In 1958, with the creation of the National Aeronautics and Space Administration (NASA), all NACA activities and facilities became the nucleus of the new agency.

NASA's aeronautics programs are conducted by the Aeronautics Research Mission Directorate (ARMD) and continue to focus on long-term investments in fundamental aeronautics research. The ARMD includes four NASA centers: NASA Langley Research Center, VA; NASA Glenn Research Center, OH; NASA Ames Research Center, CA; and NASA Dryden Flight Research Center, CA.

The current generation of civil, general aviation, and military aircraft contain many technologies developed by NASA. Fly-by-wire, flight management systems, quiet and efficient turbine engines, airframe and wing designs, incorporation of composite materials into airframes and structures, are just a few examples. Aircraft manufacturers the world over have adapted NASA-developed technologies into their products.

Additionally, ARMD researches and matures technologies that underpin the Federal Aviation Administration's air traffic management system. It has provided software tools now used by FAA to enable more efficient routing of aircraft and increase the capacity and safety of our national airspace system. NASA (ARMD) is an essential partner with FAA in the development of the Next Generation Air Transportation System – NextGen.

The ARMD programs and associated activities [FY2013 budget request is in brackets] are:

- Aviation Safety Program – conducts research to improve safety attributes of current and future aircraft and air traffic management systems.
    - System-Wide Safety and Assurance Technologies [$29.7M];
    - Vehicle Systems Safety Technologies[$36.4M]; and
    - Atmosphere Environment Safety Technologies [$14.9M].

- Airspace Systems Program – addresses air traffic management research needs for the Next Generation Air Transportation System (NextGen).
    - NextGen – Concepts and Technology Development [$55.6M]; and
    - NextGen – Systems Analysis, Integration, and Evaluation [$37.6M].

- Fundamental Aeronautics Program – develops technologies, tools, and concepts for aircraft in all speed regimes enabling them to fly faster, cleaner, and quieter, and use fuel more efficiently.
    - Subsonic Fixed Wing [$77.9M];
    - Subsonic Rotary Wing [$24.1M];
    - High-Speed (supersonics and hypersonics) [$34.4M]; and
    - Aeronautical Sciences [$32.3M].

- Integrated Systems Research Program (ISRP) – conducts research at an integrated system-level on promising concepts and technologies. ISRP focuses specifically on maturing and integrating technologies into major vehicle and operations systems and subsystems for accelerated transition to practical application.
    - Environmentally Responsible Aviation [$73.5M]; and
    - Unmanned Aerial Systems Integration in the National Airspace System [$30.5M].

- Aeronautics Test Program – manages and invests in agency aeronautics test capabilities (major wind tunnels; propulsion test facilities; flight test assets) considered strategically important to NASA and the nation.
    - Aero Ground Test Facilities [$51.7M]; and
    - Flight Operations and Test Infrastructure [$26.4M].

- Aeronautics Strategy and Management – provides management of ARMD-level activities including a low-level innovative funding program, education, and outreach.
    - Innovative Concepts for Aviation [$10.0M];
    - Education and Outreach [$5.4M]; and
    - Cross Program Operations [$11.0M].

Over the last decade, the budget for ARMD has shrunk from a peak of approximately $1B to just $569.9M in FY12. The President's FY13 budget request is slightly lower at $551.5M and remains flat in the President's budget run-out over 5 years. As a share of NASA's budget, ARMD's percentage has dropped from ~ 7 percent in 2000 to ~ 3 percent in 2012.

Aeronautics Policy

NASA's Aeronautics Research Mission Directorate program receives policy guidance from Congress, the White House, and The National Research Council. Most recently the NASA Authorization Act of 2010 directed NASA to collaborate with the Department of Defense on aeronautics research and development and the Federal Aviation Administration on the Next

Generation Air Transportation Program (NextGen). The bill also directed ARMD to pursue three fundamental goals, including;

> (1) AIRSPACE CAPACITY.—NASA's Aeronautics Research Mission Directorate shall address research needs of the Next Generation Air Transportation System, including the ability of the National Airspace System to handle up to 3 times the current travel demand by 2025.
>
> (2) ENVIRONMENTAL SUSTAINABILITY.—The Directorate shall consider and pursue concepts to reduce noise, emissions, and fuel consumption while maintaining high safety standards and shall pursue research related to alternative fuels.
>
> (3) AVIATION SAFETY.—The Directorate shall proactively address safety challenges with new and current air vehicles and with operations in the Nation's current and future air transportation system.

In 2006, the National Research Council produced the *Decadal Survey of Civil Aeronautics: Foundation for the Future*, (http://www.nap.edu/catalog.php?record_id=11664#toc) proposing a portfolio of aeronautics research programs for NASA. The report made 8 programmatic recommendations and identified 51 technology challenges it deemed essential to ensuring a robust aeronautics R&D program responsive to industry and societal needs.

Executive Order 13419, "National Aeronautics Research and Development" issued December 2006, (https://www.federalregister.gov/articles/2006/12/26/06-9895/national-aeronautics-research-and-development) states in part: "Continued progress in aeronautics, the science of flight, is essential to America's economic success and the protection of America's security interests at home and around the globe."

Budget Request

NASA Aeronautics Research Mission Directorate
President's FY2013 Budget Request

Budget Authority, $ in millions

	FY2011 Actual	FY2012 Estimate	FY2013 Author.	FY2013 Request	FY2013 v FY2012 Est	FY2014 Notional	FY2015 Notional	FY2016 Notional	FY2017 Notional
Aeronautics TOTAL	**$533.5**	**$569.4**	**$590.0**	**$551.5**	**-$17.9**	**$551.5**	**$551.5**	**$551.5**	**$551.5**
Aviation Safety	67.3	80.1	*	81.1	1.0	81.0	81.4	81.9	82.5
Airspace Systems	87.2	92.7	*	93.3	0.6	92.6	91.9	91.2	90.5
Fundamental Aeronautics	206.3	186.3	*	168.7	-17.6	171.3	173.3	175.3	177.1
Aeronautics Test Program	76.4	79.4	*	78.1	-1.3	78.0	78.0	78.1	78.2
Integrated Test Systems	75.9	104.2	*	104.0	-0.2	102.3	101.2	100.1	98.8
Aero Strategy & Management	20.4	26.7	*	26.4	-0.3	26.2	25.7	25.0	24.4
(Numbers may not add due to rounding.)									
*Authorization did not specify.									

Comparing FY2012 with the FY2013 budget request, there is little variance across the programs, except for a $17.6 million reduction in Fundamental Aeronautics. Most of the decrease is

attributable to diminished support for hypersonics research as well as the transfer of fundamental research in entry, descent and landing technologies to the Space Technology account. Topline outyear funding through FY2017 is held constant at the FY2013 level, similar to the profile received by all other NASA mission directorates.

In materials provided to committee staff, NASA identified its aeronautics priorities to be:

- Accelerate implementation and enhance the capabilities of NextGen (FAA's air traffic modernization program);
- Innovate to close critical gaps in both air traffic management and vehicles to achieve the full potential of NextGen; and
- Lead the country with a vision and revolutionary capabilities for the Nation's future aviation system.

National Research Council Report

Earlier this year the National Research Council issued a report, *Recapturing NASA's Aeronautics Flight Research Capabilities.* Dr. Wesley Harris, Professor of Aeronautics and Astronautics at MIT, chaired the committee that produced the report. He served as Associate Administrator for NASA's Aeronautics program from 1993 – 1995.

The report (http://www.nap.edu/catalog.php?record_id=13384) grew out of a request by ARMD to the NRC "to assess and make recommendations about how best to integrate flight research into the current Aeronautics Research Mission Directorate's (ARMD) fundamental research activities and integrated systems research activities." The NRC committee concluded "that the type and sophistication of flight research currently being conducted by NASA today is relatively low and that the agency's overall progress in aeronautics is severely constrained by its inability to actually advance its research projects to the flight research stage, a step that is vital to bridging the confidence gap. NASA has spent much effort protecting existing research projects conducted at low levels, but it has not been able to pursue most of these projects to the point where they actually produce anything useful. Without the ability to actually take flight, NASA's aeronautics research cannot progress, cannot make new discoveries, and cannot contribute to U.S. aerospace preeminence."

The report recommends that NASA dedicate $30 million - $50 million of its annual ARMD budget for focused flight research projects; to phase out lower-priority aeronautics projects as a budget offset; and to put each of its projects on a clearly defined path to flight testing in an appropriate environment.

Other of its recommendations include:

- NASA aeronautics should aggressively pursue collaboration with DOD, FAA, the U.S. aerospace industry, and international aeronautics research agencies. NASA should adopt management practices to facilitate effective collaboration and treat external organizations as customers and partners. NASA leadership should develop a formal process for regularly soliciting input from the U.S. aerospace industry and universities as well as key government agencies to assure the relevancy of its flight research programs to national needs.

- NASA aeronautics should become the nation's repository of flight research data and flight test results and should make these archival data readily accessible to key stakeholders—the engineers and scientists in industry, academia, and other government agencies. NASA should also require principal investigators in flight research projects to publish their results and provide funding for them to do so.

- NASA aeronautics leadership should study designating Dryden Flight Research Center as the primary flight research organization of NASA, with responsibility for the efficient use of NASA flight research aircraft, facilities, and other support resources. Dryden should adopt a customer-focused approach to flight research sponsored by NASA and external partners.

Overarching Questions

- Given its limited resources, can ARMD afford to support a broad research portfolio? Would ARMD be more effective by focusing its resources on high priority activities?
- How well does ARMD's research program align with mid- and long-term industry needs? Are there any research gaps?
- Are ARMD resources sufficient to mature technologies to a state of readiness that would enable their adoption by industry?
- How well does ARMD's research portfolio support implementation of NextGen? How effectively are NASA-developed technologies being transitioned from research to implementation at FAA?