**STATEMENT OF KEVIN WELSH**
**EXECUTIVE DIRECTOR, OFFICE OF ENVIRONMENT AND ENERGY**
**FEDERAL AVIATION ADMINISTRATION**
**HEARING BEFORE THE UNITED STATES SENATE**
**COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION**
**ADVANCING NEXT GENERATION AVIATION TECHNOLOGIES**
**MARCH 29, 2023**

Chair Cantwell, Ranking Member Cruz, and members of the committee, thank you for the opportunity to be here today to discuss the Federal Aviation Administration's (FAA) work related to advancing next generation aviation technologies. My name is Kevin Welsh, and I am the executive director of the FAA's Office of Environment and Energy. My office conducts research, develops policy, and collaborates across the U.S. government, with the aviation community, and internationally to address the environmental impacts of aviation. The FAA's core mission is to provide the safest, most efficient aerospace system in the world. This mission also includes addressing the environmental impacts of aviation, such as climate change, local air quality, and noise. As laid out in the National Aeronautics Science and Technology Priorities and U.S. Aviation Climate Action Plan, this administration is committed to net-zero greenhouse gas emissions in the aviation sector by 2050. To achieve this, we are working with industry and other important aviation stakeholders to develop new technologies, enable increased production of sustainable aviation fuels (SAF), increase the energy efficiency of air traffic operations, and conduct research and develop tools to support the FAA's mission. Our work in these areas not only helps address environmental impacts, but can also reduce costs, such as through reduced fuel burn, and supports job growth and economic development.

## TECHNOLOGY

Improvements in aircraft technology have long played a central role in reducing aviation's environmental impact. Continued FAA investment in aircraft technology research and

development is focused on accelerating the development and introduction of new aircraft technologies that reduce emissions and noise while improving fuel efficiency. For example, the FAA, aircraft manufacturers, and airlines collectively work toward further reducing aircraft noise and emissions at the source through efforts like the Continuous Lower Energy, Emissions, and Noise (CLEEN) Program, which began in 2010. The FAA's CLEEN program provides funding to develop and accelerate the introduction of technologies that will reduce noise, emissions, and fuel burn. CLEEN is implemented in 5-year phases, and we are currently in the third phase of the program. Funding for the CLEEN program, including the industry cost share component, has exceeded $500 million since its inception. Cumulatively, CLEEN Phases I and II are estimated to save the aviation industry 36 billion gallons of fuel through 2050, reducing CO2 emissions by 420 million metric tons over this period. These fuel savings would reduce airline costs by over 90 billion dollars at current jet fuel prices. These savings would also benefit passengers. These CO2 reductions are equivalent to removing three million cars from the road from 2020 to 2050. These technologies, as well as the use of SAF, will also dramatically reduce nitrogen oxide and soot emissions from aircraft operations. Technologies from Phases I and II are estimated to eliminate over 997 kilotons of nitrogen oxide emissions during landing and takeoff through 2050. Phase III will continue to target further reductions in aviation noise, emissions, and fuel burn.

A few examples of the accomplishments from the FAA's investments in the CLEEN program include:

- Under CLEEN Phases I and II, GE Aerospace has developed new low-emissions jet engine combustion systems. The enhanced "TAPS" combustion system is used in aircraft engines, reducing nitrogen oxide emissions for over 500 aircraft in service and over 5,000

on order. A further improved TAPS combustor was developed under CLEEN Phase II to reduce emissions for the forthcoming Boeing 777X aircraft.

- Under CLEEN Phase II, Boeing has developed and demonstrated advanced aircraft wings made of stronger and lighter-weight materials to support innovative development of current and future aircraft. This technology alone is expected to reduce fuel consumption by 3.5 percent.
- In addition to the technologies being developed by the CLEEN Program, our industry partners are using the knowledge gained through the program to enhance other systems. For example, Pratt & Whitney leveraged the CLEEN Program to demonstrate new engine fan technologies to further reduce fuel consumption and noise from their geared turbofan engines. This knowledge has also resulted in improvements to the design software that Pratt & Whitney uses to design all of their engines. As such, CLEEN has an impact that is far greater than the individual technologies that we are working to mature.
- Finally, data from CLEEN Program tests have contributed to the approval of a number of alternative jet fuels for safe use.

Through the FAA Center of Excellence for Alternative Jet Fuels & Environment, also known as the Aviation Sustainability Center, or "ASCENT," work is also underway to develop innovative technological solutions to reduce noise, emissions, and fuel burn from subsonic and supersonic aircraft. ASCENT technology research is complementary to CLEEN, partnering with academia, rather than industry, to advance the state of the art knowledge broadly within the aviation community. Whereas CLEEN research focuses on a higher maturity for the technology and a direct path to product application, ASCENT research can cover a wider range of ideas and different maturity levels. Further, ASCENT is using its research efforts to develop analytical

tools that can be used by industry to develop quieter, cleaner, and more efficient products. This research spans partnerships with sixteen universities, covering a breadth of technical areas, including noise reduction technologies, system-level modeling and design, propulsion-airframe integration, combustion, turbomachinery, and supersonics.

The Inflation Reduction Act of 2022 provided over $46 million for a new Low Emissions Technology grant program that the FAA calls "FAST-TECH." The FAA will launch the program this year, which will support projects to develop, demonstrate, or apply low-emission aviation technologies. This grant program is expected to support projects that are designing, prototyping, and testing new low-emission aviation technologies, as well as projects enhancing technology testing and demonstration capabilities that will accelerate a broad range of low-emission aviation technologies. FAST-TECH will play a complementary role to CLEEN and ASCENT by providing a focus specifically on low-emission aviation technologies and building up not only individual technologies, but also testing capabilities to drive a new generation of low-emissions aircraft.

The FAA also continues to demonstrate international leadership on aviation and climate change, including our leadership in setting international environmental standards for aviation at the International Civil Aviation Organization. Adoption of international environmental standards not only advances environmental protection globally, but also helps to set a level playing field and facilitates the export of Unites States-developed and manufactured aerospace technology.

**SUSTAINABLE AVIATION FUEL**

SAF presents the most promising near-to-medium-term tool to dramatically reduce aviation emissions and will be critical to longer-term efforts to decarbonize aviation. Creation of good jobs is a priority for this administration, and SAF production is expected to enhance the

creation of jobs related to agricultural production, municipal solid waste reduction, fuel refining, and engineering. Over the last 15 years, the FAA has led efforts to support SAF development through testing, analysis, and coordination across government, academia, and the private sector. The FAA supports SAF development through a robust research program that spans the breadth of fuel testing and qualification to environmental and economic analysis. Through ASCENT, the FAA advances new research on SAF production and supply chain analysis and enables streamlined fuel approval via ASTM International. Since 2006, the FAA has partnered with industry to support broad engagement of SAF stakeholders through the Commercial Aviation Alternative Fuels Initiative. Additionally, under the CLEEN Program, the FAA partners with industry to support critical SAF testing to ensure safety and performance. This administration is broadly committed to the development of SAF. In September 2021, the Departments of Transportation, Energy, and Agriculture entered into a memorandum of understanding launching a government-wide Sustainable Aviation Fuel Grand Challenge (the SAF Grand Challenge). The objective of this effort is to reduce the cost, enhance the sustainability, and expand the production and use of SAF that achieves a minimum of 50 percent reduction in lifecycle greenhouse gas compared to conventional fuel to meet a goal of supplying 3 billion gallons of SAF by 2030 (approximately 10 percent of projected jet fuel use) and sufficient SAF to meet 100 percent of domestic aviation fuel demand by 2050. The FAA is coordinating closely and collaborating with the other agencies on the SAF Grand Challenge to effectively use resources and accelerate the increased production of SAF. At the FAA we are, among other things, coordinating SAF testing and analysis, working with standards organizations to ensure the safety and sustainability of SAF, providing international technical leadership, and seeking opportunities to support the development of infrastructure to connect SAF producers with aviation users.

Finally, in addition to the FAST-TECH grant funding noted earlier, the Inflation Reduction Act of 2022 also provided $244.5M to support the development of a new SAF-focused grant program that the FAA calls Fueling Aviation's Sustainable Transition via SAF ("FAST-SAF"). The program aims to support rapid SAF deployment, focusing on domestic projects that enable SAF production, transportation, storage, and blending. The objectives of this grant program are in line with the goals of the Administration's SAF Grand Challenge, with a primary focus on enabling the rapid scale-up of the domestic production of SAF that provides significant lifecycle greenhouse gas reductions.

**CERTIFICATION OF NOVEL TECHNOLOGIES**

An important aspect of the quest to reduce aviation emissions and noise is the development of new technologies to power aircraft, such as hydrogen or electric propulsion systems. As the FAA works to certify aircraft that seek to use these technologies, safety will always be the agency's first priority. As a mechanism to help facilitate the safe introduction of new, innovative products, including new propulsion technologies, the FAA's Aircraft Certification Service established a structure and process to facilitate the introduction of new technology through early engagement with companies to identify policy and certification issues and to develop strategies to address them early in the application process for type certification.

Although current regulations may not have been drafted with these technologies in mind, our regulatory framework has the flexibility necessary to certify them. Where necessary, FAA technical specialists are developing performance-based requirements to address novel or unusual design features that current requirements do not address. In addition to applying the extensive technical knowledge and experience of our own specialists, the FAA is also leveraging the work of NASA, industry standards committees, research organizations, and other industry working

groups to broaden our understanding of the technical issues that new technologies like electric and hydrogen propulsion systems pose.

As the technology matures and the FAA and industry gain experience in the certification of these new technologies, we expect the regulatory structure to evolve. In the meantime, however, current processes are effective in ensuring the technologies meet the expected level of safety.

**CONCLUSION**

The FAA will continue to support the development and deployment of innovative technologies, SAF, and other new energy sources to reduce aviation's environmental impact, ensure continued global leadership in innovation and aviation, and support continued economic growth and job creation. We are focused on continuing to pursue and support cutting-edge research and development, and establishing and maintaining close partnerships within government, industry, and academia, as the safest and most efficient airspace system in the world evolves to meet the needs of the future. I would be happy to answer any questions you may have.

###