



U.S. Department
of Transportation
**Federal Aviation
Administration**

Office of the Administrator

September 21, 2023

Dr. John Hansman, Ph.D.
Chair, Research, Engineering and
Development Advisory Committee
Massachusetts Institute of Technology
[REDACTED]

Dear Dr. Hansman:

Thank you and the Federal Aviation Administration's (FAA) Research, Engineering, and Development Advisory Committee (REDAC) for your recommendations on the Agency's fiscal year (FY) 2025 Research and Development (R&D) Portfolio. The FAA R&D technical program execution benefits from the invaluable knowledge shared by the aviation, aerospace, and related subject matter professionals during the Winter-Spring 2023 season.

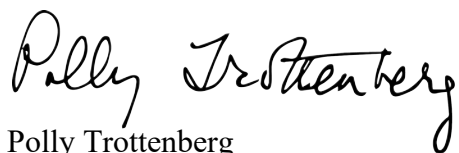
Topics discussed in your April 12, 2023, letter reinforced the importance of exemplary management of aviation programs in dynamic environments. You emphasized that the Agency must continue to excel as a critical leader, domestically and internationally, as technological advancements increase and influence the scope of air travel. REDAC acknowledgment of the resource acquired to lead the Agency's Artificial Intelligence/Machine Learning initiatives and commendation of the superlative performance from the outgoing Chief Scientist and Technical Advisor for the Office of Environment and Energy is appreciated by leadership.

The FAA appreciates how the REDAC provides direction that supports sustaining effective aviation program policies throughout the Agency's R&D Portfolio. The Committee's subject matter professionals are to be commended, as they communicate advice for the FAA's various teams of researchers, technical advisors, scientists, directors, and staff. The REDAC's comments on the Strategic Outlook for Aviation Research (SOAR) chart framework will foster consistent assessments of the FAA R&D Portfolio, enabling holistic program evaluations from three perspectives: Near-Term/Current, Mid-Term/Emerging, and Long-Term/Projected research activities.

The FAA reviewed the 19 recommendations submitted by the REDAC. The enclosed FAA Response Report reflects our responses to these recommendations. The FAA fully concurs with 15 of the 19 items, partially concurs (with noted exceptions) with 3 items and does not concur with the remaining recommendation. The FAA has addressed the partial concurrences and provided justifications for those suggestions that cannot be fully completed at this time.

We will continue to respond to all the Committee's recommendations and incorporate applicable advice to maintain our R&D portfolio, permitting increased safety, efficiency, and capacity of the air transportation system in an environmentally responsible manner. We will propel forward to enhance data-driven decision-making for a safer and brighter future in air travel.

Sincerely,

A handwritten signature in black ink, reading "Polly Trottenberg". The signature is written in a cursive, flowing style.

Polly Trottenberg
Acting Administrator

Enclosure

**Federal Aviation Administration (FAA) Response
to Research, Engineering, and Development Advisory Committee (REDAC)
Recommendations for the Fiscal Year (FY) 2025 Research and Development (R&D)
Portfolio**

Subcommittee on Human Factors

General Observations: Proactive Integration of Human Factors - The Human Factors Subcommittee was pleased to hear briefings on the FAA Info-Centric NAS and Advanced Air Mobility Innovate 28. The Subcommittee requested these briefings to gain insight into the future aviation vision concepts. The Subcommittee encourages the integration of Human Factors as the implementation plans in both areas are matured.

For the Info-Centric NAS Concept briefing, several areas for further consideration were noted. These include: the impacts of digitization of data on human operators and implications for information display and management, the changing role of the FAA user controlling more highly automated aircraft, and the use of Machine Learning/Artificial Intelligence (ML/AI) to turn data into actionable information to be used by decision makers. Factors to consider are the display of information to users and transparency and trust in automation/autonomy, which will be critical in defining human interaction with various levels of automation.

It was understood from the Innovate 28 presentation that the effort was focused on near-term demonstration of emerging AAM technologies using current airspace and procedures. However, for the implementation of AAM beyond the 2028 boundary the Subcommittee encourages understanding of the impact on the human operators of advanced automation, new flight rules, remotely piloted/autonomous aircraft, and new airspace constructs.

The Subcommittee encourages early and consistent integration of Human Factors into these efforts and encourages the FAA to continue to proactively identify emerging Human Factors research issues, so they can be submitted into the funding cycle as early as possible.

Finding: Advanced Vision Systems and Runway Safety - The Subcommittee received several briefings outlining research on advancing information presentation to pilots that included: Enhanced Vision Systems (EVS), Synthetic Vision Systems (SVS), and Augmented Reality Systems (AR). The Subcommittee understands the FAA has conducted significant human factors research into these technologies previously, however the active and planned research presented to the Subcommittee did not address whether bringing the pilot's attention into an EVS/SVS/AR information channel would diminish their attention to runway safety visual cues and warnings presented directly to the pilot. Or, conversely, if such information could be integrated into these technologies to supplement or enhance the pilot's situational awareness of runway safety information. Applications of these technologies continue to be focused on phases of flight where the risk of runway incursions exist, such as Takeoff Roll, Approach, and Landing. Runway incursion and safety warning systems continue to be developed but are not currently integrated with these other information systems.

Recommendation 1: The Subcommittee recommends that the FAA research the effect of the use of Enhanced Vision Systems (EVS), Synthetic Vision Systems (SVS), and Augmented Reality Systems (AR) on pilot attention to visual cues needed for timely pilot response to runway safety information presented directly to the pilot.

Consequences: Continued research, development, and implementation of such vision technologies without assessing the impact of their use on pilot attention to important visual cues in the environment and warnings, may increase the risk of runway incursions or other runway safety hazards.

FAA Response: The FAA concurs with the Committee's Finding and Recommendation and is undertaking the following actions to address its recommendation – The FAA conducted significant Human Factors (HF) research over the years on flight deck Advanced Vision Systems (e.g., EVS, SVS, AR) and continues to do so for both existing and emerging systems and operations. At the Summer/Fall 2023 Human Factors Subcommittee meeting, the FAA will lead an interactive discussion with Advanced Vision HF research technical sponsors and research performers to determine if effects on pilot response to runway safety information will be considered in the research.

Subcommittee on Aircraft Safety

General Observations: The Subcommittee appreciates the follow-up action that the FAA took on our previous Finding and Recommendations regarding the development of a roadmap for Artificial Intelligence/Machine Learning (AI/ML). Furthermore, the Subcommittee was pleased to learn of the FAA hiring of the Chief Scientific and Technical Advisor (CSTA) for Artificial Intelligence. This action will play an important role in broadening U.S. leadership in Research and Development related to AI/ML usage in aviation systems. The Subcommittee further encourages the use of industry forums such as Aerospace Industries Association (AIA) or Radio Technical Commission for Aeronautics (RTCA) to provide further inputs and feedback to the FAA for continued collaboration with industry.

The Subcommittee notes the value of the members receiving read ahead material and early pre-meetings to review such material. This has led to more productive and focused discussions during the REDAC Aircraft Safety (SAS) meetings.

Finding: Cyber Resiliency for Digital Safety Systems -The Subcommittee appreciates the research on Cyber Security currently being conducted on by the FAA on BLI A11DS (Digital Safety Systems) as it related to GPS interference mitigations. The Subcommittee notes an emerging transition to new air/ground data link technologies such as Internet Protocol Suite (IPS), which will, provide strong cryptographic controls to aeronautical data links used for Controller - Pilot Data Link Communications (CPDLC) as well as Automatic Dependent Surveillance – Contract (ADS-C) and air/ground applications. While emerging technologies such as IPS, provide strong cryptography protection to safety communications, the Subcommittee is unaware of any research into which actors within the industry should be responsible for monitoring the logs of cyber events to detect intentional or unintentional attacks on these safety communications networks.

Research should provide answers to the following types of questions:

1. What if several CPDLC messages to one aircraft fail digital signature and/or integrity checks, as might occur in a denial-of-service attack?
2. At what failure rate should action be taken?
3. Under what conditions should the FAA, the FAA's Data Comm service provider, and/or the airline or fleet operations center be notified and how swiftly?
4. What if the FAA and/or airline or fleet operations centers receive reports that multiple aircraft are encountering cyber-attacks?
5. Which actor in the system should declare the data link compromised and direct that controller pilot communications should revert to voice, for one specific aircraft, multiple aircraft, or all aircraft in the NAS?

Similar considerations should be given to intrusion detections occurring at ground IPS peers and by similar technologies within aeronautical data link sub networks such as, but not limited to, Inmarsat and Iridium Aeronautical Mobile Satellite (Route) Systems (AMS(R)S) SatCom sub networks. Internet Protocol Suite (IPS) standards being finalized this year at International Civil Aviation Organization (ICAO), Radio Technical Commission for Aeronautics/European Organization for Civil Aviation Equipment (RTCA/EUROCAE), and Airlines Electronic Engineering Committee (AEEC) require the IPS system components to collect logs of cyber events but there is no regulatory guidance pending on how and when those logs should be transferred and to whom.

Recommendation 1: The Subcommittee recommends that the FAA expand the research currently being conducted on BLI A11DS, Digital Safety Systems, to include data link communications cyber resiliency research to establish the relevant regulatory cyber-attack reporting requirements for industry actors who will be implementing data link communications technologies, such as IPS. The relevant regulatory cyber resiliency requirements should be published concurrently with the publication of IPS technology performance regulations to avoid costly modification of IPS avionics systems that industry would encounter to implement cyber-attack reporting requirements after the IPS systems are initially deployed.

FAA Response: The FAA appreciates the Committee's recommendation on Cyber Resiliency for Digital Safety Systems. However, we are not able to pursue this recommendation currently for the following reasons – Controller Pilot Data Link Communications (CPDLC), as well as Automatic Dependent Surveillance – Contract (ADS-C) and their air/ground applications are operational programs for the FAA. Development activities, including cyber events, are under the purview of the FAA Program Management Office (PMO). Therefore, the SAS recommendation is being or will be addressed by the FAA PMO using Facilities and Equipment (F&E) budget lines. If of interest to the Subcommittee, the FAA can provide a briefing by the CPDLC PMO on what development activities they have Facilities and Equipment (F&E) funded or are planning to fund that may address the various Subcommittee questions listed. If of interest to the Subcommittee, the FAA can also coordinate a briefing of the Cyber Security Data Science NextGen Research, Engineering and Development (RE&D) Program that does include Research and Development (R&D) for cyber events and their mitigations for industry-generated aviation eco-system use-cases, including the synthesis of communication network log files.

Finding: Use of Digital Twins for the Development and Lifecycle Support of Aircraft

Systems - The Subcommittee appreciates the research being conducted by the FAA on the application of Digital Twins, for the development and lifecycle support of aircraft avionics systems, and specifically in consideration of aircraft certification & operational credit. The Subcommittee further recognizes that the topic of the Digital Twin can apply to many areas for aircraft. For example, it is noted that Digital Twin considerations appeared in discussion of Propulsion and Fuel Systems (A11B), Software Digital Systems (A11DS), and Continued Airworthiness (A11E) during the February 2023 REDAC SAS meeting. The ongoing maturation of technologies to support aircraft avionics systems Digital Twin capability, providing a robust ability to model and simulate the functional and operational capabilities of aircraft systems with great fidelity, is proliferating across the aircraft Original Equipment Manufacturer (OEM) industry. This work incorporates model-based systems engineering, model-based development, and in some cases even auto-code generation based on system functional requirements. Along with the continued exponential increase in computer system capabilities, this is leading to the ability to create a fully virtualized airplane electronic systems environment early in the design cycle, which can be utilized to verify functional operation of the airplane systems and design. These high-fidelity models can be applied early in the design process to avionics systems to include Communication, Navigation, and Surveillance (CNS), all onboard and off-board networking & data communications for both normal and non-normal operations analysis and includes cyber-resilience systems analysis. Also, as the airplane moves from development to service, these airplane systems models can then be used provide high fidelity simulations during the operational lifecycle of the airplane, such as for the evaluation of aircraft health monitoring applications and ongoing analysis of continued airworthiness and security issues throughout the service life of the airplane.

Recommendation 2: The Subcommittee recommends that the FAA conduct further research on the application of Digital Twins to aircraft systems (to include but not be limited to Flight Deck, Communication, Navigation, and Surveillance (CNS), propulsion systems and all onboard and off-board networking & data communications). The effort should look across the SAS portfolio for use regarding both aircraft certification and operational credit. It is recommended that the research efforts begin by developing a roadmap of certification application to different aspects of the aircraft engineering development lifecycle, from model-based engineering, development, design implementation, and lifecycle operations such as applicability to aircraft health monitoring for operational credit. The work should address model maturity, verification, and validation requirements for digital twins to show regulatory compliance for both normal and non-normal functional operations of the systems, such as addressing airplane systems cyber-resilience analysis, at both the individual systems evaluation level and at the fully integrated airplane level.

FAA Response: The FAA concurs with the Committee's recommendation and is undertaking the following actions to address its recommendation(s) – The FAA plans to integrate the recommendation into its research plan at the earliest opportunity and present the updated plan in a future SAS meeting.

Finding: Hydrogen Powered Propulsion - The industry is in the process of evaluating the potential use cases for hydrogen powered propulsion systems. This is especially relevant for

Advanced Air Mobility platforms, but there are also applications being studied for legacy propulsion systems.

Recommendation 3: The Subcommittee recommends further FAA research on hydrogen powered propulsion systems that addresses:

- a. Fire and leak detection and safety
- b. Storage capabilities, both on the ground and airborne
- c. Items applicable to aircraft health monitoring
- d. Carriage and transportation of hydrogen cells
- e. Future applications
- f. Certification readiness

FAA Response: The FAA concurs with the Committee's recommendation and is undertaking the following actions to address its recommendation(s) – The FAA is developing a road map for FAA Hydrogen Research focused on three main areas of hydrogen combustion to include: fuel flexibility, through the ability to burn hydrogen and blends of fossil fuels in gas turbine engines; the ability for hydrogen fuel cells to meet large demands for electricity for aircraft propulsion and electrical systems; and hydrogen safety impacts to other aircraft systems, operation, and ground operations.

The FAA continues to work with international standards organizations, such as the Society of Automotive Engineers (SAE), the American Society for Testing and Materials (ASTM), and the European Organization for Civil Aviation Equipment (EUROCAE) to develop consensus industry standards for the implementation of hydrogen technologies on various aircraft systems and in engines. The FAA will also work with other government agencies, such as the Department of Energy, NASA, and the Department of Defense, leveraging their research in this area.

Through FAA-sponsored research, the FAA conducted early engagement with applicants on Hydrogen projects, is providing guidance using existing means of compliance, and developing a gap analysis for future rulemaking.

Subcommittee on Airports

General Observations: The Subcommittee remains supportive of the Program's ongoing work and future research directions, which continue to emphasize foundational research to support (1) advisory circulars and design guidance promulgated by the FAA Office of Airports; (2) airport capital improvements currently eligible or prospectively eligible for federal grant funding under the Airport Improvement Program; and (3) U.S leadership in areas of airport safety, planning, and airport infrastructure, and airfield pavements.

The Subcommittee had the following additional observations.

1. The Subcommittee congratulates the new permanent Manager of the Airport Technology Research & Development Branch (ATR) and the permanent assignment of the Manager of the Branch's Pavement Research & Development Section.

2. The Subcommittee continues to be impressed by the speed at which research activities associated with Uncrewed Aircraft Systems are proceeding. We remain very interested in the results of research into the efficacy of UAS detection and mitigation systems, which will inform both airport operators and government agencies tasked with counter UAS responsibilities. We were also pleased to hear about ongoing coordination efforts between the Program's research and concurrent research efforts underway by the Department of Homeland Security, including the sharing of research data.
3. The Subcommittee recognizes the need for the Branch to develop a succession plan to ensure that institutional knowledge and expertise possessed by long-time Branch leaders are passed to a new generation of experts. We encourage Branch staff to proceed with development of its internal plans to address these issues and support the Branch's ongoing efforts to attract new subject matter experts to work at the Technical Center.
4. The Subcommittee noted that it has not had briefings regarding a few key RPAs in our last few cycles of meetings and requested that Program staff provide briefings on Wildlife Hazard Mitigation, Visual Guidance, and Airport Safety Data Mining at our Fall 2023 meeting.

Finding: The Subcommittee appreciated the overview of future research focus areas provided by Branch staff and summarized in what was termed the "Strategic Outlook for Aviation Research (SOAR) Chart". Based on that presentation, the Subcommittee suggested increasing the priority of certain research areas.

Recommendation 1: Subcommittee members recommend that the FAA consider the prioritizing research in the following areas and reflecting them in the Program SOAR Charts:

- Green Pavement Technologies—including use of recycled pavements, carbon capture technologies, and other methods reducing embodied carbon in airport construction, particularly pavement construction—to the near term. Of particular concern is the compatibility of these technologies with FAA pavement mix specifications and standards.
- Standards, requirements, and operating parameters for automated and autonomous ground vehicle operations on the airside, both in movement and non-movement areas.

FAA Response: The FAA concurs with the Committee's Findings and Recommendations and is taking the following actions to address them – The FAA will revise the SOAR Chart to reflect the Subcommittee's recommendation. Both items, "Testing & Characterization of Low-Embodied Carbon Materials Airport Pavements" and "Environmentally Friendly and Sustainable Pavement Materials," will be shifted to the near term. "Carbon Capturing/Advanced Materials" will also be shifted to the near term. Research on Autonomous Ground Vehicle Operations on the airside, both in movement and non-movement areas, will be shifted to the near term.

Finding: With the publication of the Military Performance Specifications (MilSpec) for Fluorine-Free Foams (F3s) for use in Aircraft Rescue and Firefighting (ARFF) applications by the Department of Defense in January 2023, there is increased interest and urgency regarding

how and when to transition from Aqueous Film Forming Foam (AFFF) to F3 products. Since 2020, the FAA has been engaging a group of subject matter experts termed the “ARFF Advisory Group” to assess transition needs and facilitate the transition process.

The FAA Office of Airports engaged the Advisory Group—supplemented with additional airport representatives—in February and March to provide input for a F3 transition plan the FAA is preparing in response to requests from both the U.S. House of Representatives and U.S. Senate that accompanied the *Consolidated Appropriations Act, 2023*. While industry involvement in development of this plan is appreciated, continuing industry engagement will be needed beyond provision of responses to Congress to facilitate effective transition from Aqueous Film Forming Foam (AFFF) to Fluorine-Free Foams (F3) at U.S. certificated airports.

Recommendation 2: The Subcommittee recommends that the FAA continue to engage the Aircraft Rescue and Firefighting (ARFF) Advisory Group to provide subject matter expertise and guidance to facilitate the transition from AFFF to F3 products.

FAA Response: **The FAA concurs with the Committee’s Findings and Recommendations and is taking the following actions to address it** – The FAA continues to work with industry stakeholders throughout the transition phase to F3 at civilian airports. The FAA drafted a transition plan with input from industry and the ARFF Advisory Group. The FAA began developing additional training materials to support the transition and inform airport firefighters on the proper use of F3s. Furthermore, the FAA continues to utilize subject matter experts from the ARFF Advisory Group and is continuing research into the use of F3s. The FAA continues to provide guidance and recommendations as more information and material become available.

Finding: During discussions of concrete pavement testing experiments—specifically Construction Cycle 10 (CC-10), both Program staff and Subcommittee members noted that it would be valuable to assess the effect joint spacing has on pavement life.

Recommendation 3: The Subcommittee recommends that Program staff consider incorporation of joint spacing as a variable in future concrete pavement testing cycles.

FAA Response: **The FAA concurs with the Committee’s Findings and Recommendations and is taking the following actions to address it** – The FAA can address the effect of joint spacing on pavement life in future test cycles. CC10 design is complete at this time, and we would not like to introduce another set of variables into that experiment. The FAA would like to let the Committee know that there are limitations to what we can do under accelerated pavement testing because we do not test concrete slabs of similar thickness as in service heavy transport runways. Slab thickness and joint spacing are related, and thickness can dictate the upper limit of slab dimensions. During Construction Cycle 1, the FAA conducted a study and found that panels larger than 15 ft. x 15 ft. were not optimum for testing due to the high propensity for curling and warping of concrete slabs in our indoor test facility. The FAA would like the Committee to consider that this research may be better suited under the Pavement Technology Program, which is implementing a study on concrete panel size for thinner pavements. The results of that study may then be incorporated into future test cycles here at the FAA’s facilities.

Subcommittee on Environment and Energy

General Observations: The Subcommittee focused on reviewing the Research and Development (R&D) Portfolio for Office of Environment and Energy that was developed based on the RE&D budget for FY23 that was enacted on March 15, 2022 (RE&D received \$248.5M). The Inflation Reduction Act has \$297M to be spent over five years. The use of these funds within the Section 40007 Program has been programmed into the research efforts. The new Sustainable Aviation Fuel (SAF) Tax Credit and Grant Programs are significant: this includes \$297M for FAST-SAF and FAST-Tech grant programs. During the meeting, the staff from the Office of Environment and Energy (AEE) provided updates and highlighted accomplishments on all the major research projects within the portfolio since our last meeting. Work on programs such as the Aviation Sustainability Center of Excellence (ASCENT); Continuous Lower Energy, Emissions and Noise (CLEEN); Commercial Aviation Alternative Fuels Initiative (CAAFI) and the Aviation Environmental Design Tool (AEDT) have been progressing. NASA also provided a comprehensive update on its programs. The primary focus of the briefing was on ultra-efficient transport, the future airspace, high speed commercial flight and advanced air mobility.

As has been the case in previous reports from this Subcommittee, listing the individual accomplishments and their impacts on many of the different facets of aviation is not realistic during this presentation, but these accomplishments further validate the benefits and the need for sound research when developing regulations, policies, and procedures. These updates highlighted some of the new projects that have been started and are being proposed given the current mandates and additional funding within the FY23 enacted budget.

The presentations outlined a high level of communication between AEE staff and their partners to continue these necessary research efforts. The Subcommittee is pleased to see the improved working relationship between the FAA and the EPA on multiple fronts. One example of this corporation will result in the improvement in the AERMOD model, which is a key tool for airports to model community exposure to aircraft emissions. The latest FAA initiative to Eliminate Aviation Gasoline Lead Emissions (EAGLE) to lead the transition to unleaded piston general aviation fuel is very important.

As was noted before, the current Administration has made a commitment on climate change and issued an Executive Order 14008 that outlines its goals. It has commitment towards “reducing the aviation sector’s emissions in a manner consistent with the goal of net-zero emissions for our economy by 2050”. This was further captured in the U.S. Aviation Climate Action Plan. Through this document, the government announced its intention to advance the development and deployment of sustainable aviation fuels, and to maintain a leadership position at the world level with organizations such as the International Civil Aviation Organization (ICAO). Recently ICAO reached agreement on Long Term Aspirational Goal (LTAG) with some adjustments to CORSIA. So now U.S. Aviation Climate Action Plan’s net zero 2050 goal is now matched by ICAO LTAG and industry goals. We firmly believe that partnerships with other governments, other federal agencies, the Centers of Excellence, and private corporations who are involved in the research portfolios that AEE has in place are key to completing this mission and are the most effective vehicle to conduct and coordinate future research and maximize limited resources.

The Subcommittee believes that AEE is doing a very good job and has once again presented a balanced portfolio. We believe that the priorities that we had previously identified have not changed and that AEE has added research projects that address these priorities as well as those necessary to address the goals outlined by the current administration. Many of these new projects have been added to the Continuous Lower Energy, Emissions and Noise (CLEEN) and Aviation Sustainability Center of Excellence (ASCENT) portfolios. The Subcommittee members realize that there is still additional research required to address ongoing areas of concern. We are happy to see the recent addition of staff to AEE but believe that further evaluation of staffing needs should take place given the additional funding and additional projects that are required to meet the goals outlined by this current administration. The loss of the Chief Scientific and Technical Advisor (CSTA) for Environment and Energy will create a significant void for AEE. An exemplary professional, this CSTA made a significant contribution to the overall success of this program for many years, even prior to joining the FAA. The members of the Subcommittee wish him much success in his future endeavors. The need to maintain a leadership position at International Civil Aviation Organization/Committee on Aviation Environmental Protection (ICAO/CAEP) is still vital to the U.S. Aviation interest. The recent election of an FAA Environment and Energy subject matter expert as Chair of CAEP Committee bolsters the leadership role played by the US at ICAO.

The results that have been accomplished by the projects in CLEEN Phase 1 and CLEEN Phase 2, as well as ASCENT highlights the value of the Public/Private Partnerships that AEE has made an integral part of its research portfolio. The additional funding to CLEEN has enabled the FAA to expand CLEEN Phase 3 while also accelerating the start of CLEEN Phase 4. Another advantage of these partnerships is that universities and hundreds of students have benefited from these advanced research projects. The partnerships with the FAA have allowed universities to improve their facilities and capabilities and thus recruit better students that help improve the quality of the research being done in the USA. The timely awarding of these grants is still a challenge. At the time of our meeting, there were fifty-nine projects worth approximately \$33M awaiting approval through the grant approval process. The delay in approving and awarding of these projects has resulted in missed research opportunities and will create challenges in being able to address the priorities ahead and the ability to accomplish our goals. Guided by the updates and presentations, the Subcommittee has proceeded with the following “Findings and Recommendations”. The recommendations offered are all for inclusion in the REDAC report.

Finding: Sustainable Aviation Fuels (SAFs): - We know that the Sustainable Aviation Fuel (SAF) Program including efforts in the Commercial Aviation Alternative Fuels Initiative (CAAIFI), Continuous Lower Energy, Emissions and Noise (CLEEN) and Aviation Sustainability Center of Excellence (ASCENT) is a critical component of the industry’s global emission reduction strategy. To meet the federal goals of increasing the production of SAFs to at least three billion gallons per year by 2030, there will need to be an increase in the research projects within the ASCENT portfolio. We are happy to see that some of these research projects have already been added to the portfolio. The same can be said if we hope to develop fuels that can be blended above 50% in today’s fleet of aircraft. The current research has helped with the creation of several companies that have the potential to benefit the rural economies of several states and the U.S. Aviation industry. The establishment of the Sustainable Aviation Fuel Grand Challenge will ensure that the U.S. Government and the private sector are working together to address

aviation sector emissions. The signatories of the SAF MOU, the DOE, DOT and USDA are all working very hard and have made progress and have developed goals and made commitments to this program. The new SAF Credit and Grant Programs are vehicles geared towards implementation of the SAF Program. The EPA is also heavily engaged as well. There are ongoing efforts to ensure that alternative jet fuels are in Carbon Offsetting and Reduction System for International Aviation (CORSIA) through International Civil Aviation Organization/Committee on Aviation Environmental Protection (ICAO/CAEP).

Recommendation 1: The Subcommittee agrees with the mandate proposed by the current Administration that the work on Sustainable Aviation Fuels (SAF) is a critical component for the reduction of aviation sector emissions and supports the SAF Grand Challenge. Since the maturation of the Sustainable Aviation Fuel program will be a major environmental benefit for the public, will create a new industry within the U.S. that benefits rural America, and will benefit the U.S. aviation industry, we strongly recommend that the FAA AEE continues to allocate funds for the continuation of research on SAFs. We endorse what has been started but strongly recommend that AEE needs to accelerate this program to accomplish the goal of being able to supply 100% of the aviation fuel needed in 2050. The awarding of FAST-SAF and FAST-TECH grants is significant for the success of the SAF program.

FAA Response: The FAA concurs with the Committee's Findings and Recommendations and is undertaking the following actions to address its recommendations – The U.S. Government and industry are both committed to achieving three billion gallons of SAF use by 2030. This will be critical to enabling the aviation industry to get on a path to decarbonize by 2050. The FAA collaborated with the DOE, USDA, EPA, and stakeholders from across government, academia, and industry, to develop the SAF Grand Challenge Roadmap, which shows how we can all work together to achieve these goals. We will engage with other federal agencies to identify ongoing and planned activities aligned with the roadmap and gaps in Research, Development, Deployment, and Diffusion and associated funding needs. Progress will be shared with stakeholders to obtain input, identify relevant industry efforts, and find opportunities for public-private partnerships. A Sustainable Aviation Fuels (SAF) Grand Challenge website was launched, and an annual progress report is being planned. We are also continuing our long-standing efforts in the Aviation Sustainability Center of Excellence (ASCENT), the Commercial Aviation Alternative Fuels Initiative (CAAIFI), and the Continuous Lower Energy, Emissions, and Noise (CLEEN) Program to support SAF development through testing, analysis, and coordination activities. Using FY23 funding, we continue funding projects to support the certification and qualification of 100 percent SAF for use with today's fleet of aircraft and to streamline the process to certify novel fuels as being safe for use.

A new project is being funded to establish a facility to acquire, distribute, test, and document SAF and other reference conventional fuel samples to ensure timely distribution of potential SAF products from producers to evaluators and support the average 1.6x annual production growth rate necessary to achieve the planned production goals. Support also continues for working on cost-effective agricultural practices to sequester carbon, extending our domestic supply chain efforts to other world regions to aid in the expansion of SAF production globally, and understanding the potential benefits of using SAF to reduce the impacts of aviation-induced cloudiness on the climate. To reach our goal of net-zero greenhouse gas emissions

from the aviation sector by 2050, we will need to be able to use 100 percent SAF in our existing fleet of aircraft, and this SAF will need to provide a maximum reduction in climate impacts at a minimum economic cost. Additionally, we are making progress in standing up the new grant program on SAFs required under Section 40007 of the Inflation Reduction Act (IRA) of 2022. We assigned AEE the responsibility of establishing and managing the IRA grant program, and the office is currently in the process of finalizing the draft Notice of Funding Opportunity (NOFO), drafting the Submissions Evaluation Plan, and working on the requirements associated with the issuance of the NOFO.

Recommendation 2: The FAA must also maintain a leadership role in the development of SAFs to ensure that the rules to be considered at a global level International Civil Aviation Organization (ICAO) will be beneficial to the U.S. industry.

FAA Response: The FAA concurs with the Committee’s Findings and Recommendations and is undertaking the following actions to address its recommendations – The FAA appreciates the importance of continued U.S. leadership in International Civil Aviation Organization (ICAO)/Committee on Aviation Environmental Protection (CAEP) activities and will continue our long-standing efforts to leverage the Environment and Energy R&D Portfolio to inform the decision-making in ICAO on SAF. This includes providing technical leadership in the development of the life cycle greenhouse gas accounting methods of the International Civil Aviation Organization (ICAO)/Carbon Offsetting and Reduction System for International Aviation (CORSIA). We are also leveraging these ongoing efforts to inform the development of life cycle accounting methods for the new SAF blenders tax credit under IRA Sections 13202 and 13704.

Finding: Public Private Partnerships - The Subcommittee continues to acknowledge and support the fact that the Office of Environment and Energy (AEE) have proven over decades to be very good stewards of taxpayer money. The leadership team at AEE has used their budgeted amounts to conduct and coordinate the research necessary to produce informed, data-driven policies; facilitate technological advances in the aviation industry; and produced models and data that have positioned the U.S. as both a State leader at International Civil Aviation Organization (ICAO)/(CAEP) and on the global aviation stage. The execution of this research portfolio has been accomplished by working collaboratively with private industry, major universities through the Aviation Sustainability (ASCENT) Center of Excellence, other Federal Departments and Foreign Governments. Three quarters of Environment and Energy research funds generate 100% plus cost matching from non-federal partners [Continuous Lower Energy, Emissions and Noise (CLEEN), Commercial Aviation Alternative Fuels Initiative (CAAFI), and ASCENT)]. The results that we have seen in the CLEEN Phase 1 and CLEEN Phase 2 projects as well as those in the ASCENT Center of Excellence is proof that these partnerships clearly work. These partnerships leverage scarce FAA R&D funds to accomplish significant advances and improvements. In addition, we believe that government funding has been used and executed effectively to lower the risk of new and emerging technologies such that they can be adopted by industry. The research benefits of these partnerships have clearly been proven over time and is very apparent in the current projects. The maturation of new technologies has delivered improved environmental performance and has enabled aviation system growth and associated

positive economic impacts. To comply with Executive Order 14008 on Tackling the Climate Crisis, there will be an increased reliance on these Public Private Partnerships.

One of the benefits that has not been highlighted before is that these partnerships have created new industry and new jobs in aviation. In addition, private industry, universities, and hundreds of students have benefited from the partnership with the FAA. Getting the timely award of these grants is critical to the COE's ability to start vital projects.

Recommendation 3: Whereas the Subcommittee continues to endorse Public Private Partnerships like the [Continuous Lower Energy, Emissions and Noise (CLEEN), Commercial Aviation Alternative Fuels Initiative (CAAFI) and Aviation Sustainability (ASCENT) Center of Excellence (ASCENT)] programs to leverage resources, we believe that the FAA will not be able to accomplish any of the priorities set forth by the current administration without allocating robust funding for these programs. The Subcommittee recommends that AEE utilize the additional funding that it has received in FY22 and any additional funding it receives in FY23 and FY24 on new and existing projects that will enhance and accelerate research to best address the current federal mandates. The Subcommittee endorses the establishment of new partnerships with other federal agencies like the one that exist with NASA as a key to success.

FAA Response: The FAA concurs with the Committee's Finding and Recommendation and is undertaking the following actions to address its recommendation - The FAA understands the importance of maximizing the impact of taxpayer dollars. By partnering with industry, academia, federal agencies, and foreign governments, we are making our research investments go further by leveraging our collective resources. By having universities in the Aviation Sustainability Center of Excellence (ASCENT) work directly with industry partners; it increases the likelihood that industry will use the research product to mature their technologies ahead of implementation schedule to reduce noise and emissions. In addition to providing world-class research products that are helping address the environmental challenges being faced by the aviation industry, the Aviation Sustainability Center of Excellence (ASCENT) is also creating the workforce of the future. Since 2004, the Partnership for Air Transportation Noise and Emissions Reduction (PARTNER) and ASCENT supported over 674 students. For FY23, the ASCENT portfolio will include over \$16 million dedicated to SAF research and another \$10 million for advancing technological innovation within the industry. By requiring cost share within Continuous Lower Energy, Emissions and Noise (CLEEN), we increase the likelihood that the industry partner will use the new technology to reduce noise and emissions. The FY23 enacted budget provides \$38 million for the CLEEN Program, and we intend to maintain that funding level with the FY24 Presidents' budget. CLEEN, Commercial Aviation Alternative Fuels Initiative (CAAFI), and ASCENT are successful because of their strong engagement with the industry. Each of these programs has had strong partnerships with, and support from, the industry for over a decade. In addition, the establishment of the new IRA SAF and Technology grant program will allow AEE to further collaborate with industry, academia, local governments, and potentially others in accelerating the introduction of SAF in the supply system and accelerate the development of even more low-emissions aviation technology. As with the ASCENT and CLEEN programs, the cost-sharing provisions of these new IRA grants will also allow AEE to further extend the impact and reach of the provided federal funding.

Finding: Global Leadership - Despite the fact that the FAA AEE currently maintains a leadership role in International Civil Aviation Organization/Committee on Aviation Environmental Protection (ICAO/CAEP) and has been the driving force behind the push for data driven rule making, based on the commitments made by the current administration on Climate Change, the Subcommittee firmly believes that maintaining the U.S. global leadership position at ICAO/CAEP is essential and advantageous to U.S. aviation industry and will allow the U.S. government to defend its positions based on scientific research. Previous work that has been done with ASCENT and the Volpe Center has clearly allowed the FAA to maintain a scientifically supported position at ICAO/CAEP. The close collaboration with NASA and individuals that have been involved in research projects under the E&E portfolio have played significant roles at ICAO/CAEP and that is also clearly supporting U.S. global leadership. The work done within the CAEP Task Group to reach an agreement on a Long-Term Aspirational Goal for international CO₂ emissions (LTAG TG) is major accomplishment and one example of this collaboration and support setting the stage for U.S. leadership. Establishing international standards for Sustainable Aviation Fuel (SAF) is also important. Anything that jeopardizes ongoing research at AEE will impact the FAA/U.S. global leadership position at ICAO/CAEP. The FAA's ability to attend in person meeting and represent the U.S position regarding international policy making at the international level is essential.

Recommendation 4: The Subcommittee recommends the continuing strong support of all research efforts/programs that will allow the FAA and the U.S. to maintain its current global leadership position at ICAO/CAEP. It is the belief of the Subcommittee that if the FAA/U.S. does not maintain its leadership position at ICAO/CAEP it will not be able to influence policy/rulemaking and this could have a significant negative impact on the U.S. aviation industry.

FAA Response: **The FAA concurs with the Committee's recommendation and is undertaking the following actions to address its recommendation** - The FAA appreciates the support of the Subcommittee for our International Civil Aviation Organization/Committee on Aviation Environmental Protection (ICAO/CAEP) activities and the importance of continued U.S. leadership therein. We made considerable investments over the years to support the work of ICAO/CAEP, and that continues today, as FAA leadership is critical to securing U.S. objectives at ICAO. The commitments that FAA made to ICAO international leadership span a range of integrated efforts that include funding Aviation Sustainability Center of Excellence (ASCENT) research projects in support of ICAO CAEP's work program, supporting technical assistance from DOT/Volpe, hiring subject matter experts to play key technical roles with ICAO CAEP's technical working groups, collaborating with other government agencies such as NASA and EPA, and assigning DOT and FAA personnel to fulfill critical leadership roles across ICAO/CAEP's working groups. ICAO relies on FAA-funded research and analyses to inform its environmental work, much of which is done by ASCENT universities and the Volpe Center, under the direction of the FAA and in close collaboration with NASA and industry. In addition, the FAA Office of Environment and Energy (AEE) efforts were critical to defining how Sustainable Aviation Fuels (SAF) is credited under Carbon Offsetting and Reduction System for International Aviation (CORSIA), and we expect our SAF research to take on additional importance within ICAO.

Our ongoing ASCENT projects to support CAEP standard-setting efforts will continue to provide us with the understanding and information needed to lead the international community in developing a new integrated noise and carbon dioxide emissions standard. These projects will also support exploring metric systems that could be used to control full-flight nitrogen oxide emissions and interdependencies with non-volatile particulate matter emissions. Existing ASCENT projects are also supporting CAEP's technical development for Supersonic engine emissions certification standards and recommended practices (SARPs), as well as En Route Noise SARPs. In addition, AEE is continuing to fund research to support the development of noise standards that would enable the introduction of drones, Advanced Air Mobility (AAM) vehicles, and Supersonic aircraft.

Finding: Noise Research - Aviation noise is and will continue to be one of the biggest environmental impacts related to the aviation industry and it requires ongoing research to address the concerns of the citizens. Even though we have learned a lot based on the results of many of the projects in the "Noise Portfolio", the Subcommittee's position on noise has not changed in that there is much research that is still necessary to address the ongoing topic of aviation noise. Whether there are new technologies or new procedures that can be implemented to help reduce the impacts of noise as the aviation industry rebuilds needs to be evaluated. Historically, advances in aircraft technology have been the major factor in reducing aviation's environmental impacts. The Subcommittee recognizes that there is about a seven (7) year lag between flight testing a technology and it is appearing in the fleet. Therefore, if we want to consider any new technology being introduced into the fleet in early 2030, we need to invest in the research now. The use of government resources during the initial research stages helps mitigate technology risk and incentivize private companies to invest and develop cleaner, quieter technology. The FAA Office of Environment and Energy (AEE) has seen several research projects that have contributed to more fuel efficient and quieter aircraft. They have also developed new operational procedures that have reduced the noise impacts in communities in and around airports. There are several new research projects that have been added to address issues related to new entrants, such as Unmanned Aerial Systems (UAS) and Advanced Air Mobility (AAM) into the aviation system. Many of these new entrants will be active participants in our airspace in the not-too-distant future. There is strong collaboration with NASA on the noise front. There also have been significant upgrades made to the Aviation Environmental Design Tool (AEDT). AEE has established an AEDT User Review Group for ideas and feedback to ensure that the tool is beneficial to the actual users. FAA has also launched an initiative to partner with airports to gather more noise data resulting from noise complaints. Finally, AEE is working with industry to accelerate the development of technologies that reduce noise through the Continuous Lower Energy, Emissions and Noise (CLEEN) Program.

Recommendation 5: The Subcommittee once again recommends the continued prioritization of noise research and the prioritization of the projects that will support informed decision-making as it relates to the introduction of new entrants to the national air space.

FAA Response: The FAA concurs with the Committee's Finding and Recommendation and is undertaking the following actions to address its recommendation - The FAA is committed to developing meaningful and equitable solutions to address the complex and nuanced issue of aviation noise. We continue to execute the research program that was captured on January 13, 2021, in the Federal Register Notice, Overview of FAA Aviation

Noise Policy and Research Efforts. This includes research not only on the fleet of existing fixed-wing aircraft and helicopters but also on Unmanned Aircraft, Advanced Air Mobility (AAM), and Supersonic aircraft. The FAA increased our coordination with NASA's Revolutionary Vertical Lift Technology (RVLT) Program in this area to further understand the acoustics of new entrants and the human response to the noise created by them. We are continuing several research projects within the Aviation Sustainability Center of Excellence (ASCENT) to further analyze UAS field measurements data to improve our modeling methods and tools, expand our understanding to allow for quieter designs and operation, and support the development of appropriate standards and policies. In addition to the ASCENT projects to improve noise modeling of AEDT near the airport and further afield, we also have a project focused on the development of a tool for the rapid computation of noise levels and uncertainty distributions resulting from AAM operations, an approach much better suited to the expected nature of UAS and AAM vehicle operations. We also continue to support research at Boston University, the Massachusetts Institute of Technology, and the University of Pennsylvania on the health, economic, and sleep disturbance impacts of aircraft noise. Lastly, we have several projects in support of the development of technological mitigation solutions to noise. These projects range from efforts to improve physics modeling and analysis and design tools to looking at specific technologies and complement the work being done by ASCENT on assessing the system-level improvements expected because of the introduction into the fleet of the Continuous Lower Energy, Emissions and Noise (CLEEN) II technologies.

Finding: Staffing - Given the mandates and financial support from the current Administration to climate change and increased Sustainable Aviation Fuel (SAF) production, the FAA Office of Environment and Energy (AEE) has added several new projects to the portfolio. With additional funding from the Inflation Reduction Act and new SAF Tax Credit and Grant Program, there will be many additional projects being created in the near term. The Subcommittee has concerns that they are not sufficient subject matter staff to oversee and manage the increased workload. AEE needs to carefully examine its staffing to ensure that it has sufficient staff to support the expansion of public private partnerships and planned future projects. The loss of the Chief Scientific and Technical Advisor and other subject matter leads has created some additional challenges for AEE leadership.

Recommendation 6: The Subcommittee strongly recommends that the FAA, AEE carefully examine the workload on its current staff and ensure that it has sufficient staff to support the additional priorities and projects that have been added to the portfolio.

FAA Response: The FAA concurs with the Committee's Finding and Recommendation and is undertaking the following actions to address its recommendation – The loss of the Chief Scientist and other senior staff within AEE is likely to result in some challenges for the Office R&D program. In addition, the effort by the Office to establish a new Energy Division, AEE-500, to oversee work related to SAF and unleaded aviation gasoline and interagency efforts associated with research and policy just came to fruition. However, these changes did not arrive unexpectedly, and therefore a planned and orderly transition and reassignment of responsibilities was possible. While the AEE team is not very large, the exceptional level of expertise, professionalism, dedication, and cohesiveness of the staff will provide the framework the Office will require to endure the transition and continue thriving while

management works to find and hire new personnel. Vacancy announcements were released for the senior positions, including that of the Chief Scientist, as well as for other staff positions, and the AEE management continues to work to ensure that those vacancies are filled with the best candidates as quickly as the process allows.

Finding: Grants - There has been additional funding for new grant programs. The Subcommittee is concerned that any delay in approving and awarding of these projects will result in missed research opportunities and will create challenges in being able to address the priorities ahead and the ability to accomplish our goals.

Recommendation 7: The FAA needs to streamline the process and remove any obstacles that are delaying the approval and awarding of these projects that are necessary to the success of its mission.

FAA Response: The FAA concurs with the Committee's Finding and Recommendation and is undertaking the following actions to address its recommendation. – The FAA understands the need for and importance of ensuring the timely awarding of Aviation Sustainability Center of Excellence (ASCENT) grants. AEE, with the active support of the FAA Office of Policy, International Affairs, and Environment (APL), maintains close coordination with both the FAA Office of NextGen and DOT to help with the smooth processing of grants. The new FY23 OST Grants Guidance Memo no longer requires the COE grants to undergo a full review by OST, so APL/AEE will coordinate closely with both entities to ensure new grants packages proceed as quickly as possible through the FAA approval process and then clear the remaining OST review within the prescribed time window. The Inflation Reduction Act – Fueling Aviation's Sustainable Transition (IRA - FAST) Grants program, however, has been identified as a Tier 1 program in the OST guidance due to its high visibility and, therefore, will have to undergo the most detailed review and approval. APL's established coordination process will help ensure that FAST will move through that process according to the expected schedule.

Subcommittee on NAS Ops

General Observations: When planning and executing a research program, strategy development, strategic thinking, and strategic communications are vital for organizational success; further, the more diverse and interdependent the organization is, the more vital these skills and tools are. The new Strategic Outlook for Aviation Research (SOAR) framework presented by the Deputy Director of the FAA William J. Hughes Technical Center, is an excellent illustration of how to produce and deliver the much needed “who, why, and how” of these strategic functions, for both internal and external audiences. The framework underscores the need for strategic clarity in the FAA's Research, Engineering, and Development (RE&D) Portfolio to avoid misperceptions and ensure accurate understanding across stakeholders. Articulating the RE&D Portfolio across three strategic domains (Near Term/Current; Mid Term/Emerging; and Long Term/Projected), along with implications for FAA actions in each, is effective. The NAS Operations Subcommittee commends this messaging initiative and encourages the FAA to exploit the SOAR framework to enhance its ability to communicate existing and planned RE&D efforts.

The success of the Remote Tower (RT) project is highly laudable. The NAS Operations Subcommittee endorses the FAA decision to transition the RT pilot program toward centralized testing and evaluation of vendor-applicants for System Design Approval (SDA) using a new testbed being deployed at the National Research and Technology Park at the FAA William J. Hughes Technical Center. The FAA's transition from distinct single-system sites to a common testbed for Remote Tower System evaluations will provide additional flexibility, the ability to directly compare system solutions, and support related standards development and validation.

Finding: Acceleration of AAM CNS Technology Development - The Subcommittee received a briefing on "*The Industry Case for AAM Acceleration via Refined Focus on CNSi Technologies and Standards*" presented by Virginia Stouffer of Aura Network Systems. The analysis referred to the UAM Maturity Level (UML) structure that NASA developed as a framework for research projects in the NASA AAM program. The premise of the assessment is that due to a current focus on longer-term investments for UML-4 (long-term, involving a high volume of autonomous operations), there is a gap in government RE&D investment toward the needs of industry at the nearer-term UML-2 and -3 (mid-term) levels, where industry will first deploy commercial operations and create revenue. This gap creates a financial, regulatory, and schedule risk for AAM system innovation. The assessment produced an understanding that there is a need to expand integrated technology investment and involvement of the FAA and NASA with industry that supports integrated Communications, Navigation, and Surveillance (CNS) capabilities to enable nearer-term AAM operations of all kinds, including low-altitude, regional, and urban operations.

Recommendation 1: The NAS Operations Subcommittee recommends that the FAA, industry, and NASA develop a joint framework for AAM ecosystem maturity levels that accurately reflects projected timelines and the maturation of the industry over the past two years. The FAA may then develop a clear RE&D strategy to partner with industry specifically to accelerate mid-term emerging CNS-related efforts. This effort should be conducted in partnership with NASA, industry, and other stakeholders, especially with respect to CNS technologies. Example technical areas include command and control for beyond visual line of sight operations, airspace conflict management, detect and avoid technology, alternative positioning, navigation, and timing capabilities, and cloud architectures with corresponding cybersecurity considerations. FAA investments could include enhanced support to standards development organizations, support for collaborative ground and airborne testing, simulation support, etc. The strategy should be provided as a briefing by the FAA to REDAC and should include an assessment of the current RE&D CNS investments and shortfalls in the context of the needed technologies.

FAA Response: The FAA concurs with the Committee's Finding and Recommendation and is undertaking the following actions to address its recommendation - The FAA, NASA, and industry stakeholders worked closely together to develop and implement the Urban Air Mobility (UAM) Maturity Level framework, which includes CNS evolution. The FAA is working on a complementary regulatory framework to UMLs that will allow UAM/AAM operations to be fully integrated into the airspace and operate alongside traditional aircraft in the near term and beyond.

Finding: Commercial Space Research Alliance - Commercial Space operations are growing rapidly and can be expected to have significant impact on NAS operations, affecting both throughput and capacity, with potential implications on safety. The FAA's Office of Commercial Space Transportation (AST) research portfolio is in the process of transitioning from its prior Center of Excellence to a new planned public-private Research Alliance. Successful public-private partnerships have been built on frameworks and processes that are well-known in the aerospace sector. Now is the moment to take the time to study and implement best practices from successful public-private research and innovation alliances so that this new framework is most effective.

Recommendation 2: The NAS Operations Subcommittee recommends that the FAA carefully design the new AST public-private Research Alliance partnership by identifying and then applying best practices from other government-industry-academia technology alliances, to maximize the probability of success. This step could be implemented through any of several unbiased entities in the FAA network, including FFRDCs or the National Institute of Aerospace.

FAA Response: The FAA concurs with the Committee's finding and recommendation and is undertaking the following actions to address its recommendation - The FAA is currently hiring additional personnel to allow us to reprioritize the Research Alliance. We are moving to a Research Alliance structure based on lessons learned from our previous Center of Excellence for Commercial Space Transportation (COE CST). We believe the Research Alliance will provide several advantages over the COE CST, including additional participation and collaboration with government and industry, as well as the ability to leverage those two areas in addition to academia for R&D resources beyond what the FAA can provide by itself. We looked at the Department of Energy's Alliance format, where the department was able to leverage \$7 for each dollar they spent. We plan to work this fiscal year to lay the groundwork for an appropriate contract vehicle to create and manage the Research Alliance.

Finding: Wake Program Sensor Refresh - The Wake Program's existing Light Detection and Ranging (LIDAR) equipment, used to empirically measure aircraft wakes near airports, is aging out of maintenance windows and requires replacement. The FAA has initiated a sensor study to identify and procure the next generation of wake sensors. The need for a refresh of wake turbulence sensor technology is vital for maintaining operational safety in the NAS as affected by wake turbulence. The increase of new entrant Advanced Air Mobility (AAM) aircraft [(including electric vertical take-off and landing (eVTOL) and conventional take-off and landing (eCTOL)] in the NAS, and their potentially unconventional mission profiles, poses new requirements for the characterization of wake turbulence effects. The transition to new wake measurement systems represents an opportunity to consider a broader focus of wake data collection to include new airport locations and new AAM entrants.

Recommendation 3: The selection of sensors should be derived from an overarching wake research plan and its corresponding requirements for data collection. The NAS Operations Subcommittee recommends that the FAA complete its wake sensor study while including consideration for deployment to new locations and configurations to collect data related to AAM vehicles and operations. This may result in different factors being considered in the selection of sensors than has been the case for conventional aircraft operations.

FAA Response: The FAA concurs with the Committee's recommendation and with the noted exceptions and clarifications and intends to undertake the following actions to address its recommendation - The Wake Turbulence Research Program identified the requirements for continued wake data collection to maintain an acceptable level of wake safety in the NAS. These requirements consider the current and proposed fleet mix operating in the NAS and the most likely areas of operations for new aircraft types. The sensor and site selection process will take these key factors into account when determinations are made to meet the program's research goals.

Finding: Wake Program Business Case Development - The Wake Re-categorization Program has been developing and assessing dynamic wake solutions that could enhance NAS efficiency, but this program is ending with no further funding or transition planned. It is not clear that a comprehensive business case study has been completed by which future research investments into dynamic wake solutions would be guided. Work under this program also does not appear to be coordinated with AJV-S to ensure that potential enhancements are operationally sound and captured in the architecture plans for the NAS.

Recommendation 4: The NAS Operations Subcommittee recommends that the FAA conduct and complete a comprehensive cost/benefit business case for the employment of a range of dynamic wake procedures that could be employed at different airports and operating environments, including potential future Advanced Air Mobility (AAM) operations. This work should be coordinated with AJV-S to ensure that potential enhancements are operationally sound and captured in the architecture plans for the NAS.

FAA Response: The FAA concurs with the Committee's recommendation and with the noted exceptions and clarifications intends to undertake the following actions to address its recommendation - The Wake Re-Categorization Program's goals for the next fiscal year include completing the development of the terminal Dynamic Wake concept. As we define Agency requirements, they will dictate the concept for future implementation. This program goal could inform a future business case study and discussion as NAS operations and systems continue to evolve.

Finding: Remote Tower Technology for Advanced Air Mobility (AAM) - The Subcommittee notes that the Remote Tower (RT) strategy has not accounted for the prospective value of RT concepts to AAM operations, especially for higher density operations that involve mixed traditional and new entrant operations in shared airspace. This aspect becomes more challenging when including the planned deployment of third party commercially operated Providers of Services to UAM (PSUs) and Command and Control Communication Service Providers (C2CSPs) responsible for managing the AAM airspaces of interest.

Recommendation 5: The NAS Operations Subcommittee recommends that the FAA incorporate AAM considerations into planning for the Remote Tower (RT) testbed being deployed at the FAA William J. Hughes Technical Center. As an interim step, the Subcommittee requests a briefing on the FAA's strategy considering the value of the Remote Tower technologies in AAM operations, especially regarding higher density and mixed fleet airspace operations. The Subcommittee anticipates that this strategy would be based in part on lessons learned from the

current remote tower project, and that NASA's role in prospective related research would be considered.

FAA Response: The FAA concurs with the Committee's recommendation and with the noted exceptions and clarifications and intends to undertake the following actions to address its recommendation - The FAA is considering Remote Tower application for all use cases of a brick-and-mortar tower. Currently, the FAA is focusing initial resources on evaluating RT concepts in Visual Flight Rules (VFR) tower environments. The current scope of the Remote Tower pilot program would not exclude airports with AAM operations. The FAA expects to finalize approval of its first RT system for use in a VFR tower environment by the end of 2025. However, the final approval timeline depends on the vendor system's ability to meet FAA standards.