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[redacted]

April 25, 2023

The Honorable Billy Nolen
Administrator
Federal Aviation Administration
[redacted]

Dear Administrator Nolen:

Attached below please find the Findings and Recommendations from the Aircraft Safety, Airports, Environment and Energy, Human Factors, NAS Operations Subcommittees from the Winter-Spring 2023 meetings which have been reviewed and supported by the full REDAC on April 12, 2023.

The REDAC noted a number of positive elements in the management of the Research and Development portfolio that we wanted to bring to your attention

*Artificial Intelligence/Machine Learnin*g – The REDAC was pleased to see the appointment of an Agency Chief Scientist for Artificial Intelligence and Machine Learning. The REDAC had highlighted this as an area of increasing importance and this action is a movement in a positive direction.

Strategic Outlook for Aviation Research Framework – The Strategic Outlook for Aviation Research Framework (SOAR) was prototyped at several of the REDAC Subcommittee meetings and the framework seems to be an effective mechanism to both communicate the strategy of the research portfolio and support effective feedback from stakeholders and the REDAC.

Environment and Energy Research Leadership – The REDAC wanted to commend and note the leadership of Dr. Jim Hileman who has recently left the FAA. We had previously noted the quality of the research in the Environment and Energy portfolio and FAAs leadership nationally and internationally as reflected in the impact on ICAO sustainability efforts and the high quality of the US Aviation Climate Action Plan. Jim has left the Agency a strong position to continue leadership in this area.

We appreciate the opportunity to support the FAA in promoting the safety, efficiency and sustainability of aviation. We stand ready to assist you and the FAA mission.

Sincerely,

R. John Hansman
Chair, FAA Research, Engineering and Development Advisory Committee

Enclosure

Research, Engineering, and Development Advisory Committee (REDAC)
Recommendations for Fiscal Year 2025 Research and Development 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 investing 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: 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 ques 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.

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: 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.

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: 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.

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: 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

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: 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 constriction—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.

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 AFFF to F3 at U.S. certificated airports.

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

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

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 of 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 in order 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 59 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 (CAAFI), CLEEN and ASCENT) is a critical component of the industry's global emission reduction strategy. In order to meet the federal goals of increasing the production of SAFs to at

least 3 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 a number of 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 insure 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: 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 in order 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. 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 (ICAO) will be beneficial to the U.S. industry.

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 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 has 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. In order 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: 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 similar to the one that exist with NASA as a key to success.

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 CO_2 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: 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.

Finding: Noise Research - Aviation noise is and will continues to be one of the biggest environmental impacts related to the aviation industry and it requires ongoing research in order to address the concerns of the citizens. Despite the fact that 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's 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. AEE has seen a number of 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 a number of 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 in order 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: 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.

Finding: Staffing - Given the mandates and financial support from the current Administration to climate change and increased Sustainable Aviation Fuel (SAF) production, AEE has added a number of 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 handle 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: 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.

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: 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.

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 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 and contrast 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 as a whole. 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: 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.

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: 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.

Finding: Wake Program Sensor Refresh - The Wake program's existing 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 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: 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.

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 coming to an end 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: 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 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.

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: The NAS Operations Subcommittee recommends that the FAA incorporate AAM considerations into planning for the remote tower 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.