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**Aeronautics and Astronautics
Massachusetts Institute of Technology**

April 29, 2024

The Honorable Michael Whitaker
Administrator
Federal Aviation Administration
[Redacted]

Dear Administrator Whitaker:

Attached below please find the Findings and Recommendations from the Aircraft Safety, Airports, Environment and Energy, Human Factors, and NAS Operations Subcommittees from the Winter-Spring 2024 meetings which have been reviewed and supported by the full REDAC on April 17, 2024.

In addition, the full REDAC discussed a number of more general observations for your consideration.

Emergence of AI/ML – The emergence of potential Artificial Intelligence, Machine Learning and non-deterministic software applications across the FAA's domain of responsibility is a key area of opportunity and potential risk. The applications are broad and range from low risk analysis tools to higher risk operational systems such as autonomous flight control systems. There is the need for research and expertise to guide the appropriate policy and regulatory processes for civil aviation.

Increased Cybersecurity Exposure – The emergence of increasingly information centric NAS operations including emerging remotely commanded vehicles combined with increasing cybersecurity threats highlight the importance of cyber resilient aviation operations. The FAA has unique areas of responsibility not covered by the Cybersecurity Infrastructure Security Agency and needs to invest in the development of capabilities to respond to the increased cybersecurity exposure.

Aviation Safety Research and Development Strategy - The REDAC applauds the development of the Aviation Safety Research and Development Strategy and has agreed to support the review and evaluation of the proposed strategic thrusts.

Challenge with Research Grant – The REDAC reiterates its concern with the slow and complex process for the review and approval of aviation research grants. The process has resulted in significant delay of new and continuing research efforts. These delays impact both the execution of the research resulting in delayed or incomplete efforts but also causes significant stress and disruption to students. The REDAC understands that there are efforts underway to improve this situation but would be interested in hearing more on what progress can be made.

We appreciate the opportunity to support the FAA in promoting the safety, efficiency and sustainability of aviation. I would be happy to meet at your convenience to discuss how the REDAC could be of assistance.

Sincerely,

A handwritten signature in blue ink, appearing to read 'R. John Hansman'.

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

Enclosure

**Research, Engineering, and Development Advisory Committee (REDAC)
Recommendations for Fiscal Year 2026 Research and Development Portfolio**

Subcommittee on Human Factors

General Observations:

1. Flight Deck and Air/Ground Information Integration - The Subcommittee observed the FAA previously recognized the importance of investigating information integration from multiple sources and its presentation on the flight deck, by conducting preliminary research on the differentiation of certified and uncertified information presented to the pilot. However, that work has concluded, and despite the prominence of the “connected aircraft” concept in the FAA’s vision, there’s no ongoing work, proposed for several years to address the challenge of integrating offboard information from multiple sources with onboard information into the flight deck operational environment for pilot use. With the proliferation of mobile devices and various “apps”, and, already finding their way onto the flight deck, as well as the long lead time required to understand the safety implications of integrating new information into flight operations, the Subcommittee strongly suggests the FAA continue progress in this area. Concurrently, it appears that the proposed work in the Air/Ground integration portfolio is also stalled without research planned on information integration. The Subcommittee is concerned that information integration needs for air and ground will not be considered in time to meet the industry’s needs.

2. Training and Checking Program Changes

After discussions with the FAA at the FY24 Winter/Spring meeting, the Subcommittee understands that the FAA has determined that the situation described in our previous S/F 23 Finding and Recommendation 4, “Training and Checking Program Changes due to Changing Pilot Entry-Level Experience”, does not suggest a research need, but agreed that the issue raised is a concern. The Subcommittee observes that this issue, is a clear and present concern and suggests that the FAA give it due attention internally, even if new research is not deemed necessary to address it. The objective of this effort would be to proactively manage emerging risks in the system rather than being reactive to events when they arise.

Finding: Advanced Flight Deck Alerting Systems - The REDAC Human Factors Subcommittee was delighted to see that under Operational Capabilities for Advances and Innovation in New Technologies and Operations, a new project is proposed to develop Design Standards for New and Advanced Alerting Systems. This research was planned to commence mid-2024 and finish in late 2025 and was supported by the Human Factors Subcommittee’s recommendation at a prior Winter/Spring 2022 meeting. However, this project is no longer confirmed for funding.

Due to the complexity of this challenging research, it is anticipated the project may take several years to complete. As the number of alerts in the flight deck increases, improved capabilities such as integration of alerts within a category (e.g., into “umbrella” messages) are being implemented. Complexity increases with the integration of the alerting capabilities with other systems and technologies such as Head Up Displays, Head Worn Displays, Artificial Intelligence, etc. Complexity also increases as new technologies and new aircraft are developed.

There is a need to understand empirically, how to best direct appropriate flight crew attention with alerting system design to system failures and flight path deviations and to guide appropriate flight crew response to the alerts. With new aircraft on the horizon, there is an urgent and timely need for updated guidance that accounts for new forms of information integration, combinations of systems, and utilization of advanced technologies.

Recommendation: Due to the criticality and urgency for guidance and design standards for new and advanced crew alerting systems, the Human Factors Subcommittee recommends this project be assigned high priority to ensure research begins in a timely manner to meet industry and FAA needs. The project should also include a mechanism for getting input from industry experts (e.g., Original Equipment Manufacturers, Suppliers, Academia, Airline operators, Pilots, etc.) to ensure the needed industry expertise is utilized in the research. The outputs of this research should be used to support FAA guidance but also could inform industry standards groups.

Consequences: The current guidance for flight deck alerting systems is woefully out of date. Without new guidance to develop effective advanced alerting systems, the FAA and industry will have to work the issues simultaneously as they develop these systems. This could potentially result in divergent standards and designs that could impact safety and certification standards.

Finding: Aviation Maintenance Training Projects - The Subcommittee commends the FAA for introducing and funding several research projects focused on aviation maintenance training. These projects will identify knowledge, skills, and experience gaps that may have contributed to maintenance-related accidents and incidents in global transport category aircraft accidents from 2010-present. The suite of projects will also identify the training and operational policies/procedures needed to address gaps in existing FAA guidance and identify ways to design effectively for maintainability. The Subcommittee believes these projects provide a good balance of investment across work groups in the portfolio.

Recommendation: The Subcommittee recommends the FAA continue to invest in Maintenance Human Factors and to prioritize these planned projects to ensure that support for improvements in aviation maintenance is realized and that these projects are commenced in a timely manner.

Consequences: This research is long overdue, and without it the FAA will not have the needed information to create appropriate guidance for existing operations and new guidance for new aircraft.

Subcommittee on Aircraft Safety

General Observations:

1. The Subcommittee appreciates the update on Aviation Safety Research & Development strategy. Moving from a budget-based research approach to a project/learning based approach can provide agility to shift focus as concerns develop throughout the aviation ecosystem. The Subcommittee believes there is value in informed investment in lab facilities,

workforce development and research priorities with more flexibility, speed, and alignment within government agencies and industry.

2. The Subcommittee appreciates the briefing from the Grant Office on the Overview of Aviation Safety Center of Excellence Programs. This provided insight to the integration, process, and potential opportunities for robust Aircraft Safety Research and the development of Aviation professionals throughout the career spectrums.
3. The Subcommittee is thankful for the opportunity to brief on Model Based Systems roadmaps and digital-twin activities from various industry members. We believe these initiatives in the industry will provide increased safety and more robust certification activities in current and future products and services.

Finding: Future Thrusts: Regarding adding a Cybersecurity Thrust - The REDAC Subcommittee on Aircraft Safety (SAS) appreciates the good efforts of the FAA to strategically organize the research portfolio around critical Thrusts. In addition, the SAS supports the FAA's discussion regarding development of a new SAS Thrust on the Aviation Cybersecurity. Also, industry recognizes the leadership from the FAA in teaming with industry to establish the Cyber Safety Commercial Aviation Team (CSCAT) in 2019, intended to be the cyber equivalent of CAST/ASIAS. However, it is likely time for another more wholistic evaluation of where the aviation community is regarding aviation cyber-safety, and where appropriate research effort make sense. For example, the Aviation Rulemaking Advisory Committee on Aircraft Systems Information Security/Protection (ARAC ASISP) was chartered a decade ago, concluded its recommendations eight years ago, and was limited in scope by excluding Integrated Control Systems (ICS) and cyber physical systems considerations. Aviation cybersecurity is an area of exponential evolution driven by a number of factors including: ongoing growth in aviation connectivity providing new and higher bandwidth networking access to aviation systems globally, software functionality growth including the ongoing integration of commercial based software into air vehicle platforms and ground support systems, proliferation of aircraft integrated system designs hosted on software-enabled networks, Moore's law implications regarding computational power available to compromise and deprecate current state of the art cryptography, advancements in bad actor cyber tools and capabilities including advance AI based cyber threats, and the growing introduction of emerging entrants that do not have the same safety design background and culture as traditional aviation industry stakeholders.

In addition, what were nation state level cyber threat actor capabilities a decade ago, are now widely available to cyber terrorists, cyber hackers and in many cases Script Kiddies (i.e., amateur cyber threat actors). It is recommended that the FAA add a Cybersecurity Research Thrust with a scope that addresses both the classic IT & networking cybersecurity challenges (e.g., ASISP) in combination with the aviation Integrated Control Systems (ICS) "cyber physical systems" challenges (e.g., Aircraft systems challenges like PNT/GPS, and other related ICS areas such as the supply chain to include aircraft/component manufacturing environments). The SAS is highly supportive of the two current Cybersecurity programs (i.e., GPS/PNT and CSDS research efforts) as they are aligned with aviation community needs, are well coordinated with industry, and should continue. Unlike physical attacks which can be mitigated with local physical

solutions, cybersecurity attacks can be applied against individual systems but also against multiple systems simultaneously.

Recommendation: The REDAC SAS recommends that the FAA should create a roadmap that incorporates how the FAA cybersecurity efforts integrate with the “cybersecurity, cyber-safety and cyber-resilience” efforts of ICAO, including for example the Trust Framework Panel (TFP) and Cybersecurity Panel (CySecP), and efforts like IPS cybersecurity, etc. The proposed Cybersecurity thrust should explicitly include all forms of aircraft Communications, Navigation, and Surveillance (CNS) capabilities in addition to PNT/GPS and should include jamming and spoofing of Radio Frequency signals in addition to “network-like” attacks on aircraft systems. The proposed Cyber security thrust should explicitly include the detection of, assessment of, and mitigations against varying scales of cybersecurity threats from attacks against individual NAS systems, airport systems, and aircraft, up to simultaneous, systemic cybersecurity attacks against multiple NAS systems, airport systems, and fleets of aircraft.

Finding: Detection of Bleed Air Contaminants - In a previous Finding on Detection of Bleed Air Contaminants, the Committee stated that follow-on research is required to determine if there is a direct correlation between exposure to cabin air, beyond engine bleed air, and reported illnesses in well maintained passenger aircraft. Specifically, scientific study is needed to establish which substances are both hazardous and present in concentrations of concern. The research should support development of standards to inform in-situ measurement techniques that could identify required maintenance as well as confirm safe environments. The FAA stated in their response they did not agree with the recommendation to initiate research in the potential health effects of cabin air in general under both normal and off-nominal situations. The recommendation was too broadly scoped (‘any possible exposure’) to be actionable or affordable and was not guided by any risk-prioritization that indicates a health hazard in existing operations. The Committee agrees that the recommendation was too broadly scoped and is submitting a more narrowly focused recommendation.

Recommendation: The Subcommittee on Aircraft Safety (SAS) recommends that the FAA conduct research to determine if there is a direct correlation between exposure to cabin air, beyond engine bleed air, and reported illnesses in well maintained passenger aircraft. Specifically, conduct scientific study to establish if a direct correlation exists between illness complaints and nano-particulates of engine oil, de-icing fluid, hydraulic fluid, or jet fuel chemical components that could be both hazardous and present for durations, and in concentrations of concern, other than incidentally during events that require maintenance. And establish if such chemical presences originate solely from aircraft systems or are also drawn in from outside (i.e., ramp or taxiing) to provide useful information to original equipment manufacturers (OEMs) in design systems.

Finding: Leveraging FAA Centers of Excellence - The Subcommittee appreciated the briefing by the Grant Office on the FAA authority to make grants to institutions of higher education to establish and operate regional centers of air transportation excellence (49USC44513). Currently, there are five active Centers of Excellence (COE) which focus in the following areas: jet fuel and environment, advanced materials, unmanned aviation systems, general aviation, and technical training & human performance. The Subcommittee noted that this process and the COEs have

significant potential to access subject matter expertise, facilities and resources from academia, state governments, industry, and non-profits. The Subcommittee also noted the potential for COEs to multiply the research power of the FAA by leveraging the requirement for a minimum 50% match from non-FAA funds. Based on the presentation provided to the SAS, it was not clear how to identify which Research and Development (R&D) projects within the current and proposed research portfolio were utilizing COE and whether each R&D Budget Line Item (BLI) considered using COEs. To provide better understanding, the General Aviation COE named Partnership to Enhance GA Safety, Accessibility and Sustainability (PEGASUS) provided a detailed briefing of their specific projects and process for consideration of new/future R&D project activities. The GA COE is currently funded in FY23 for \$205k and is planned to maintain the same level for FY24. However, the GA COE is available and interested in supporting additional R&D activity and shared several ideas and proposals. The process for the COE, along with its strong partner coalition of academia and industry, to put forward proposals for new R&D projects that could be considered by FAA and its advisory committees was unclear to the SAS.

In addition, during the FAA budget update briefing, the Subcommittee noted a 100% increase from \$10 to \$20M in the FY24 Transportation, Housing and Urban Development (THUD) Conference Report being directed by Congress for the budget line item “Aviation Grant Management and Section 625 Workforce Development.” This provides significant opportunity to further leverage COEs while also supporting the Section 625 workforce development objectives as each COE includes responsibility for conducting research and on the supply of trained air transportation personnel [49USC44513(b)(1)(A)(v)].

Recommendation: The Subcommittee on Aircraft Safety (SAS) recommends that the FAA increase the visibility and use of Centers of Excellence (COEs) to utilize the opportunity to access subject matter expertise, facilities and resources from academia and industry while also leveraging FAA’s R&D funding and expertise. FAA Aviation Safety R&D Portfolio summary documents should identify COE projects and funding levels within each domain/BLI and the total project funding including the COE contribution. In addition, the portfolio of proposed projects should include whether they can be supported or accomplished in whole or in part through a COE providing an opportunity for input and recommendations from FAA and Advisory committee participants.

Recommendation: SAS recommends that the FAA provide a transparent, streamlined process for COEs to propose R&D projects for consideration by FAA and advisory committees including the opportunity to take advantage of industry resources and matching funds. This has the potential of multiplying the research power of the FAA to the benefit of safety and the taxpayer.

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.

Additionally, the Subcommittee is pleased to see the increasing emphasis the Program has on emerging entrants, developing technologies, and sustaining capital investments in one-of-a-kind pavement testing capabilities present at the National Airport Pavement Testing Facility (NAPTF).

The Subcommittee had the following additional observations -

1. The Program's Strategic Outlook for Aviation Research (SOAR) Chart (and supporting explanatory text) have been helpful in informing decision makers—including the Subcommittee—about both high priority and emerging research areas. As noted in our Fall 2023 report, the Subcommittee has found the SOAR Chart particularly useful in identifying research efforts that need to be expedited such as green pavement technology and automated ground vehicles research.
2. Additional subject matter expertise is needed on the Subcommittee to address unrepresented stakeholders and provide subject matter expertise regarding key emerging technologies. Subcommittee members concurred that representation from emerging entrants—Advanced Air Mobility (AAM), Unmanned Aircraft Systems (UAS), and possibly commercial space—would be helpful. In addition, representation from airlines, general aviation, and construction stakeholders would help to round out Subcommittee expertise. The Subcommittee intends to solicit additional representatives later this year, following finalization of full REDAC membership.
3. The Subcommittee appreciates the dedicated efforts of Program staff to meet very demanding deadlines associated with UAS detection and mitigation research, which have already been used to inform the findings and recommendations of the FAA's UAS Detection and Mitigation Systems Aviation Rulemaking Committee and provide a foundation for future UAS detection system standards.
4. We also appreciate the productivity and collaborative engagement of researchers working under the Airport Asphalt Pavement Technology Program (AAPTP) and Airport Concrete Pavement Technology Program (ACPTP) which have supplemented the Program's other pavement research efforts.
5. The Subcommittee noted its continuing support for new pavement materials testing facilities, especially to enable asphalt binder testing. The Subcommittee agreed that the new facilities will provide faster and higher-quality in-house testing than is currently available, facilitating planned pavement research.
6. Subcommittee members observed that improved coordination and communication between Program researchers, industry associations represented on the Subcommittee, and those associations' members could help expand Program research that relies on field instrumentation. Program researchers and Subcommittee representatives agreed that direct outreach to airports regarding field instrumentation opportunities—possibly through a virtual meeting(s) would be useful.

Finding: Engineered Materials Arresting System (EMAS) - During Airports Subcommittee discussions of emerging research needs, Subcommittee members agreed that renewed efforts to identify if there are alternatives available to the two Engineered Materials Arresting System (EMAS) solutions that have been approved for use by the FAA. As the first EMAS systems installed in the United States approach (or exceed) the end of their design lives, airport operators would like to understand if there are additional alternatives that could be used in their place. Program staff suggested that they could issue a broad industry announcement (BAA) requesting information about potential alternatives to the two EMAS systems that are currently approved for use by FAA.

Recommendation: The Subcommittee recommends that Program staff investigate whether there are new EMAS technologies worthy of consideration by the FAA, with the goal of expanding the range of available EMAS solutions that are approved by the FAA for use at US certificated airports via a BAA or comparable means.

Subcommittee on Environment and Energy

General Observations: The Environment and Energy (E&E) Subcommittee of the FAA Research, Engineering and Development Advisory Committee (REDAC) conducted its hybrid meeting hosted at the DOT Headquarters in DC. There was a decent mix of in-person and remote participants from those who could not travel. The AEE Subcommittee focused on reviewing the 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 SAF Tax Credit and Grant Programs are significant: this includes \$297M for FAST-SAF and FAST-Tech grant programs. There is a major concern about the lack of an FAA authorization for FY-24 and possible government shutdown. 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 (CAAIFI) 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. The DOE presented a very informative briefing. The Subcommittee would like to see more collaboration between the FAA and the DOD so that everyone is aware of the work that each agency is doing. 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 based on the funding that the agency receives. The benefits already seen and anticipated because of the research within the CLEEN program is quite significant.

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 with the selection of the new Chief Scientific and Technical Advisor and with the recent addition of staff to AEE. We also believe that acting senior executive management has been doing a good job managing the Office of Environment & Energy since the various senior level management departures. We also believe that the creation of a separate Energy Division was a smart decision. Understanding that the need to maintain a leadership position at ICAO CAEP is still vital to the U.S. Aviation interest and we are happy to learn that the FAA AEE executive has been able to step into the previous held leadership roles in ICAO CAEP.

The results that have been accomplished by the projects in CLEEN Phase 1 and CLEEN Phase 2 as well as ASCENT highlight 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 that needs to be addressed. As was noted before, 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.

Finding: Sustainable Aviation Fuels (SAFs) - We know that the Sustainable Aviation Fuel (SAF) Program (including efforts in the Commercial Aviation Alternative Fuels Initiative (CAAIFI), 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. We are happy to see the increased number of companies that are now approved to produce SAF and the increase in the amount of SAF that is being produced. 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 CORSIA through ICAO CAEP. It is good to see the global approach towards the production of SAF.

Recommendation: The AEE 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 AEE 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 Center of Excellence (ASCENT), 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. 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. It should be noted that Dr. Oldani graduated from one of our partner universities. 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 CLEEN, CAAFI and 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 (3): Global Leadership - Despite the fact that the FAA AEE currently maintains a leadership role in 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 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: Aviation Noise - 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 may be a need to identify which new entrants are the furthest along in their development and thus will be most likely to impact our airspace soonest. 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 CLEEN Program.

Recommendation: The Subcommittee once again recommends the continued prioritization of noise research and the prioritization of projects that will support informed decision-making as it relates to the introduction of new entrants to the national air space. Focus should also be given on the new entrants that are furthest along in development and most likely to impact our airspace.

Finding: Grants - There has been additional funding for new grant programs. The need to address the research required for additional SAF production and other projects requires that we

remove the delays that we have seen in approving and awarding these grants. These projects are the key to making smart, informed regulations and accomplishing 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: The NAS Operations Subcommittee continues to be interested in the FAA's Strategic Outlook for Aviation Research (SOAR) framework as it matures and becomes available for review. A strategic overview of major research areas and their phases over time will help the subcommittee and others understand how FAA Research, Engineering, and Development (RE&D) is prioritized and planned to address critical needs. We would like to request a presentation reviewing the current status of the SOAR framework, including examples of its application to several research areas, at our Fall 2024 meeting.

Finding: **Artificial Intelligence (AI) / Machine Learning (ML) RE&D Coordination -** The Subcommittee received FAA briefings on Artificial Intelligence (AI)-related matters of relevance to future (2040) Air Traffic Management (ATM) strategies and related Human Factors considerations. The emphasis in the strategies is on safe and secure use of AI, as is most appropriate. We find that the AI tools being explored (e.g., Natural Language Processing, Machine Learning (ML), Deep Learning), cross-agency partnering (e.g., NASA / NARI and internal FAA R&D units), and approaches (e.g., assessments of suitability of current software certification and assurance processes, AI suitability in applications, AI risk components, functional use-cases, Safety Risk Management) appear to be well constructed and tailored to the unique attributes on the potential value for Artificial Intelligence (AI) solutions within selected domains of applications. The earliest fields of applications currently pursued in the briefings we received were in lower risk arenas involving AI assisted human performance in ATM functions. We are also aware that the FAA AI Roadmap, which has been briefed to industry in other venues, includes a focus on more challenging safety-critical AI applications in flight deck operations, which is laudable.

The Subcommittee observes that R&D in AI is a relatively new field of practice for the FAA. We further observe that both the AI/ML industry itself and the aerospace industry working to implement AI tools are likely to outpace the FAA's R&D project milestones. We offer the finding that because AI is such a fast-moving technology affecting virtually every facet of aerospace design, engineering, manufacturing, operations, analysis, and related regulatory matters, the current FAA RE&D investments do not appear to be matched with the pace of industry and technology advancement of value to the nation's aerospace enterprise.

Recommendation: The NAS Operations Subcommittee encourages the FAA to pursue a holistic strategy across the breadth of AI applications, including in the ways in which the FAA manages the regulatory processes themselves. This means that all lines of business need to be engaged in understanding the implications of AI in their individual units, but even more importantly that the

Agency provides an integrative function for how AI-related strategic initiatives are structured and managed in ways that account for cross-functional implications. In particular, the Subcommittee recommends that the research efforts being conducted under AVS (AI Roadmap) be closely and strategically coordinated with the efforts under ANG (AI / ML Certification Framework) and with Human Factors AI-related research. The FAA should also engage with and make best use of input from industry, academia, national laboratories, and other government agencies (e.g., Department of Defense) to accelerate the development of certification standards for AI / ML across a range of criticality levels.

Finding: AI / ML Certification Framework Analysis Metrics - The Subcommittee received an overview of initial research developing a certification framework for AI technology under the New ATM Requirements portfolio within the office of NextGen (ANG). At this stage, the framework is intended to be applied to low-safety-risk traffic management applications. The Subcommittee agrees that this work is important, especially given the accelerated pace of AI / ML development within and outside the FAA.

The framework that was presented includes a range of factors to consider when determining the level of rigor required in performing AI / ML certification, but operational impact of the AI technology was not explicitly included among them. Certain traffic management tools could have significant operational impact risk, e.g., related to the magnitude and equitable distribution of delays across airspace users that result from the tool's use.

Recommendation: The NAS Operations Subcommittee recommends that the FAA more explicitly and formally include consideration of operational impact, including metrics such as aggregate delay or equitable distribution of delays across airspace users, when determining the degree of rigor to be applied in its AI / ML certification process for traffic management applications. Methods to estimate and quantify that operational risk will need to be developed and applied. The subcommittee would like to see an example applying the framework to a selected AI / ML use case at our Fall 2024 meeting.

Finding: Weather RE&D for Advanced Air Mobility (AAM) - Weather can negatively affect flight operations causing safety, efficiency, and reliability concerns. The FAA strives to be a global leader in how to safely integrate new users and technologies into the aviation system. These emerging entrants may regularly transition in and out of the airspace traditionally managed by the FAA. Capabilities are also rapidly increasing for private industry to observe, process, and disseminate weather information in addition to government providers. The FAA must be at the forefront of developing unifying standards for weather information used by the advanced air mobility stakeholders operating across a large range of altitudes. Standards must address the type of information and associated accuracy, resolution, latency, necessary redundancy, etc. related to weather observations and forecasts. The weather guidance and associated uncertainty need to be clear and easily understood by users.

Recommendation: The NAS Operations Subcommittee recommends that the FAA enhance and closely coordinate AAM-weather-relevant research within the Weather Program and UAS / AAM Integration Research Program to develop appropriate guidance for AAM weather information providers. At the same time, these RE&D efforts should engage with the aviation weather industry to ensure that considerations for third-party providers of weather information are included.

Finding: **Low-altitude Weather Information Remote from Observation Systems** - New entrants, including small Unmanned Aerial Systems (UAS) and other Advanced Air Mobility concepts, have the potential to involve increasing numbers of aviation operations at relatively low altitudes in regions remote from weather observation systems. The ability to maintain an accurate understanding of current and forecast weather conditions in remote regions will be important to ensure the safe and efficient operation of these vehicles. One example application could involve the ability to generate information analogous to Meteorological Aerodrome Reports (METARs) and Terminal Aerodrome Forecasts (TAFs) at any arbitrary location, but with the caveat that those METARs are not explicitly measured at that location.

Weather conditions in remote regions can be estimated and forecasted by fusing and extrapolating observations, where available, with numerical weather prediction model data, but effective methods to determine the accuracy and spatio/temporal validity of those estimates need to be developed, especially when weather may change dynamically over short distances or times. It is also anticipated that there are significant human factors issues related to how pilots and operators may interpret and act on this type of estimated weather information. Some initial research on this topic has begun within the Weather Research portfolio.

Recommendation: The NAS Operations Subcommittee recommends that the FAA expands research on performance standards for weather information in regions remote from observation systems. This would include determining appropriate requirements for accuracy, update rate, and spatio/temporal validity of low-altitude weather information elements such as wind speed and direction, precipitation type and rate, temperature, and ceiling and visibility. It is anticipated that these standards may be a function of the type of operation being conducted, i.e., different standards may be appropriate for piloted fixed-wing general aviation compared to remotely-piloted small UAS. This work should be coordinated between the Weather Research portfolio and the UAS/AAM integration research plan so that applications to both general aviation and UAS/AAM can be leveraged.