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

Office of the Administrator

[redacted]

January 24, 2023

Dr. John Hansman, Ph.D.
Chair, Research, Engineering and
Development Advisory Committee
[redacted]

Dear Dr. Hansman:

Thank you and the Federal Aviation Administration's (FAA) Research, Engineering, and Development Advisory Committee (REDAC) for your October 21, 2022 letter providing recommendations for the fiscal year (FY) 2025 Research and Development (R&D) portfolio. The vast knowledge of the aerospace, aviation, and related industry communities continue to inform and promote outstanding research performance as we optimize safety and efficiency in the National Airspace System (NAS). The invaluable guidance shared by the exemplary cadre of experts during the Summer-Fall 2022 season and the full meeting on October 5, 2022, is sincerely appreciated.

The diverse scope of topics addressed the magnitude of existing and future technologies that will impact the dynamic environments of aviation profoundly. With astute advice provided by the REDAC, the FAA will continue as an influential leader and collaborator, evoking increased opportunities for technical excellence, domestically and internationally. As you have noted, there are several outstanding examples of the critical engagements of FAA professionals. Thank you for acknowledging and supporting the accomplishments in the Environment and Energy portfolio pertaining to International Civil Aviation Organization sustainability initiatives and the superior caliber of the U.S. Aviation Climate Plan.

The significant knowledge-sharing discourse during meetings also identifies the heightened awareness and evolution of technological advances in artificial intelligence and machine learning. This Agency recognizes that research program efforts in these disciplines and several others, like data mining, will result in data-driven decision-making and outcomes to ensure immediate and long-term successes in aviation. There is also the cognizance of various resultant impacts of the pandemic that served as drivers for developing enhanced evaluation and tracking mechanisms through longitudinal tracking. This critical assessment approach will create opportunities to gauge multiple performances in the NAS over spans of time. The pre and post-pandemic tracking analyses will lead toward viable risk mitigation and improved research and development strategies for airspace operations and maintenance.

The Committee's review of the FAA's R&D portfolio yields guidance that supports sustaining effective aviation program policies. Subject matter professionals with proficiencies in the key program areas of Aircraft Safety, Human Factors, Environment and Energy, NAS Operations, and Airports communicate advice for the objectives of diverse teams of researchers, technical advisors, scientists, directors, and staff.

I have reviewed the 22 recommendations submitted by the REDAC. The enclosed FAA Response Report reflects our Agency's replies to these recommendations. The FAA Response Report includes our dispositions for the total of 22 recommendations made by the 5 subcommittees and authorized by the REDAC as follows: Environment and Energy (7); NAS Operations (4); Airports (2); Human Factors (3); and Aircraft Safety (6). The FAA fully concurs with 20 of the 22 items, partially concurs with the noted exception of 1 item, and does not concur with the remaining recommendation submitted in the current report. The FAA has identified efforts to address the partial concurrences and provided justifications for those suggestions that cannot be fully completed at this time.

We will continue to address and respond to all of the Committee's recommendations and incorporate applicable advice necessary to maintain our R&D portfolio to increase the safety, efficiency, and capacity of the air transportation system in an environmentally responsible manner.

Sincerely,

Billy Nolen
Acting Administrator

Enclosure

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

Subcommittee on Environment and Energy

General Observations: The Subcommittee focused on reviewing the Research and Development (R&D) portfolio for the Office of Environment and Energy (AEE) that was developed based on the Research, Engineering, and Development (RE&D) budget for Fiscal Year (FY) 2022 that was enacted on March 15, 2022 (RE&D received $248.5 million). The Inflation Reduction Act (IRA) has $297 million to be spent over five years. The use of these funds within the Section 40007 Program is still to be determined. We were advised that the FY23 budget had a request for $260.5 million for RE&D, and the target for FY24 is $267 million. During the meeting, the AEE staff 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. The National Aeronautics and Space Administration (NASA) also provided a comprehensive update on its programs. The primary focus of the briefing was on ultra-efficient transport, future airspace, high-speed commercial flight, and advanced air mobility (AAM).

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 FY22 enacted budget.

There are still some lingering COVID-19 impacts on some projects, but the Subcommittee continues to be satisfied and very impressed with the job the leadership and AEE staff have been doing. 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 Federal Aviation Administration (FAA) and the Environmental Protection Agency (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.

As was noted before, the current Administration has made a commitment to climate change and issued Executive Order 14008 that outlines its goals. It has a 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 (SAFs) and to maintain a leadership position at the world level with organizations such as the International Civil Aviation Organization (ICAO). The establishment of the new SAF Grand Challenge aimed at dramatically increasing the

production of SAFs demonstrates U.S. leadership. We are happy to see that the Administration has solidified its commitment by providing additional funding that is already being used on research projects specifically geared toward accomplishing these goals. We firmly believe that partnerships with other governments, other federal agencies, the Centers of Excellence (COEs), and private corporations that 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 CLEEN and 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 we 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 need to maintain a leadership position at the ICAO Committee on Aviation Environmental Protection (CAEP) (ICAO CAEP) is still vital to the U.S. aviation interest.

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, which helps improve the quality of the research being done in the U.S. The timely awarding of these grants is still a challenge. At the time of our meeting, there were 59 projects worth approximately $33 million awaiting approval through the grant approval process. The delay in approving and awarding 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 Response to the Research, Engineering, and Development Advisory Committee (REDAC) report.

Finding: Sustainable Aviation Fuels (SAFs) – We know that the SAF Program (including efforts in 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 percent in today's fleet of aircraft. The current research has helped with the creation of several companies that have the potential to benefit the rural economies of several states and the U.S. aviation industry. The establishment of the SAF 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 Memorandum of Understanding, the Department of Energy (DOE), the Department of Transportation (DOT), and the United States Department of Agriculture (USDA) are all working very hard and have made progress, developed goals, and made commitments to this 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 the ICAO CAEP.

Recommendation 1: The Subcommittee agrees with the mandate proposed by the current Administration that the work on SAFs is a critical component for the reduction of aviation sector emissions and supports the SAF Grand Challenge. Since the maturation of the SAF program will be a major environmental benefit for the public and will create a new industry within the U.S. that benefits rural America and 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 accelerate this program to accomplish the goal of being able to supply 100 percent of the aviation fuel needed in 2050.

FAA Response: The FAA concurs with the Committee's findings and recommendations and is undertaking the following actions to address its recommendations – The U.S. Government and industry are both committed to achieving 3 billion gallons of SAF use by 2030. This will be critical to enabling the aviation industry to get onto a path to decarbonize by 2050. We in the FAA worked with the DOE, USDA, EPA, and stakeholders from across government, academia, and industry, to develop the SAF Grand Challenge roadmap, which shows how we can all work together to achieve these goals. We are also continuing our long-standing efforts in ASCENT, CAAFI, and CLEEN to support SAF development through testing, analysis, and coordination activities. Using FY22 funding, we are funding projects to support the certification and qualification of 100 percent SAF for use with today's fleet of aircraft and to continue our long-standing efforts to streamline the process to certify novel fuels as being safe for use. We are supporting work to quantify how agricultural practices to sequester carbon can cost-effectively reduce life cycle greenhouse gas emissions. We are also working to extend our domestic supply chain efforts to other world regions to aid in the expansion of SAF production globally. Additionally, we are funding work to understand the potential benefits of using SAF to reduce the impacts of aviation-induced cloudiness on the climate. To reach our goal of net-zero greenhouse gas emissions from the aviation sector by 2050, we will need to be able to use 100 percent SAF in our existing fleet of aircraft, and this SAF will need to provide a maximum reduction in climate impacts at a minimum economic cost. We are also working to stand up a new grant program on SAFs as required under Section 40007 of the IRA of 2022. The responsibility of establishing and managing the IRA grant program was assigned to AEE, and the Office is currently in the process of developing the execution plan and initiating the process to stand up the new grant program.

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

FAA Response: The FAA concurs with the Committee's findings and recommendations and is undertaking the following actions to address its recommendations – The FAA appreciates the importance of continued U.S. leadership in ICAO CAEP activities and will

continue our long-standing efforts to leverage the Environment and Energy R&D portfolio to inform the decision making in ICAO on SAF. This includes providing technical leadership in the development of the life cycle greenhouse gas accounting methods of the ICAO CORSIA. We are also leveraging these ongoing efforts to inform the development of life cycle accounting methods for the new SAF blenders tax credit under the IRA Sections 13202 and 13704.

Finding: Public/Private Partnerships - The Subcommittee continues to acknowledge and support the fact that AEE has 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 produce 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 ASCENT, other federal departments, and foreign governments. Three-quarters of Environment and Energy research funds generate 100 percent plus cost matching from non-federal partners CLEEN, 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, are 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 are 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 have not been highlighted before is that these partnerships have created a new industry and new jobs in aviation. In addition, private industry, universities, and hundreds of students have benefited from the partnership with the FAA. Getting the timely award of these grants is critical to the COE's ability to start vital projects.

Recommendation 3: Whereas the Subcommittee continues to endorse Public/Private Partnerships like the 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 exists with NASA as a key to success.

FAA Response: The FAA concurs with the Committee's finding and recommendation and is undertaking the following actions to address its recommendation - The FAA understands the importance of maximizing the impact of taxpayer dollars. By partnering with industry, academia, federal agencies, and foreign governments, we are making our research

investments go further by leveraging our collective resources. By having universities in ASCENT work directly with industry partners, it increases the likelihood that industry will use the research product to mature their technologies ahead of implementation schedule to reduce noise and emissions. In addition to providing world-class research products that are helping address the environmental challenges being faced by the aviation industry, the ASCENT is also creating the workforce of the future. Since 2004, the PARTNER and ASCENT have supported over 674 students. With the FY22 enacted budget, we have increased the ASCENT portfolio by a factor of two to be over $35 million per year. We intend to maintain this funding level with the FY23 President's budget. Of this amount, $15 million is dedicated to SAF research, and another $10 million is advancing technological innovation within the industry. By requiring cost share within CLEEN, we increase the likelihood that the industry partner will use the new technology to reduce noise and emissions. The FY22 enacted budget has doubled the size of the CLEEN Program to $37.5 million, and we intend to further increase that funding level to $42 million with the FY23 Presidents' budget. CLEEN, CAAFI, and ASCENT have all been successful because of their strong engagement with the industry. Each of these programs has had strong partnerships with, and support from, the industry for over a decade. In addition, the establishment of the new IRA SAF and Technology grant program will allow AEE to further collaborate with industry, academia, local governments, and potentially others in accelerating the introduction of SAF in the supply system and accelerate the development of even more low-emissions aviation technology. As with the ASCENT and CLEEN programs, the cost-sharing provisions of these new IRA grants will also allow AEE to further extend the impact and reach of the provided federal funding.

Finding: Global Leadership - Despite the fact that the FAA AEE currently maintains a leadership role in the ICAO CAEP and has been the driving force behind the push for data-driven rulemaking, 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 the 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 Environment and Energy R&D 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 evaluate the feasibility of a long-term aspirational goal for international CO_2 emissions (LTAG TG) is 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 meetings and represent the U.S. position regarding international policymaking at the international level is essential.

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

FAA Response: The FAA concurs with the Committee's recommendation and is undertaking the following actions to address its recommendation - The FAA appreciates the support of the Subcommittee for our ICAO CAEP activities and the importance of continued U.S. leadership therein. We have made considerable investments over the years to support the work of ICAO CAEP, and that continues today, as FAA leadership is critical to securing U.S. objectives at ICAO. The commitments that FAA has made to ICAO international leadership span a range of integrated efforts that include funding ASCENT research projects in support of ICAO CAEP's work program, supporting technical assistance from DOT/Volpe, hiring subject matter experts to play key technical roles with ICAO CAEP's technical working groups, collaborating with other government agencies such as NASA and EPA, and assigning DOT and FAA personnel to fulfill critical leadership roles across ICAO CAEP's working groups. ICAO relies on FAA-funded research and analyses to inform its environmental work. In fact, FAA AEE's research efforts provided critical information and data that enabled key outcomes at ICAO related to the adoption of a long-term aspirational goal for international aviation CO2 emissions. Much of this analytical work was done by ASCENT universities and the Volpe Center, under the direction of the FAA and in close collaboration with NASA and industry.

In addition, FAA AEE's efforts have also been critical to defining how SAF is credited under CORSIA, and we expect our SAF research to take on additional importance within ICAO. This year, we have stood up two new ASCENT projects to support CAEP standard-setting efforts. These projects will help us understand the opportunities to reduce aircraft noise and carbon dioxide emissions through an integrated standard-setting process, as well as explore metric systems that could be used to control full-flight nitrogen oxide emissions while further exploring interdependencies with non-volatile particulate matter emissions. These new projects will enable us to provide intellectual leadership to the international community as we seek means to reduce noise and emissions from aircraft. We are also continuing to fund research to support the development of noise standards that would enable the introduction of drones, AAM vehicles, and supersonic aircraft. Existing ASCENT projects are also supporting CAEP's technical development for supersonic engine emissions certification standards and recommended practices (SARPs), as well as en route noise SARPs.

Finding: Noise Research - Aviation noise is and will continue to be one of the biggest environmental impacts related to the aviation industry, and it requires ongoing research in order to address the concerns of the citizens. Even though we have learned a lot based on the results of many of the projects in the "Noise Portfolio," the Subcommittee's position on noise has not changed in that there is much research that is still necessary to address the ongoing topic of aviation noise. Whether there are new technologies or new procedures that can be implemented to help reduce the impacts of noise as the aviation industry rebuilds needs to be evaluated. Historically, advances in aircraft technology have been the major factor in reducing aviation's environmental impacts. The Subcommittee recognizes that there is about a seven-year lag between the flight testing of technology and its appearance 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 several new research

projects that have been added to address issues related to new entrants, such as unmanned aircraft systems (UAS) and 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 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. The FAA has also launched an initiative to partner with airports to gather more noise data resulting from noise complaints. Finally, AEE is working with the industry to accelerate the development of technologies that reduce noise through the CLEEN Program.

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

FAA Response: The FAA concurs with the Committee's finding and recommendation and is undertaking the following actions to address its recommendation - The FAA is committed to developing meaningful and equitable solutions to address the complex and nuanced issue of aviation noise. We are continuing to execute the research program that was captured on January 13, 2021, the Federal Register notice (Overview of FAA Aviation Noise Policy and Research Efforts). This includes research not only on the fleet of existing fixed-wing aircraft and helicopters but also on unmanned aircraft, AAM, and supersonic aircraft. The FAA has increased our coordination with NASA's Revolutionary Vertical Lift Technology (RVLT) program in this area to further understand the acoustics of new entrants and the human response to the noise created by them. We have initiated several research projects within ASCENT to further study acoustics and potential certification approaches of new entrants as well. We also have a number of research projects within ASCENT to improve the noise modeling of AEDT in areas well outside of the DNL 65 contour that is laying the foundation for AEDT version 4. Further, we are expanding our noise research effort on a number of fronts. We are working to expand the research efforts of the team at U. Pennsylvania to examine how broadband sounds could help to mitigate sleep disruption due to aircraft noise. Further, we are looking to continue and expand the long-standing work of Boston University to understand the potential health impacts of aviation noise exposure. Finally, with the expansion of the work of the CLEEN Program, we will be able to support additional work to accelerate the development of technologies to reduce noise.

Finding: Staffing - Given the mandates and financial support from the current Administration to climate change and increased SAF production, AEE has added a number of new projects to the portfolio. With additional funding expected from the IRA, there will be many additional projects being created in the near term. The Subcommittee has concerns that there is 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.

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

FAA Response: The FAA concurs with the Committee's finding and recommendation

and is undertaking the following actions to address its recommendation – With the increased funding for the Environment and Energy portfolio, the FAA will need to bring on additional RE&D personnel to oversee the work. Over the past few years, we have had 16 personnel supported by the RE&D funds within the Environment and Energy R&D portfolio (these are on top of operations-funded personnel who also work within AEE). In line with the recommendation, the FAA is expanding the number of personnel supported by RE&D funds, with three new personnel being added in the spring of 2022 and two more senior staff being brought in during the summer. The two most recent additions are focused on research efforts related to sustainable aviation fuels and technology development. More recently, we have had senior staff leave for opportunities within FAA, and we are working to fill those slots. Lastly, we are looking to bring in four more staff in the coming months to support the new IRA Section 40007 grant program.

Finding: Grants - The Subcommittee was surprised to learn that there are still issues surrounding the timely awarding of research grants to the COEs. There are some 59 projects worth approximately $33 million awaiting approval through the grant approval process for the ASCENT. The delay in approving and awarding 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.

Recommendation 7: The FAA needs to address the process that is delaying the approval and awarding of grants for these COE research projects that are necessary for the success of its mission.

FAA Response: The FAA concurs with the Committee's finding and recommendation and is undertaking the following actions to address its recommendation. – The FAA understands the need and importance of ensuring the timely awarding of ASCENT grants. AEE is currently coordinating with the DOT Office of Aviation and International Affairs, Office of Transportation Policy, and Office of Research and Technology to update the guidance on reviewing and approving Tier 3 routine research grants to try to expedite the process.

Subcommittee on National Airspace System (NAS) Operations

Finding: Advanced Air Mobility (AAM) Wake Research - The National Airspace System (NAS) Operations Subcommittee received briefings on the Wake RE&D and Wake Re-categorization portfolios. Work under these portfolios has been mainly focused on conventional aircraft performing conventional takeoff and landing operations at airports. Analyses have

included a range of in situ wake measurement, modeling, and risk assessment activities that have led to the selection of specific wake separation criteria.

Given the potential growth of AAM involving new aircraft types, including Vertical Takeoff and Landing (VTOL) and/or Short Takeoff and Landing (STOL) vehicles performing new types of arrival and departure operations, there will be a growing need to understand the potential wake risks from these operations and set wake separation criteria when required. Persistent rotor wash or other effects, including interaction with nearby buildings in urban environments, may result in turbulence or upset risks to the following aircraft during takeoff and landing, but these effects have not been quantified for these new aircraft types.

Recommendation 1: The NAS Operations Subcommittee recommends that the FAA begin planning to execute Wake RE&D efforts focused on AAM operations with VTOL and STOL aircraft performing both conventional and non-conventional approach and departure procedures. This may include measurement campaigns to empirically understand wake effects, modeling to allow extrapolation of effects to other vehicles and conditions, and risk assessment and operational analysis to determine appropriate wake separation criteria for AAM operations. Where possible, these efforts should be closely coordinated with and leverage industry development of AAM vehicles as well as ongoing NASA research. To support and plan for these activities, the FAA should begin developing an AAM Wake RE&D roadmap, with associated milestones and funding targets.

FAA Response: The FAA concurs with the Committee's recommendation with the noted exceptions - The FAA Wake Turbulence RE&D program reviews new VTOL and STOL aircraft as part of the assessments for new aircraft types and includes AAM vehicles. These assessments determine wake separations between aircraft for use when wake separations apply (aircraft receiving Air Traffic Services). These assessments can include data and information from measurement campaigns, modeling, risk assessment, and operational analysis. Coordination with industry and other AAM groups within the FAA and NASA is already occurring.

The noted exception to the recommendation is related to operations around buildings in urban environments that can cause upsets that are out of scope for aircraft wake generation and wake encounter research, and wake separations are generally not applicable in those potential operational environments.

Finding: UAS-Related Academic Research Funding Pathways - The NAS Operations Subcommittee received briefings on the FAA's COE for Unmanned Aircraft Systems and the UAS/AAM Integration Research Plan. The former presentation noted that the FAA has committed to sending all UAS-related academic research to the COE. At the same time, the latter presentation underscored the fact that the scope and volume of potential UAS research have continued to grow rapidly and span small to large UAS across a wide range of operational concepts.

The NAS Operations Subcommittee noted that the requirement to fund all UAS-related academic R&D through the COE constrains the FAA's flexibility to leverage research organizations that are not associated with the COE but that have specific expertise and facilities that could accelerate, broaden, and strengthen research outcomes. Example areas where the COE might be strengthened with broader outside collaboration include conducting larger-scale high-fidelity

modeling, simulation, prototyping, and demonstrations; access to relevant operational data and high-performance computing; use of sensitive, export-controlled, or proprietary information; data exchange architectures and cyber security; advanced artificial intelligence (AI) and machine learning (ML) technology; and connectivity to key domestic and international interoperability and standards-making communities.

While the Subcommittee understands there is congressional language requiring certain funding to be allocated to the COE, there may be opportunities to leverage sub-awards or alternate funding vehicles to institutions beyond the COE's immediate membership.

Recommendation 2: The NAS Operations Subcommittee recommends that the FAA develop alternate funding mechanisms for UAS-related academic research and development that would facilitate forming research partnerships with academic and other institutions that cannot currently be funded through the COE for UAS. These partnerships would strengthen the research products generated for UAS integration and enhance the ability of those products to directly inform technical requirements and policy decisions. An expanded process should be developed for identifying and selecting the most effective research organizations to conduct a given study, along with associated efficient funding vehicles that would enable those organizations to perform research with minimal delay, overhead, or other fees.

FAA Response: The FAA appreciates the Committee's finding and recommendation on UAS-related academic research funding pathways. However, we are not able to pursue this recommendation because, with the competitive award of the FAA COE for Unmanned Aircraft Systems (UAS) (also known as ASSURE), we made a commitment to creating a base of expertise in this research area. Going to academic institutions outside of the COE would be counter to this goal. The COE is required to address any research needs the FAA has, and if the capability does not exist in the current COE team, they are obligated to reach out to other institutions to establish that capability within the COE, either to include them as core members, affiliate members, or as business partners. At this time, this arrangement will continue through May 7, 2025. Additionally, we can use our non-COE funding to seek other opportunities with many highly qualified research performers outside of the academic community.

Finding: Wrong-Surface Landing (WSL) Prevention Analysis - The NAS Operations Subcommittee received a briefing on the Runway Incursion Reduction Program, which included an outline of plans to begin research into Wrong Surface Landing (WSL) prevention in FY25 through a demonstration at the Lincoln, NE airport. It was not apparent to the Subcommittee that plans were in place to develop underlying concepts of operation for WSL prevention systems or to conduct a fundamental analysis of surveillance performance requirements that would help inform and guide research on this topic.

Recommendation 3: The NAS Operations Subcommittee recommends that the FAA develop concepts of operation for WSL prevention systems and processes for both ground-based and cockpit-based systems and conduct fundamental analyses of surveillance performance requirements and technology requirements to support WSL detection and alerting as a function of distance and geometry during approaches. Such analyses would provide guidance toward future surveillance and alerting technology as well as help to identify candidate airports and cockpit equipage (if appropriate) for those technologies.

FAA Response: The FAA concurs with the Committee's finding and recommendation and is undertaking the following actions to address its recommendation(s) - The FAA will ensure that concepts of operation will be developed, and performance requirements analyses will be conducted to support future WSL prevention research.

Recommendation 4: The NAS Operations Subcommittee recommends these analyses be performed as soon as practical given recent WSL incidents (e.g., near-landing on a taxiway in San Francisco, CA in 2017) and accidents (e.g., mid-air collisions due to lining up toward the incorrect parallel runway at Centennial Airport, CO in 2021; North Las Vegas, NV in 2022).

FAA Response: The FAA concurs with the Committee's finding and recommendation and is undertaking the following actions to address its recommendation(s) - The FAA will perform the analyses noted in the above response as soon as practical.

Subcommittee on Human Factors

Observation: The Human Factors Subcommittee is pleased to note the responsiveness of the FAA to its previous findings and actions. The current and planned future projects have incorporated several of the Subcommittee's inputs into the FAA Research Plan, including Flight Deck information management, pilot training, coordination, and collaboration across FAA Air Traffic Control facilities to effectively manage air traffic and human factors considerations for the integration of AI and ML capabilities into air traffic control, air traffic management, and maintenance operations. Such research will help to provide guidance to ensure the successful, continued evolution of the aviation system in the future.

Finding: Competency-Based Training for Maintainers - The Human Factors Subcommittee received a briefing on Winter/Spring FY2022 Flight Deck research and potential project plans on (1) maintenance training and (2) methods to identify the root cause(s) of human factors risks in maintenance programs. Although this research plans to review industry activity and needs across these areas, there was no mention of the emerging application of competency-based training for maintainers.

Recommendation 1: The Human Factors Subcommittee recommends that the planned research proposed by the FAA in Aviation Maintenance Human Factors and Training include the following additional activities:

- Review documentation on competency-based training and assessment to understand what the international community is recommending and how it is different from what is currently done in the United States:
    - ICAO Doc 10098: Manual on Competency-based Training and Assessment (CBTA) for Aircraft Maintenance Personnel
    - ICAO Doc 9868: Part III of the Procedures for Air Navigation Services — Training.
    - IATA White Paper: Competency-Based Training and Assessment (CBTA) Expansion within the Aviation System

- Sample industry activities on CBTA to identify associated benefits and challenges, specifically CBTA development, implementation, and means of evaluating the effectiveness of available methodologies and practices.
- Identify opportunities for global harmonization and collaboration in maintenance training, e.g., methods, data exchange, and the use of new technologies.

Consequences: Without reviewing and examining new training approaches recommended by ICAO and IATA and ongoing industry works, the FAA's proposed and planned Maintenance Training and Human Factors projects may not realize the potential benefits of new approaches to training or understand its implications, positive or negative.

FAA Response: The FAA concurs with the Committee's finding and recommendation and is undertaking the following actions to address its recommendation(s) - The FAA is currently in the process of executing and planning aviation maintenance human factors research, such as "Human Factors Data on the Adequacy of Policy for Maintenance Training." At the FY23 Winter/Spring Human Factors Subcommittee meeting, the FAA will identify if planned research in aviation maintenance could potentially address this recommendation.

Finding: Guidance for Operational Approval of New Applications for the Electronic Flight Bag (EFB) - At the Winter/Spring FY2022 meeting, the HF Subcommittee requested a briefing from the FAA on planned and past Electronic Flight Bag (EFB)-related research and findings. The FAA provided a briefing at the Summer/Fall FY2022 meeting that showed that the FAA has performed a significant amount of research on EFB job aids and operational approval guidance. However, it appears additional work is needed to address specific gaps in the EFB operational approval guidance.

Recommendation 2: EFB research should be conducted to understand the impact of using a single screen to display information where multiple items of information are needed simultaneously, especially when engaged in manual flight operations. An example is to understand the operational impact of having to switch between views (e.g., apps, windows) to sequentially display information, compared to having all the needed information sources simultaneously visible. More specifically, when at the gate, pilots need to simultaneously look at the Dispatch release, 10-9 Chart, Standard Instrument Departure Chart, Minimum Equipment List, and Normal checklist. How many (and which) of these can be safely migrated to the EFB? Furthermore, when in-flight with a non-normal situation, pilots need to look at the Approach chart, 10-9 chart, Normal checklist, and Quick Reference Handbook simultaneously; how many (and which) of these can be safely migrated to the EFB? The results of this research could be used to develop guidance for Principal Operational Inspectors in making approval decisions on satisfactory real-world operational uses for EFB systems and for evaluating human performance and operational performance associated with EFB use.

Consequences: EFB systems enable operators to add applications that are operationally approved. Inspectors might not have sufficient expertise to evaluate the operational and human performance impacts of adding new applications to the EFB that may over-task pilots at critical flight phases or situations.

FAA Response: The FAA concurs with the Committee's finding and recommendation and is undertaking the following actions to address its recommendation(s) - The FAA has some

planned research relevant to the recommendation, such as "Information management on the flight deck of highly automated aircraft," "Connected flight deck technologies – Anticipated human factors issues," and "Pilot interactions with advanced flight deck technology." However, these projects do not address the operational approval aspects. At the FY23 Winter/Spring HF Subcommittee meeting, the FAA will brief research projects on flight deck information management and technologies that are most relevant to this recommendation and discuss options for addressing the gaps.

Finding: Naturalistic Research for Air Traffic Controllers - The REDAC Human Factors Subcommittee previously submitted an action for the FAA to provide a briefing regarding "Training Air Traffic Controllers for Increased Automation Use." As part of this action, the Subcommittee noted the need to conduct research to determine whether or not "skill degradation" is occurring due to extensive use of automation, long periods away from work, lack of practice, or by some other means. Past research, both in aviation and in other fields, has relied on interview studies and controlled experimental studies, which, while useful, have not been conclusive regarding the occurrence of skill degradation and its prevention or mitigation if it is occurring. One limitation of controlled experimental studies is that they are not well suited to the timeframes needed to study skill degradation over extended periods of time. There is an opportunity to complement these previous studies with *naturalistic studies* that leverage the ability to study the potential for skill degradation at air traffic facilities and over extended periods of time.

Recommendation 3: The FAA should conduct long-term research at air traffic facilities to investigate ways to define and assess manual and cognitive skills and determine whether they are at risk for potential degradation from extensive automation use, time away from work, or some other factor. For example, the research could first assess manual and cognitive skills developed by air traffic personnel before some new type of automation support is introduced at a facility and then reassess those skills after they have been performing their tasks with the automation support (e.g., decision-support tools) after an extended period. Such research could be conducted by analyzing actual job performance over the course of time to determine if skill degradation occurs, why it occurs, and how to mitigate it. This longitudinal research also could be used to evaluate the effectiveness of proposed mitigations focused either on the design of automation and associated procedures or on training strategies.

Consequences: There is limited data available on the definition and assessment of manual and cognitive skills. While it is assumed that skill degradation is occurring, it is not clear why or how this happens, either from automation use or something else. It is necessary to fully understand the nature and impact of this phenomenon and to provide objective data to guide the design of mitigations. Longitudinal naturalistic studies can help ensure the ecological validity of guidance to mitigate such impacts.

FAA Response: The FAA concurs with the Committee's finding and recommendation and is undertaking the following actions to address its recommendation(s) - The FAA Human Factors research portfolios have addressed air traffic controller skill degradation risk in recent years, such as "Human Performance Considerations: Unintended Impacts and Mitigations for Degraded NextGen Operations." However, these have not included research at facilities that study skill degradation over long periods of time. Furthermore, operations have not formally documented deficiencies in maintaining proficiency in the air traffic workforce. If such research

needs are identified by the Air Traffic Organization, there may be opportunities to conduct the research. At the FY23 Winter/Spring HF Subcommittee meeting, the FAA will identify research progress related to this recommendation.

Subcommittee on Aircraft Safety

Finding: UAS Cybersecurity Oversight and Risk Management Process Clarification - The Subcommittee on Aircraft Safety appreciates the great need and new efforts planned for A11L.UAS.95 – Illustrate the Need for UAS Cybersecurity Oversight and Risk Management. In the briefing, it was not clear whether the intent is to develop an "oversight & risk management" process or a "risk assessment" process. The title indicates that the intent is to develop an "oversight & risk management" process. However, the presentation implies an intent to research the "risk assessment" process application to UAS. An "oversight & risk management" process example from traditional aviation safety would be a Safety Management System (SMS) process, and an example from aviation cybersecurity would be the Information Security Management System (ISMS) process efforts being worked via RTCA/EUROCAE, e.g., as related to addressing Part IS. As presented, it was not clear if the intent is to consider a "risk assessment" process (i.e., cyber SRA – Safety Risk Analysis) that would consider fundamental aviation cybersecurity risk assessment processes like the FAA-approved cyber safety means of compliance processes discussed in the appendix of RTCA DO-356A/EUROCAE ED-203A – Airworthiness Security Methods and Consideration. Alternatively, clarification is needed if the intent is to address operational risk assessment considerations applicable to UAS like those defined in Joint Authorities for Rulemaking on Unmanned Systems (JARUS) Specific Operations Risk Assessment (SORA) Annex E (Cyber)

Recommendation 1: The Subcommittee on Aircraft Safety recommends that the FAA state the clear research intent of A11L.UAS.95.A58 as to the objective being the development of an "oversight & risk management" process, a "risk assessment" process, or something else.

FAA Response: The FAA concurs with the Committee's recommendation and is undertaking the following actions to address its recommendation(s) - The goal of this project is to proactively address the need to have UAS Cybersecurity Oversight and Risk Management processes. As per the United States Government Accountability Office (GAO) publication "GAO-19-105: Agencies Need to Improve Implementation of Federal Approach to Securing Systems and Protecting against Intrusions," agencies throughout the Federal Government were found to be at risk or high risk for gaps in cybersecurity. This research requirement will address the need for UAS Cybersecurity Oversight and Risk Management as it pertains to the relationship to the NAS and FAA systems.

Finding: Past Cyber Safety Risk Assessment Efforts - In the A11L.UAS.95.A58 presentation to the Subcommittee on Aircraft Safety, only non-aviation cyber sources were referenced in the briefing. The briefing did not recognize the years of effort to address cyber safety risk assessment efforts across the global aviation community, including UAS-specific cyber efforts. These efforts include (1) FAA-approved cyber safety means of compliance processes discussed in the appendix of RTCA DO-356A/EUROCAE ED-203A, (2) the UAS Command and Control Minimum Aviation System Performance Standards MASPS, RTCA DO-377A, which will be

evoked in Advisory Circular (AC) 20-187, scheduled to be released by 05/26/23, and Technical Standing Order (TSO)-C213a, scheduled to be released by 02/24/23, (3) FAA Information Security and Privacy Program & Policy, FAA Order 1370.121B, and (4) other FAA research done on cyber safety risk assessment (SRA) methodologies like that was done by the FAA WJH Tech Center on maturing the STPA-SEC methodology in conjunction with the Cyber Safety Commercial Aviation Team.

Recommendation 2: The Subcommittee on Aircraft Safety recommends that the FAA (1) revise the scope of A11L.UAS.95.A58 to avoid duplication of past research that resulted in the development of the documents identified in the above Finding.

FAA Response: The FAA concurs with the Committee's recommendation and is undertaking the following actions to address its recommendation(s) - The FAA requires all UAS research performers to conduct a literature review as the first deliverable to ensure that past applicable research is leveraged and not duplicated. To that end, the performer for A11L.UAS.95_A58 has identified and considered the following documents in the course of this particular research:

(1) The cyber appendix of RTCA DO-356A / EUROCAE ED-203A;

(2) The UAS Command and Control MASPS, RTCA DO-377A, which will be evoked in AC 20-187, scheduled to be released by 05/26/23, and TSO-C213a scheduled to be released by 02/24/23;

(3) FAA Information Security and Privacy Program & Policy, FAA Order 1370.121B; Additionally, the FAA will ensure that the research performer leverages the Cyber Safety Risk Assessment (SRA) methodology research performed by the FAA William J. Hughes Technical Center (WJHTC) in conjunction with the Cyber Safety Commercial Aviation Team. This research focused on maturing the System-Theoretic Process Analysis for Security (STPA-SEC) methodology.

Recommendation 3: The Subcommittee on Aircraft Safety further recommends that the FAA offices responsible for the documents identified in the above Finding be advised of any impact to these existing FAA documents resulting from the A11L.UAS.95.A58 research.

FAA Response: The FAA concurs with the Committee's recommendation and is undertaking the following actions to address its recommendation(s) - The FAA offices responsible for and associated with the three documents identified in the Finding will be advised by the FAA research sponsor and research program manager of any impact to these existing FAA documents resulting from the outcomes of A11L.UAS.95.A58 research.

Finding: Research Landscape Inclusion – Novel Fan Blade Integrity - The Subcommittee on Aircraft Safety appreciates the FAA research in Propulsion and Fuel Systems (A11B) budget line items regarding durability issues and non-destructive evaluation (NDE) for uncontained engine failures. However, the Subcommittee on Aircraft Safety finds that a potential research gap may exist. Significant research is ongoing as it pertains to the nickel and titanium components of the rotor contained in the hot section of the aircraft engine; however, the fan area is a research gap.

Recommendation 4: The FAA should expand the research landscape to include fan blade integrity for blades that are a novel concept and material(s).

FAA Response: The FAA concurs with the Committee's recommendation and is undertaking the following actions to address its recommendation(s) - The FAA will include the fan blade structural integrity section in the scope of A11B. The FAA recognizes the trend toward new materials and methods of construction used in the fan section of the recent and future designs of gas turbine engines. Fan disk materials have always been a part of the research in A11B, and it is appropriate to incorporate fan blades. Some of the advanced methods for process controls, NDE, and structural integrity assessment developed for disks (i.e., life-limited parts) are also applicable to fan blade materials and methods of construction. Many of the research projects performed under A11B are coordinated with industry (e.g., Aerospace Industry Association [AIA] Rotor Integrity Sub-committee [RISC] and NDE Working Groups, Jet Engine Titanium Quality Committee [JETQC], Jet Engine Nickel Quality Committee [JENQC]). The FAA, in coordination with industry through the existing activities, will review and update the research portfolio to ensure that the overall scope includes addressing structural integrity and fleet safety, such as modeling and vulnerability assessments to improve the prediction of the structural integrity of fan blades constructed using novel material and manufacturing methods and design principles.

Finding: electric Vertical Takeoff and Landing (eVTOL) Aircraft Fan Blade Research - The Subcommittee on Aircraft Safety finds that innovative technologies exist that may incorporate additive manufacturing and composite fan and/or rotor blades, particularly for electric Vertical Takeoff and Landing (eVTOL) aircraft. Modeling for scatter patterns for these innovative technologies must evolve as technology evolves. Locations of rotor blades in proximity to the cabin are varied among entrants and should be evaluated. For example, for the safe return to service of the B777, a different and more modern inspection method was required to detect new methods of failure. As the inspection methods have changed, the physics of a Fan Blade Out (FBO) event has not changed. Modeling, analytics, and research should continue to evolve.

Recommendation 5: The FAA should expand the research landscape to include fan and/or rotor blade integrity for blades that are of a novel concept and material(s). The SAS recommends that the FAA add research into eVTOL aircraft fan blades to A11B or the appropriate budget line item. As a life-limited part based on a novel design, research should be directed toward fan blade structural integrity for new potential designs and materials. This should include new inspection methodologies to assess materials for strength and integrity, as well as detailed modeling of failure modes and dispersion. Current regulations include blade out testing. However, research should be directed to failure modes and scatter patterns for a blade failure to protect the aircraft.

FAA Response: The FAA concurs with the Committee's recommendation and is undertaking the following actions to address its recommendation(s) - The FAA will include eVTOL rotor blades, as well as novel materials and design of blades for conventional aircraft (the latter also noted in Response to Recommendation above), in assessing their structural integrity and inspection methods. FAA research planned for FY25 will address blade

release, debris dispersion, and hazard mitigation for novel concept and material blades included in eVTOL propulsion and open rotor (un-ducted) fan engines. This includes adapting impact modeling and vulnerability analysis tools developed under the research project Advanced Analysis Methods for Impact of Aircraft Materials from Rotor Burst and Blade Release (A11B.PS.2) for ensuring a high level of safety for new propulsion systems while also working in conjunction with new start electric propulsion research project Electric Propulsion - fault propagation in a multi-rotor aircraft (A11B.PS.8) aimed at understating fault propagation in a multi-rotor aircraft. The FAA also conducts research on composite/metal bonding for aircraft structures that may be leveraged for eVTOL rotor blades.

Finding: Detail Phased Roadmap for Artificial Intelligence (AI) and Machine Learning (ML) - The Subcommittee on Aircraft Safety appreciates the response from the FAA regarding our recommendation from our Spring 2022 meeting regarding the need for the industry to have a published phased roadmap for Artificial Intelligence (AI) and Machine Learning (ML) regulatory guidance from the FAA. The Subcommittee on Aircraft Safety further appreciates the efforts in which FAA is working with NASA to develop an Autonomy Verification & Validation (V&V) Vision 2045 with an associated roadmap.

However, the Subcommittee on Aircraft Safety views AI/ML as a different portfolio of technologies than autonomy technologies. While AI/ML technologies can be used for autonomous operations, it is also possible to use more traditional technologies, such as deterministic systems for autonomous operations. Furthermore, AI/ML can be used for applications other than autonomy, such as providing advisory information to a flight crew, which is unrelated to autonomous operation of the air vehicle. The industry is reluctant to introduce AI/ML technologies into new products due to the current certification uncertainties.

The Subcommittee on Aircraft Safety re-emphasizes the importance of developing this roadmap with enough details to ensure it adequately informs the industry on the sequence in which the FAA plans to release regulatory guidance on methods and procedures to (1) certify systems of various safety criticalities, (2) certify AI/ML based on various types and sources of AI/ML training and testing data, and (3) procedures for updating AI/ML models in previously certified systems based on updated training and test data sets. Other regulators have issued such a roadmap. However, they have been vague, ambiguous, and not useful to the industry in supporting their business models.

Recommendation 6: -Given the speed at which demands AI/ML technologies are being developed, the REDAC Subcommittee on Aircraft Safety reiterates its previous recommendation for the FAA to expeditiously prepare and publish a detailed phased roadmap for AI/ML research and development required to formulate AI/ML regulatory guidance, taking into account the FAA safety continuum and use case to accelerate deployment for lower risk aviation applications.

FAA Response: The FAA concurs with the Committee's recommendation and is undertaking the following actions to address its recommendation(s) - The FAA will develop a detailed roadmap for research and development required to formulate regulatory guidance for AI/ML applications and technologies. The FAA recently hired a new Chief Scientific and Technical Advisor in this area. The FAA is currently in the process of reviewing and

documenting our analysis of the various approaches being utilized by applicants to prepare the gap analysis and outline a detailed roadmap for research. The FAA will provide an update for the spring 2023 REDAC meeting.

Subcommittee on Airports

Observations: The Subcommittee on Airports remains supportive of the Program's ongoing work and future research directions, which continue to emphasize foundational research to support (1) ACs 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, airfield pavements in particular.

The Airports Subcommittee had the following specific observations:

1. The Subcommittee recognizes the contributions that Dr. Michel Hovan made to the Program in his role as Manager of the Airport Technology Research & Development Branch (ATR). During his tenure at ATR, Dr. Hovan streamlined the Branch's research portfolio, implemented successful succession plans bringing on new researchers as senior researchers retired, and pivoted to address emerging policy and technology issues, including the emergence of UAS and AAM. Although Dr. Hovan retired from the FAA in June, the Subcommittee was able to wish him well virtually during our September meeting.
2. The Subcommittee appreciates the speed and scope of Program research work to address new entrant aircraft compatibility and integration at and near airports. The Branch's work to evaluate the beneficial use of UAS at airports has been particularly helpful. We are also looking forward to the findings from evaluations of UAS detection and mitigation systems, which will inform both airport operators and government agencies tasked with counter-UAS responsibilities. Although the Subcommittee's recommendations regarding the FAA's UAS/AAM Research Plan are forthcoming, we appreciate the Branch's efforts to incorporate airport-related research needs in the Plan. We also look forward to working with the Branch and the FAA Office of Airports on Plan refinements.
3. The Subcommittee also appreciates ATR's ongoing airport resiliency research, which is bringing attention to some of the more critical climate resiliency issues facing U.S. airports. As noted in the Findings and Recommendations, the Airports Subcommittee would like to see this research portfolio expanded to include aspects of resiliency beyond climate change.
4. The Airports Subcommittee looks forward to new areas of firefighting research that the Branch will pursue when its research regarding the transition from aqueous film-forming foam (AFFF) to fluorine-free foam (F3) is completed. The airport community is particularly interested in the firefighting needs associated with increased airside electrification.

5. The Subcommittee on Airports again commends the Branch on its continuing development of global-leading airfield pavement modeling capabilities, including the Branch's work to develop simulation models of reflective cracking through the use of machine learning techniques.
6. The Airports Subcommittee also notes that continued funding for the AAPTP and AACTP in the upcoming FAA reauthorization cycle is important. Both of these pavement research programs provide key supplemental research to the pavement research activities the Branch undertakes directly.

Finding: Airport Resiliency Portfolio - The Subcommittee on Airports appreciates the Program's focus in recent years on airport climate change resiliency. However, the explicit incorporation of resiliency as an airport capital project justification within the Bipartisan Infrastructure Law and growing awareness of the breadth of resiliency considerations that affect airports suggest that the Branch's resiliency portfolio should be expanded to include elements in addition to climate change, such as non-climate related natural disasters, utility disruptions, and security-related disruptions.

Recommendation 1: The Subcommittee on Airports recommends that we, and the FAA Office of Airports, collaborate on a research tasking to clarify the definition of airport resiliency and provide improved policy and technical guidance regarding how resiliency considerations can be incorporated into airport planning and development efforts. As a first step, the Airports Subcommittee proposes to develop a draft research tasking for the Office of Airports to consider.

FAA Response: The FAA concurs with the Committee's finding and recommendation and is undertaking the following actions to address its recommendation(s) - The FAA Office of Airports will collaborate with the Subcommittee towards establishing a clear definition of airport resiliency. The Office of Airports is currently working on an operational definition of airport resiliency with our ongoing research with Volpe and developing frameworks to systemically integrate resiliency considerations into airport planning and development efforts. The Office of Airports will consider the Subcommittee's draft research tasking to consider augmenting our current research in this area. We look forward to continued collaboration with the committee on resiliency efforts.

Finding: F3 Transition Plan Development and the Aircraft Rescue and Fire Fighting (ARFF) Advisory Group - The Airports Subcommittee is excited by the progress that the FAA and U.S. Department of Defense (DOD) are making to enable the use of F3 in the place of AFFF for aircraft rescue and firefighting. However, as noted in our prior reports, there is an array of research-driven information airport operators need in advance of transitioning from AFFF to F3, including training requirements, firefighting tactics, and equipment requirements. The Airports Subcommittee also acknowledges that the FAA, airport operators, foam manufacturers, aircraft manufacturers, and DOD all have important expertise and perspectives on these transition issues. We also recognize that some airport operators will have external regulatory, legislative, or policy imperatives to transition from AFFF to F3 as soon as practicable following FAA approval of F3 products for use.

Recommendation 2: The Subcommittee on Airports recommends that the FAA utilize the Aircraft Rescue and Fire Fighting (ARFF) Advisory Group, which was formed in 2020 in response to a past recommendation from the Subcommittee, to assist in the expedited development of an F3 transition plan that provides guidance to airport operators and ARFF personnel regarding training, equipment requirements, firefighting tactics, and other relevant considerations.

FAA Response: The FAA concurs with the Committee's finding and recommendation and is undertaking the following actions to address its recommendation(s) - The FAA Office of Airports will engage the ARFF Advisory Group and seek their collaboration in the development of a transition plan to F3 that provides guidance for airport operators and ARFF personnel on relevant considerations of implementing F3 products into their operations.