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October 21, 2022

The Honorable Billy Nolen
Administrator
Federal Aviation Administration
[redacted]

Dear Administrator Nolen:

Attached below please find the findings and recommendations from the Safety, Airports, Environment and Energy, Human Factors, NAS Operations subcommittees from the fall meetings which have been reviewed and supported by the full REDAC on October 5, 2022.

The full REDAC also made several general observations for your consideration.

Environment and Energy Research Leadership – The REDAC would again like to commend the program and quality of the research in the Environment and Energy portfolio. This is reflected in the FAAs leadership nationally and internationally as reflected in the impact on ICAO sustainability efforts and the high quality of the US Aviation Climate Action Plan.

*Artificial Intelligence/Machine Learnin*g – The rapid and pervasive growth of AI/ML capabilities provide both an opportunity and challenge for the FAA. Data mining of operational data can increase understanding of complex NAS operations and has the potential for a data driven approach to improving aviation safety and sustainability. The FAA will also be challenged to certify systems by applicants and providers who seek to employ AI/ML approaches in the aviation systems. Fundamental research and consideration of new approaches to design and evaluate the safety of these software intensive critical systems is necessary to enable the next era of aviation while maintaining or improving the level of safety.

Longitudinal Tracking of NAS Performance – The rapid changes in demand and operations of the NAS during the COVID period resulted in a natural experiment which provided insight into the performance and dynamics of the NAS. This highlighted the opportunity to more formally track the performance of the NAS over time (longitudinal tracking) to both identify opportunities to improve performance but also to identify emergent risks. The REDAC recommend considering both a historical longitudinal analysis of NAS performance before and during the COVID period and developing a more comprehensive approach for documenting and tracking NAS performance in the future.

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

Sincerely,

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

Enclosure

Research, Engineering and Development Advisory Committee (REDAC)
Guidance on the FY 2025 Research and Development Portfolio

Subcommittee on Environment and Energy

General Observations: The Subcommittee focused on reviewing the R&D portfolio for Office of Environment and Energy that was developed based on the RE&D budget for FY22 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 is still to be determined. We were advised that the FY 23 budget had a request for $260.5M for RE&D and the target for FY24 is $267M. During the meeting, the staff from the Office of Environment and Energy (AEE) provided updates and highlighted accomplishments on all of the major research projects within the portfolio since our last meeting. Work on programs such as the Aviation Sustainability Center of Excellence (ASCENT); Continuous Lower Energy, Emissions and Noise (CLEEN); Commercial Aviation Alternative Fuels Initiative (CAAFI) and the Aviation Environmental Design Tool (AEDT) have been progressing. NASA also provided a comprehensive update on its programs. The primary focus of the briefing was on ultra-efficient transport, the future airspace, high speed commercial flight and advanced air mobility.

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

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). The establishment of the new Sustainable Aviation Fuel Grand Challenge aimed at dramatically increasing the production of sustainable aviation fuels 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 and Private Corporations who are involved in the research portfolios that The Office of Environment and Energy (AEE) has in place are key to completing this mission and are the most effective vehicle to conduct and coordinate future research and maximize limited resources.

The Subcommittee believes that AEE is doing a very good job and has once again presented a balanced portfolio. We believe that the priorities that we had previously identified have not changed and that AEE has added research projects that address these priorities as well as those necessary to address the goals outlined by the current Administration. Many of these new projects have been added to the Continuous Lower Energy, Emissions and Noise (CLEEN) and Aviation Sustainability Center of Excellence (ASCENT) portfolios. The Subcommittee members realize that there is still additional research required to address ongoing areas of concern. We are happy to see the recent addition of staff to AEE, but believe that further evaluation of staffing needs should take place given the additional funding and additional projects that are required in order to meet the goals outlined by this current administration. The need to maintain a leadership position at the International Civil Aviation Organization Committee on Aviation Environmental Protection (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 highlights the value of the Public/Private Partnerships that AEE has made an integral part of its research portfolio. The additional funding to CLEEN has enabled the FAA to expand CLEEN Phase 3 while also accelerating the start of CLEEN Phase 4. Another advantage of these partnerships is that universities and hundreds of students have benefited from these advanced research projects. The partnerships with the FAA have allowed universities to improve their facilities and capabilities and thus recruit better students that help improve the quality of the research being done in the USA. The timely awarding of these grants is still a challenge. At the time of our meeting, there were 59 projects worth approximately $33M awaiting approval through the grant approval process. The delay in approving and awarding of these projects has resulted in missed research opportunities and will create challenges in being able to address the priorities ahead and the ability to accomplish our goals.

Guided by the updates and presentations, the Subcommittee has proceeded with the following "Findings and Recommendations". The recommendations offered are all for inclusion in the REDAC report.

Finding: Sustainable Aviation Fuels (SAFs) – We know that the Sustainable Aviation Fuel (SAF) Program (including efforts in the Commercial Aviation Alternative Fuels Initiative (CAAFI), Continuous Lower Energy, Emissions and Noise (CLEEN) and Aviation Sustainability Center of Excellence (ASCENT) is a critical component of the industry's global emission reduction strategy. In order to meet the federal goals of increasing the production of SAFs to at least 3 billion gallons per year by 2030, there will need to be an increase in the research projects within the ASCENT portfolio. We are happy to see that some of these research projects have already been added to the portfolio. The same can be said if we hope to develop fuels that can be blended above 50% in today's fleet of aircraft. The current research has helped with the creation of a number of companies that have the potential to benefit the rural economies of several states and the U.S. Aviation industry. The establishment of the Sustainable Aviation Fuel Grand Challenge will insure that the U.S. Government and the private sector are working together to

address aviation sector emissions. The signatories of the Sustainable Aviation Fuels (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 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 International Civil Aviation Organization Committee on Aviation Environmental Protection (ICAO CAEP).

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

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

Finding: Public Private Partnerships - The Subcommittee continues to acknowledge and support the fact that the Office of Environment and Energy (AEE) have proven over decades to be very good stewards of taxpayer money. The leadership team at AEE has used their budgeted amounts to conduct and coordinate the research necessary to produce informed, data-driven policies; facilitate technological advances in the aviation industry; and produced models and data that have positioned the U.S. as both a State leader at (ICAO CAEP) and on the global aviation stage. The execution of this research portfolio has been accomplished by working collaboratively with private industry, major universities through the ASCENT Center of Excellence, other Federal Departments and Foreign Governments. Three quarters of Environment and Energy research funds generate 100% plus cost matching from non-federal partners [Continuous Lower Energy, Emissions and Noise (CLEEN), Commercial Aviation Alternative Fuels Initiative (CAAFI), and Aviation Sustainability Center of Excellence (ASCENT)]. The results that we have seen in the CLEEN Phase 1 and CLEEN Phase 2 projects as well as those in the ASCENT Center of Excellence is proof that these partnerships clearly work. These partnerships leverage scarce FAA R&D funds to accomplish significant advances and improvements. In addition, we believe that government funding has been used and executed effectively to lower the risk of new and emerging technologies such that they can be adopted by industry. The research benefits of these partnerships has clearly been proven over time and is very apparent in the current projects. The maturation of new technologies has delivered improved environmental performance and has enabled aviation system growth and associated positive economic impacts. In order to comply with Executive Order 14008 on Tackling the Climate Crisis, there will be an increased reliance on these Public Private Partnerships.

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

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

Finding: Global Leadership - Despite the fact that the FAA AEE currently maintains a leadership role in the International Civil Aviation Organization (ICAO) Committee on Aviation Environmental Protection (ICAO CAEP) and has been the driving force behind the push for data driven rule making, based on the commitments made by the current Administration on Climate Change, the Subcommittee firmly believes that maintaining the U.S. global leadership position at ICAO CAEP is essential and advantageous to U.S. aviation industry and will allow the U.S. government to defend its positions based on scientific research. Previous work that has been done with ASCENT and the Volpe Center has clearly allowed the FAA to maintain a scientifically supported position at ICAO CAEP. The close collaboration with NASA and individuals that have been involved in research projects under the E&E portfolio have played significant roles at ICAO CAEP and that is also clearly supporting U.S. global leadership. The work done within the CAEP Task Group to 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 meeting and represent the U.S position regarding international policy making at the international level is essential.

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

Finding: Noise Research - Aviation noise is and will continues to be one of the biggest environmental impacts related to the aviation industry and it requires ongoing research in order to address the concerns of the citizens. Despite the fact that we have learned a lot based on the results of many of the projects in the "Noise Portfolio", the Subcommittee's position on noise has not changed in that there is much research that is still necessary to address the ongoing topic of aviation noise. Whether there are new technologies or new procedures that can be implemented to help reduce the impacts of noise as the aviation industry rebuilds needs to be evaluated. Historically, advances in aircraft technology have been the major factor in reducing aviation's environmental impacts. The Subcommittee recognizes that there is about a seven (7) year lag between flight testing a technology and its appearing in the fleet. Therefore if we want to consider any new technology being introduced into the fleet in early 2030, we need to invest in the research now. The use of government resources during the initial research stages helps

mitigate technology risk and incentivize private companies to invest and develop cleaner, quieter technology. AEE has seen a number of research projects that have contributed to more fuel efficient and quieter aircraft. They have also developed new operational procedures that have reduced the noise impacts in communities in and around airports. There are a number of new research projects that have been added to address issues related to new entrants, such as unmanned aerial systems (UAS) and advanced air mobility (AAM) into the aviation system. Many of these new entrants will be active participants in our airspace in the not too distant future. There is strong collaboration with NASA on the noise front. There also have been significant upgrades made to the Aviation Environmental Design Tool (AEDT). AEE has established an AEDT User Review Group for ideas and feedback in order to ensure that the tool is beneficial to the actual users. FAA has also launched an initiative to partner with airports to gather more noise data resulting from noise complaints. Finally, AEE is working with industry to accelerate the development of technologies that reduce noise through the CLEEN Program.

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

Finding: Staffing - Given the mandates and financial support from the current Administration to climate change and increased SAF production, AEE has added a number of new projects to the portfolio. With additional funding expected from the Inflation Reduction Act, there will be many additional projects being created in the near term. The Subcommittee has concerns that they are not sufficient subject matter staff to handle and manage the increased workload. AEE needs to carefully examine its staffing to ensure that it has sufficient staff to support the expansion of public private partnerships and planned future projects.

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

Finding: Grants - The Subcommittee was surprised to learn that there are still issues surrounding the timely awarding of research grants to the Centers of Excellence. There are some 59 projects worth approximately $33M awaiting approval through the grant approval process for the ASCENT Center of Excellence. 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.

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

Subcommittee on NAS Operations

Finding: Advanced Air Mobility Wake Research - The 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 Advanced Air Mobility (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 following aircraft during takeoff and landing, but these effects have not been quantified for these new aircraft types.

Recommendation: 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.

Finding: UAS-Related Academic Research Funding Pathways - The NAS Operations Subcommittee received briefings on the FAA's Center of Excellence (COE) for Unmanned Aircraft Systems and the UAS / AAM Integration Research Plan. The former presentation noted that the FAA has committed to send 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 has continued to grow rapidly and spans 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 and machine learning technology; and connectivity to key domestic and international interoperability and standards-making communities.

While the Subcommittee understands there is Congressional language requiring certain funding 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: 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.

Finding: Wrong-Surface Landing Prevention Analysis - The NAS Operations Subcommittee received a briefing on the Runway Incursion Reduction Program (RIRP) 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: The NAS Operations Subcommittee recommends that the FAA develop concepts of operation for Wrong Surface Landing (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.

Recommendation: The NAS Operations Subcommittee recommends these analyses be performed as soon as practical given recent WSL incidents (e.g., near-landing on a taxiway at 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).

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 in order to effectively manage air traffic, and human factors considerations for the integration of artificial intelligence and machine learning 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 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: 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 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 potential benefits of new approaches to training or understand its implications, positive or negative.

Finding: Guidance for Operational Approval of New Applications for the Electronic Flight Bag (EFB) - At the Winter/Spring FY2022 meeting the Human Factors Subcommittee requested a briefing from the FAA on planned and past EFB-related research and findings. The FAA provided a briefing at the Summer/Fall FY2022 meeting that showed 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: 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.

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: 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 of time. 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.

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 "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. 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) (http://jarus-rpas.org/sites/jarus-rpas.org/files/jarus_sora_cyber_annex_final_1.pdf

Recommendation: 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.

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 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, 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: 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.

Recommendation: 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.

Finding: Research Landscape Inclusion – Novel Fan Blade Integrity - The Subcommittee on Aircraft Safety appreciates the FAA research in 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: The FAA should expand the research landscape to include that of fan blade integrity for blades that are a novel concept and material(s).

Finding: 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 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 amount 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: 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 material. This should include new inspection methodologies to assess materials for strength, integrity, as well as detailed modeling of failure modes and dispersion. Current regulations include blade out testing. However, research should be directed as to failure modes and scatter patterns for a blade failure to protect the aircraft.

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 industry to have a published phased roadmap for AI/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 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. 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 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: -Given the speed at which demands for AI/ML technologies are being developed, the REDAC Subcommittee on Aircraft Safety reiterates its previous recommendation for the FAA to expeditiously prepare and published 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.

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) 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, 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 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 United States 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 fire-fighting 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 fire fighting 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, explicit incorporation of resiliency as an airport capital project justification within the Bipartisan Infrastructure Law (BIL) 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: 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.

Finding: F3 Transition Plan Development and the 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 use of F3 in the place of AFFF for aircraft rescue and fire fighting. 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: The Subcommittee on Airports recommends that the FAA utilize the 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.