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June 3, 2021

The Honorable Stephen Dickson Administrator Federal Aviation Administration

Dear Administrator Dickson:

Attached below please find the findings and recommendations from the Safety, Airports, Environment and Energy, Human Factors, NAS Operations subcommittees from their winter/spring meetings which have been reviewed and endorsed by the full REDAC.

The full REDAC also made several cross cutting observations during the meeting regarding the RE&D program at the recent virtual meeting on April 21, 2021.

Lessons Learned from COVID – As we emerge from the COVID pandemic we recommend a comprehensive review of the lessons learned from the experience and for this to inform research to support system resilience and operational continuity for future disruptive events be they biological, cyber or political.

Machine Learning and AI in Aviation – Several of the subcommittees noted the increased emergence of Machine Learning and AI (ML/AI) and anticipate these tools to be applied in aircraft and ATC systems. The FAA has unique requirements in its oversight role and there is research required to support the certification and operational approval of these systems and the impact on pilots, controllers and other operational personnel. In addition Machine Learning techniques are expected to be valuable in exploiting the vast pool of operational data to improve the safety and operational performance. The REDAC recommends that the FAA take a strategic approach to defining functionality and acceptable uses of AI/ML for its unique applications.

Sustainability – The committee noted the increased national focus on sustainability. The FAA is well positioned to contribute to this with a strong AEE research and solid partnerships with stakeholders. Pressure on aviation will increase as other energy users transfer to sustainable sources and we urge the FAA to take a leadership position in increasing the sustainability of aviation

We appreciate the opportunity to support the FAA in promoting the safety, efficiency and effectiveness of our national aviation infrastructure. I would be happy to meet to provide further insight on these observations or explore ways in which the REDAC can more effectively support you and the FAA mission.

Thanks for the opportunity to contribute.

Sincerely,

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

Enclosure

## Research, Engineering and Development Advisory Committee (REDAC) Recommendations for Fiscal Year 2023 Research and Development Portfolio

### Subcommittee on Human Factors

**Finding: Human Factors for Aircraft Certification -** The FAA seems to be very responsive to the recent Aircraft Certification, Safety, and Accountability Act, however it is not clear how the identified research requirements are being fulfilled and what the timing/funding would be. The Subcommittee was also pleased to hear about the FAA's plans for integration of Human Factors into policy and processes for certification and flight standards based on scientific, engineering, and operational data, but there was no clarity on the mechanisms for doing so.

**Recommendation:** The FAA should pursue the research requirements established in the Aircraft Certification, Safety, and Accountability Act, and conduct research needed to support the integration of Human Factors into policy and processes for certification. This should include identifying and engaging research areas associated with the integration of Human Factors into the certification process, from identification of metrics and instruments for human performance to policy and guidance updates that account for a human system integration approach.

<u>Consequences</u>: Delay to harmonize the industry around appropriate methods to integrate human factors may result in multiple approaches that result in partial integration of Human Factors. The lack of research and methods to integrate Human Factors into the FAA's certification process may result in certification of advanced aircraft flight deck and flight control systems that could have unintended safety consequences.

#### Finding: Improved methods to determine individual proficiency of operational personnel -

The FAA seems engaged in research on training; however, the current research does not specifically investigate scientifically valid ways to develop, assess, and maintain full-spectrum (psycho-motor, cognitive, etc.) proficiency of operational personnel. Current evaluation methods rely on observable compliance with published procedures, and on performance parameters kept within clearly defined limits. Assessing cognitive skills associated with more complex cognitive processes, such as information integration, are even more difficult to observe. Proficiency in cognitive skills is currently assessed mostly by subjective judgment of instructors/examiners, whose assessments are very difficult to standardize. Research is needed to determine how proficiency and skills are developed, trained, assessed, and maintained, including the length of time after training skill proficiency can be expected to be retained.

**Recommendation:** The FAA should pursue research to address the assessment of cognitive skills associated with more complex cognitive processes, such as information integration, that are difficult to observe and to determine the length of time after training that proficiency can be expected to be retained. This research should include the definition of proficiency, qualification standards and assessment methods, methods for maintaining and improving proficiency, and realistic proficiency retention timelines that are based on scientifically validated principles for the operational workforce. The results of this work could provide important methods for developing and measuring proficiency and may be extended to include initial definitions of proficiency needs for human interaction with autonomy and automation.

**Consequences:** Failure to identify proper evaluation methods may result in inadequate identification and mitigation of risks associated with developing and maintaining proficiency in operator skills. This may increase the opportunities for human error and impose additional hazards to system performance and operations.

## **Subcommittee on Airports**

**Observations and Commendations:** The Subcommittee was pleased to see that the Program's research had resumed in the latter half of CY2020, albeit with continuing restrictions on travel and certain on-site activities at the FAA William J. Hughes Technical Center. We commend Program and Technical Center staff on their work to manage myriad issues associated with the pandemic response and their flexibility and initiative in adjusting research activities and priorities to reflect COVID-19 realities.

We appreciate FAA's continuing focus on time-critical research projects. These include evaluation of alternative aircraft fire fighting agents and assessment of Unmanned Aircraft detection and mitigation systems, both of which are associated with legislative requirements in the 2018 FAA Reauthorization Act. With respect to the latter project, the Subcommittee was encouraged to learn during our meeting of the FAA's selection of four airports as pilot testing sites for UAS detection and mitigation systems: Huntsville International Airport, Rickenbacker International Airport, Seattle-Tacoma International Airport, and Syracuse Hancock International Airport. These four airports join Atlantic City International Airport (New Jersey) in the program, where preliminary work began in Fall 2020.

We also understand that in spite of best efforts, there will be some delay in these time-sensitive research projects. This is of greatest concern for alternative firefighting agent research, where there is a legislative deadline for research findings this year. As noted in our recommendations below, the Subcommittee recommends (and supports) the FAA requesting an extension to this deadline to ensure that data collection and analysis can be performed.

Finally, we want to acknowledge the successful conclusion of the FAA's Neighborhood Environmental Survey research effort, which culminated with publication of survey results in January 2021 (DOT/FAA/TC-21/4). The survey effort, which began in 2014, is a critical initial step towards refinement of U.S. aviation noise policies, noise mitigation approaches, and community outreach. The collaborative between the FAA Offices of Environment & Energy and Office of Airports and their respective research programs provides a foundation for a challenging, but necessary conversation regarding aviation noise and its effects on communities.

**Finding:** Alternative Firefighting Agent Research Project - As we noted in our Fall 2020 report, the Subcommittee recognizes that disruptions caused by the COVID-19 pandemic have delayed time-critical research activities, including those associated with provisions in the FAA Reauthorization Act of 2018. The Program's alternative firefighting agent research project is of particular concern because:

• The Project's findings are needed to support FAA action regarding Section 332 of the FAA Reauthorization Act of 2018. Section 332 included a three-year deadline—ending

on October 4, 2020—for FAA to "not require the use of fluorinated chemicals to meet the performance standards referenced in chapter 6 of AC No: 150/5210–6D and acceptable under 139.319(l) of title 14, Code of Federal Regulations."

- Airport operators are under considerable pressure from state and local governments and local communities to reduce or eliminate use of polyfluoroalkyl substances (PFAS) at airports.
- There are significant and growing concerns about the human health impacts and associated liability associated with PFAS contamination on and near airports.

Based on our discussions of this project during the meeting, it seems that it will be challenging to complete necessary testing and analysis this year despite best efforts on the part of Program staff to do so, principally because of COVID-19 research disruptions during the first half of 2020. The Subcommittee also recognizes the need for the FAA's efforts to be coordinated closely with complementary research efforts that have been underway within the U.S. Department of Defense.

**Recommendation:** Consistent with Recommendation 1 from our Fall 2020 report, the Subcommittee encourages the FAA to assess whether additional time will be needed to complete its alternative firefighting agent research and coordinate this research with the U.S. DoD. The Subcommittee would support FAA requests for an extension of the October 4, 2021 legislative deadline to address these issues if the FAA seeks them from Congress.

**Finding: Unmanned Aircraft Systems (UAS) -** UAS research remains a high priority for the Subcommittee. Actions that the FAA has taken in the last six months to facilitate UAS operations (e.g., over people, beyond visual line of sight) and facilitate UAS tracking in the National Airspace System via remote identification systems coupled with increasing UAS capabilities make these aircraft very attractive for a variety of beneficial uses at airports.

**<u>Recommendation</u>**: We encourage the FAA prioritize its research into beneficial UAS use cases and implementation hurdles at airports, expediting this work if possible.

# Subcommittee on NAS Ops

**General Observations:** The FAA is pursuing Research, Engineering and Development (RE&D) related to Machine Learning/Artificial Intelligence (ML/AI) technologies for Air Traffic Control (ATC), Air Traffic Management (ATM), and increasingly automated air vehicles. This work includes applying Safety Risk Management (SRM) processes to identify and assess potential safety risks from these new technologies. The Subcommittee applauds these activities, and also notes that there will be a growing need to ensure that SRM tools and techniques effectively cover new certification and risk assessment challenges brought about from advanced ML/AI systems and how they interact with humans. This will likely result in the need to define and tailor research efforts focused on improving and extending the SRM and certification processes for ML/AI systems.

The NAS Operations Subcommittee was pleased to learn that the A11.i Air Traffic Control / Technical Operations program is beginning to address job task requirements and training gaps

for personnel at the Air Traffic Control System Command Center (ATCSCC). The Subcommittee feels this work is important to strengthen the capabilities and performance of these critical personnel who may not have had directly-relevant training or experience with the strategic traffic management challenges addressed at the ATCSCC. The Subcommittee looks forward to hearing updates on this activity in the future.

**<u>Research Landscape Updates</u>**: The NAS Operations Subcommittee reviewed the FAA Research Landscape for the National Airspace System and provided several recommendations for extensions and enhancements based on members' understanding of the changing aerospace landscape. These included:

- There is continuing interest in mixed operations, issues handling mixed equipage, and certification of new technologies. There is a need to harmonize mixed equipage traffic within the airspace, as this is inhibiting some of the potential benefits from NextGen. One example is the challenge in extracting benefits from Required Navigation Performance (RNP) procedures when some regional jets do not carry the necessary equipage. The Landscape should ensure that mixed-equipage challenges are considered where relevant.
- Certification of new entrant concepts and operations, including Urban Air Mobility and the rapid growth in Commercial Space Transportation, is seen as a key challenge that will require a focused research and development plan to accomplish. This also includes defining future communication, navigation, and surveillance requirements for these operations which will need to expand beyond CONUS to global coverage to enable many of these operations.
- There is increased interest in new vehicles and missions, and in particular a move toward de-carbonization and advanced fuels and energy storage. There will be a transition to new energy sources and sustainable aviation fuels, some of which are available now but require support. In particular, it was noted that hydrogen and electric vehicles need more attention from DOE, DOT, and NASA.
- The Subcommittee noted strong environmental Research and Development (R&D) initiatives in Europe have extended beyond vehicles, to include other targets to reduce environmental impact such as the operation of navaids or applying novel energy sources at airports.
- Autonomous vehicles at airports, including airport Ground Service Equipment (GSE), will involve a transition to hydrogen power and "carbon-aware" GSE. It was noted that there are more than 40,000 Hydrogen powered forklifts across the U.S. which has had a great impact on improved air quality in warehouses. More than 4,000 cellphone towers have shifted from diesel to Hydrogen backup power sources. Microsoft and others are using Hydrogen for backup power. Research should continue into similar efforts at airports and other facilities.

- Risk-based decision-making research should extend not just to safety risks, as currently covered in the Landscape document, but also to include operational decision-making from the air traffic management perspective. An example would be the use of weather forecast confidence information in making a risk-balanced traffic management decision.
- There are growing spectrum issues, especially with the existing and planned evolutions from 4G to 5G to 6G. The rapid growth in small Unmanned Aircraft Systems (sUAS) will place additional pressure on the communications spectrum. This may warrant a new research topic in the Landscape or a more detailed extension to the "Increased Connectivity by Cyber-Physical Systems (Internet of Things)" research element.

**Finding: Weather-related RE&D funding -** The Subcommittee received briefings on the overall Research, Engineering, and Development (RE&D) budget followed by updates from the A11.k Weather Program, A11.q NextGen – Weather Technology in the Cockpit (WTIC) program, and A11.o Wake Turbulence program.

The FY21 Enacted RE&D budgets for A11.k, A11.q, and A11.o show significant reductions from prior year levels: down to approximately 40%, 55%, and 55% relative to their FY19 funding levels, respectively. Although major weather-related air carrier accidents are rare, they continue to be a concern especially for general aviation and helicopter operations. Weather remains the largest single cause of air traffic delay, and it is likely that weather-related delays will become increasingly problematic as the nation returns to pre-COVID-19 traffic levels over the next few years. Research is needed to ensure that the improvements afforded by NextGen decision support capabilities are robust to weather conditions. At the same time, growing interest in small Unmanned Aircraft System (sUAS) and Advanced Air Mobility (AAM) concepts will require consideration of weather impacts on these new types of vehicles and missions to enable them to operate safely and effectively. These operations pose unique requirements for aviation meteorology knowledge in the Earth's boundary layer (below 1,000 feet AGL).

Also the technologies to enable options for services are expanding rapidly, including the evolution of the Low Earth Orbit satcom WiFi and 5G services from companies OneWeb, Kuiper (Amazon), Starlink (SpaceX), and SpaceMobile (AST Science). Of particular concern are the needs for improved weather sensing away from traditional airports and the need to better understand, model, and forecast low-level and urban-area weather. Concerns about aircraft wake turbulence also relate to the ability to model and forecast winds, and research may need to be expanded to safely enable upper-altitude (Upper E) operations involving particularly sensitive air vehicles such as long-endurance balloons. Given these new drivers of demand and technology enablers, now would be a good time to increase funding for the FAA Weather Program, not reduce it.

**Recommendation:** The NAS Operations Subcommittee recommends that the FAA make a directed effort to improve awareness of the importance of weather-related research and the impacts that the FAA's prior weather research has had on improving the safety and efficiency of the National Airspace System.

**Recommendation:** The Subcommittee also recommends that the weather-related RE&D programs strengthen connections with major FAA programs and strategic thrusts including Trajectory Based Operations (TBO), Future Flow Management, Unmanned Traffic Management (UTM), Advanced Air Mobility (AAM), and NAS Integration of Transiting Operations (NITRO) to ensure that weather considerations are included and that a robust prioritized list of weather RE&D initiatives are identified to support those programs.

## Subcommittee on Aircraft Safety

**Finding:** Visibility in the Source of Research, Engineering, and Development (RE&D) Funding - The Subcommittee on Aircraft Safety (SAS) found that some FAA Research, Engineering, and Development activities are being sponsored and managed under Facilities and Equipment (F&E) funding. Furthermore, SAS learned that some research topics such as Air Traffic Management (ATM) and Communication, Navigation and Surveillance (CNS) were moved from RE&D funding to F&E funding in the late 1990s. Additionally, the SAS learned that Unmanned Aircraft Systems (UAS) Pilot Programs research is being managed with F&E funding. Some Research, Engineering, and Development being conducted under F&E funding also serve to inform FAA aviation safety policy, regulations, and rulemaking. Lack of SAS visibility into projects sponsored and managed under F&E funding leads to an incomplete SAS review of research related to aviation safety policy, regulations, and rulemaking. In addition, potential exists for regular F&E activities, pressures, and priorities to overcome and negatively impact the prioritization and resources for mid- and long- term research.

**Recommendation:** The SAS recommends that the FAA brief the SAS on the process by which the Research, Engineering and Development sponsored and managed within the RE&D funding and F&E funding is coordinated and ensure mid- and long-term research objectives prioritization is appropriately maintained. The SAS recommends that the FAA include F&E Research, Engineering, and Development which inform FAA aviation safety policy, regulations, and rulemaking BLI and/or projects in future SAS briefings.

**Finding:** Ice Crystal Icing (ICI) - The Subcommittee appreciates the FAA research in A11D budget line item for Research on Ice Crystal Icing Conditions to Address Fundamental Knowledge of High-Altitude Icing on Turbine Engine Damage and Power loss. The project is currently un-funded through the 2023 fiscal year. Further in-depth research can aid current rulemaking work to address this issue appropriately.

Prior funding was used for several flight campaigns, however, the data analysis portion requires addition funding for an additional flight test campaign evaluating the effects of atmospheric Aerosol content on ice crystal concentrations at high altitude. Additionally, as many projects are put on hold during the COVID-19 pandemic, funding should be available for ongoing work including additional testing for modeling and testing for ICI accretion behind the fan.

**Recommendation:** The FAA should consider prioritization for further Ice Crystal Icing research for Fiscal years 2021 and beyond to ensure it is adequately addressed in certification and rulemaking. The FAA should consider additional research in the following fields:

• Aerosol testing to determine the effects on high altitude ice crystal concentrations.

- Continental vs Oceanic Mesoscale Convective Systems and lapse rates and their effect on High Altitude ICI.
- Basic physics studies of ice formations within turbine engine flow paths from high altitude ice crystal icing in mesoscale convective systems.

**Finding: Machine Learning/Artificial Intelligence (ML/AI)** - The SAS was pleased to learn about the on-going and planned research on Machine Learning and Artificial Intelligence. Future advancements in control system technologies will depend upon an artificial learning process that has the potential to impact the basis of certification for such systems. The demands of industrial or ground-based systems differ greatly from those requirements for aircraft systems. If not fully researched and understood, the impact to aviation safety critical systems is significant. While both industry and academia are placing a large emphasis on the development of ML/AI, more research is required to better understand the means to establish criteria to judge the confidence and validation of such systems that ultimately can lead to a basis of certification of these same systems. Furthermore, there is significant standards development work being conducted by the Radio Technical Commission for Aeronautics (RTCA), Society of Automotive Engineers (SAE), and American Society for Testing Materials (ASTM) on these technologies across the entire aviation ecosystem, both airborne and ground, addressing both manned and unmanned systems. This includes Unmanned Traffic Management (UTM) solutions.

**Recommendation:** The SAS recommends that FAA place a priority on research in ML/AI. This research will enable the FAA to work toward achieving a means of compliance by addressing the added challenge of better understanding the current and future scope of technology. On a more strategic basis, we further recommend identifying the unique attributes where those ML/AI applications can safely be used.

**Recommendation:** In addition, the SAS recommends for close collaboration with industry to understand the FAA requirements and FAA to understand the technology to develop/modify requirements based on new technology. On a more strategic basis, we further recommend identifying the unique attributes where those ML/AI applications should be used.

#### Subcommittee on Environment and Energy

<u>General Observations</u>: 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 FY 21 that was enacted on December 27, 2020. During the meeting, the staff from the Office of Environment and Energy (AEE) provided updates on all of the major research areas within the portfolio. 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 updates highlighted accomplishments, since our last meeting, that have been realized both locally and on the international front directly linked to the ongoing research. These accomplishments further validate the need for sound research when developing regulations and policies and procedures. Despite the COVID-19 concerns that we had expressed in our previous report, the Subcommittee was very impressed with the job the leadership and staff of AEE has been doing. The presentations were well done and reflected impacts and or potential impacts, because of COVID-19, to the research that is being done and is proposed in the future. The presentations outlined a high level of communication between AEE staff and their partners to continue these necessary research efforts, but they also showed the challenges associated with COVID-19 restrictions and how they have impacted many projects, be it financial or time delays.

The overall impacts of COVID-19 on the citizens of the world are unprecedented! The aviation industry is currently going through a crisis of historic magnitude and the road to recovery and future growth still has many uncertainties. The dramatic reduction in air travel and aviation related activities has brought significant attention to the environmental impacts associated with the aviation industry. Members of this Subcommittee believe that the FAA and the aviation industry are at a unique point in history and AEE and its partners are well positioned to address the additional environmental questions that are being asked on noise and emissions. The answers to the questions can only be found through additional research and development with the financial support from the U.S. government. We have already seen where other governments have pledged support to their environmental research agenda.

The U.S.A must maintain its leadership position at the global stage in order to protect the U.S. aviation industry as we continue down the path of recovery and address new growth. This leadership position can be sustained by further expanding the Environmental and Energy R&D Portfolio using the proven blueprint that was presented to this Subcommittee. The expected results of current and future research under this portfolio will also help us address the concerns within the U.S.A as well. We know where we want to be, we need to use our partnerships with other federal agencies, universities and businesses and our research portfolio to get there.

The Subcommittee believes that AEE is doing a good job and has once again presented a balanced portfolio. We believe that the research priorities that the Subcommittee has previously identified, growth from Commercial Subsonic traffic, Urban Air Mobility (UAM), Unmanned Aerial Systems (UAS), Supersonic Civil aircraft and Commercial Space vehicles do not need to be adjusted. The Subcommittee was happy with the briefings we received on a number of new research projects have been added to address these priorities. The Subcommittee members realize that there is still additional research required to address ongoing areas of concern. There were additional discussions among the members on whether there are any research opportunities that currently exist because of the impacts that COVID 19 has had on aviation industry.

The Subcommittee is comfortable that AEE, the ASCENT Center of Excellence, CLEEN Program, CAAFI and others efforts, as well as and their partners, including NASA, are working together to realistically address the impacts that the COVID-19 pandemic has had on continued research efforts. The long term impacts of this pandemic on the citizens of the world and the aviation industry are still not known, but we believe that AEE has a proven blueprint that can be used to address future research needs. 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:** 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. The overall reduction in aircraft movements as a result of the pandemic has definitely increased the focus on noise. The Subcommittee realizes 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. AEE has research projects that are looking at the impacts of noise on children's learning, sleep impacts, community annoyance and cardiovascular health.

AEE is looking at the certification requirements for Supersonic aircraft, as well as, Unmanned Aircraft System (UAS) and Advanced Air Mobility (AAM) vehicles. AEE is also examining how to reduce the noise from commercial aircraft and helicopters through changes in operational procedures. There are a number of new research projects that have been added to address issues related to new entrants into the aviation system. There also have been significant upgrades made to the Aviation Environmental Design Tool (AEDT). 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 strongly supports and recommends the continued prioritization of the noise research! Noise is a source of everlasting "headaches" for the aviation community and despite the great improvements made by the FAA, communities have become less tolerant of noise.

**Finding: Public Private Partnerships -** The Subcommittee wishes to acknowledge and support the fact that the Office of Environment and Energy (AEE) have proven over decades to be very good stewards of taxpayer money. The leadership team at AEE has used their budgeted amounts to conduct and coordinate the research necessary to produce informed, data driven policies, facilitate technological advances in the aviation industry, and produced models and data that have positioned the U.S. as both a State leader at International Civil Aviation Organization/Committee on Aviation Environmental Protection (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 (CLEEN, CAAFI, and ASCENT). This leverages 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 benefits of these partnerships has clearly been proven over time and is very apparent in most of the current projects. To date, the CLEEN and CLEEN II programs sponsored by the FAA have been responsible for the maturation of aircraft technologies responsible for significant decreases in fuel burn/CO2, decreases in NOx emissions and noise reductions that would not have happened otherwise.

**<u>Recommendation</u>**: 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 and recommends that FAA should continue to allocate robust funding for these programs. Given the current drop in air traffic levels, now is the perfect time for Phase III of the CLEEN program to develop and mature technologies that would have an even more substantial impact on aviation environmental concerns.

**Finding:** Sustainable Aviation Fuels (SAFs) - Significant gains have been realized in the Sustainable Aviation Fuel (SAF) Program (including efforts in CAAFI, CLEEN and ASCENT. SAFs are a critical component of the industry's emissions reduction strategy and must be developed if industry is to get to their carbon neutral growth goals after 2020 and their 50% emissions reduction goals in 2050. This 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. In 2020, 4.6M gallons of SAF were used by the U.S. Aviation Industry, a 190% increase over 2019, and this increased consumption happened in spite of the current downturn in aviation traffic.

Business aviation has also seen significant interest in SAF. Based on industry data, there should be a significant increase in production and consumption in the coming years. Recent support from a number of agencies, including from DOE and USDA, will further support SAF production. The FAA is working through the International Civil Aviation Organization/Committee on Aviation Environmental Protection (ICAO CAEP) to ensure that a wide range of sustainable aviation fuels are included in Carbon Offsetting and Reduction System for International Aviation (CORSIA). The FAA has also been conducting research to examine whether other types of fuel besides SAF could be used in different kinds of air vehicles. This work should prove insightful for understanding how hydrogen could be used by aviation, both in the near and longer terms.

**Recommendation:** It is still the position of this Subcommittee that the work on Sustainable Aviation Fuels (SAF) is critical to the U.S. industry and the FAA should maintain a global leadership role in the development of SAF. 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. This includes finding ways to use SAF as blending percentages above 50% and work towards the use of 100% SAF in today's aircraft. The partnerships with the Department of Energy and the U.S. Department of Agriculture must also be reinforced.

**Finding: Global Leadership** - It is evident that the FAA AEE currently maintains a leadership role in ICAO CAEP and has been the driving force behind the push for data driven rule making. Because of the impacts of COVID 19 on aviation globally, and the continuing importance being placed on environmental issues around the globe, other governments have made commitments to their own research and environmental agenda. As a result, the Subcommittee firmly believes that maintaining the U.S. global leadership position at ICAO CAEP is not an option, it is essential and advantageous to the U.S. aviation industry. Work that has been done with ASCENT and the

Volpe Center has clearly allowed the FAA to maintain a scientifically supported position at International Civil Aviation Organization/Committee on Aviation Environmental Protection (ICAO CAEP). The close collaboration with NASA at ICAO CAEP is also clearly supporting global leadership. Anything that jeopardizes ongoing research at AEE will impact the FAA/U.S. global leadership position at ICAO CAEP.

**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 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.