



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

Office of the Administrator

800 Independence Ave., S.W.  
Washington, D.C. 20591

February 6, 2020

Dr. R. John Hansman, Ph.D.  
Chair, Research, Engineering and  
Development Advisory Committee  
Massachusetts Institute of Technology  
77 Massachusetts Avenue  
Cambridge, MA 02139

Dear Dr. Hansman:

Thank you and the Federal Aviation Administration's (FAA) Research, Engineering, and Development Advisory Committee (REDAC) for your October 23, 2019, letter providing recommendations on the Fiscal Year (FY) 2022 Research and Development (R&D) Portfolio. The important guidance generated during the REDAC summer - fall 2019 meeting held on October 10, 2019, is sincerely appreciated.

Occurring during this meeting were important discussions regarding research topics that included, but were not limited to, the integration of new entrants and vehicle classes into the National Airspace System (NAS), Unmanned Aircraft Systems (UAS) program updates, and the enhanced development of the FAA Research and Development Landscape. These areas and other emerging technologies will affect the evolution of policy guidance and strategic technical program decisions required to promote and sustain safe operations. Examples of emerging technology themes included UAS; Commercial Space Operations; Supersonic Business Jets; Optionally Piloted Vehicles; Electronic Vertical Take-off and Landing; Extremely Short Take-off and Landing; and Electric, Hybrid, and Solar Vehicles. The professional subject matter insight provided by the cadre of REDAC aviation and aerospace experts promoted continuous guidance in support of the Agency's R&D programs and related projects.

I have reviewed the 24 recommendations submitted by the REDAC. The enclosed FAA Response Report reflects our Agency responses to these recommendations. The FAA Response Report includes our dispositions for the total of 24 recommendations made by 5 Subcommittees as follows: Environment and Energy (7); NAS Operations (7); Airports (4); Human Factors Subcommittee (3); and Aircraft Safety (3). The FAA fully concurs with 13 of the 24 items, partially concurs with eight and non-concurs with three of the submitted recommendations in the report. The FAA has identified efforts to address the partial concurrences and provided justifications for those suggestions that are unable to be completed at this time.

We will continue to address all of the Committee's recommendations and incorporate those applicable as we maintain our R&D portfolio that addresses the safety, efficiency, and capacity of the air transportation system in an environmentally responsible manner.

Sincerely,

A handwritten signature in black ink that reads "Steve Dickson". The signature is written in a cursive style with a large, stylized "S" and "D".

Steve Dickson  
Administrator

Enclosure

# FAA Response to Research, Engineering and Development Advisory Committee (REDAC) Guidance for the Fiscal (FY) Year 2022 Research and Development Portfolio

## Subcommittee on Environment and Energy

**General Observations:** Members of the Subcommittee were happy to learn that there has been progress made in getting grants awarded to the Aviation Sustainability Center of Excellence (ASCENT). We were briefed on some of the results of work that has been accomplished by ASCENT, as well as other parts of the Environment and Energy Portfolio. The Subcommittee reaffirms the belief that there will continue to be growth from commercial subsonic traffic, and a significant likelihood of new entrants including Urban Air Mobility (UAM)/Unmanned Aerial System (UAS), supersonics civil aircraft and commercial space vehicles (in that order). The FAA needs to be in a position to address the noise, emissions and impacts of all these users of the airspace. The Subcommittee believes that it is vital that the U.S. maintains a global leadership position at ICAO CAEP and the FAA continues to develop the necessary knowledge, tools, and information to guide that position.

**Finding: Noise Research** - The Subcommittee realizes that aviation noise is an ongoing issue that is critical to both the sustainability of our existing National Airspace System and opening new aviation markets. While there has been significant progress, additional research is still necessary to address the ongoing topic of aviation noise. If not properly addressed, it will continue to be a constraint on the growth of the U.S aerospace industry. This Committee reconfirmed the current prioritization of commercial subsonic aviation, Urban Air Mobility (UAM)/ Unmanned Aerial System (UAS), supersonics and commercial space.

Noise concerns have been one of the primary limiting factors to implementing more efficient operational routes into and out of airports for commercial aircraft. There has been excellent coordination with NASA in establishing new supersonic standards, and this coordination needs to continue so that the U.S. can maintain leadership in this arena.

Smaller UAS are beginning to be used in commercial applications and there is significant investment being made in UAM concepts for moving both people and cargo. Due to the different nature of the noise generation and human perception of both of these vehicle types, current standards do not adequately apply to their certification. There is a growing sense of urgency to accelerate the understanding of noise impacts from these classes of vehicles so that proper standards can be established. There is a strong symbiotic relationship between the FAA and NASA in the area of predicting noise, understanding impacts and also mitigating the effects of noise.

**Recommendation 1:** The Subcommittee strongly supports the existing prioritization of the noise research that will support informed decision-making and enable NextGen Deployment. The FAA needs to be prepared to address certification and standards for UAM and UAS noise before these vehicles enter service. This action is urgently needed so that local communities are not compelled to establish their own standards that will both limit growth of the market and create an inconsistent and confusing regulatory environment. We recommend that the FAA strengthen its relationship with NASA in this domain and move to establish regulatory guidance related to UAM and UAS noise.

We believe that, when limited resources are available, the focus should be on impacts of commercial subsonic aviation, Urban Air Mobility (UAM)/Unmanned Aerial System (UAS) (UAM/UAS), supersonics and then commercial space vehicles, in that order. The FAA should aggressively move forward with its research efforts, as research is the key to establishing sound policy.

**FAA Response:** The FAA concurs with the Committee's finding and recommendation and is undertaking the following actions to address it - Noise continues to pose a challenge to the growth of aviation and could impact the introduction of new vehicle types to the National Air Space (NAS). We have been working for many years to better understand the issues associated with noise from subsonic airplanes and helicopters and to identify solutions that could help address noise concerns. For example, we are continuing to explore operational procedure concepts that could help mitigate noise issues while also improving the Aviation Environmental Design Tool (AEDT) to ensure it can quantify aircraft noise at further distances from airports, where some communities are expressing concerns. Noise reduction from gas turbine powered fixed wing aircraft will also be an area of emphasis for the third phase of the Continuous Lower Energy, Emissions and Noise (CLEEN) Program, which will start in 2020 and is included in the FY 2020 President's budget request.

We are also working in close collaboration with NASA to address noise from subsonic and supersonic aircraft, helicopters, UAS, and UAM. As one example of our collaborative efforts, NASA are going to use AEDT to model the collective noise that results from the introduction of UAM into metropolitan areas. We participate in joint activities with NASA on UAS and UAM as well. We are also standing up a new Aviation Sustainability Center of Excellence (ASCENT) Center of Excellence (COE) project that will build off our successful efforts on helicopter noise modeling to examine UAM noise. In addition to these efforts on UAM, we are also working to obtain certification-quality noise measurements from UAS through the Integrated Pilot Program. At present, we have high quality noise data from only a few UAS and are actively looking for opportunities to get more data. Furthermore, we are in the process of standing up another new ASCENT COE project to develop an analytical framework to aid in the evaluation of noise from widespread UAS use. Finally, we are also looking to see if there are other areas of research that are needed with respect to UAS and UAM noise to support their introduction into the NAS. We will continue to update the Subcommittee as these efforts unfold.

**Finding: Global Leadership** - There have been indications from the European Commission that sustainability will be the number one aviation priority going forward. The Carbon Offsetting and Reduction System for International Aviation (CORSIA) that was adopted by the International Civil Aviation Organization/Committee on Aviation Environmental Protection (ICAO CAEP) is a result of FAA efforts and valuable research that the FAA has been doing. This research is also informing U.S. positions on international standards, such as for noise from supersonic aircraft, which in turn allows the U.S. aviation industry to maintain its competitiveness throughout the world. The Subcommittee believes that maintaining the U.S. global leadership position at ICAO CAEP is essential to protecting U.S. aviation interests. This position is only possible because of the FAA's ability to maintain its current research goals and its ability to evaluate the impacts of future entrants on the environment to continue to lead the world in international settings.

**Recommendation 2:** The Subcommittee recommends the prioritization of all research efforts/programs that will allow the FAA and the U.S. to maintain its current global leadership position at International Civil Aviation Organization/Committee on Aviation Environmental Protection (ICAO CAEP) and, in particular, to expedite university research grants through the Aviation Sustainability Center of Excellence (ASCENT) that support the U.S. work in 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 it - The FAA appreciates the support of the Subcommittee for our ICAO CAEP activities and the importance of continued U.S. leadership therein. We concur it is critical for FAA to have robust participation in the ICAO CAEP process and we have devoted resources such that we can provide leadership in many of the working groups of CAEP. FAA prioritized research efforts include developing the modeling capabilities and generating the data to support the decision-making process within ICAO CAEP. Much of this work is being done by ASCENT COE universities and the Volpe Center, in close collaboration with NASA and industry. We are currently working with U.S. stakeholders and the international community to develop noise standards for supersonic aircraft with a focus on landing and takeoff noise.

These aircraft will need the operational flexibility to be able to take off and land in other countries, which will require international agreement at ICAO on noise standards. As AEDT is the primary tool for supporting decision making at ICAO CAEP, we are working with the Volpe Center to enhance its capabilities to include supersonic aircraft. In addition to these efforts, we are also standing up a new project in ASCENT, which will be done in close collaboration with NASA, the U. S. Department of Defense, and industry, to develop improved models to enable the development of supersonic aircraft that will have reduced jet noise on takeoff.

**Finding: Alternative Jet Fuels** - It is the position of this Subcommittee that the work on Alternative Jet Fuels (AJF) is critical to the U.S. industry and should be supported at the highest levels. Having the FAA maintain a leadership role in the development of AJF will also ensure that the rules that are developed internationally will benefit the U.S. industry. A lot of progress has been made in the development of AJFs and any reduction of funding for the Alternative Jet Fuel Program (including efforts in the Commercial Aviation Alternative Fuels Initiative (CAAFI), Continuous Lower Energy, Emissions and Noise (CLEEN) and ASCENT Center of Excellence will have a catastrophic effect on the maturation of this fledgling industry. It is our view that the new companies and the industry that have been created will not be able to continue the work on AJF without government support and the policies and procedures that are currently in place. AJFs are a critical component of the industry's emissions reduction strategy and must be developed if the aviation industry is to get to its carbon neutral growth goals after 2020 and their emissions reduction goals in 2050.

**Recommendation 3:** Since the maturation of the Alternative Jet Fuel program will have a major environmental benefit for the public, create a new industry within the U.S. that benefits rural America, and benefit the U.S. aviation industry, we strongly support funding for the continuation of research on AJF.

**FAA Response:** The FAA concurs with the Committee's finding and recommendation and is undertaking the following actions to address it - The FAA appreciates the Committee's inputs on the importance of alternative jet fuels to industry. This industry pull is driving our continued efforts on alternative jet fuels. Our research efforts ensure that these fuels are safe for use and the results of our efforts are reducing the time and costs to get new fuels approved. Continued approvals for new fuels ensure that the aviation industry has access to a broad range of fuel options, and having more fuel options should reduce the cost of fuel production, enable greater environmental benefits, and allow for greater blend levels. Our research efforts also ensure that a wide range of aviation fuels can receive credit under the ICAO Carbon Offsetting and Reduction Scheme for International Aviation (CORSA). This is critical to not only allowing airlines additional means to meet their international commitments under CORSA, but also to gain international agreement on what is meant by sustainability. Our research efforts are also supporting techno-economic analysis to understand how to reduce fuel costs and producing scenarios of future production to inform decision making and planning by both governments and industry. The research program is also providing substantial support to Commercial Aviation Alternative Fuels Initiative (CAAFI), which is essential for coordinating efforts across the aviation industry.

**Finding: Public Private Partnerships** - During the meeting, the Office of Environment and Energy (AEE) provided updates on successes that have been realized as a direct result of the collaborative work that has been done with private industry, major universities through the Aviation Sustainability Center of Excellence (ASCENT), other federal departments and foreign governments. AEE has used their budgeted funds to conduct and coordinate the research necessary to produce informed 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. Three quarters of Environment and Energy research funds generate 100% cost matching from non-federal partners [Continuous Lower Energy, Emissions and Noise (CLEEN), Commercial Aviation Alternative Fuels Initiative (CAAFI), and (ASCENT)] and CLEEN has generated a 200% cost match thus far. It was noted that there have been improvements made to the grant approval process and most of the grants that were stuck in the government's pipeline, are now moving forward.

**Recommendation 4:** As has been shown by the successes that have been realized, the Subcommittee continues to endorse the robust funding of Public Private Partnerships (PPP) like the CLEEN, CAAFI and ASCENT that leverage scarce resources and helped the U.S. to maintain a leadership position at a global level. The Subcommittee recommends that FAA continues its strong support of these PPPs to continue to realize value of both U.S. industry and to bolster FAA's position in international settings. The Subcommittee is also pleased with the close collaboration between NASA and the FAA. The Subcommittee supports the improvements that have been made to the existing grant approval process, but would like to see additional streamlining of the process to reduce the time required to go from idea development to grant execution.

**FAA Response:** The FAA concurs with the Committee's finding and recommendation and is undertaking the following actions to address it - The FAA supports the Administration's

vision to maximize the impact of taxpayer dollars by improving the efficiency of Federal programs through partnerships with industry and creating benefit for the American public. The vast majority of the Environment and Energy R&D program has been leveraging resources from the private sector via public-private partnerships. Continuous Lower Energy, Emissions and Noise (CLEEN), Commercial Aviation Alternative Fuels Initiative (CAAFI), and Aviation Sustainability Center of Excellence (ASCENT) have all been successful because of their strong engagement with industry. ASCENT builds on the PARTNER Center of Excellence, which also had strong engagement with industry. Each of these programs, CLEEN, CAAFI, and ASCENT/PARTNER, have had strong partnerships with, and support from, industry for over a decade. We also appreciate the recognition of our close partnership with NASA and its value. We are also working in close collaboration with a number of Federal Agencies in the area of alternative jet fuels. We have worked diligently to develop these partnerships over many years.

As discussed at the Summer 2019 meeting, we have augmented the ASCENT COE grant approval process to directly incorporate senior FAA leadership decision-making at the outset of the process of developing project ideas. While the changes in the process have not, as yet, substantially reduced the time required to execute grants, it has improved the quality of the ASCENT COE research portfolio. The new process should though improve the time required for next year's grant approvals as many of the new projects are multi-year efforts. Further, we are currently working with the NextGen Office to identify potential means to streamline the approval process and reduce the time requirements for grant execution.

**Finding: Emissions** - AEE has identified challenges associated with the use of the Aviation Environmental Design Tool (AEDT) to evaluate compliance with air quality standards. AEE has also identified challenges in getting air quality and noise data to support modeling efforts. The FAA relies on AEDT to accurately conduct environmental impact analyses of proposed changes to airspace and airport design. The Subcommittee is supportive of the work that has been done to develop this tool, but believes that a plan needs to be developed to address air quality modeling challenges and to compare Aviation Environmental Design Tool (AEDT) results with field measurements.

**Recommendation 5:** The Subcommittee recommends the FAA continue the simultaneous balanced development of usability improvements, enhanced features, and increased accuracy of AEDT in the near term. The FAA should make a point of emphasis to improve the dispersion modeling that is used by AEDT to evaluate air quality impacts.

**FAA Response:** The FAA concurs with the Committee's finding and recommendation and is undertaking the following actions to address it - The FAA appreciates the support of the Subcommittee to improve the dispersion modeling of the air quality capabilities within AEDT. As required by the Environmental Protection Agency (EPA), AEDT uses AERMOD to model the dispersion of criteria pollutants. However, AERMOD was not designed for aircraft emissions. For example, it cannot accurately capture the three-dimensional effects of a rising aircraft plume. The FAA has awarded a grant to the University of North Carolina under the ASCENT Center of Excellence to help us determine an appropriate and efficient approach to address the dispersion modeling deficiencies that are currently in the AERMOD tool, and we have subsequently developed an expedited work program to accelerate the overall timeline for model development. In the interim, we are working to develop solutions

to improve the

accuracy within the limits of the current EPA model and identify means for airports to show their projects are in compliance with air quality standards through the use of their monitoring data.

**Recommendation 6:** We also recommend that the FAA reach out to airports that use air quality and noise monitors and partner with them in order to get their emissions and noise data that would support their modeling efforts.

**FAA Response:** The FAA concurs with the Committee's finding and recommendation and is undertaking the following actions to address it - The FAA appreciates the direction from the Subcommittee and we are indeed looking to identify means to obtain high quality air quality data to validate the results from the new dispersion model for Aviation Environmental Design Tool (AEDT). At present, we intend to use Aviation Sustainability Center of Excellence (ASCENT) research to gather this data, but we will also examine other means to get this information, including through the use of existing airport air quality monitors. In addition, we are also working with ASCENT COE researchers and industry partners to determine whether we could use noise monitor data to improve our noise modeling capabilities at relatively large distances from the airport as well as to determine if differences in how aircraft are actually flown are having a substantial impact on noise levels.

**Finding: Staffing** - Staff vacancies within the organization are a big concern. The Subcommittee is very supportive of the work that AEE does and believes that E&E is well managed and has a well-balanced portfolio. We also know that the workload has increased and that they do not have the full complement of staff that is required to maintain the same level of research to inform decision-making and advance solutions such that the FAA can achieve its core mission. The loss of skilled staff could further delay the completion of critical projects. We are happy to hear that the FAA has a plan and is committed to addressing the staffing vacancies.

**Recommendation 7:** The Subcommittee recommends the FAA place a high priority on filling staff vacancies to manage the AEE portfolio and support the expanding workload.

**FAA Response:** The FAA concurs with the Committee's finding and recommendation and is undertaking the following actions to address it - The FAA understands the Subcommittee's concern about staff availability within the Office of Environment and Energy (AEE). We are in the process of executing a hiring plan that was developed in accordance with administration guidance. To accommodate the evolving nature of the industry and the FAA's needs, we are seeking individuals who could cover a variety of needs to fill these openings. AEE have had good success over the years in filling positions with highly qualified environmental professionals. This is due in part to the students and staff that have been trained as a part of Partnership for Air Transportation Noise and Emissions Reduction (PARTNER) and Aviation Sustainability Center of Excellence (ASCENT), the FAA Centers of Excellence for environment and alternative jet fuels.

## Subcommittee on NAS Operations

**Finding: Continuing Capability Utilization Evaluation Program** - With the growing complexity and inter-relationships between automation systems [e.g., Time-based Flow Management (TBFM), Terminal Spacing and Sequencing (TSAS), Terminal Flight Data Manager (TFDM), Standard Terminal Automation Replacement System (STARS), EnRoute Automation Modernization (ERAM)] and new procedures and capabilities [(e.g., Performance Based Navigation (PBN), Initial Trajectory Based Operations (iTBO)], it is becoming increasingly important to monitor the use of these systems to ensure their envisioned benefits are being realized. Gathering data on capability utilization is critical to validate assumptions made during system development, identify operational, safety, efficiency, and user training challenges, and inform future research priorities. This will become especially important as future capabilities increasingly rely on Artificial Intelligence (AI) / machine learning-based systems that need to be periodically retrained due to changing operational conditions, data inputs, or other variables. The ATC / Technical Operations Human Factors portfolio (A11.h) includes this type of activity, but it is extremely limited in scope relative to the broad range of new capabilities being fielded.

**Recommendation 1:** The FAA should establish a crosscutting airspace services capability utilization-monitoring program that collects data on existing and newly deployed automation systems and procedures. This program would include collecting data on overall system performance and benefits (e.g., are assumptions on delay reduction being realized; are optimal procedures being used during convective weather impacts; etc.) as well as more detailed human-use considerations (e.g., are training enhancements needed; are workload limits managed within appropriate boundaries). Data could be provided to Aviation Safety Analysis and Sharing (ASIAS) and other repositories for broader analysis and identification of airspace services safety risk trends. To ensure long-term continuity, a reliable funding stream and staffing levels need to be identified to maintain the effectiveness of this program.

**FAA Response:** The FAA appreciates the Committee's general finding and recommendation on the need to establish a continuing capability utilization evaluation program. However, we are not able to pursue this recommendation within the scope of the Research and Development portfolio. From a lifecycle perspective, this falls under the scope of implementation and post-implementation activities.

On the post-implementation end of the lifecycle, the FAA already has an established Post-Implementation Review (PIR) process that assesses the results of an investment program against baseline expectations after the deployment of a system at an operational site. This process is executed under FAA's Acquisition Oversight and Reporting Division, which is outside the scope of FAA's research and development efforts. For context, PIRs are conducted to examine the differences between estimated and actual investment costs, schedules, benefits, performance, and mission outcomes. Furthermore, data collection and analysis are performed to support the evaluation of each measure. These factors confirm whether the investment program achieved its

performance and benefit targets, whether it met the service needs of customers, and whether the original business case is still valid.

In addition to the formal PIR process, review of operational use of capabilities has formed an important element of the implementation strategy for Initial Trajectory Based Operations

(iTBO). This focused effort has examined current operational use of capabilities within the iTBO scope (e.g. en route time based management). This is being weighed against other risks and benefit opportunities in order to inform decisions on prioritized implementation and operationalization of further iTBO capabilities. This effort considers not only the deployment of new capabilities, but also the training, change management, and operational use as core to the successful rollout of iTBO.

**Finding: Wake Turbulence** - During the Fall 2019 NAS Operations REDAC meeting, the Subcommittee was briefed by the NextGen Wake Turbulence Program Office on the FY2022 proposed portfolio for Budget Line A12.a. The Wake Turbulence programs objective is to safely increase capacity during peak demand periods.

The role of wake hazard advisory technology in flight deck operations has not yet been considered in this BLI activity (which has been focused on controller tools). Additional paths of inquiry make sense to include in this domain of investigation. For example, by what means can the flight deck be informed about wake hazards, EnRoute as well as Terminal? What are the appropriate pilot actions in the context of what Air Traffic Controllers see and know? How do atmospheric affect optimal flight deck wake avoidance guidance data/graphics, in particular, for business and general aviation operators. How can we use real-time data from the aircraft to provide physics-based modeling of actual on-condition aircraft wake generation, decay, drift, and descent behaviors?

**Recommendation 2:** We encourage the evaluation of the potential benefits of the wake hazard research program being applied to general aviation that could be extended to the flight decks for business, as well as commercial aviation through the study of flight deck graphical wake avoidance advisories on mobile devices. In addition, the program office should develop a plan and strategy on how the EnRoute wake encounter data being gathered through the Aviation Safety Reporting System (ASRS) and ASIAs are being leveraged and applied to inform the needed research as well as mitigation technologies and procedures.

**FAA Response:** The FAA appreciates the Committee's finding and recommendation on a study of flight deck graphical wake avoidance advisories. However, we are not able to pursue this recommendation at this time due to current fiscal year funding levels, identified program goals, and the current state of real time weather information to provide data for wake hazard identification. At this time, there are no plans to pursue a flight deck tool for wake turbulence. Dynamic display of wake was a concerted effort in wake research earlier through extensive work with NASA without achievable results. This concept could again be pursued in the farther term as the dynamic display of wake turbulence based on science and available data is still to be investigated.

The FAA concurs with the Committee's finding and recommendation on EnRoute wake encounter data. Currently, EnRoute Aviation Safety Reporting System (ASRS) data is being

used to inform concept development. This allows the program to develop concepts using a data-driven approach to address EnRoute wake hazards. The concept development will inform future mitigation technologies and procedures.

**Finding: Runway Incursion Reduction Program (RIRP)** - During the Fall 2019 NAS Operations REDAC meeting, the Subcommittee was briefed by the Runway Incursion Reduction Program on the FY2022 proposed portfolio for Budget Line S09.02-00. The RIRP program's objective is to reduce the risk to people and property caused by collisions in the runway environment.

Projected RIRP research in FY'20/'21 emphasizes the development of technology transfer documentation, contract solicitation and award for capability developed under this program, for example the Small Airport Surveillance System (SASS) and Runway Incursion Prevention through Situational Awareness (RIPSA). The Subcommittee commends the program office for taking steps to address runway incursion risks. However, when questioned on the associated acquisition concept, the RIRP program representative asserted that airport operating authorities would choose to procure the system in partnership with industry. It is not clear, however, how a critical mass of airport operators would come together to accomplish this, how they would effectively contract with industry to complete first article development, testing and acceptance, and what the ongoing role of the RIRP program would be. It is difficult for the Subcommittee to assess the value of the recommended out year RIRP program, given the vagueness of the acquisition concept.

**Recommendation 3:** The program office should develop a more detailed acquisition concept including a list of candidate airports, quantitative assessment of the safety or operational impact that deployment of the targeted technologies would achieve at these airports, and a notional process by which the program office would support these airports in the system development and acquisition process. This acquisition concept should be presented to the Subcommittee at the spring 2020 meeting.

**FAA Response:** The FAA appreciates the Committee's view on the Runway Incursion Reduction Program (RIRP). However, we are not in agreement with this finding and cannot pursue this recommendation for the following reasons:

The finding appears to have misidentified the role of RIRP and the airport operating authorities in the development and acquisition of the Runway Incursion (RI) prevention systems. Through its ongoing multi-year efforts with the RIPSA and SASS projects, the RIRP is conducting first article development, operational testing and evaluation (OT&E), and development of final system requirements for the technologies under consideration. None of these tasks are under the purview of the airport operators, as described in the finding.

RIPSA and SASS are focused on improving RI reduction at towered airports without existing ground surveillance and safety systems such as AMASS, ASDE-X, ASSC and RWSL. Currently, only 43 of the approximately 520 towered airports in the NAS have one or more of these deployed systems. RIPSA and SASS benefits are intended to address the remaining approximately 475 towered airports.

The OT&E for these systems is planned to occur between FY22-25. Upon completion of the RIRP's OT&E process, if the systems meet the technical requirements laid out in the First Article requirements, and prove to be feasible; then, in accordance with the FAA's AMS process, the RIRP will proceed with acquisition management activities.

The acquisition strategy development for these technologies is planned to commence in the FY24. The objective and subjective data collected during the OT&E process will be used to quantify the benefits that the system(s) can claim, and to build a potential business case for an acquisition decision by the FAA. As such, it would be premature for the RIRP to present any acquisition concept to the Committee at the Spring 2020 meeting before OT&E for these systems commences.

As an alternate to the FAA's AMS process; the RIRP's sponsor, the Office of Runway Safety (AJI-14) is currently working with the PMO and other FAA LOB's to assess the feasibility of allowing airport operators to receive Airport Improvement Plan (AIP) funds for future Runway Safety related improvements. Consequently, any towered airports in the NAS may be able to use AIP funding to acquire safety systems, such as one or more RIPSAs technologies that conform to the final requirements developed by the RIRP. The mechanism for this alternate source of funding is currently under investigation by the agency, and the RIRP will continue to apprise the committee of any updates.

**Recommendation 4:** Furthermore, the program office should develop a strategic plan on how the individual research elements within the program are integrated and address the runway incursion risk.

**FAA Response:** The FAA appreciates the Committee's view on the Runway Incursion Reduction Program (RIRP). The RIRP concurs with this recommendation; and is currently developing a strategic plan with a tentative timeline that integrates the key individual research elements underway; namely RIPSAs and SASS to address Runway Incursion and Wrong Surface Operations risk.

The RIRP anticipates OT&E for these research technologies to culminate in an integrated, mixed-use system in the FY25-29 timeframe. This system would utilize elements of non-cooperative surface surveillance with a localized direct to pilot annunciator (developed under RIPSAs), integrated with cooperative surveillance (developed under SASS) to identify targets.

**Recommendation 5:** In addition, the program office should develop a concept of operations on the integrated set of technologies and operations, as well as the actions all users of the NAS are to take on the information being displayed and/or provided to them. The program office should develop a set of metrics to measure the effectiveness of the technologies and proposed new operations as well as the application of the technologies and operations to specific events that lead to runway incursions.

**FAA Response:** The FAA appreciates the Committee's view on the Runway Incursion Reduction Program (RIRP). The RIRP concurs with this recommendation; the concept of operations for each test system undergoing OT&E is a part of the Test Plan for that system, along with the relevant metrics such as Missed Detections (MD) and False Alerts (FA) that are used to measure the effectiveness of the technologies.

A concept of operations on the integrated set of technologies and operations will take place in conjunction with the development of the integrated system in the FY25-29 timeframe. In the interim, the Human Factors (HF) impact of each of the technologies and systems will be assessed as part of the OT&E for that system, and will be used to inform the future concept of operations.

**Finding:** **Weather Technology in the Cockpit Program (WTIC)** - During the Fall 2019

NAS Operations REDAC meeting, the Subcommittee was briefed by the NextGen Weather Technology in the Cockpit office on the FY2021 & 22 proposed portfolio for Budget Line A12.c. The WTIC Program research enhances safety, efficiency and capacity impacts related to weather.

The introductory portions of the WTIC briefing to the Subcommittee provided a solid list of stakeholders (Government, industry, academia, standards setting organizations) and metrics for program success. However, the process through which these foundational elements determine the particular projects that are being pursued currently, and planned for the out years, is not clear. The particular research efforts briefed to the subcommittee seem disjoint and it is not clear how they contribute to the strategic goals of the program.

**Recommendation 6:** The WTIC Program should develop an end-to-end strategic plan and brief this to the Subcommittee at the Spring 2020 meeting. This should augment the existing material on stakeholders and metrics with a clearer statement of desired program outcomes, a process for optimizing the research projects selected for funding to achieve these outcomes, and a stronger explanation of why the projects briefed to the subcommittee are important to this strategy.

**FAA Response:** The FAA concurs with the Committee's recommendations and with the noted exceptions and clarifications intends to take the following actions to address its recommendations. Action Plan - The WTIC Program maintains program artifacts with the information requested in the recommendation. The WTIC Program presented samples from these artifacts to the committee in past meetings. In response to the Committee's recommendation, samples from the current versions of these artifacts will be presented at the Spring meeting. These artifacts are not presented to the Committee regularly due to the required briefing format used for the meetings and time constraints, but the WTIC Program maintains them and will present examples from them. In addition, the FAA has, and will continue to, monitor these artifacts at internal Program Management Reviews and project scoping meetings.

In response to the recommendation, the WTIC Program will present samples from the following artifacts at the Spring meeting:

1. WTIC MS Project Master Schedule – This overall program plan shows how the WTIC projects lineup to achieve overall program objectives and produce MinWxSvc recommendations for technical transfer.
2. Gap Analysis Tracking Spreadsheet – The spreadsheet shows the gaps and operational shortfalls related to cockpit weather information and technology identified by the WTIC program and its stakeholders, and their status in being resolved. These gaps and operational shortfalls are used as the basis to form the research projects that are intended to resolve them.
3. Technical Transfer Tracking Sheet – This spreadsheet tracks the technical transfers of WTIC research MinWxSvc recommendations to the proper stakeholders (industry, standards and guidance issuing agencies including the FAA and RTCA, pilots, training materials). The tracking sheet documents past transfers and plans for future technical transfers to occur in the next year or two.

**Recommendation 7:** Furthermore, the program should document the specific weather translation activities and probabilistic analysis to be able to clearly convey and set expectations for the users on the weather products for them to make informed decisions.

**FAA Response:** The FAA concurs with the Committee’s recommendation with the noted exceptions and clarifications. Probabilistic weather and weather-translation are in scope for the Aviation Weather Division; however, the WTIC Program is currently not performing research in either of these areas. In addition, there were no plans presented by the WTIC Program to the Committee at the Fall meeting indicating these are planned research areas so the request that “the program should document the specific weather translation activities and probabilistic analysis” needs clarification by the Committee at the Spring 2020 meeting.

### **Subcommittee on Airports**

**Finding: FAA Research Landscape -** The Subcommittee reviewed the FAA Research Landscape, which was presented by Shelly Yak and Eric Neiderman and is supportive of this strategic approach to prioritizing FAA research and development activities. Subcommittee members view the Research Landscape as a key mechanism to identifying and motivating crosscutting research activities—those that involve multiple FAA lines of business and program areas. The Subcommittee believes that it—and other REDAC Subcommittees—should continue to be involved with development of the Research Landscape and, more importantly, involved with translating the research needs articulated within it into meaningful research projects.

**Recommendation 1:** The Subcommittee recommends allocating time during each of its semi-annual meetings for discussion of the Research Landscape, with an eye towards providing recommendations and guidance regarding how the Airport Technology Research & Development Branch can move airport safety, planning, design, and engineering research priorities forward.

**FAA Response:** The FAA concurs with the Committee’s finding and recommendation and is undertaking the following actions to address its recommendation - The Airport Technology Research branch will allocate time in future semi-annual meetings to review and discuss the ATR portfolio’s alignment with the Research Landscape. This will be done in the two key areas of Airport Safety and Airport Infrastructure, and this will also allow for the identification of potential areas that might be considered for future inclusions and expansion of ATR’s portfolio.

**Finding: UAS Detection System Research -** The Subcommittee appreciates the work that the Airport Technology Research & Development Branch is doing regarding Unmanned Aircraft Systems (UAS) focused both on (1) facilitating authorized UAS operations on and near airports for the benefit of airports and their users and (2) means, methods, and technologies to detect and mitigate threats posed by unauthorized UAS operations on or near airports. With respect to the latter topic, UAS disruptions at multiple airports worldwide (most compellingly at London Gatwick Airport in December 2018 and the fortunately unsuccessful UAS “protest” on the part of the Heathrow Pause activist organization) and

UAS-enabled attacks on infrastructure (most notably the September 2019 attack on oil production facilities in Saudi Arabia) have raised significant concerns for airport operators across the U.S. Urgent action is needed to provide airport operators with better tools and guidance regarding how to address threats posed by unauthorized UAS operations.

**Recommendation 2:** Although UAS issues—especially those associated with unauthorized UAS activity on or near airports—cut across multiple FAA research programs as well as those of other federal agencies, the Subcommittee recognizes that the Airport Technology Research & Development Branch has a leading role in developing performance standards and use guidance for airport-deployable UAS detection systems if these systems will be eligible for FAA grant funding. We strongly recommend that the FAA expedite this UAS detection system research.

The Subcommittee also strongly supports ongoing research into airport UAS use cases and research & development activities by other FAA lines of business regarding UAS detection, tracking, interdiction, and traffic management.

**FAA Response:** The FAA concurs with the Committee’s finding and recommendation and is undertaking the following actions to address its recommendation - The Airport Technology Research branch, in coordination with the FAA’s Office of Airports, is forming an internal Airports-related UAS Research Program, dedicating financial, human and other resources. In coordination with other FAA Lines of Business, this program will focus on expediting UAS detection research at and near airports, and will also be responsible for all other non-detection UAS-Airports related research.

**Finding: AFFF/PFAS Alternatives Research** - The Subcommittee—and the broader community of airport operators—continues to be extremely concerned about a broad range of issues associated with the use of per- and polyfluoroalkyl substances (PFAS) in aircraft fire fighting agents. PFAS are a class of fluorinated hydrocarbon molecules that have been linked to adverse health outcomes in humans.<sup>1</sup>

In the airport context, PFAS are used in aqueous film-forming foam (AFFF) to suppress and extinguish aircraft fuel fires. Under current FAA regulations, certificated airports are required to use AFFF because of the high level of performance it provides (e.g., ease of dispensing via current ARFF equipment, fire knockdown times, fire burn-through times). This said, over the last decade there have been numerous alternative foams that have come onto the market and are being used at airports around the world.

The Airport Technologies Research Program does have a research program currently underway to evaluate the performance of fluorine-free fire-fighting agents and Subcommittee members were provided with the opportunity to tour the new fire testing facility under construction at the FAA Technical Center during our Summer 2019 meeting.

**Recommendation 3:** The Subcommittee reiterates its recommendation that the FAA proceed with all due speed with defensible research into the performance and use of alternatives to AFFF in the civil aviation sector including completing and commissioning its new fire research facility at the Technical Center. We also request that the FAA provide updates prior to Subcommittee meetings if unexpected events or circumstances delay this research.

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

is undertaking the following actions to address its recommendation - The Airport Technology Research Branch is commissioning the newly built ARFF research facility in the fall of 2019, and is planning to start testing of candidate AFFF alternative firefighting agents in early 2020. The Airport Technology Research branch will inform the Subcommittee, prior to scheduled committee meetings, if unexpected events or circumstances arise with the potential impact to delay the research significantly.

**Recommendation 4:** We also recommend that the FAA coordinate its firefighting agent testing research with subject-matter experts in industry, including representatives from the National Fire Protection Association (NFPA) and airport rescue and fire-fighting professionals. To this end, we suggest that the FAA consider establishing an expert advisory panel similar to expert panels that have been established for airfield pavement research and aircraft braking friction research. Doing so will help to ensure consensus regarding research approaches early, before resource-intensive data collection efforts commence.

<https://www.epa.gov/pfas/basic-information-pfas#health>

**FAA Response:** The FAA concurs with the Committee's recommendation(s) and with the noted exceptions and clarifications intends to undertake the following actions to address its recommendation(s) - The Airport Technology Research branch will consider forming an advisory AFFF Technical Working Group with representatives from FAA, the U.S. Department of Defense (DoD), NFPA, and airport rescue and fire-fighting professionals. However, since this research is under a congressional mandate with strict deadlines, fire tests and data collection will commence as planned. At this time, it should be noted that FAA ARFF specialist are active members on NFPA, DoD, and ICAO Panel/committees and regularly brief these committees on current ARFF on-going research.

### **Subcommittee on Human Factors**

**Finding: Integration of Air/Ground Research** - Within the four Human Factors (HF) BLIs the research objectives and execution generally considers the perspectives of the flight crew and the air traffic controllers separately. Separation of air and ground domains is primarily due to the FAA's budgeting structure within RE&D. Although it may be challenging to study air and ground domains in an integrated manner, studying the domains separately will likely result in different products for each domain. Therefore, where appropriate, studies should assess the impacts on both domains to ensure adequate integration of air and ground and their impacts on both domains in the context of each other to create valid deliverables in terms of tools, processes, recommendations and guidance.

**Recommendation 1:** Identify opportunities where integration of air and ground research would benefit from integrated air/ground studies and identify how such integrated studies can be accomplished within the constraints of the current funding structure and available resources. Report out at next HF REDAC meeting the results of this and include any issues or barriers with executing this recommendation.

**Consequences:** A consequence of not carrying out integrated studies is concepts may inappropriately allocate tasks or procedures to one domain causing unnecessary workload and

errors on the other domain. This has a high potential to result in rework when the concepts get implemented due to inadequate integration across the domains.

**FAA Response:** The FAA concurs with the Committee's observations with respect to air/ground capabilities. The NextGen-specific Human Factors (HF) lines have addressed this recommendation as part of its research planning, since NextGen has a focus on air and ground operations for ATC/ATM. In addition, the NextGen HF lines are establishing guidance to air/ground capabilities/programs in general and not individual capability/program Human Factors, which this recommendation is applicable too. Programs such as Datacomm continue to look at both flight deck and controller human engineering as it develops individual capabilities. The HF lines are not NASOPS only and need to address the general environment of the ground and air operations, which sets the basis for the more detailed ATC/ATM capabilities analysis. Within that scope, the FAA will identify potential integrated air/ground research opportunities and report out at the next HF Subcommittee meeting.

**Finding: Strategic Inputs to the Research Prioritization Process** - ANG-C1 has been doing an excellent job of addressing several important human factors issues of importance to the missions of ATO, AVS, NextGen and the FAA more generally. However, it appears that the current research prioritization process is dominated by reactive, shorter term pressures that is limited to a three year look ahead planning cycle. While these shorter-term focus areas are important, there is a need to better integrate broader strategic considerations into the planning and prioritization process for determining the human factors research portfolio.

**Recommendation 2:** Leverage industry input to identify research needs beyond the 3-year planning cycle, and within the current research proposal and prioritization process identify opportunities to flexibly accommodate high priority emerging needs.

**Consequences:** Focusing on shorter-term inputs to the research prioritization process alone will not enable the Agency to integrate broader strategic considerations into the planning and prioritization process and consequently miss important emerging issues.

**FAA Response:** The FAA concurs with the Committee's recommendation and with the noted exceptions and clarifications intends to undertake the following actions to address its recommendation. The FAA will continue to leverage industry input from HF Subcommittee meetings, including the FAA Research Landscape. However, each HF BLI has its own process for defining and prioritizing research requirements. We note that the NextGen BLIs has always been more strategically focused, although as we move more closely into integrated TBO the focus has of necessity become somewhat more tactical. As part of those processes, the FAA will internally convey specific research needs that the HF Subcommittee identifies for further FAA consideration, and provide status reports at the two Subcommittee meetings in FY20.

**Finding: Urban Air Mobility (UAM) Research Gap** - As part of its emerging issues list, the Human Factors Subcommittee has noted new entrants and operations associated with emerging markets, such as Urban Air Mobility (UAM), that are expected to be realized within the next 5-10 years. Given this timeframe, the Subcommittee previously recommended research on human factors issues involving the certification of new vehicles, integration of operations into

the airspace, and safe introduction of increasingly automated systems need to be addressed within the next five years. The Subcommittee noted the research presented at the August 2019 meeting did not include any work in these areas and nor did it appear any such research is planned through FY22.

**Recommendation 3:** The Subcommittee recommends the FAA invest in Human Factors (HF) research associated with increasingly automated operations (such as UAM) as soon as possible. FY22 research plan provided by both ANG and AVS should specifically identify the need to address UAM HF issues. This research should include human-machine systems integration, pilot/operator training and certification, and airspace interoperability between traditional and UAM operations, as appropriate to the organization. Report out at the next Human Factors Subcommittee meeting, the UAM HF research plan.

**Consequences:** The FAA will be unprepared to provide guidance and approvals for Urban Air Mobility (UAM) Original Equipment Manufacturers (OEMs), operators, and operations targeting an EIS date prior to 2025.

**FAA Response:** The FAA concurs with the Committee’s observation of need and is addressing these issues as part of its overall portfolio. UAM is part of the FAA’s overall RE&D and F&E programs starting in FY20. Our current engagement with our NASA partners is to work with industry to clarify the myriad of proposals for method of operating, levels of autonomy and operations within the airspace. At this time, there are no UAM categories for which overall guidance could be based, but there are some general HF analyses that can be conducted early, such as an effort starting in FY20 to look at human impacts from new operations and new uses of autonomy. A goal is to provide a basis to review the operations that individual applicant are bringing forward in the coming years. FAA will report current and planned UAM RE&D and F&E activities at the next HF Subcommittee meeting.

### **Subcommittee on Aircraft Safety**

**Finding: Funding of New and Emerging Safety Risks Research and Development (R&D)** - The FAA REDAC Sub Committee for Aircraft Safety (SAS) has a charge to “provide advice to the Administrator through the REDAC regarding needs, objectives, plans, approaches, content and accomplishments for the FAA research program.” The SAS has historically been able to meet this objective through a thorough review of ongoing and planned research activities. A reality that the SAS must recognize is that the lengthy budget cycles significantly restrict the ability of the FAA to plan and conduct research in near real time to address emerging issues. Based on the pace of development in industry, some of these issues have the potential to influence the current strategies around the NAS and could create a challenge to safety if the right levels of oversight are not provided. In all cases, the experts at the FAA are best equipped to make decisions with respect to the prioritization of research in the interest of safety.

**Recommendation 1:** A process should be established (ideally as part of the appropriation process) to set aside a portion of the RE&D budget for discretionary efforts to address out of cycle emerging issues that are agreed to have a potential impact on aircraft safety.

**FAA Response:** The FAA concurs with the Committee's recommendation and with the noted exceptions and clarifications intends to undertake the following actions to address its recommendation - The budget process do not allow for the FAA to "set aside" funding as it is required to specify what projects the funds are for; however, the FAA will continue to utilize built-in flexibility in the AVS R&D process including the Aviation Safety unbudgeted (i.e. "pop- up") process and the flexibility in appropriation process including reprogramming of funds up to 10 percent among BLIs as specified in the congressional language to provide funding for out of cycle emerging issues in the year-of-execution. In order to provide additional flexibility, we are exploring with Finance, the development of a process to allow shifting funds within a BLI from projects specified in the budget narratives to unbudgeted projects with proper justification as well as exploring possibility of creating a new BLI for emerging technologies. An update on improvements in this subject will be presented at the next Subcommittee meetings.

**Finding: AVS Research Planning Process** -The Subcommittee received a briefing on the rebuilding of the AVS research proposal and prioritization process. The Subcommittee was encouraged to see the effort to refine the process from the Agency's experience. Part of the discussion highlighted the FAA's aspiration of creating a balance between emerging issues and current issues. However, the Subcommittee was concerned that strategic material developed with industry and subject matter expert input contained in the Research Landscapes for the National Airspace System is not explicitly included as reference, or required guidance, in the development of research proposals. Nor is it explicitly built into the rubric for selecting research proposals in order to achieve the balance.

**Recommendation 2:** The Subcommittee for Aviation Safety recommends that, as the research proposal and selection process is refined, guidance for the use of Research Landscapes and their associated Research Challenges, as reference for individuals proposing new research, and also that those Landscapes and Challenges are considered as part of the selection rubric. The Subcommittee for Aviation Safety recommends that the guidance shall establish a definition of emerging issues, in contrast to current issues, and the percentage of the RE&D budget that shall be allocated to emerging issues for the FY planning year.

**FAA Response:** The FAA concurs with the Committee's recommendation and with the noted exceptions and clarifications intends to undertake the following actions to address its recommendation - The FAA continues to identify emerging technologies and challenges facing aviation industry through many different venues with contacts across industry, academia, and other government organizations. Introduced over the last year, the landscapes are a new way to collect and collate this type of information, some of which is already addressed in the research portfolios. At this time, the plan is to perform a first cut review of the proposed FY22 FAA portfolio against the initial landscapes at the FAA level to identify any gaps or issues, to gain experience using the landscapes, to mature the landscapes, and to begin developing FAA level definitions of emerging issues and processes for achieving balance between emerging and current needs before embedding them in the lower level Program Planning Team processes. As stated in the August Subcommittee meeting, the landscapes are currently available to the FAA research community as additional input for consideration. Results of the FAA level review will be presented at the next Subcommittee meetings.

**Finding: Additional Funding for Complex System Research and Development** - The Subcommittee has identified the certification of complex, non-deterministic systems as a significant emerging issue for several years now. Addressing this multifaceted, complicated challenge involves many different related aspects. The Subcommittee applauds FAA research into assurance cases and model-based systems engineering. However, the Subcommittee is concerned that there are some aspects, which are being under-addressed involving such areas as the validation and verification of complex digital systems employing non-deterministic software elements to include autonomous systems, artificial intelligence, and machine learning. Also, under-addressed are design standards and best practices for safety critical non-deterministic systems. While autonomous flight is likely to have implications for all aspects of aviation, it is most likely to have near-term implications for systems, which enable unmanned aircraft, urban air mobility type operations, and the use of single pilot operations in cargo aircraft.

**Recommendation 3:** The FAA should place a high priority on future funding for Digital System Safety. Adequate funding needs to be available to sufficiently address this complicated challenge in a timely fashion given the direct relationship to the scope of Unmanned Aircraft Systems. The FAA should continue to leverage, where appropriate, research investments at NASA and the Department of Defense. The Subcommittee would like a detailed update on FAA progress, plans, and relationships in this area at a future meeting.

**FAA Response:** The FAA concurs with the Committee's recommendation and with the noted exceptions and clarifications intends to undertake the following actions to address its recommendation - The FAA agrees with the REDAC's finding regarding the importance of the validation and verification of complex digital systems employing non-deterministic software elements to include autonomous systems, artificial intelligence, and machine learning. To this end, the FAA proactively focused on requirements and policy for a number of these areas several years ago by engaging with standards development bodies. For example, ASTM 3269 was written as an architectural standard for non-deterministic systems to encourage their use in properly bounded use cases. The FAA continues to actively engage with SAE (G-34 Applied Artificial Intelligence in Safety Critical Systems Committee) and other standards bodies to address the needs for artificial intelligence and machine learning, creating internal draft requirements that can be prototyped when projects come to the FAA with these features.

Research in these areas must have practical application and use for enhancing safety of the civil aircraft industry. To this end, the FAA encourages the REDAC to actively work with industry subject matter experts to identify and propose potential research gaps that can be addressed in a timely manner, with direct applicability to certification of these technologies utilizing an incremental approach to functional criticality. An update on FAA progress, plans, and relationships will be presented at the next Subcommittee meeting.