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Massachusetts Institute of Technology

Aeronautics and Astronautics

October 23, 2019

The Honorable Steve Dickson Administrator Federal Aviation Administration

Dear Administrator Dickson:

Attached below please find the findings and recommendations from the REDAC subcommittees from their fall meetings. In accordance with our standard procedure we noted a few high level points that cross the subcommittees and we would bring to your attention.

- One of the important drivers that the REDAC has noted is the emergence of multiple new classes of vehicle and operations are likely to request airworthiness approval and integration into the NAS. Vehicles include small and large UAS/RPAS, Supersonic Business Jets, Commercial Space, Optionally Piloted Vehicles (OPV), Electric, Hybrid and Solar Electric Vehicles, eVTOL, eSTOL. Operations include mixed manned an unmanned, low altitude urban, high latitude loiter supersonic and sub orbital operations. These create new and emerging requirement for research.

- The agency RE&D budgeting process makes it difficult for the agency to respond to these emerging research requirements. It is impossible to anticipate all specific research needs 3 years in advance of the research as the current process requires. The REDAC suggests that some fraction of the planned research funding be allocated for emerging research requirements to allow flexibility for the agency to respond to these needs.

- The REDAC was pleased to see progress and participate on the Research and Development Landscape in the identification of research drivers. This document as well as other strategic input will be valuable to complement the strong bottoms up development of research requirements. We would like to see the current research portfolio mapped against the research drivers which will give insight into gaps in the portfolio and if there are elements missing from the roadmap.

- Finally we note the global market trends on the importance of sustainability in air transportation. This is increasingly recognized by industry as a key international competitive factor in the future of the US industry.

I would be happy to meet with you, at your convenience to discuss these findings and how the REDAC can best help you and the agency.

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) Guidance on the FY 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:** 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, 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.

**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:** 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 ICAO CAEP and, in particular, to expedite university research grants through the ASCENT Center of Excellence 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.

**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:** 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.

**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 ASCENT Centers of Excellence, 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 (CLEEN, 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:** 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.

**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:** 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.

**<u>Recommendation</u>**: 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.

**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.

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

# 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:** 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.

**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 atmospherics 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:** 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.

**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:** 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.

**<u>Recommendation</u>**: 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.

**Recommendation**: 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.

**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:** 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.

**<u>Recommendation</u>**: 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.

# 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.

**<u>Recommendation</u>**: The Subcommittee recommends allocating time during each of its semiannual 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.

**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:** 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.

**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:** 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.

**Recommendation**: 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.

<sup>&</sup>lt;sup>1</sup> <u>https://www.epa.gov/pfas/basic-information-pfas#health</u>

#### **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.

**<u>Recommendation</u>**: 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.

**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.

**<u>Recommendation</u>**: 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.

**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), 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:** 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 UAM Original Equipment Manufacturers (OEMs), operators, and operations targeting an EIS date prior to 2025.

# 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.

**<u>Recommendation</u>**: 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.

**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.

**<u>Recommendation</u>**: 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.

**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:** 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.