



U.S. Department  
of Transportation

**Federal Aviation  
Administration**

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Office of the Administrator

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

Dr. R. John Hansman, Ph.D.  
Chair, Research, Engineering and  
Development Advisory Committee  
Massachusetts Institute of Technology  
[REDACTED]

Dear Dr. Hansman:

Thank you and the Federal Aviation Administration's Research, Engineering and Development Advisory Committee (REDAC) for your October 20, 2016, letter providing strategic guidance recommendations for the Fiscal Year 2019 Research and Development (R&D) Portfolio. The REDAC acknowledgement of the Agency's efforts pertaining to key topics of significant interest that include initiatives of the small Unmanned Air Systems Integration in the National Airspace System; the industry engagement supporting Performance Based Navigation Time, Speed and Spacing Strategy; and the National Aviation Research Plan enhancements is highly appreciated. These vital focus areas remain paramount for successful improvements within the R&D portfolio and we will continue to address these key objectives.

I have reviewed your recommendations and enclosed are the responses to the Subcommittee recommendations.

We will continue to incorporate the Committee's recommendations and foster increased communications as we build an R&D portfolio that addresses safety, efficiency, and capacity of the air transportation system in an environmentally sound manner.

Sincerely,

Michael P. Huerta  
Administrator

Enclosure

**FAA Response to REDAC Guidance for the Fiscal Year (FY) 2019 Research and  
Development (R&D) Portfolio**

**Subcommittee on Aircraft Safety**

**Finding: Real Time System-Wide Safety Assurance** - In the fall of 2014, the REDAC Aircraft Safety (SAS) Subcommittee identified, and defined, Real Time System-Wide Safety Assurance as a significant emerging issue worthy of future FAA research resource expenditure. NASA has also identified this subject, although possibly defined slightly differently, as one of its top strategic thrusts. The topic has risen to the level of a NASA/FAA Joint Research Transition Team item. SAS received a briefing on this subject and was pleased to enhance its knowledge of government efforts and strategic direction on this important topic. In particular the definition of “real-time” as meaning in time to mitigate the hazard is very appropriate. The Committee also supports the vision for a capability that is distributed among users who can employ system-wide knowledge and information to mitigate local and regional safety issues. SAS will use this new knowledge to refine its emerging issue going forward in hopes of adding value to the Research Transition Team (RTT) efforts.

**Recommendation (1):** The System-Wide Safety Research Transition Team should provide the SAS and other appropriate industry sectors with updates on progress toward real-time system-wide safety and solicit regular input from those stakeholders. We also recommend that focus be put on short term research deliverables (less than 5 years) as the need for the ability to make an impact for in-time mitigations is immediate and necessary.

**FAA Response: The NASA/FAA System-Wide Safety Assurance Research Transition Team (RTT) leadership concurs with the Committee’s recommendation and is undertaking actions to address the recommendation.** In FY 2017, the RTT will host three system safety themed workshops including Human Performance, Data Tools & Prognostics, and Verification & Validation. Workshop invitations will be extended to members of the REDAC Subcommittee on Aircraft Safety, the FAA, and NASA as well as government/industry safety teams including Commercial Aviation Safety Team (CAST) and General Aviation Joint Steering Committee (GA JSC). The RTT will use information collected during the workshops to identify common critical safety assurance goals and coordinate relevant system safety research efforts. In addition, the RTT will prioritize work by focusing on near-term technology infusion (5 years or fewer). Further, NASA will use information from the workshops to inform their multi-year Thrust 5: Real-Time System-Wide Safety Assurance plans.

**Finding: Additive Manufacturing** - The Subcommittee finds that progress has been made in accelerating research activities around the topic of additive manufacturing. The Additive Manufacturing National Team (AMNT) is in place with an approved charter and initial documents have been released to the Aircraft Certification Office (ACO) and Manufacturing Inspection District Office (MIDO) to aid in the certification of parts produced by additive manufacturing methods. Collaborations are also ongoing with industry organizations including Aerospace Industries Association (AIA) and Society of Automotive Engineers (SAE) to establish working groups and committees. An FAA Additive Manufacturing roadmap is under development which includes training and education, development of regulatory documents,

Research and Development (R&D) plan and interagency communication. The roadmap and R&D plan were not shared with the Subcommittee.

**Recommendation (2):** The FAA should share the draft roadmap and accompanying R&D plan with the Subcommittee for review and comment.

**FAA Response:** The FAA concurs with the Committee's recommendation on Additive Manufacturing (AM) with the noted exceptions and clarifications and intends to undertake the following actions to address the recommendation. The strategic FAA AM roadmap is due to the FAA Aircraft Certification Service management by September 2017, in accordance with the official Additive Manufacturing National Team charter. The roadmap is being developed and matured; however it will only be available in a draft form by the time of the next SAS meeting (early March 2017) and will not be reviewed by the FAA management at that time. Therefore, the roadmap will not be presented to SAS in its entirety. Instead, the information to be presented at the next SAS meeting will include the outline of the roadmap and its key elements necessary to provide sufficient context for the multi-year AM R&D plan that will be presented as well.

**Finding: Fatigue Knowledge Affecting Aviation Safety** - FAA implemented science based flight and duty time regulations for commercial passenger carriers in February 2014. These rules were the first significant revisions made in over 60 years and greatly changed how the agency regulates airline operations. Evaluations are ongoing with the regulatory situation for large cargo carriers and smaller commercial operations. This is an acknowledgment from FAA that pilot fatigue remains a significant safety concern and must be addressed. The Subcommittee is concerned because there is no evidence that significant FAA research into human fatigue incidence, effects, mechanisms, or countermeasures in US civil aviation is taking place. Without objective data or evidence gathered by research, it is very difficult to validate existing regulations or develop new ones.

Experience and recent data suggests that even though the new regulations seem to be an effective mitigation to pilot fatigue in many cases, the fatigue problem has not been solved, and continues to create risk in various aspects of flight operations ranging from commercial to general aviation in both fixed-wing and rotary-wing aircrew. Experience from the Department of Defense (DOD) suggests that operator fatigue will be a problem in UAS operators as well.

The Subcommittee acknowledges comments from the FAA that fatigue research occurs in various programs across the research portfolio, but is unable to evaluate the efficiency, applicability and adequacy of the current and future programs since they have not been presented to the Subcommittee in any organized form.

**Recommendation (3):** The SAS requests that, in the upcoming SAS 2017 spring meeting, the FAA presents a coherent and holistic view of the fatigue problem in U.S. aviation. The presentation should include the knowledge gaps in fatigue potentially affecting aviation safety and the relevant research programs at FAA and other government agencies concerned with aviation and non-aviation fatigue, which can be both, funded and unfunded, and/or current and planned research activities. If the conclusion is that further research is not needed, the rationale for that conclusion should be provided.

**FAA Response:** The FAA concurs with the Committee's recommendation and is undertaking the following action to address its recommendation. We will give the SAS a presentation covering the FAA view of fatigue in flight operations and maintenance at the spring 2017 meeting.

### **Subcommittee on Environment and Energy**

**Finding:** **Strategic Aspects of the Environment and Energy R&D Plan** - The Subcommittee reaffirms its previous finding that there is a strong strategic context to the Environment & Energy RE&D plan. The program identifies specific goals for noise, air quality, energy /efficiency, and climate. These goals are set to achieve environmental protection for sustainable aviation system growth. The plan is developed after consideration of the need to balance / prioritize projects related to the five pillars, i.e., improving scientific understanding and tools, developing technology for mitigating environmental impact, operational efficiency improvement, developing / qualifying sustainable alternative aviation fuel, and maintaining US leadership in global aviation environmental policy and market based measure development. The FAA, in consultation with the Subcommittee, has also rebalanced the portfolio when needed to fit the funding profile or to achieve time critical capabilities.

**Recommendation (1):** Given the current environmental landscape and the impact of the various environmental issues on the aviation system, the Subcommittee recommends the Environment & Energy portfolio focus on noise and operations, environmental impact reduction technology maturation (CLEEN), alternative fuels, and tools to support policy development. The Subcommittee also recommends that the FAA continue to consider the interdependencies between noise, air quality, and CO2 in these plans.

Operationally noise has become a constraint to the implementation of flight procedures that can deliver improved efficiency, and airport capacity and access. In addition to the development of efficient procedures, a better understanding of annoyance, acceptability, and effective community engagement are needed to make more progress on this NextGen goal. Thus the subcommittee feels that successful and rapid execution of the Noise roadmap is necessary.

While operational procedures will provide emissions reductions in the near term, in order to achieve the aggressive longer term goals, low emissions airplane / engine technologies need to be matured and validated for implementation in future designs. To achieve this, the Subcommittee recommends the continuation and acceleration of CLEEN and alternative aviation fuel development and qualification.

**FAA Response:** The FAA concurs with the Committee's recommendation and is undertaking the following actions to address its recommendation. The FAA appreciates both the Subcommittee's positive evaluation of the Environment and Energy R&D Portfolio and your input on priorities.

Noise is the FAA's number one environmental issue. Noise is a challenge to the implementation of Performance-Based Navigation operational procedures and the capacity and efficiency benefits of NextGen. We have a number of efforts ongoing to address this challenge within our noise roadmap. Next year will see the completion of the airport community noise survey. This is



a key component of our aviation noise roadmap that is eagerly anticipated by our stakeholders. We are also excited about our recently announced collaboration with Massport as this research effort could lead to ideas on how noise can be reduced from changes in aircraft operations. We are also seeking additional opportunities to mitigate noise at its source through the use of new technologies and changes in aircraft operations.

We appreciate the Subcommittee's support for technology maturation through the CLEEN Program and our efforts to advance alternative aviation fuels. We also appreciate the support of the Subcommittee for the development of analytical tools to support policy development. These analytical tools have been critical to our activities in the International Civil Aviation Organization/Committee on Aviation Environmental Protection (ICAO CAEP) and the continued U.S. leadership therein. Continued funding is critical to the development of our modeling capabilities. Funding is needed to ensure we have robust participation in the ICAO CAEP process and the generation of data to support the decision-making process within ICAO CAEP.

**Finding: Aviation Environmental Design Tool (AEDT)** - The Subcommittee recognizes that this program has delivered an environmental assessment tool, the AEDT suite, which has and is enabling informed policy decisions and US leadership in International Civil Aviation Organization/Committee on Aviation Environmental Protection (ICAO/CAEP). The AEDT tool has also been released to stakeholders outside of FAA to perform environmental assessments. The development of these tools required significant resources from 2010 to 2015 funded by the NextGen F&E. Starting in 2017, the F&E funding has been zeroed out. But several functionality and usability related improvement needs have been identified for the AEDT tool.

**Recommendation (2):** Given the resource constraints, the Subcommittee recommends that the AEDT development needs list be reviewed and prioritized based on considerations of value and urgency. Improving usability that delivers additional value to a broader stakeholder group may be preferred over adding a capability that may help a limited stakeholder group except in situations of strategic importance in FAA's support of national and international initiatives. Improved usability may also bring additional users. Making the right priority choices is important since this development will now have to be covered in the RE&D funds that support the high-priority research identified earlier.

**FAA Response: The FAA concurs with the Committee's recommendation and is undertaking the following actions to address its recommendation.** We appreciate the recognition that our Aviation Environment Design Tool (AEDT) is enabling informed policy decisions and providing U.S. leadership in ICAO/CAEP. AEDT has been at the core of our efforts to support the ICAO/CAEP standard setting process and it is the required tool for environmental analyses under the National Environmental Policy Act. We agree that AEDT development needs to be prioritized, and the Office of Environment and Energy (AEE) are currently developing a long term plan. This plan will be shared with the REDAC next year.

**Finding: Inter-Agency Collaborations and Partnerships** - The Subcommittee is pleased to see the continuing collaboration between the FAA and NASA and other government agencies.

**Recommendation (3):** As NASA executes on its revamped aeronautics program, the Subcommittee encourages FAA to look for more collaboration opportunities, including gathering

noise and emissions data, that may help projects in the FAA portfolio, i.e., go beyond sharing plans and results.

**FAA Response:** The FAA concurs with the Committee's recommendation and is undertaking the following actions to address its recommendation. We agree on the need for continued collaboration with NASA as well as the entire Federal Government. This is especially important given reduced federal funding for R&D.

NASA and AEE are working closely together in several areas. Individuals from NASA and AEE co-led the development of the Federal Alternative Jet Fuel Strategy that was recently released. We are working closely together on research that will streamline the approval process for new alternative jet fuels. We have a number of efforts that are ongoing with NASA wherein we are looking at the noise from supersonic aircraft, helicopters, and unmanned aircraft. We also are working closely with NASA to conduct particulate matter emission measurements from commercial aircraft engines. AEE will continue to engage NASA to find efforts that deliver benefits to both agencies.

**Finding:** Environmental Human Resources and Subject Matter Experts - Several Subcommittee members are concerned about staff availability at FAA-AEE to continue to execute this program efficiently with an ever-growing set of responsibilities.

**Recommendation (4):** The Subcommittee encourages the FAA to continue to feed their pipeline of environmental professionals.

**FAA Response:** The FAA concurs with the Committee's recommendation and is undertaking the following actions to address its recommendation. We appreciate the Subcommittee's concern about staff availability within AEE. Their work load has indeed increased due to increasing concerns regarding aviation noise and our international efforts to mitigate aircraft carbon dioxide emissions. AEE has had good success 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 PARTNER and ASCENT, the FAA Centers of Excellence for environment and alternative jet fuels. AEE has also seen a number of their environmental professionals go to other parts of the FAA, which is helping the Agency as a whole to be better equipped to handle environmental issues.

### **Subcommittee on NAS Operations**

**General Observations:** UAS Integration in the NAS - The Subcommittee commends the continuing progress that the FAA is making in responding to the challenge of integrating UAS in the NAS. In its previous meeting, the Subcommittee recommended that the FAA actively engage with the UAS stakeholder community and share the work it has done to date, including the FAA UAS Concept Maturation Plan. The Subcommittee further recommended that the FAA establish high level system engineering leadership that can prioritize UAS research and development across all the FAA organizations. The Subcommittee has the following findings and recommendations:

**Finding: UAS Stakeholder Community Engagement** - The FAA has begun to engage the UAS stakeholder community as part of the NASA UAS Traffic Management (UTM) workshops. The FAA has established a framework for future engagement through the Drone Advisory Committee and has developed a UAS External Stakeholder Plan. The Subcommittee finds that these are significant steps in the right direction.

**Recommendation (1)**: The Subcommittee recommends that the FAA continue this momentum, placing considerable emphasis on communication of its technical and operational challenges to the user community, through sharing of documents such as the UAS Concept Maturation Plan, and in turn merging input received from a broad range of UAS stakeholders into future planning activities. While the FAA ultimately has the responsibility for the safety and efficiency of the NAS, it is the Subcommittee's strong opinion that an open dialogue of these issues with the user community will foster a more collaborative environment in which to solve them.

**FAA Response: The FAA concurs with the Committee's findings and recommendation and is undertaking the following actions to address the recommendation.** We have met with the Drone Advisory Committee (DAC) and a DAC Subcommittee has been formed to engage with the community on priority topics. We are also maintaining our close cooperation with the community through our standards groups such as RTCA SC228, NASA on UTM, and UAS in the NAS, which includes their industry partners, the UAS COE (ASSURE), the UAS EXCOM, ICAO, and efforts through the National Academies.

**Finding: UAS Leadership Structure** - FAA has recently established an agency-wide UAS leadership structure consisting of a senior UAS Board, a UAS Executive Committee, and a UAS Implementation Plan Working Group. These steps are valuable in accelerating the pace of FAA engagement with the burgeoning industry. However, the Subcommittee remains concerned about the adequacy of these actions alone to sustain the pace of engagement necessary to avoid having the industry and government lose ground in economic opportunities for the nation. In its briefing to the Subcommittee, the FAA stated that this structure was intended to organize and prioritize the UAS research, development, and implementation across the FAA. During its briefing on the FY2017 budget, the FAA provided the Subcommittee with the language that accompanied the House and Senate marks on the FY2017 RE&D budget request. In previous years, the Unmanned Aircraft Systems Budget Line Item (BLI) has been used to perform safety-related research (e.g., airframe safety and certification) overseen by AVS. The Subcommittee notes that the FY2017 language pertaining to Unmanned Aircraft Systems Research includes language that would allow the FAA to use a portion of that BLI to develop and validate operational concepts and procedures supporting the integration of UAS into the National Airspace System that are necessary to close the operational and technical shortfalls identified in the UAS Concept Maturation Plan. This would require participation of multiple FAA organizations to accomplish work within this single BLI. There is a clear need to prioritize and coordinate UAS research and development across the RE&D and F&E budgets and across FAA organizations.

**Recommendation (2)**: The FAA should leverage the new UAS leadership structure to prioritize and plan UAS research and development across budget elements and across organizations. The UAS Concept Maturation Plan provides one potential framework for this plan.



**FAA Response:** The FAA concurs with the Committee's findings and recommendation and is undertaking the following actions to address its recommendation. The FAA is using the UAS Implementation Plan, and its ongoing efforts with its partners, to develop a UAS R&D roadmap during FY 2017. The roadmap will include the combined efforts across FAA UAS budgets, partner activities such as NASA UAS efforts and will be mapped to key decision points and rulemaking, policy, and operational targets.

#### **Subcommittee on Airports**

The following Findings and Recommendations were developed during the Airport Subcommittee deliberations.

**Finding :** **National Airport Pavement Materials Research Center (RPA P2)** - The Subcommittee is pleased with the work on reflective cracking under Research Project Area (RPA) P2, but believes the research needs to consider the effects vertical loads--both vehicular and environmental—have on such cracking.

**Recommendation (1):** The Subcommittee recommends that the FAA include vertical loads in its reflexive cracking test plan.

**FAA Response:** The FAA concurs with the Committee's finding and is undertaking the following actions to address its recommendation(s). An asphalt overlay of a concrete test lane will be constructed at National Airport Pavement and Materials Research Center (NAPMRC) in one of the future Test Cycles to study reflective cracking under both environmental and vehicular loads. Aircraft vertical loads will be applied using the Heavy Vehicle Simulator.

**Finding:** **Asphalt Concrete Pavement Heat Exposure** - The effects of environmental conditions—particularly sustained exposure to high temperatures—on asphalt concrete pavements are not being fully considered in current FAA pavement design guidance.

**Recommendation (2):** The Subcommittee recommends that pavement testing being undertaken Under RPA P2 provide necessary data to incorporate a wider range of environmental factors into FAA pavement design software, which is developed and refined under Software Program Development and Support (RPA P7).

**FAA Response:** The FAA concurs with the Committee's finding and is undertaking the following actions to address its recommendation(s): Asphalt pavement performance data under high pavement temperatures is being collected from full-scale tests at NAPMRC (RPA P2). Laboratory tests are planned on asphalt materials (both binders and mixes) to characterize the material properties (master stiffness curves) under different environmental (temperatures) and loading (rate of loading/frequency) conditions. A database of material properties will be developed for different asphalt binder grades and mixes (allowed under FAA AC 150/5370-10G) which will be incorporated into FAARFIELD.

**Finding:** **Runway Surface Safety Technology (RPA S6)** - Both Subcommittee and FAA staffs believe that additional subject matter expertise is needed to ensure that aircraft braking friction



research being conducted under RPA S6 is producing valid data and is appropriately synchronized with other FAA and industry research regarding aircraft braking.

**Recommendation (3):** The Subcommittee strongly supports the creation of an expert working group that can advise and review FAA Airport Technology and Flight Standards Aircraft Braking research programs. This expert working group should involve representatives from the FAA, academia, aircraft/braking system manufacturers, and others that are developing runway braking friction assessment technologies.

**FAA Response:** The FAA concurs with the Committee's finding and is undertaking the following actions to address its recommendation(s): The FAA will sponsor the formation of an expert working group in the first quarter of FY 2017. The group will have Subject Matter Experts from FAA, industry, and academia. The working group will meet at least twice a year to review, discuss and provide technical guidance on the FAA's Aircraft Braking Friction research programs. Note: it is intended to have the first meeting of this working group in early winter 2017.

### **Subcommittee on Human Factors**

**Finding: Mixed Equipage** - The Human Factors (HF) Subcommittee asked if any HF research was going on in mixed equipage. Two years ago the REDAC Committee identified mixed equipage as one of the top issues the FAA will face in the next ten years. While an effort to address this began in FY 2015 with a literature review, there is currently no HF research addressing the mixed equipage issue.

**Recommendation (1):** HF researchers conduct a deep dive on mixed equipage and report out at a future HF Subcommittee meeting on their plan to conduct research in this area.

**FAA Response:** The FAA appreciates the Committee's recommendation regarding a deep dive on human factors research related to mixed equipage. However, the FAA does not concur with the deep dive as an approach to addressing mixed equipage human factors research. In place of a deep dive, the FAA will facilitate a discussion on mixed equipage at the next Human Factors Subcommittee meeting.

**Finding: Human Factors UAV Guidance** - The HF Subcommittee recommended that the FAA HF community provide HF guidance to UAV industry to influence UAV design and operation in the short term in a previous finding and recommendation. The Subcommittee was not fully satisfied with the HF community response as the response was to generate new specific guidance documents. The HF Subcommittee believes while this is useful for the long-term, it will take too long to impact current designers and that already existing guidance is sufficient to give initial guidance to UAS designers.

**Recommendation (2):** The FAA HF Community engages UAV industry quickly to share UAV HF guidance principles and report out on their progress at the next Subcommittee meeting.

**FAA Response:** The FAA concurs with the Committee's recommendation and is undertaking the following actions to address the recommendation. Because the UAS industry needs to be better informed regarding human factors guidance that is available, we are preparing information that can be presented at UAS industry meetings and will report on the progress at the next Subcommittee meeting.

**Finding: Human Factors Portfolio Prioritization** - The Subcommittee continues to observe that HF research funding is now focused more on Next Gen and UAVs and there is a significant reduction in HF Core research dollars. The Subcommittee is concerned about critical areas such as fatigue and other key HF research areas that may suffer as a result of this shift in emphasis. This is a previous action item.

**Recommendation (3):** The Subcommittee recommends the HF research community evaluate its overall portfolio and discuss with your key FAA stakeholders to ensure the HF research portfolio is focused on the top priorities including core research areas, and report out to the HF REDAC Subcommittee at its next meeting.

**FAA Response:** The FAA concurs with the Committee's recommendation and has undertaken the following actions to address the recommendation. The FAA has already coordinated with the technical sponsors of the research projects to ensure that the top priorities are addressed.

**Finding: Human Factors Consultation** - The HF Subcommittee continues to be concerned about the FAA not meeting their Next Gen efficiency goals due to lack of Human Factors consideration. Recent results with Performance Based Navigation (PBN) is one area that this Subcommittee has previously identified as an issue and continues to be a problem as Next Gen implements new increments in the FAA system.

**Recommendation (4):** The HF Subcommittee recommends the FAA HF research community assess Next Gen implementation and identify areas where efficiencies could be increased with HF consultation or HF research and report out to the HF Subcommittee on their results.

**FAA Response:** The FAA concurs with the Committee's recommendation with the noted exceptions and clarifications and intends to undertake the following actions to address the recommendation. The NextGen Human Factors budget lines must be used for pre-implementation activities that support NextGen concept development and validation at the enterprise level; therefore, post-implementation assessments of NextGen tools are outside of the approved purview of the office. However, Office of NextGen, Human Factors Division, recognizes the opportunity to positively influence potential efficiency gains by proactively identifying enterprise-level Human Factors considerations and developing mitigation strategies and best practices to address these considerations during the development and validation of NextGen concepts. Specific activities to influence post-implementation efficiency gains of NextGen concepts include the development of a PBN Procedures Development Guidebook (in progress), developing an approach for collecting and utilizing PBN workload metrics (planned), exploring ways to optimize contingency operations in a degraded NextGen environment (planned), and researching how to support the implementation of time, speed, and spacing tools through effective change management practices (planned).