

**R. John Hansman**

T. Wilson Professor of Aeronautics and Astronautics  
Director, International Center of Air Transportation



**Massachusetts Institute of Technology**

77 Massachusetts Avenue, Building 33-303  
Cambridge, Massachusetts 02139-4307

**Aeronautics and Astronautics  
Engineering Systems Division**

Phone 617-253-2271  
Fax 617-253-4196  
Email rjhans@mit.edu

November 6, 2015

The Honorable Michael P. Huerta  
Administrator  
Federal Aviation Administration  
800 Independence Avenue, SW  
Washington, DC 20591

Dear Administrator Huerta:

A handwritten signature in black ink that reads "Michael".

Please find the attached findings and recommendations from the Fall 2015 meetings of the standing REDAC Subcommittees which were discussed by the full committee on October 7.

The REDAC is pleased to see the progress the FAA has made towards integration of UAS in the NAS and applauds the efforts of the agency in developing the initial ConOps as well as streamlining Section 333 exemptions and initiating exploratory "Pathfinder" programs. We are hopeful that these initial UAS integration operations will be designed and documented to provide data to support broader UAS integration in an efficient way.

It is clear that defining the research to support the integration of UAS in the NAS is extremely challenging due to the broad range of potential vehicles, missions and operator capabilities as well as the experimental nature of the initial ConOps. As a consequence the REDAC plans to focus on this area over the next meeting cycle.

Our current plan is for each of the REDAC subcommittees review the current FAA UAS research activities and requirements from the perspective of their areas of expertise and experience (Aircraft Safety, NAS Operations, Environment and Energy, Airports, and Human Factors). By better understanding the current UAS research we hope to be able to better advise and support you in defining the most effective research agenda to enable effective UAS integration in a timely way.

I would note that the REDAC recognizes that the strong public interest in UAS makes this area even more challenging and we do not want to add to the confusion. We want to help in the most effective way, open to other ways we can assist. If you have thoughts on how we might be able to help, I be happy to meet at your convenience.

Sincerely,

R. John Hansman

A handwritten signature in black ink that reads "R. John Hansman".

Chair, FAA Research, Engineering and Development Advisory Committee

Enclosure

## Federal Aviation Administration

### Research Engineering and Development Advisory Committee (REDAC) Guidance on the FY 2018 Research and Development Portfolio

#### Subcommittee on Environment and Energy

The Environment and Energy Subcommittee of the FAA Research, Engineering and Development Advisory Committee (REDAC) met in Washington, DC on August 6 - 7, 2015. Following is the report on the outcome of this meeting. The recommendations offered are all for inclusion in the REDAC report. There are no recommendations from this meeting for the letter to the Administrator.

**Finding:** Noise continues to be a significant challenge for the implementation of Performance Based Navigation (PBN) for operational efficiency improvements, which are a critical element of NextGen.

**Recommendation:** In the near term, the FAA should ensure that the operational procedure development and implementation work is continued. Effective community and airport engagement techniques are an especially important part of the implementation. The recent reductions in the F&E budget could result in undesired delays in the development and implementation of these procedures.

To increase the success-rate of implementing PBN-based procedures, it is necessary to better understand the impacts of these procedures and define acceptability criteria for their use. In addition to the recommendations made at the March 2015 subcommittee meeting, the subcommittee recommends the FAA initiate research to understand the additional annoyance due to the noise focusing aspects of PBN. We would recommend you follow this work with research to develop ATM and/or operational concepts that will mitigate the identified noise impacts from PBN implementation. The safety and efficiency aspects of these changes would need to be considered. Finally, we recommend that the FAA use the knowledge gained from this research to develop the necessary mission support tools, policies and procedures to inform decision-making.

**Finding:** We commend the FAA/AEE for vigorously leveraging the efforts of, and working with, other divisions of the FAA, other government agencies, (e.g., EPA, NASA, DOE, DOD), and industry and utilizing available databases to advance the Environment and Energy R&D portfolio. A recent example is their use of the Medicare and Women Health Initiative medical databases to understand if there is a correlation between aircraft noise exposure and health impacts.

**Recommendation:** The subcommittee encourages FAA to continue to find additional collaboration opportunities. For example, the development of the NASA Aeronautics Research Mission Directorate (ARMD) Strategic Research Plan suggests an opportunity for NASA, FAA and other agencies to update the National Aeronautics Research Plan and achieve greater synergy in R&D. With regards to using databases from other fields of study, the appropriateness and limitations of the databases to support the objectives of the study should be considered.

**Finding:** The CLEEN program tasks are ending in 2015. The subcommittee is very pleased with the successes from the CLEEN Program in achieving the maturation and validation of a wide suite of technologies that will reduce noise, emissions and fuel burn from the aircraft fleet.

**Recommendation:** The subcommittee recommends the FAA continue to implement and execute the second phase of CLEEN (known as CLEEN II) to mature technologies as they will enable the achievement of the CLEEN II goals for noise, emissions and fuel burn reductions.

**Finding:** The Environment and Energy R&D portfolio have delivered significant results, and the FAA are doing a better job of communicating these successes, but there is more needed to highlight these in public communications.

**Recommendation:** The subcommittee recommends the FAA make these accomplishments visible broadly. FAA has taken significant steps here by developing websites for CLEEN and ASCENT COE, publishing CLEEN Fact Sheets summarizing the CLEEN program's significant accomplishments, and developing brochures on the FAA's Environmental and Energy Strategy. The Subcommittee is impressed with the quality of these materials and they recommend that they be communicated broadly. The subcommittee encourages regular updates to these to highlight recent accomplishments and to continue developing additional communication materials such as a new Environment and Energy website for the FAA.

**Finding:** Based on the information presented by the FAA at the Subcommittee meeting, the Subcommittee feels the Environment and Energy R&D portfolio is reasonably balanced in terms of the resource allocation among technologies, tools, policy / standards development, sustainable alternative fuels, and ATM and operations improvements.

**Recommendation:** As the aviation environmental tool suite effort matures from development to implementation and use in decision making, including standard setting and other policy making efforts, there may be opportunities to strengthen the R&D efforts on operational improvements within the Environment and Energy portfolio. These have been negatively impacted due to the F&E funding reductions in the past three years. The need to better understand the impact of aviation emissions on climate should also be considered in this Environment and Energy R&D portfolio planning. The subcommittee encourages the FAA to leverage efforts with ACRP studies like enhanced data gathering on noise and emissions impacts. The regular evaluation of the Environment and Energy R&D portfolio should be continued with consideration of "what does it take to be where we need to be in 2025 and beyond". To achieve these goals, additional collaborative technology development would be required.

**Finding:** The environmental impacts of Unmanned Aerial Systems (UAS) are going to be a growing issue. Given the recent surge in the number of UAS operation approvals, there is a need to get ahead of this issue.

**Recommendation:** The subcommittee recommends that the FAA start plans to assess and understand the noise impact of UAS. This would include development of assessment tools and impact mitigation concepts.

**Finding:** Real-time information-based decision making represents an opportunity for improving the operational efficiency and environmental impact of air vehicles.

**Recommendation:** The subcommittee recommends that the FAA support research to develop technology that enables integration of relayed information (e.g., weather, 4D trajectories, etc.) with cockpit information. This will enable higher levels of onboard automation and the ability to further reduce the environmental impacts from aviation.

### **Subcommittee on NAS Operations**

**Findings:** UAS Integration in the NAS: The Subcommittee recognizes the significant effort and substantial progress that the FAA has made since 2011 in establishing a concept of operations for routine UAS access to the NAS. This activity has explored important nominal and off-nominal operational scenarios and the critical ATC regulatory and procedural structures necessary to ensure safe and effective inclusion of UAS in the NAS. The Subcommittee was very pleased to see the degree to which the FAA has demonstrated significant flexibility in its concepts for small UAS certification and segregation of airspace for operations. The Subcommittee has the following findings:

- 1- While the work described above sets the stage, the FAA has yet to substantially engage the UAS stakeholder community on the development of the vision and expectations for operating in the NAS. As UAS markets continue to emerge and technology capabilities accelerate, it becomes increasingly important for the FAA to reach out beyond their capable set of internal subject matter experts and include these new airspace users. These new entrants largely come from the IT community not traditionally experienced in aviation. Their business cadence is much faster, and they are more comfortable with uncertainty and risk-based implementation approaches. This cultural difference must be addressed with early and substantial discussion.
- 2- The three focus areas chosen for exploration and prototyping (i.e., small UAS within visual line of sight, extended visual line of sight in rural areas, and beyond visual line of sight in rural areas) all contain significant limitations (i.e., through the amount of airspace that can be allocated to these operations and the numbers of UAS that can simultaneously operate within that airspace). With the projection of explosive growth in UAS operations, these limits will be quickly reached and the FAA has not yet established a method by which the limited resources inherent in the concepts will be allocated to users.
- 3- The FAA has not yet substantially explored future UAS operational concepts that offer significant potential to mitigate the fundamental limitation of the near term focus areas described above (e.g., the NASA UAS Traffic Management concept).
- 4- In its most recent marks of the FY16 budget, Congress increased the amount of RE&D funding for UAS research and development. However, these RE&D efforts

are focused on airframe safety and certification, not the development of operational concepts and procedures that is necessary for UAS operations in the NAS, particularly in the near term. This latter work is contained within the FAA F&E budget request which was reduced by Congress. This apparent mismatch in funding priorities will likely further delay the integration of UAS in the NAS.

**Recommendations:** The Subcommittee has the following recommendations -

- 1- The FAA should move aggressively to engage the broadest set of external stakeholders of the UAS business community to explore market opportunities, innovative technology developments and implementation paths, and flexible and transparent airspace resource allocation schema. This should be initiated as soon as practical.
- 2- The FAA should employ the effective Research Transition Team structure to include government entities engaged in UAS R&D and bring the best of breed technologies and operational approaches to safe and effective UAS integration. Include the NASA UAS Traffic Management (UTM) activity in this effort. A near term focus for this effort should be how such future concepts should be designed and certified.
- 3- During its budget process, the FAA should clearly articulate the relationship between the research and development associated with UAS platform safety and certification and the development and validation of operational concepts, procedures, and systems required for UAS integration in the NAS. This should be presented as an integrated program to enable budget decision makers to avoid potential budget disconnects that could unintentionally delay this integration.

**Background:** Runway Incursion Reduction Program - The Subcommittee received a briefing on the Runway Incursion Reduction Program (RIRP) and had findings and recommendations relevant to three projects: Low Cost Ground Surveillance (LCGS), Runway Safety Assessment (RSA), and Small Airport Surveillance Sensor (SASS). The LCGS project is intended to develop a low cost surveillance system for small airports for which a cost benefit analysis does not justify more costly surveillance systems such as ASDE-X. Similarly, the SASS project is intended to provide a secondary (beacon) surveillance system to provide improved controller situational awareness and safety and efficiency at smaller towered airports. Finally, the RSA project is intended as a small airport solution to address the NTSB recommendation A-00-66 (July 6, 2000), which states:

*“[The FAA should] require, at all airports with scheduled passenger service, a ground movement safety system that will prevent runway incursions; the system should provide a direct warning capability to flight crews. In addition, demonstrate through computer simulations or other means that the system will, in fact, prevent incursions.”*

The FAA reported to the Subcommittee that their Joint Resources Council had made a decision to not go forward with the LCGS project because of an unfavorable cost benefit ratio and that an estimate of the safety benefit of LCGS was not included in this ratio.

The FAA reported to the Subcommittee that they were proceeding with technology assessment and development for the RSA and SASS projects in anticipation of a future investment decision.

**Findings:** Runway Incursion Reduction Program - The Subcommittee has the following findings -

- 1- The NTSB recommendation fails to address the cost/benefit assessment that should be considered in any investment decision. It falls to the FAA to make this determination.
- 2- The FAA has not performed a benefit analysis of either the SASS or RSA project and therefore cannot accurately estimate the potential safety or efficiency benefit pool available to offset the life cycle cost of the SASS or RSA projects. Without this estimate, it is impossible to evaluate the subject technologies for their implementation feasibility.
- 3- The decision to not include an estimate of the safety benefit in the LCGS investment decision appears inconsistent with the investment decision associated with other safety systems such as Runway Status Lights or ASDE-X, where the benefits were largely attributed to safety.

**Recommendations:** The Subcommittee has the following recommendations -

- 1- The FAA should establish and consistently apply a clear policy with regard to investment decisions on airport surveillance and safety systems that establish what benefits (e.g., safety, efficiency, etc.) will be included and how those benefits will be calculated.
- 2- The FAA should use this policy to estimate the benefits pool available to the RSA and SASS projects and compare this to a life cycle cost estimate of the RSA and SASS technologies. Further technology development in these projects should be contingent upon a positive cost/ benefit estimate.

## Subcommittee on Airports

The Subcommittee met on August 25 and 26 in the Director's Conference Room at the FAA William J. Hughes Technical Center (the Tech Center) in Atlantic City with representatives from the Airport Technologies Research Branch as well as select representatives from the FAA Office of Airports. During the meeting the Subcommittee reviewed the ongoing progress Branch staff have made on the varied airport safety, planning, design, and pavement projects within the Branch's research portfolio and reviewed the Branch's proposed FY2016-2017 budget and discussed potential additional work for FY2018.

The following section summarizes the Subcommittee's findings and recommendations.

**Finding:** The Subcommittee believes that the Airport Technology Research Program is on a solid footing and supports the allocations of program funds for FY2016 and 2017 presented by Branch staff. The Subcommittee also believes that FY2018 project priorities are appropriate, excepting the minor comments in contained in subsequent findings and recommendations contained in this report. The Subcommittee applauds the Branch staff's efforts classify its research projects on the basis of subject-matter based research program areas (RPAs) rather than solely on the basis of individual research projects. The Subcommittee believes that this classification will improve our effectiveness in reviewing research program accomplishments and identifying future funding needs.

**Recommendation:** The Subcommittee recommends that Branch staff expedite their efforts to classify projects by RPA and provide budget and spending reports using these classifications well in advance of the Subcommittee's Spring 2016 meeting so we have ample time for review and comment.

**Finding:** In the review of the long life pavement design project, information as to the variability of engineering properties of materials that meet FAA specifications. It has been known that local materials—especially aggregates—can meet FAA specifications but may result in a wide range of resulting performance. As the system moves towards more engineering based designs understanding this variability and accounting for it in the design process is critical in providing consistent long-life pavements.

**Recommendation:** A study should be initiated that looks into the variability of asphalt and concrete mix designs that meet FAA specifications. Special attention should be paid to a range of local materials—especially aggregates—that meet national specifications that are known to have marginal performance.

**Finding:** As we noted in our Spring 2015 report, the Subcommittee appreciates that the proof of concept work associated with the low cost ground surveillance systems (LCGSS), particularly the optical surveillance system that has been pilot tested at Seattle-Tacoma

International Airport. However, given the ongoing development of alternative surface surveillance systems, continuing reductions in the costs associated with automated dependent surveillance-broadcast (ADS-B) transponders, and the oncoming 2020 ADS-B equipage deadline, the Subcommittee is interested in understanding the role LCGSS are likely to play at airports if and when they are available for implementation before significant additional research into these systems is conducted. We also recognize the need for this research to be coordinated with other research programs within the FAA—particularly the air traffic management and safety research programs—as well as with NASA, which is engaged in a significant airport surface management research effort of its own.

**Recommendation:** The Subcommittee reiterates our recommendation that Branch staff develop a concept of operations that defines the roles and applications of the LCGSS in the National Air Transportation System given other surface surveillance programs and technology deployments that are underway, particularly surface surveillance systems that rely on ADS-B technology. The concept of operations should consider what unique capabilities or deployment opportunities would exist for LCGSS as well as those capabilities that are likely be duplicated by ADS-B based surface surveillance systems. We also strongly recommend increased collaboration among the FAA’s research programs and with NASA regarding both surface surveillance and airport surface management.

**Finding:** The Subcommittee agrees that research is needed to develop rational overload criteria for flexible pavements (e.g., asphalt concrete pavements). The current ICAO overload criteria for flexible pavements limits overload to 10 percent above the reported pavement classification number (PCN); for rigid pavements (e.g., Portland cement concrete), the limit is 5 percent above the reported PCN. The research shows that the 10 percent flexible pavement overload may be overly conservative for thin flexible pavements. In addition, many general aviation airfields with rigid pavements have performed well and exceeded their design lives while supporting loads that far exceed the rigid pavement design strength. This suggests that the ICAO 5 percent rigid pavement overload criteria are may also be overly conservative as well.

**Recommendation:** The Subcommittee recommends the overload project be expanded to reevaluate the 5 percent overload criteria for rigid pavements and 10 percent overload criteria for flexible pavements.

### **Subcommittee on Human Factors**

**Finding:** The Civil Aerospace Medical Institute provided the HF Subcommittee with an overview briefing that surveyed advances in both Medical Technology and technology with potential implications for Aerospace Medicine and Human Factors in aviation, including safety. The subcommittee observed that the presented technologies pose two distinct but related challenges; the breadth and number of areas of advancement, and the pace at which technology is advancing.

However at this time there is insufficient synthesis of the technologies and their associated research to enable assessment or prioritization for consideration of specific future FAA research planning.

**Recommendation:** The HF Subcommittee recommends that the FAA develop a methodology to both track advances in technology with potential implications for operations, Aerospace Medicine and Human Factors in aviation, as well as assess the implications, both positive, and from a safety and risk management perspective, in order to better inform research and plans for both potentially rising issues, and opportunities that these technologies represent.

**Observation/Finding:** The committee was pleased to see support for a Human Factors UAS project in FY15 that addresses several key initiatives the Subcommittee has noted in the past. Specifically, the Subcommittee has previously stated that Human Factors is an important component of creating an acceptable integration of operating UAS in the NAS and hence ensuring continued prioritization of items related to control station design and approval, operator/pilot qualifications and training, as well as procedure and air space design is essential. Having Human Factors a priority within the UAS program is a positive step in achieving this essential component of UAS in the NAS.

### **Subcommittee on Aircraft Safety**

The Aviation Safety Committee of the REDAC met on September 9, 10, 2015 at the FAA Technical Center in Atlantic City, NJ for its fall meeting. The objectives of the meeting included review of FY15 R,E&D aviation safety portfolio; targeted deep dives of program areas with previously identified emerging issues; early input for FY2018 research plan; and development of any findings and recommendations. The deep dives included such topics as Certification of Advanced Materials and Structural Technologies; Dependability of Increasingly Complex Systems; Mixed UAS and Manned Aircraft Operations; Real Time System-wide Safety Assurance and General Aviation Alternative Fuels. Below are the Findings and Recommendations from the committee, which should be used to consider improvements in current research programs, their controls and to also inform the 2018 Research Plan as it develops. Thank you to the committee members for their engaged participation and dedicated time. Also a strong thank you to all at the FAA that made the meeting a success through their support by providing research details, tours and immediate responses to committee questions.

**Finding:** Improved Clearer Link between Research Activities and Overarching Safety Objectives and Goals - The SAS Committee is spending considerable time and energy trying to understand the big picture of the FAA's research programs as they relate to aviation safety. In 2015 there are over 70 research requirements with a total budget expenditure for the safety portfolio on the order of \$90 million. This size of investment in research warrants a clear picture into the programs including overall research objectives, sponsor outcomes, financial commitments over multiple years, research exit criteria, etc. Good progress has been made in producing individual research program quad charts describing specific targeted contract research efforts. However, visibility to the comprehensive research picture is still lacking and confused by the presentation of the material in individual Budget Line Item (BLI) format and focused on contracted dollars only versus a total dollar view. Program documentation is also apparently produced for the use

of SAS committee only, which, while appreciated, seems counter to good program management techniques. Lacking clear line of sight to the higher program level makes providing SAS committee input into overall research programs fragmented and incomplete at best.

**Recommendation:** FAA should create a comprehensive program description for safety research that clearly identifies, and communicates, the higher level research objectives, by topic, (icing, fire safety, structural technologies, etc.) as well as provides connectivity to the comprehensive set of specific targeted research objectives in each area. This description needs to clearly communicate how individual research supports the overall objectives. The description should be easily updateable and designed so that it primarily adds FAA management value as well as supports the SAS Committee objectives.

**Finding:** Enhanced International Collaboration on Safety Research - The Subcommittee received an overview presentation on the Association of European Research Establishments in Aeronautics (EREA) Future Sky Safety program. We were pleased to see that the FAA Aviation Safety organization will be engaged in the activity by being part of the Advisory Board. The program's four themes are addressing issues, which align with many of the FAA's aviation safety priorities.

**Recommendation:** Given that Aviation Safety issues span international borders, the FAA should consider taking a leadership role in deepening US-European collaboration on Aviation Safety research by initially focusing on one or two specific areas of common interest. One potential is big data analytics associated with aviation safety data exploration. Both the FAA and NASA have significant on-going investments in this area, which aligns nicely with the Future Sky Safety project on Emergence Detection and Big Data, which is intended for a start in 2017. Through joint efforts we are likely to be able to magnify the safety impact of research investments of all parties.

**Finding:** Immediate Needs for Additive Manufacturing Certification Support - There has been continued progress accelerating the development of a FAA Additive Manufacturing Roadmap and the identification of focused Additive Manufacturing research. In parallel, industry is continuing to accelerate efforts to incorporate additive manufacturing technologies as full-scale production processes. The Subcommittee was presented with an update on Additive Manufacturing research activities ongoing at the Air Force Research Laboratory and the identified design, manufacturing and inspection challenges associated with this technology. In July 2015 the Air Force issued an Airworthiness Bulletin to its Program Offices highlighting the process steps to be followed to insert Additive Manufacturing technologies. This near term action is seen as a positive step to assure implementation is consistent with strategic planning with respect to qualification of new materials and processes. The Subcommittee also received a briefing from the FAA Fatigue and Damage Tolerance Chief Scientific and Technical Advisor (CSTA) on recent progress including collaboration with the Air Force Research Laboratory on the qualification and certification of parts produced via Additive Manufacturing processes. The Subcommittee finds that a near term strategy is required to help the certification directorates assess type designs or type design changes which incorporate parts produced utilizing additive / advanced manufacturing methods.

**Recommendation:** The Subcommittee recommends that the FAA develop guidelines describing the considerations, which should be assessed relative to the incorporation of parts produced by Additive Manufacturing. Target for implementation of these guidelines should be immediate (on the order of 3 months). The Subcommittee further recommends that the FAA assess the need for additional research to supplement the initial guidelines for the potential longer-term codification of Additive Manufacturing guidance.

**Finding:** Research to Mitigate the Impact of Cockpit Laser Strikes - The potentially negative effects of laser beams striking the human eye and interfering with flight operations are well documented by previous research conducted by the FAA, among others. The frequency of reported laser strikes has increased more than 10 fold since 2006; that year, FAA reported 384 such events. In 2014, the agency reported 3,894 laser strikes and, unfortunately, the number of reported strikes this year has spiked about 35% higher than last year with more than 2,625 reported as of June 2015. Whereas low-powered handheld lasers were previously in common use, more powerful lasers that pose a greater threat to the pilot are becoming available to potential offenders. While considerable research has been conducted within the military, much of this work is classified, focused on specific threats, and therefore will not provide a complete solution for the civilian sector. To date the FAA's approach to mitigate the impact of a laser illumination event is to document and characterize these events, and educate flight crews on how to recognize an event and then respond in a manner to help identify and prosecute offenders. Despite these efforts and others, the number of laser strikes is expected to continue to rise and there has yet to be identified a robust, reliable countermeasure that will protect pilots' vision and preserve flight safety. Currently, there is no funding in the FAA R&D portfolio of activities to investigate and/or develop potential technical solutions to mitigate the impact of a laser strike. Achieving a workable, affordable technical solution to this problem, rather than relying primarily on law enforcement and education campaigns to mitigate the risk, would represent a significant safety accomplishment that would benefit the traveling public and cockpit flight crews.

**Recommendation:** The SAS Committee recommends that the FAA include within its R&D portfolio the resources to conduct research aimed at identifying a technical, onboard solution to prevent or greatly reduce the potential for a laser strike against aircraft and mitigate its impact. The extensive R&D conducted within the DoD should be leveraged to the maximum extent possible considering security and intelligence concerns. As envisioned, the solution would:

- Require no action by the flight crew that would disrupt or unduly complicate normal operations,
- Be effective against a high percentage of laser strikes,
- Be capable of being used on any aircraft, but the primary focus should be for aircraft in FAR Part 121 and/or Part 135 services,
- Not impair pilots' visual acuity or ability to correctly interpret colors of messages, warnings, etc., on cockpit displays at any time, or otherwise degrade performance, while operating the aircraft,
- Be affordable within FAA analysis results of safety risk benefits versus cost criteria.