U.S. Department
of Transportation

**Federal Aviation
Administration**

Office of the Administrator

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

March 11, 2016

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 for your November 6, 2015, letter providing guidance on the Fiscal Year 2018 Research and Development (R&D) Portfolio that includes critical topics like Unmanned Air Systems (UAS) Integration in the NAS.

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

We will continue to incorporate the Committee' recommendations 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) 2018 R&D 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 (1): 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.

FAA Response: The FAA agrees that noise presents a significant challenge to the timely implementation of Performance Based Navigation (PBN) operational procedures, and this challenge will need to be overcome in order for anticipated safety, capacity, and efficiency gains to be realized. To better understand the impacts of these procedures and to potentially aid in the definition of acceptability criteria for their use, the Office of Environment and Energy (AEE) continues to examine airports where PBN has been implemented using a variety of noise metrics. The Office of Airports , AEE, and Office of NextGen are collaborating to develop research projects using FY 2016 funds that could increase the success of future PBN implementations. One of these projects would examine the Equivalent Lateral Spacing Operation concept as a means to mitigate noise resulting from concentrated flight tracks associated with PBN operational procedures. In addition to this, the Noise Research Roadmap is continuing to be expanded to define and integrate projects to develop the data and information that will be required for our scientific and technical basis to inform future noise policy considerations. AEE, Air Traffic Organization (ATO), and others

within the Agency are also working together on several new and expanded efforts in the area of community involvement to identify effective approaches and practices for outreach and engagement, as well as lessons learned, to increase the success of future PBN implementation and guide future research opportunities.

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 (2): 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.

FAA Response: The FAA agrees that we need to continue to foster collaboration across the FAA and to leverage efforts that are being made outside of the FAA. It is especially important given reduced federal funding for R&D. As a part of this, the FAA is leveraging existing databases to assist us in our evaluations of the potential impacts of aviation noise on health. The FAA has been and will continue to carefully consider how we leverage efforts outside of FAA and what information and databases are appropriate for FAA research use. The FAA will keep the REDAC apprised of our progress on this front.

The FAA, National Aeronautics and Space Administration (NASA), and other agencies that were involved in the creation of the National Aeronautics Research Plan have been working together on the development of the National Alternative Jet Fuel Strategy. This document, like the National Aeronautics Research Plan, is being developed under the auspices of the Office of Science and Technology Policy. Once the National Alternative Jet Fuel Strategy document is completed and released, the time could be right for the National Aeronautics Research Plan to be revisited.

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 (3): 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.

FAA Response: The FAA appreciates the longstanding support of the REDAC for the CLEEN Program. The FAA thinks the public-private partnership has been successful. One of CLEEN technologies, GE's TAPS II Combustor, showed landing and take-off nitrogen oxide (NOx) emissions were reduced 60 percent compared to the International Civil Aviation Organization

(ICAO) NOx standard adopted in 2004, meeting one of the CLEEN goals. This combustor will be used in CFM International's LEAP turbofan engine and is expected to enter service in 2016 with over 8,000 orders. With CLEEN II, the FAA is continuing this partnership with eight companies to accelerate the maturation of technologies that will reduce noise, emissions and fuel burn. As was the case with the first phase of CLEEN, the maturation effort will culminate with ground and/or flight test demonstrations of certifiable aircraft technologies with an expected entry into service by 2026. These technologies, along with those matured during the first phase of CLEEN, will provide benefits for many years to come in terms of reduced noise, fuel burn and nitrogen oxide emissions.

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

Recommendation (4): 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.

FAA Response: The FAA agrees on the importance of communicating the results from the Environment and Energy portfolio, especially those that have resulted in significant progress. The FAA is pleased that the REDAC considers the communications materials to be high quality. The Environmental and Energy Strategy brochures are used regularly as a part of our communication efforts and full size banners were created from the brochure materials. These materials were all featured at the recent ASCENT Center of Excellence meeting. The FAA is currently updating the Environment and Energy website for the FAA and an update should be ready during the next REDAC Environment and Energy Subcommittee meeting.

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 (5): 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 Airport Cooperative Research Program (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.

FAA Response: The FAA appreciates the REDAC's positive evaluation of the balance of the Environment and Energy R&D Portfolio. Previous recommendations from the REDAC have been instrumental in adjusting the Environment and Energy R&D Portfolio to accommodate F&E funding reductions. The FAA agrees that as ongoing efforts are completed, opportunities need to be evaluated for both near term R&D needs and those that are a few years down the road. As an example, as work on particulate matter emissions shifts from measurements to analysis, additional funds could be available for other areas such as the examination of operational improvements and/or the consideration of the climate impacts of aviation emissions. The FAA will continue to examine previously completed Airport Cooperative Research Program (ACRP) studies to see if there are results that could be used within the Environment and Energy R&D portfolio, monitor ongoing ACRP studies to guide their direction, and to work with ACRP to develop new projects that could enhance data gathering on noise and emissions impacts. Finally, as a part of its next summer meeting, the FAA will request the REDAC Environment and Energy Subcommittee to consider what it would take to be where we need to be in 2025 and beyond.

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 (6): 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.

FAA Response: UAS are indeed a growing issue and the FAA agrees that the noise from these systems needs to be evaluated. Prior to developing tools and mitigation concepts, accurate noise measurements are needed. To achieve this, the FAA is leveraging the ASSURE Center of Excellence and R&D activities that are ongoing at NASA Langley. The FAA is also seeking international partners for this through the ICAO Committee on Aviation Environmental Protection.

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

Recommendation (7): 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.

FAA Response: Real-time information-based decision-making could indeed represent an opportunity to reduce the environmental impacts of air vehicles. The Office of Environment and Energy will examine what is being done elsewhere in the FAA and at NASA and then identify the opportunities for R&D in this area.

Subcommittee on NAS Operations

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:

Finding: 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.

Finding: 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.

Finding: 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).

Finding: 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.

The Subcommittee has the following recommendations -

Recommendation (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.

FAA Response: We appreciate the discussion around this topic, as it brought insight into a different dimension associated with the validation of our operating concepts and scenarios. Yes, we will pursue engaging the UAS business community and their respective viewpoints when we conduct our external stakeholder engagement sessions.

Currently, however, there are active avenues for engagement that the FAA has already pursued:

- The FAA selected the Mississippi State University led team (ASSURE) as the FAA's Center of Excellence (COE) for Unmanned Aircraft Systems on May 8, 2015. The UAS COE is comprised of 22 leading UAS and aviation universities both domestically and internationally. The COE has engaged a broad cross-section of industry and has over 100 partners in UAS research initiatives, including many that will aid UAS NAS integration needs. The COE and FAA plan to leverage these partnerships in the business community to meet common research goals and integration needs.

- The FAA introduced the UAS Pathfinder Program on May 6, 2015, to help explore ways to expand the use of UAS while comments to the current UAS Notice of Proposed Rulemaking are being addressed. We have partnered with three leading U.S. companies who will work with us on exploring three key unmanned aircraft operational areas. CNN will be researching how visual-line-of-sight operations over people may be safely executed in urban areas. Precision Hawk, a manufacturer, will be researching extended visual line of sight operations in rural areas. BNSF Railroad will explore the challenges of using UAS to conduct rural operations beyond visual line-of-sight. As recently as October 2015, the FAA expanded its Pathfinder effort by partnering with a fourth company, CACI International Inc. to evaluate how the company's technology can help detect UAS in the vicinity of airports.

Recommendation (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.

FAA Response: The FAA and NASA currently have six Research Transition Teams (RTTs) in place. Quarterly status meetings are presided over by Jaiwon Shin, NASA Associate Administrator for Aeronautics and Edward Bolton, Assistant Administrator for NextGen to document RTT related accomplishments and discuss future outcomes and deliverables.

Most recently, the FAA and NASA initiated a RTT in October 2014 to explore NASA's UAS Traffic Management (UTM) concept for enabling safe UAS operations in low-altitude airspace.

In May of 2015 FAA and NASA expanded the UTM RTT to include the U.S. Department of Defense (DoD), U.S. Department of Homeland Security, and U.S. Department of Commerce.

As RTTs are usually formed as concepts mature, the FAA is committed to engaging in future RTTs at the appropriate time. It is our view that RTTs are most effective when the content is manageable and more focused. This allows for the appropriate individuals from the affected organizations to receive the matured product(s).

Recommendation (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.

FAA Response: The FAA does consider the interrelationship between research in its RE&D and F&E budget. This is a key point during the budget formulation and validation process. Efforts are complementary while remaining within the scope of the funding type. The RE&D is heavily vehicle capability focused which is appropriate while the F&E is focused on the accommodation and integration into the National Airspace. Clear links are being made in these efforts to identify the required operator and ATM performance capabilities.

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.

Runway Incursion Reduction Program - The Subcommittee has the following findings -

Finding: 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.

Finding: 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.

Finding: 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.

The Subcommittee has the following recommendations -

Recommendation (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.

FAA Response: The Runway Incursion Reduction Program (RIRP) concurs with this recommendation and the need for a clear policy regarding investment decisions. The policy that defines the cost/benefit calculations and what benefits can be included is a part of the FAA Acquisition Management Systems (AMS) Lifecycle Management Process which the RIRP adheres to. Specifically the RIRP activities, including Runway Safety Assessment (RSA) and Small Airport Surveillance Sensor (SASS), fall under the Concept and Requirements Definition Readiness Decision phase.

Recommendation (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.

FAA Response: The RIRP concurs with this recommendation and the need to estimate benefits pool and compare to lifecycle cost estimate of RSA and SASS technologies. The process of benefits pool estimation and lifecycle cost estimation are carried out on systems that are deemed to be technically feasible and operationally suitable for use in the National Airspace System (NAS). Per the FAA AMS Lifecycle Management Process, Concept and Requirements Definition Readiness Decision phase, the RIRP is responsible for evaluating new safety technologies/systems for technical feasibility and operational suitability in the NAS. If the technologies are found to meet both these requirements, the RIRP carries out pre-Investment

Analysis Readiness Decision (IARD) activities to generate both, lifecycle cost and benefits pool estimates.

These lifecycle cost estimates factor in important information and requirements discovered during the RIRP's testing and evaluation of the technology in the NAS, and the costs incurred and estimated during this test and evaluation phase. Any lifecycle cost estimates generated for either RSA or SASS prior to the RIRP's preliminary field testing and evaluation would be inaccurate, and would need to be re-calculated at the end of the evaluation process to be compliant with the FAA AMS.

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 (1): 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.

FAA Response: We concur with the recommendation. For FY 2017 and beyond, Projects will now be re-classified by Research Program Areas (RPAs) and RPA budgets will be provided to the Subcommittee 2 weeks ahead of the 2016 spring meeting

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 (2): 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.

FAA Response: We concur with the recommendation. There are two concurrent projects in progress that can provide data/information to study the variability of asphalt and concrete mix designs that meet FAA specification. Pavement material samples collected from airport sites under Extended Life project and Field Instrumentation & Testing project can be used for the study. In addition, we will coordinate across the FAA to investigate whether FAA Regional Offices could augment our database by providing mix designs and material samples from specific construction projects at airports in their region. FAA's NextGen Pavement Materials Testing Laboratory is fully equipped to perform strength and performance tests on these materials/samples collected.

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 (3): 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.

FAA Response: We concur with the recommendation. A concept of operations for Low Cost Ground Surface Surveillance (LCGSS) will be prepared and will provide a description of

LCGSS systems and their detailed role in enabling enhancements to the safety, operations and surveillance capacity of airports. The description of the role of LCGSS will take into account the heterogeneous and evolving landscape of other available surface surveillance technologies, the coincidence with Automated Dependent Surveillance-Broadcast (ADS-B) systems and interface with legacy surveillance systems. LCGSS will be considered as an independent system for small to mid-sized airports and as a complementary system to existing surveillance systems at larger airports. Our approach will include increased collaboration among other relevant research programs within the FAA and with NASA with respect to airport surface surveillance and 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 (4): 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.

FAA Response: We concur with the Subcommittee's recommendation. Current full-scale testing at the National Airport Pavement Test Facility (NAPTF) in Construction Cycle 7 (CC7) is intended to evaluate the ten above PCN overload criterion for flexible pavements and to recommend more rational criteria. Preliminary results from CC7 confirm that the ten percent criterion is highly conservative. We plan to use the first phase of testing in Construction Cycle 8 (CC8) to similarly evaluate the five percent above PCN overload criterion for rigid pavements.

Subcommittee on Human Factors

Finding: The Civil Aerospace Medical Institute (CAMI) provided the Human Factors 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 (1): 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.

FAA Response: CAMI has a methodology in place to track technological advances in bio-engineering and engineered replacement tissues and organs, genomics and gene therapies, stem cells and regenerative medicine, brain computer interfaces, neuro-technologies, biomedical devices, medical micro electro mechanical systems, body-worn sensors and networks, nano medicine, medical robotics, etc. This process involves regular conversations with technology experts as well as study of newsletters/reports that identify and describe technological advances (nationally and internationally). Based on their scientific knowledge and expertise in aerospace medicine and aerospace human factors, CAMI personnel assess the implications from both a positive and a safety and risk management perspective of these technological advances and identify the potential practical impacts of these technologies upon the users of civil aviation transportation systems. FAA research requirements are identified and prioritized based on the operational needs of FAA R&D sponsoring organizations such as AVS and ATO. CAMI has identified a research strategy to address advanced medical technologies that can potentially affect aviation safety, in line with the FAA Administrator's Initiatives, and viable to pursue within the current research funding constraints. The areas of research include the identification of pathology risk, high performance computing and visualization technology, and emergent medications and medical devices.

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 (1): 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.

FAA Response: The FAA agrees that a comprehensive program description for the FAA R,E&D aircraft safety research portfolio is essential to provide an integrated and coherent view of the FAA aviation research programs and activities to meet high-level goals and objectives in support of the Agency's strategic priorities of making aviation safer and smarter through risk-based decision making. The FAA has a very structured R,E&D process to develop and to manage the research requirement portfolio for aircraft safety, which are initiated/proposed by technical personnel and reviewed/approved by the management of the FAA Office of Aviation Safety (AVS).

Although the requirements as presented may appear to be fragmented and disconnected, collectively they shape up the AVS research requirement portfolio for aircraft safety based on the R,E&D strategic guidance with defined high level goals and objectives by the AVS Senior Leadership. The FAA recognizes the needs to present the aircraft safety research portfolio by subject topics, instead of individual requirements, to better demonstrate how these requirements jointly meet high-level goals and objectives. The FAA aircraft safety research team will work with SAS to develop a better means to present the program that will be informative to the FAA senior management to make R&D investment decisions and to support 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 (2): 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.

FAA Response: The FAA agrees that technical collaborations are essential to meet the Agency's strategic priorities of enhancing global leadership to improve safety through an integrated, data-driven approach that shapes global standards and enhances collaboration and harmonization. The FAA utilizes its cooperative agreement program to collaborate with foreign civil aviation authorities (CAAs) to exchange technical information and to pursue joint technical projects, including R&D activities. The FAA has several on-going such cooperative agreements with individual countries in the European Union , such as the Netherland CAA, French CAA, the German CAA, etc., to conduct joint research on aircraft safety. The FAA will take a more proactive roll to further develop U.S.-European collaborations on aviation safety, particularly with a focus in the area of big data analytics on aviation safety that fits nicely with the FAA strategic priorities of making aviation safer and smarter based on Safety Management System principles.

The FAA will continue to explore other avenues of coordination through groups such as the Safety Management International Collaboration Group that currently includes 18 different countries with the chair rotating between Federal Aviation Administration, European Aviation Safety Agency, and Transport Canada Civil Aviation. Specific to the Future Sky Safety project, the Aviation Safety, Office of Accident Investigation and Prevention has signed a memorandum agreeing to provide a member for the projects advisory board when it is constituted, and we are coordinating participation with our EASA counterparts.

Finding: Immediate Needs for Additive Manufacturing (AM) 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 (3): 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.

FAA Response: The FAA recognizes the need for guidelines to implement additive manufacturing technology safely and has formed an Additive Manufacturing National Team to achieve this goal. Near-term, the FAA plans to develop a policy memo for the certification of additive manufacturing parts with failure conditions of minor and below as well as checklists for approving additive manufacturing parts for Aircraft Certification Offices and Manufacturing Inspection District Offices. Longer-term, the FAA will be developing the national AM roadmap (including R&D plans), and continue coordinating with other government agencies, industry groups, and manufacturers.

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 tenfold 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 (4): 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; and
- Be affordable within FAA analysis results of safety risk benefits versus cost criteria.

FAA Response: The FAA recognizes the need to continue flight deck safety improvements and puts a significant amount of attention and effort to improve pilot safety. We are aware that there has been an increased number of reported events since the institution of a reporting system in 2005, and that there have also been an increased amount of attention by the community when these events have occurred. The FAA has focused on working with officials towards laser strike prevention, which include gathering information about these events and providing information to the public, as well as educating them about laser strike hazards and how to report these events. However, the agency is limited in its ability to enforce all possibilities of unauthorized laser uses and is increasingly dependent on working with law enforcement officials to assist in mitigating these occurrences. Research assessments must be applied carefully toward identifying mitigation methods, while keeping in mind the practicality, economical, and safe-use of these methods when determining operationally safe and viable solutions. The FAA has placed emphasis on assessing strategies toward mitigation, such as the practical and safe use of eyewear to mitigate cockpit laser events. Prior to considering additional research and efforts on laser mitigation, the FAA will assess the work that has already been accomplished, how it may effectively address both prevention and mitigation, and determine if additional emphasis on laser safety is required.