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October 30, 2020

The Honorable Stephen Dickson
Administrator
Federal Aviation Administration
[redacted]

Dear Administrator Dickson:

Attached below please find the findings and recommendations from the Safety, Airports, Environment and Energy, Human Factors, NAS Operations subcommittees from their fall meetings.

The full REDAC also made several cross cutting observations meeting regarding the RE&D program at the recent virtual meeting on October 7, 2020.

Impact of COVID – The unprecedented changes in the air transportation system from the COVID crisis indicate the need to monitor and conduct a strategic review of the impact of COVID on the NAS (including demand, capacity, fleet, CNS equipage, workforce, etc.) and how this may change R&D requirements.

Impact of Automation – The ability to take advantage of the significant advances in automation, machine learning, AI in the operational aviation system requires innovation in approaches to certify and operationally approve automation. In addition it is important to understand the changes in human roles and performance in these automated and distributed systems and to develop approaches to identify and mitigate emergent human-automation risk events in normal and abnormal conditions

We appreciate the opportunity to support the FAA in promoting the safety, efficiency and effectiveness of our national aviation infrastructure in these challenging times. I would be happy to meet to provide further insight on these observations or explore ways in which the REDAC can more effectively support you and the FAA mission.

Thanks for the opportunity to contribute.

Sincerely,

R. John Hansman
Chair, FAA Research, Engineering and Development Advisory Committee

Enclosure

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Research, Engineering and Development Advisory Committee (REDAC)
Guidance on the FY 2023 Research and Development Portfolio

Subcommittee on Airports

General Observations and Commendations:

The Subcommittee appreciated the FAA's update regarding how the COVID-19 pandemic has affected pprogram research in the Spring and Summer of 2020. The closure of the FAA Technical Center facilities and the extenuating impacts COVID-19 has had on Program contractors and university partners have had consequential impacts on key research projects, including projects that undertaken in response to research requested by Congress in the FAA Reauthorization Act of 2018.

We are particularly concerned about research regarding (1) unmanned aircraft system (UAS) use at airports, (2) UAS detection and mitigation systems, and (3) alternatives to aqueous film-forming foam (AFFF) used in aircraft rescue and fire-fighting (ARFF) applications.

The Subcommittee was pleased to learn that, despite COVID impacts, the FAA has moved forward with important elements of several ongoing research projects. These include preparation of broad agency announcements for vendors and airports for UAS detection and mitigation system evaluations, establishment of an industry expert group regarding alternative firefighting agents, and completion of several safety and pavement projects for which laboratory work had finished or was unnecessary.

As we noted in our May 2020 report, the Subcommittee recognizes that the impacts COVID-19 has had and will continue to have on the aviation industry are broad and severe. We also recognize that these impacts—and associated research needs to address them—may require both new research activities and reprioritization of current research priorities. The Subcommittee stands ready to assist the FAA with these efforts as the pandemic and our collective response efforts evolve and mature.

We commend the Program's research efforts to support statutory mandates in the FAA Reauthorization Act of 2018. These mandates include Sections 136 and 183 regarding the use of state highway pavement specifications for airfield pavements, Section 146 regarding the use of retroreflective glass beads for airfield marking conspicuity, and Section 525 regarding the use of geotextiles for airport pavement applications. Program research into these topics have enabled the FAA to revise its guidance to airports in all three areas.

The Subcommittee also commends the FAA for its release of Version 2.0 of FAARFIELD[1], the FAA's pavement thickness design software. The software was in need of the update to make it a more user-friendly and consistent with other engineering software in the public domain. The FAA released Version 2.0 of the software in June. It incorporates a new user interface, a new finite element computational library, an updated aircraft library, and incorporation of new International Civil Aviation Organization (ICAO) pavement assessment criteria. The Subcommittee looks forward to future FAARFIELD enhancements to address other key

[1] FAARFIELD = FAA Rigid and Flexible Iterative Elastic Layered Design.

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pavement design issues including top-down cracking failure criteria for rigid pavements and vertical strain in asphalt layers for flexible pavements.

Finding: COVID – 19 Research Impacts - The Subcommittee recognizes that disruptions caused by the COVID-19 pandemic have delayed time-critical research activities, including those associated with provisions in the FAA Reauthorization Act of 2018. The Program's alternative firefighting agent research project is of particular concern because:

- The Project's findings are needed to support FAA action regarding Section 332 of the FAA Reauthorization Act of 2018. Section 332 permits use of non-fluorinated chemicals for aircraft firefighting provided they meet applicable FAA and National Fire Protection Association (NFPA) performance standards.
- Airport operators are under considerable pressure from state and local governments and local communities to reduce or eliminate use of PFAS at airports.
- There are significant and growing concerns about the human health impacts and associated liability associated with PFAS contamination on and near airports.

The Subcommittee also recognizes the need for the FAA's efforts to be coordinated closely with complementary research efforts that have been underway within the U.S. Department of Defense.

Recommendation: With respect to the alternative firefighting agent research project, the Subcommittee recommends that the FAA carefully monitor research timelines in light of COVID-19 delays, prioritizing those activities associated with Congressional deadlines. The FAA should keep the Subcommittee and Congressional liaisons informed about the status of the research and the ability to meet the aforementioned deadlines.

Finding: Emerging Pavement Additives - The Subcommittee generally supports the research into emerging pavement additives (e.g., carbon nanotubes mixed into cementitious materials to promote self-monitoring concrete pavements to see if damage in the micro-structure of pavements is occurring). While the Subcommittee realizes the useful potential of these additives, we note that consideration needs to be given to how these particles affect full-scale pavement construction.

Recommendation: The Subcommittee recommends the FAA consider evaluating emerging pavement additives in the National Airport Pavement Testing Facility test facility during future construction cycles, inclusive of assessing impact the additives have on the full-scale production of concrete during placement, consolidation, and finishing.

Finding: Airport Technology Research Program - The Subcommittee remains very interested in the Airport Technology Research Program's involvement in UAS research—both from the perspective of their beneficial use at and near Airports and from the perspective of managing the safety and security risks associated with unauthorized use of these and near airports. We also recognize the growing interest in advanced air mobility systems (AAM)—also known as urban air mobility systems. AAM, like UAS, represent a new class of aircraft that will need to share use of airspace on and near airports.

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Recommendation: We continue to recommend that the Airport Technologies Research Program utilize the Subcommittee to provide airport stakeholder input and insight into its UAS and AAM research activities, as well as in crosscutting research undertaken elsewhere within FAA.

Subcommittee on Human Factors

General Observation: Capture Lessons Learned from COVID-19 Pandemic -
The COVID-19 pandemic has introduced an opportunity to capture experiences, challenges, and successes associated with a major global disruption to the aviation sector. The subcommittee applauds the FAA for their participation in the global response to ensure a smooth transition back to full operations. The subcommittee believes there is an opportunity to collect data and promote best practices from successes and identify gaps from these challenges. The subcommittee encourages the FAA to collect experiences on how organizations and operations are adapting to change and identify ways to be resilient and proactive in the face of uncertainty. Data on these experiences can enable the FAA to identify and mitigate HF-related risks associated with adapting to and recovering from global disruptions such as the COVID-19 pandemic.

Finding: Data Analytics for Operational Personnel -The implementation of many NextGen initiatives, such as Trajectory Based Operations, drives a tighter coupling of the tasks performed by different FAA facilities. In order to improve inter-facility coordination in such cases, improved data analytics support for operator feedback is required. It is important to identify requirements that ensure operational personnel at each facility receive effective visibility into operational performance issues. These requirements need to identify both the information necessary to detect coordination issues and the analyses necessary to diagnose the causes.

Recommendation: The FAA should conduct research to identify those TBO initiatives where an effective learning feedback loop is needed to coordinate process improvements across facilities. The research should propose potential information requirements to provide operational personnel with the feedback necessary to detect weaknesses in inter-facility coordination and to diagnose the underlying causes.

Consequences: Without improved data analytics for operator learning and training, the FAA will not be able to identify NextGen initiatives that may result in inter-facility inefficiencies and their associated causes.

Finding: Workforce Proficiency Training Requirements and Risks of Skill Degradation -
The COVID-19 pandemic has resulted in reduced operations, driving furloughs, repurposing aircraft from passenger to cargo, and rapid storage and de-storage of aircraft. The operational workforce (e.g. air traffic controllers, maintainers, and pilots) is experiencing backlogs in training, extended periods of work inactivity, increased time periods since training or requirements for retraining. To ensure continuity of operations, there have been temporary extensions of personnel certifications, and new-personnel certification in the current low-traffic environment. However, we do not know how these disruptions affect and exacerbate the issues associated with workforce proficiency.

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For example, pilot training footprints have remained relatively stable over recent decades despite an increasing volume of learning objectives. A "one size fits all" approach has been in place for decades; for example, the long-standing currency requirements (such as 3 landings in 90 days), or the traditional 14 CFR part 121 subpart O periodicities of 6 months between recurrent training events for Captains and 12 months for First Officers. Many operators rely heavily on Advanced Qualification Program data to justify and maintain current footprints while adding more content into the scheduled time. However, stability of pass rates and task level performance grades do not provide sufficient insight into the underlying questions of knowledge and skill retention. Similar issues exist for other workforce groups such as maintainers and controllers.

To understand the effectiveness of existing training/proficiency requirements and programs, the FAA needs scientific human performance data. The aviation industry simply does not data to determine how long workforce (e.g. operators and maintainers) skills and knowledge are retained, and this issue is exacerbated by COVID-19.

Recommendation: The FAA should conduct research to determine realistic, justifiable, training quantities and frequencies, to inform realistic assessment of current training footprints and intervals, guidance on practice needed to maintain proficiency, and means to restore proficiency after time away from work.

Consequences: Because training is expensive, there is an economic motive to keep training footprints as small as possible; no operator will voluntarily increase their footprint over what is either required by regulation or generally accepted as "industry standard," because to do so would put them at an economic disadvantage compared to their competitors. Without scientific data to define proficiency retention, the FAA may not have the data needed to determine the suitability of training footprints and intervals. The FAA may continue to rely on training standards and requirements that do not address widespread skill degradation risks, such as from pandemics.

Subcommittee on Aircraft Safety

General Observations: During the REDAC SAS meeting, FAA presented a series of updates and a review of the R&D program accomplishments. It was observed that many of the R&D efforts have the potential to support on-going developments in industry, especially many of the new entrants to aviation. Given the international scope of aviation today, it will be important for the FAA to collaborate with other regulators to find a common set of requirements and how those requirements can be used as a means of compliance to the regulations. This will allow companies to develop aircraft and systems that will be accepted worldwide. In addition, it will be important for the FAA to build on the R&D efforts to collaborate closely with industry to establish a solid regulatory framework for this new technology. This is critical for innovation and bring new entrants into the aviation eco-system.

Finding: FAA's R&D Efforts during COVID-19 Pandemic - The REDAC SAS received briefings on the FAA's R&D program developments. It was clear that tremendous progress has been made during the past six months, in spite of the challenges of COVID-19. Industry representatives on the SAS were impressed at that progress and commend the FAA for its efforts during this pandemic. While significant progress has been achieved during these unprecedented times in our nation's history, from a long-term perspective, to meet the needs of the industry, a

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continued focus on the R&D program will be imperative. The Committee was briefed on the COVID-related suspension of all FAA human subjects research; the potential for budgetary and programmatic disruption is of concern. In addition to the COVID-19 situation, both industry and the FAA have had the additional burden of dealing with the outcomes of the Boeing 737MAX re-certification effort. As further lessons are learned from the investigation and subsequent re-engineering requirements, the potential exists to put new priorities on the R&D program.

Recommendation: As the FAA continues its R&D work program, the REDAC SAS further encourages the continued focus on those funded programs. The REDAC SAS requests regular updates to any programs that may be negative impacted by the COVID-19 crisis, including re-planning of milestones and areas where the REDAC SAS can assist.

Recommendation: As progress is made on the recertification of the 737MAX, at the appropriated time the REDAC SAS requests a briefing on what lessons have been learned and the impact they are having on the FAA's R&D portfolio and any changes to its priorities.

Finding: Fatigue Risk Management R&D Portfolio - At the Fall 2020 REDAC SAS meeting, the committee received an update on the FAA's research efforts focusing on aircrew fatigue. This followed a similar briefing during the Spring 2020 meeting. The Subcommittee continues to be impressed with the dedication of the researchers briefing their fatigue research, and notes efforts to bring together fatigue-related research from different policyholders, funding programs, and research organizations within the FAA. Notably, the overdue addition of rotary-wing aviation operations to the fatigue working group is recognized.

The SAS recognizes that efforts are ongoing to provide a) a fatigue research program that provides a method of surveillance for early indicators of fatigue hazards across aviation operations in U.S., and b) a structured research program to assess the effectiveness of FRMP/FRMS in Part 121 passenger-carrying operations. Dr. Nesthus briefed two proposed studies into the fatigue issue, one dealing with short haul flying and the other on circadian shift during long haul operations. Dr. Nesthus also stated that due to funding constraints, emphasis would be placed on accomplishing the short haul study initially due to the level of risk and the current gaps in existing research. The committee agrees with this reasoning and that the short haul study should be done first.

However, despite the FAA's apparent support for the FMWG and for increased fatigue research, the SAS made two observations: 1) There still does not appear to be any planned research aimed at reviewing the existing FRMP/FRMS program to assess its performance in long-haul commercial aviation operations. Such research could take the form of surveys, event reports, accident reviews, data analysis, etc. 2) SAS committee received budgetary information showing that several fatigue research requirements, including the two studies mentioned above, are unfunded in FY2022. The researchers indicate that these studies may be suspended due to lack of continued funding.

The FAA's method of annually re-prioritizing research and funding on multi-year projects can negatively impact the methodology and study design if there is a year-long or more break in the study. Furthermore, since FRM research involves volunteer human subjects, there is an underlying personal risk those individuals subject themselves to when participating in a study. If

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that study is subsequently canceled or postponed, they have then been exposed to that risk for no reason. The Committee hopes that funding reforms in the FAA will correct this problem.

Recommendation: The Subcommittee would like to see additional information on the FAA's fatigue-related projects to enable a better understanding of funded research objectives and deliverables. The SAS is requesting an update at the Spring 2021 meeting on the progress and continued funding of this research.

Recommendation: The Subcommittee recommends for the FAA to restore full multi-year funding for the two research projects discussed above, which follow up on the effectiveness and utility of the FRMS/FRMP and allow the FAA to identify shortfalls and potential enhancements to the current flight time/duty time regulations. Furthermore, the Subcommittee recommends the FAA reevaluate its methodology for prioritization and funding for multi-year human subject research that results in a more stabilized and continuous support for those projects.

Finding: Aircrew Stress Biomarker Research - The SAS REDAC received an update on aircrew stress biomarker research at the FAA's Civil Aerospace Medical Institute (CAMI). The committee is impressed with this world-leading research effort. Objective markers for degraded aircrew performance and health are urgently needed to replace current subjective reporting methods that fail to reliably aid accident investigators in assessing human factors in accident causation. This ground-breaking research into gene expression and genetic-based biological indicators at CAMI is unique in the federal government and aims to deliver tools that can identify pre-accident aircrew stress states (e.g., fatigue, hypoxia, disorientation) that will revolutionize aircraft accident investigation. Additionally, these techniques, when validated, can serve as fitness-for-work assessments, giving safety and management personnel tools for real-time risk assessment decision-making.

Recommendation: The Subcommittee requests that the FAA consider the potential short- and long-term benefits of objective genetic-based biomarkers for aircrew stress and impaired performance and evaluate possible stable funding strategies to support this important and unique forward-looking research program.

Finding: Ice Crystal Icing - The Subcommittee appreciates the FAA research in Ice Crystal Icing on High Altitude Icing on Turbine Engine Damage and Power loss. The project is currently funded through the 2020 fiscal year but not beyond. Further in-depth research can aid current rulemaking work to address this issue appropriately.

Current funding was used for several flight campaigns however, the data analysis portion requires addition funding for consultants. Additionally, as many projects are put on hold during the COVID-19 pandemic, funding should be available for ongoing work including additional testing for modeling and testing for ICI accretion behind the fan.

Recommendation: The FAA should consider further funding for Ice Crystal Icing research for Fiscal years 2021 and 2022 and beyond as this problem has not been adequately addressed in certification and rulemaking. The FAA should consider additional research in the following fields:

- Aerosol testing to determine how the water droplet adheres to the pollutant.
- New engine entrants and components (e.g. wide cord fans, composites, etc.)

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Subcommittee on Environment and Energy

General Observations: The Subcommittee once again focused on reviewing the R&D portfolio for Environment and Energy that was developed based on the FY20 budget that was enacted on December 20, 2019 and an update on the FY21 budget. During the meeting, the Office of Environment and Energy (AEE) provided updates on all of the major research components of the portfolio. Work on programs such as the Aviation Sustainability Center of Excellence (ASCENT); Continuous Lower Energy, Emissions and Noise (CLEEN); Commercial Aviation Alternative Fuels Initiative (CAAFI); Carbon Offsetting and Reduction System for International Aviation (CORSIA) and the Aviation Environmental Design Tool (AEDT) have been progressing. The updates highlighted accomplishments that have been realized both locally and on the international front directly linked to the research that has been completed since our last meeting. There was some discussion on how to publicize the accomplishments of the AEE research.

Despite the COVID-19 concerns that we had expressed in our last report, the Subcommittee was very impressed with the job the leadership and staff of AEE has been doing. The presentations were well done and reflected impacts and or potential impacts, because of COVID-19, to the research that is being done and is proposed in the future. The presentations outlined a high level of communication between AEE staff and their partners to continue these necessary research efforts. The Subcommittee is also very happy to learn about the number of staff that have been hired to fill staff vacancies and the fact that the grant process has been improved resulting in a large number of grants being awarded.

The Subcommittee believes that AEE is doing a good job and has once again presented a balanced portfolio. We believe that the research priorities that the Subcommittee has previously identified do not need to be adjusted. The Subcommittee was happy to see that a number of new research projects have been added to study the impacts of UAS/UAM and Supersonics. The Subcommittee members realize that there is still additional research required to address ongoing areas of concern. There was some discussion among the members on whether there are any research opportunities that currently exist because of the impacts that COVID 19 has had on aviation industry.

The Subcommittee is comfortable that AEE, the ASCENT Center of Excellence, CLEEN Program, CAAFI and others efforts, as well as and their partners, including NASA, are working together to realistically address the potential impact that the COVID-19 pandemic could have on continued research efforts. This pandemic continues to have a major impact on the citizens of the world and the aviation industry, among others.

Finding: Global Leadership - It is evident that the FAA AEE currently maintains a leadership role in ICAO CAEP and has been the driving force behind the push for data driven rule making. Despite the impacts of COVID 19 on aviation globally, the Subcommittee firmly believes that maintaining the U.S. global leadership position at ICAO CAEP is essential and advantageous to U.S. aviation industry. Work that has been done with ASCENT and the Volpe Center has clearly allowed the FAA to maintain a scientifically supported position at ICAO CAEP. The close collaboration with NASA at ICAO CAEP is also clearly supporting global leadership. Anything

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that jeopardizes ongoing research at AEE will impact the FAA/U.S. global leadership position at ICAO CAEP.

Recommendation: The Subcommittee recommends the continuing strong support of all research efforts/programs that will allow the FAA and the U.S. to maintain its current global leadership position at ICAO CAEP. It is the belief of the Subcommittee that if the FAA/U.S. does not maintain its leadership position at ICAO CAEP it will not be able to influence policy/rulemaking and this could have a significant negative impact on the U.S. aviation industry.

Finding: Public Private Partnerships - The Subcommittee wishes to acknowledge and support the fact that the Office of Environment and Energy (AEE) have proven over decades to be very good stewards of taxpayer money. The leadership team at AEE has used their budgeted amounts to conduct and coordinate the research necessary to produce informed, data driven policies, facilitate technological advances in the aviation industry, and produced models and data that have positioned the U.S. as both a State leader at ICAO CAEP and on the global aviation stage. The execution of this research portfolio has been accomplished by working collaboratively with private industry, major universities through the ASCENT Center of Excellence, other Federal Departments and Foreign Governments. Three quarters of Environment and Energy research funds generate 100% plus cost matching from non-federal partners (CLEEN, CAAFI, and ASCENT). This leverages scarce FAA R&D funds to accomplish significant advances and improvements. In addition, we believe that government funding has been used and executed effectively to lower the risk of new and emerging technologies such that they can be adopted by industry. The benefits of these partnerships has clearly been proven over time and is very apparent in most of the current projects. The maturation of new technologies has delivered improved environmental performance and has enabled aviation system growth and associated positive economic impacts.

Recommendation: The Subcommittee continues to endorse Public Private Partnerships like the CLEEN, CAAFI and ASCENT programs to leverage resources and recommends that FAA should continue to allocate robust funding for these programs.

Finding: Sustainable Aviation Fuels (SAFs) - Significant gains have been realized in the Alternative Jet Fuel (AJF) Program (including efforts in the Commercial Aviation Alternative Fuels Initiative (CAAFI), CLEEN and ASCENT). Sustainable Aviation fuels (SAFs) are a critical component of the industry's emissions reduction strategy and must be developed if industry is to get to their carbon neutral growth goals after 2020 and their emissions reduction goals in 2050. This research has helped with the creation of a number of companies that have the potential to benefit the rural economies of several states and the U.S. Aviation industry. More than 3 million gallons of SAF was used in the first half of 2020 and expectations are positive that there will be a significant increase in consumption as production is increased. Recent support from a number of agencies, including the DOE will support SAF production. There are efforts to ensure that alternative jet fuels are in CORSIA through ICAO CAEP. The subcommittee members were very pleased to see that funding in this area has been restored in the President's budget for FAA AEE and they applaud the FAA leadership for their foresight on this matter as they are making it once again a vital part of their overall investment portfolio

Recommendation: It is still the position of this Subcommittee that the work on Sustainable Aviation Fuels is critical to the U.S. industry and the FAA should maintain a leadership role in

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the development of SAFs to ensure that the rules to be considered will be beneficial to the U.S. industry. Since the maturation of the Alternative Jet Fuel program will be a major environmental benefit for the public, will create a new industry within the U.S. that benefits rural America, and will benefit the U.S. aviation industry, we strongly recommend that the FAA AEE continues to allocate funds for the continuation of research on SAFs.

Finding: Noise Research - Aviation nose continues to be an issue that requires ongoing research. The Subcommittee realizes that there is much research that is still necessary to address the ongoing topic of aviation noise. AEE has a number of research projects that are looking at the impacts of noise on children's learning, sleep impacts, community annoyance and cardiovascular health. AEE is looking at the certification requirements for supersonic aircraft as well as UAS that are larger than 55 pounds. AEE is also examining how to reduce the noise from commercial aircraft and helicopters through changes in operational procedures. There are a number of new research projects that have been added to address issues related to new entrants into the aviation system. There also have been significant upgrades made to the Aviation Environmental Design Tool (AEDT). FAA has also launched an initiative to partner with airports to gather more noise data resulting from noise complaints. Finally, AEE is working with industry to accelerate the development of technologies that reduce noise through the CLEEN Program.

Recommendation: The Subcommittee strongly supports the prioritization of the noise research that will support informed decision-making, the introduction of new entrants to the national air space, and enable NextGen deployment.

Subcommittee on NAS Operations

Finding: Research Landscape - The Subcommittee received a briefing describing the FAA's progress in developing and exploiting its Research Landscape for the National Airspace System. The briefing included an overview of the purpose and framework for the Landscape, and a view ahead to next steps for the effort.

The Subcommittee appreciates the utility of defining research Drivers and mapping them to the various RE&D activities within the FAA. The organization of the Landscape into four major Driver categories (Advances in New Vehicles / New Missions; Advances in Technology and Materials; Advances in Data and Processing Power; System Wide Advancements / Improvements) is helpful toward understanding how the broad range of RE&D programs span the space of work required to progress beyond NextGen. Some challenges in the roll-out of this process were identified, including the need to better socialize the various Drivers so that program managers understood where their programs would fit within the Landscape, and some practical matters such as requiring the ability to allow program managers to map their work to more than one Driver. We anticipate that those challenges will be easily addressed in the near future. At this time, however, the connection between the Research Landscape and the FAA's research planning process has not been clearly articulated. The Subcommittee identified an opportunity to more explicitly connect the Research Landscape to the FAA's RE&D planning and prioritization efforts.

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Recommendation: The NAS Operations Subcommittee recommends that the FAA more clearly define how the results of the Landscape effort will inform RE&D prioritization, and subsequently report out periodically to the REDAC Subcommittees on the prioritization process. By making a connection between Drivers and priorities, we anticipate there will be more utility extracted from the Landscape process beyond its current value in communicating Driver-to-Research mappings. Ideally, the Subcommittees would be provided with regular updates on the connections between Drivers, RE&D programs, and their priorities, to build a more holistic understanding of the FAA's research portfolio.

Consequences: A failure to explicitly connect the Research Landscape to RE&D program priorities would limit the utility of the Landscape effort. Lacking that connection would represent a missed opportunity to make full use of the efforts expended in building and maintaining the Landscape.

Finding: Resilient autonomy in the future NAS – The Subcommittee received briefings on the FAA 2035 Vision and related development of a 2045 Vision by NASA. These invoke a significantly higher degree of autonomy than today's NAS, with machine learning (ML) and artificial intelligence (AI) supporting a dense operations environment comprised of diverse vehicles and operating entities. These visions allude to the need for operations-recovery constructs and infrastructure resiliency when off-nominal conditions occur. The subcommittee notes, however, that responding to novel, or previously unobserved situations (and recognizing precursors to these) is particularly challenging for ML/AI technology.

Recommendation: Development of strategies for effectively responding-to and recovering-from significant, off-nominal scenarios should be a priority in these future NAS visions. The off-nominal scenarios encompass both unplanned operational events as well as system failures. In system failures, the likelihood that significantly-more-intense operational responsibilities will need to shift back temporarily to the human work force in a graceful manner (airline, air-traffic control and flow-management) during off-nominal situations should be considered. In addition, historical data on these autonomous systems performance and behavior does not exist, and thus a prognostic analytical approach is needed to determine the system health as well as assist in standards development and certification processes. Furthermore, the autonomous systems will need to co-exist and be integrated into the traditional human centric systems. The subcommittee recommends that future versions of these FAA and NASA visions, and their related RE&D efforts, explicitly address strategies for off-nominal event management, recovery, and graceful system degradation, and that these be briefed to the subcommittee when appropriate.

Consequences: If research on autonomous system resilience is not explicitly included in the future NAS vision and its associated RE&D programs, there is a risk that additional costs will be incurred later in the development process to achieve the high levels of safety and efficiency that are required.

Finding: Flight Deck Data Exchange Requirements Program Coordination -

The Subcommittee received separate briefings on A11.r Flight Deck Data Exchange Requirements and on Aircraft Systems Information Security Protection (ASISP) research. These presentations described the benefits, initial accomplishments, and anticipated future research in each program.

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Both of these efforts are targeted at identifying and mitigating potential cyber vulnerabilities in aircraft systems including air-ground information exchange. An important part of the cyber analysis process is developing a methodology that is both effective and vetted across multiple stakeholders including the FAA and other government agencies, and industry spanning airframe manufacturers, avionics, ground systems, and data communications systems. The ASISP program has built a strong cyber Safety Risk Assessment (SRA) methodology that has been closely coordinated with industry and government stakeholders including the Cyber Safety Commercial Aviation Team (CS CAT) and broader constituencies such as the tri-agency Aviation Cyber Initiative (ACI) and the international Aviation Information Sharing and Analysis Center (A-ISAC). ASISP has successfully conducted several cyber system analyses on critical components such as the Flight Management System.

In contrast, the cyber analysis process currently being used in A11.r was not explained directly, and it was apparent that this effort is not closely coordinated with or leveraging the methodologies and accomplishments of the ASISP program. Some efforts, such as analysis of Aircraft Information Displays and Flight Management Systems, appear to be duplicative or overlapping with ASISP.

Recommendation: The FAA should ensure that the A11.r research effort is making full use of and closely coordinating with the ASISP program. Findings and methods used in ASISP should be informing the methods used in A11.r, and likewise results from A11.r should be coordinated with ASISP and the broader ACI and A-ISAC communities.

Consequences: A failure to closely coordinate the activities under A11.r and ASISP risks duplicative efforts and reduced progress in the important work required to ensure aviation cyber security. Especially given the limited RE&D budgets available for cyber work, it is important to ensure all efforts are coordinated and augment progress.

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