Research, Engineering, and Development Advisory Committee (REDAC)

HYBRID SESSION
Wednesday, April 12, 2023
Meeting Minutes
Federal Aviation Administration (FAA) Headquarters
FOB 10A, 5th Floor Conference Center
800 Independence Ave, SW
Washington, DC 20591

Purpose	REDAC Findings and Recommendations on the FY 2025 R&D Portfolio
Facilitators	• Dr. R. John Hansman, *Research, Engineering, and Development Advisory Committee (REDAC) Chairperson, Massachusetts Institute of Technology (MIT)* • Ms. Shelley Yak, *FAA William J. Hughes Technical Center (WJHTC) Director and REDAC Executive Designated Federal Official*
Note Taker	Ms. Beth Arnz

Presentation: Welcome Address and Opening Remarks | **Presenters:** Dr. R. John Hansman, *REDAC Chairperson, MIT,* and Ms. Shelley Yak, *WJHTC Director and REDAC Executive Designated Federal Official, FAA*

Dr. R. John Hansman opened the meeting with a brief introduction, including agenda review and administrative notes. Ms. Shelley Yak announced the public meeting notice posted in the *Federal Register* on March 17, 2023 as required.

Presentation: Public Forum – Aviation Impacted Communities Alliance (AICA) | **Presenters:** Dr. Cindy Christiansen and Darlene Yaplee, *Co-Founders of AICA*

Dr. Hansman informed the Committee that the public had provided a submission for REDAC review. Dr. Cindy Christiansen and Darlene Yaplee, the co-founders of AICA, addressed the Committee. AICA has recommended five additional research proposals to the FAA (in addition to the six recommendations made at the October 5, 2022 REDAC Summer/Fall Meeting, and the seven recommendations made at the November 18, 2022 REDAC Special Session). Ms. Yaplee, co-founder of AICA, stated that aviation noise is and continues to be one of the largest environmental impacts related to aviation and requires ongoing research to address public concerns. Ms. Yaplee and Dr. Christiansen shared five additional recommendations for REDAC consideration:

(1) <u>A Process Study of the FAA's Noise Policy Review:</u> This review, which AICA believes will be highly consequential, should be "robust, data-driven, and inclusive" as affirmed by the Agency. The Committee was asked to provide independence, rigor, and data to the policy review. The intent of the recommendation is to avoid an unacceptable FAA Report to Congress, as occurred in April 2020 when alternative noise metrics

were not evaluated, resulting in a report that did not fully capture noise impacts. The FAA currently has a two-year interagency agreement with the Federal Mediation Conciliation Services to ensure that the updated report is effective, inclusive, timely, and thorough.

(2) Impacts of Quiet Sonic Booms over Land Study: A study of the expected noise on the ground and public health effects caused by supersonic aircraft.

(3) Family of Area Navigation (RNAV) Dispersion Study: In January 2016, Dr. Tom G. Reynolds of the Air Traffic Control Systems Group at MIT Lincoln Laboratory described a family of RNAVs as a way to disperse aircraft. The study should assess the feasibility, benefits, and barriers for implementing "RNAV-family" or "multi-RNAV" procedures to disperse concentrated flight paths in areas not adjacent to major airports but that are disproportionately impacted by aviation noise from performance-based navigation procedure implementation.

(4) Quiet Descent Requirements Study: A study to design and implement existing and future arrival procedures and approaches that allow aircraft to fly in a clean configuration all the way to final approach at least 90% of the time. This includes design criteria for instrument arrival procedures and approaches that enable aircraft to fly idle and in a clean configuration all the way to final approach and to increase slightly the in-trail separation between aircraft to avoid the need for Air Traffic Control to speed up or delay arriving aircraft before final approach because of air traffic or airport congestion.

(5) NextGen Reduction in Fuel Study: A study designed to determine whether NextGen met the goal to reduce aviation pollution by reducing fuel usage. AICA recommended estimating and comparing pre/post NextGen fuel usage of all operations for at least ten major U.S. airports (separately) using airport fuel data. The comparison should adjust for pre/post-differences in enplanement, aircraft, cargo, destination, operation counts, and weather. If fuel usage per flight is available, researchers should use airport enplanement, aircraft, cargo, weather, and fuel data to estimate flight-path fuel usage for short- and long-haul departure operations between paired airports in pre/post-NextGen RNAV implementation time periods.

Dr. Christiansen stated that AICA's hope was that the Committee would take a balanced, independent, and inclusive research perspective to sufficiently represent the local community stakeholders who could be substantially and negatively affected by aviation noise and pollution. Dr. Hansman thanked Ms. Yaplee and Dr. Christiansen for their recommendations and stated that they were consistent with what AICA had previously recommended.

Presentation: Strategic Outlook for Aviation Research (SOAR) Overview| **Presenter:** Ms. Shelley Yak, *WJHTC Director and REDAC Executive Designated Federal Official, FAA (ANG-E)*

Ms. Shelley Yak discussed the new Strategic Outlook for Aviation Research (SOAR) messaging. The purpose of the presentation was to solicit feedback on the SOAR charts. She explained that the FAA needs to articulate an understandable and relatable story about its research initiatives to internal and external stakeholders, connecting what the research is to the flying experience. Currently, on a yearly basis, the FAA delivers a briefing to the House Science Committee by research domain. Ms. Yak presented an example slide (Airport Infrastructure and Technologies) with an overview of the FY 2023 domain priorities. For each domain, the slide includes the budget line items associated with the domain, the research purpose, and the fiscal year domain priorities. She explained that this is how the FAA communicates today.

Ms. Yak then explained the need to change the way the portfolio is communicated. The message is repetitive (research doesn't happen in one year) and is overly focused on the near-term. Because of the way the FAA builds

and communicates its budget, she explained that the perception is that research does not end or conclude, is not completed in a timely manner, and may not keep pace with technology trends and industry needs. Therefore, a new approach will be taken to change the perception. The new messaging should share and facilitate discussion on the FAA's R&D portfolio/strategy – expected outcomes, research drivers, and long-term projections.

Ms. Yak presented a new slide entitled "Strategic Outlook for Aviation Research: BY DOMAIN AREA" to purposely look at research areas where the FAA needs to lead (likely near-term), strategically partner with others (academia, industry, other governmental agencies), and what the trends are/what is coming down the pike. The new communication concept will provide visibility on the R&D portfolio over a 15-year timeframe and is organized in the following way: "Near Term/Current (2024-2028):" current, outcome-focused activities (what will research be used for), "Mid Term/Emerging (2029-2033):" emerging activities that the Agency is watching and/or partnering to address, and "Long Term/Projected (2034-2038):" projected trends that the FAA is watching and learning about. Ms. Yak then walked the Committee through an example: "Strategic Outlook for Aviation Research – Airport Infrastructure & Technologies." The intent is that this format be used for briefing the department, house science committee, etc. Although there are slides for all budget line items, the information is raw and in draft form currently, Ms. Yak stated. She anticipates that Committee and Subcommittee reviews/discussions on the SOAR charts would help the Agency anticipate future needs and better educate itself on how to support change.

The next steps are to continue refining the SOAR charts, share them for review and input at next REDAC Subcommittee meetings, incorporate updates, and baseline the charts. Ms. Yak explained that she wants to understand what industry is doing, what the priorities are, what is missing, any opportunities to partner, and what else is there to learn. Information will continue to be rolled up to the domain. These SOAR charts will be used in the FY 2025-2029 National Aviation Research Plan (NARP) and internal/external budget briefings. Ms. Yak stated that this new communication concept will enable the FAA to build research roadmaps (at program and domain levels) based on industry priorities and the Agency's role (aligning people, laboratories, partnerships, and investment areas).

Ms. Yak then invited Committee feedback on SOAR. Mr. Bob Pearce of NASA stated that he applauded the effort and what the FAA is trying to accomplish. He stated that what is missing are the elements of vision and context in areas where FAA has already taken the lead, such as the Infocentric NAS. Ms. Yak agreed that the Agency's current initiatives (e.g., vision documents on the Infocentric NAS and Landscapes work) and partnerships (e.g., NASA) need to be factored into the SOAR charts. Dr. Hansman agreed with the importance of linking SOAR/ traceability to other artifacts. Mr. Ian Redhead stated the Environment and Energy Subcommittee thought that the near-term should be more accomplishments-based (investments, partnerships) since these accomplishments will factor into the Agency's mid-term and far-term plans. He added that the FAA needs to take credit for things it has already accomplished (noise, changes to airport design, etc.); this will help change the impression that the Agency conducts research that never ends.

Mr. Chris Oswald thanked Ms. Yak for the presentation and stated that the Subcommittee appreciated getting an early look at the SOAR concept. He stated that the question he has was whether SOAR looking at a process/communication of research activities or anticipated outcomes; he believes that milestone research outcomes are important. Additionally, he would like to know how to expedite guidance through the research that the William J. Hughes Technical Center (WJHTC) does. Dr. Jim Kuchar added that dividing up research to align to the six domains almost aligns one-to-one with each Subcommittee, which will be beneficial for Subcommittee review of the SOAR concept. However, Digital Systems is not captured by a Subcommittee; he asked whether there was consideration to form a new Subcommittee. Dr. Hansman answered that this is always in play. Although it is a cross-cutting effort (like Human Factors), Digital Systems is worth a discussion. Dr. Hansman wondered if there was enough there to

merit its own Subcommittee. Dr. Hansman also recommended that the Subcommittees review their applicable SOARs at the next meeting. Ms. Yak stated that the SOAR drafts will be at the program level (and eventually rolled up to the domain level once feedback is incorporated) and would potentially have a look-back for accomplishments. Dr. Hansman stated that there is value to highlight not only budget line items but emerging research areas in the SOARs. Ms. Yak agreed.

Presentation: NASA Update | **Presenter:** Mr. Robert Pearce, *Associate Administrator, Aeronautics Research Mission Directorate, NASA*

Mr. Robert Pearce led a presentation to provide REDAC with a NASA Aeronautics Research Mission Directorate (ARMD) update. He also introduced the Deputy Associate Administrator for AMRD, Mr. Steven Clarke, to the Committee.

Mr. Pearce communicated the NASA ARMD vision that aligns the portfolio into four major areas: ultra-efficient transport (how do we get to next generation and net zero emissions by mid-century), high-speed commercial flight (increase speed of aircraft to make long haul flights shorter), future airspace and safety (work with FAA to achieve more efficient options; it is a more complex area – unique business models, aircraft characteristics, safety considerations, etc.), and advanced air mobility (AAM). These areas represent the NASA priorities for sustainability, greater mobility, and economic growth.

Mr. Pearce reviewed the FY 2024 budget request, noting that AMRD is awaiting Congressional approval on its operating plan. The FY 2023 Enacted amount of $935M represents a 6% increase over FY 2022 (AMRD had requested a 10% increase). He then reviewed the changes between the FY 2023 and FY 2024 budget requests. Major changes included a budget decrease for the sustainable flight demonstrator and electrified powertrain flight demonstration projects to better reflect current planning estimates, and a budget increase for zero emissions aviation activities (he highlighted a study of next generation aircraft designs, with a request for proposal coming out in fall 2023, and award later in the year). He discussed a workshop with the national academies on current state of science – focusing on contrails. Additionally, ARMD is working with industry partners on cost-sharing and bringing assets to the table to do this work. He stated that it is critical get the science right on contrail management. Mr. Pearce also mentioned that ARMD is getting pressure from Congress to do more research on Hypersonics. NASA has a plan to make research available to industry and the Department of Defense (DOD), including research on commercial Hypersonics. Finally, Mr. Pearce highlighted a budget increase to composite aircraft manufacturing to support technology development for both fuselage and wing structures.

Mr. Pearce then discussed NASA's cornerstone investment called the Sustainable Flight National Partnership initiative, which includes all elements for next generation. The initiative is based on 15 years of research to get to a technology readiness level (TRL) 4, and then a down select for the most promising technologies. There are two projects on the propulsion side and two projects on the airframe side (all are cost-share partnerships). This initiative will introduce electric power into propulsion systems to better optimize turbine engines (mild-hybrid) to achieve 30% more fuel efficiency. On the manufacturing side, NASA is trying to increase manufacturing rates and drive down production costs by a factor of six or seven. Additionally, NASA is working to enable use of 100% sustainable aviation fuels, through optimization of combustors.

Mr. Pearce reviewed the Sustainable Flight Demonstrator (SFD) Project which is a funded space act agreement (FSAA) to Boeing in 2023. NASA is providing $425M in direct investment and Boeing/industry partners are

providing $725M in direct investment. The aim is to get the Transonic truss-based wing into flight by 2028. Mr. Pearce explained that Boeing is mainly testing the structural and aerodynamic integration.

On the Operations side, Mr. Pearce referred to NASA-led Sustainable Flight National Partnerships (SFNP) Operations Demonstrations. There are four planned operational demonstrations (including all the development required to do the demonstrations, such as algorithm development). The first is the Collaborative Digital Departure Reroute (FY 2022-2025) which are airline tools that are live now at Dallas/Ft. Worth airport with American and Southwest airlines and which have been very successful; the Sustainable Oceanic Airborne Re-Routing, which had to be pushed out beyond FY 2023 due to a lack of funding; Irregular Ops Recovery/Disruption Management; and 4D Trajectory Optimization which is integration between the flight deck and ground systems to enable greater efficiencies.

Mr. Pearce then reviewed some of the FY 2022 realized benefits from Collaborative Digital Departure Reroute, which included somewhat modest but real benefits in terms of fuel cost, emissions, and delay savings. He gave the example of envoy, which stated that the above savings enabled solvency during the COVID 19 pandemic. NASA is working with the FAA on further flight trials.

For High-Speed Commercial Flight, NASA is trying to achieve an overland noise standard. The test method will be to deliver a dose of noise and survey the community to see if it is acceptable. The X-59 aircraft will be used for the testing. Mr. Pearce stated that fabrication is complete on the X-59, with its first flight planned for late 2023.

For Advanced Air Mobility (AAM), Mr. Pearce highlighted National Campaign 1 (NC-1) Accomplishments included trajectory performance, noise generation, including an automation architecture ground air, which NASA is working with the FAA to develop. This will be a big step up, according to Mr. Pearce. Mr. Pearce also highlighted AAM noise research/prediction, upon which NASA is working closely with the FAA at the vehicle and community level to predict noise profiles and noise mitigation strategies.

On the Safety side, Mr. Pearce highlighted the Verification and Validation (V&V) Capabilities for the Engineering Lifecycle (from requirements and design to verification and validation). In yellow and green on the slide are tools NASA has developed to automate and improve the V&V process. This V&V process represents a hidden yet enormous cost that holds back innovation and adds cost to the final product. NASA worked with industry to measure the benefits, which included cost savings and quality improvements in different use cases. NASA is working closely with the WJHTC on this effort, including on a V&V of autonomous systems which will be published in the next month or so.

Mr. Pearce stated that NASA is starting a project in 2023 on Advanced Capabilities for Emergency Response Operations which will test emerging aviation technologies applied to identify, monitor, and suppress wildfires. NASA worked to establish trust with the wildfire-fighting community and gathered requirements. They are currently working to form a partnership with impacted federal and state resources (first step will be to develop a CONOPS and roadmap). The project can be used as a model for other emergency response scenarios (post-storm).

The final initiative Mr. Pearce presented to the Committee was the University Leadership Initiative (ULI). This has been very successful; it brings universities into the aeronautics program in ways that had not been done in the past. NASA recently awarded the 6th round of ULI awards (awards total $178M). In ULI, universities take the lead, build their own teams, and set their own research paths. The initiative has garnered great feedback from program stakeholders.

Presentation: Unmanned Aircraft Systems (UAS) Integration Update | **Presenters:** Ms. Sabrina Saunders-Hodge, *Director, UAS Research, FAA (AUS-300)* and Mr. Jeffrey Vincent, *Executive Director, UAS Integration Office, FAA (AUS-001)*

Dr. Hansman stated that Ms. Sabrina Saunders-Hodge would provide an update on the FAA's UAS Task Integration Research. Mr. Jeffrey Vincent, Executive Director of UAS Integration, introduced himself to the Committee. He was formerly Vice President of Air Traffic Services. Mr. Vincent expressed that he has been in his new role for less than 90 days, has learned a lot about Unmanned Aircraft System/Advanced Air Mobility (UAS/AAM), but believes that the FAA is not moving fast enough on UAS/AAM. He has been concentrating on operations beyond a visual line of sight.

Ms. Saunders-Hodge framed the UAS discussion using a SOAR chart for "Cross-Cutting Research in Emerging Operations: UAS and AAM." Ms. Saunders-Hodge walked through the chart, which highlights a five-year rolling plan, on which the Committee provided commentary. It demonstrates the organization's focus and priorities within the different five-year terms (she highlighted beyond visual line of sight operations). Ms. Saunders-Hodge's organization needs to provide data to allow internal organizations to assess compliance (e.g., detect/avoid). The organization is working with offices of primary responsibility (e.g., Counter-UAS, ASH, Airports) to provide planning to support primary responsibilities. She gave an example that you can prove something scientifically that risk is low, but community is last line of defense for accepting safety risk. Research is outcome focused in near-term.

For the mid-term research outlook, Ms. Saunders-Hodge stated that they are looking at operations that have been successful and thinking about far-term; a progression where Advanced Air Mobility (AAM), (Artificial Intelligence) (AI) and Machine Learning (ML) come into their own. She stated that they must keep the cadence up with evolving operations in the NAS for UAS/AAM.

Ms. Saunders-Hodge informed the Committee that she receives many questions about partnering. The organization partners with every line of business (LOB) across the Agency to make sure that the UAS/AAM integration strategy is robust, is hitting targets, and is filtered through a rigorous criterion, as they need to make the best of limited funds. On a monthly basis, Ms. Saunders-Hodge hosts a roundtable for all LOBs to come together and discuss research; she has been doing this since 2017. With regard to overarching research partners, she reiterated that they work closely with internal and external partners, including REDAC, federal partners, NASA, industry, standards groups, and others.

Ms. Saunders-Hodge then reviewed the Committee comments on the FAA's UAS/AAM Integration Research Plan from the closed session held in November 2022 and the FAA's responses to those comments. She thanked the Committee and Subcommittees for their efforts to review Edition 5 of the plan (2021 to 2026). It served to raise awareness of content needing clarity/enhancement, but also served to validate some improvements that were underway. Her team is actively working to integrate comments into Edition 6 (2023-2028). This should be ready by the end of 2023. The introductory material was too much; the FAA agreed and will move this information to an appendix. Additionally, Ms. Saunders-Hodge stated that she received great feedback on timeline charts. They are being recalibrated to show research durations, timeframes for results, linkages between projects, etc. She also plans to include a high-level summary of completed research and key outcomes. Every comment was considered. The charts available for review offline.

Ms. Saunders-Hodge then discussed specific comments and recommendations from each Subcommittee: Aircraft Safety, Airports, Environment and Energy, Human Factors, and NAS Operations. She mentioned that the feedback

from different Subcommittees were well-aligned and most asked similar questions. She did not review all the comments and responses outlined in her slide presentation. Key takeaways included planned development of a research accountability framework; revised timelines with more granularity, linkages, and interdependencies in Edition 6; plans to develop a standalone executive summary; and continued community engagement.

Dr. Hansman thanked Ms. Saunders-Hodge for responding to Subcommittee comments and solicited questions from the Committee. Mr. Ian Redhead noted that consolidation in the Unmanned Aircraft Systems/Advanced Air Mobility (UAS/AAM) industry is expected due to financial constraints and other factors. He asked if the FAA is seeing this. Mr. Jeffrey Vincent responded that industry will drive itself; the FAA's concern is UAS/AAM integration into the NAS. The infrastructure challenge is below 400 ft. for drones. Dr. Hansman stated that there is a lot of action happening in the unpiloted zone (e.g., WISK, X-Wing, Reliable Robotics). This has already started and the timelines are shorter than the initial UAS/AAM five-year bucket. He asked to what extent is there feedback when companies are showing up with applications were not expected; does this new information get factored into the integration plan. Dr. Hansman believes that industry is on the cusp of pretty good technology with definitive go-forward plans and CONOPS. What has happened in the past two years that makes the FAA rethink the substance of the larger integration plan, and not only the executive summary, as industry moves faster than anticipated. Dr. Hansman foresees much progress in unpiloted large vehicles (taking the technology that has been proven for small UAS and moving it to large UAS). Ms. Saunders-Hodge had executives review their portfolios to determine what was and was no longer relevant (Feb 2023). This exercise will be done on a continuous basis. She stated that the organization will continue to ask whether the research is producing what is needed in a timely fashion. Dr. Hansman stated that this was good, although he is more worried about innovations on the horizon. He recommended looking at WISK CONOPS and asked if the FAA ready to complete the interface (How would Air Traffic Control issue a clearance when there is no pilot?). Joe Bertapelle questioned how to communicate UAS/AAM integration to small flight centers. Do you worry about drones and the question about uncontrolled air space vs. controlled air space? Ms. Yak stated that part of the question is related to pilot training on the future environment. Jeffrey Vincent added that the question is are machines able to comply with ATC; the answer is yes, this is happening today in the environment.

Presentation: Artificial Intelligence/Machine Learning| **Presenter:** Dr. Trung T. Pham, *Chief Scientific and Technical Advisor for Artificial Intelligence – Machine Learning, FAA (AIR-020)*

Dr. Trung Pham presented a roadmap to "Artificial Intelligence and Machine Learning (AI/ML) in Aviation" at the FAA. Dr. Pham joined the FAA as Chief Scientist of AI and ML in July 2022, coming from the U.S. Air Force Academy. In Spring 2022, the Subcommittee on Aircraft Safety made a recommendation to FAA to have an AI/ML roadmap to inform the aviation industry of the sequence in which the Agency plans to release regulatory guidance on methods and procedures for AI/ML certification so that the industry can incorporate AI/ML innovation. This roadmap must offer technical guidance on completing the tasks to accomplish the roadmap milestone.

Dr. Pham defined AI as a technological discipline that mimics human intelligence in computational machines. The definition and scope of AI is broad and covers almost every field of engineering (e.g., Smart System – has flavor of AI in it). The FAA learned from its European Union Aviation Safety Agency (EASA) counterpart that instead of focusing on covering everything in its AI roadmap all at once, the Agency will focus initially on ML. ML is used to bypass the expertise of an engineer to design a system based on requirements (ML is an area of AI). The disadvantage of AI is that it is difficult to verify and validate from a certification standpoint. Dr. Pham then reviewed the background history of ML technology assessment from 2019 to 2023. Although the FAA did not have an

Artificial Intelligence/Machine Learning (AI/ML) Roadmap, it did make research investments in AI/ML during this time.

Dr. Hansman asked Dr. Pham to clarify for the Committee his focus area: Dr. Pham responded that it is on certification of AI/ML algorithms on aircraft/avionic/aviation systems. In 2023, the Agency will develop an AI/ML roadmap to certify AI/ML systems to encourage industry to engage in innovative AI/ML. To meet this one-year deadline, the Agency intends to use as much of the existing framework as possible. Dr. Pham stressed that he is grateful for EASA's teachings from experience with their AI/ML roadmap. His opinion is that FAA regulations for existing technology should help the Agency move forward on the new AI/ML technology and should be used as much as possible.

Dr. Pham also emphasized that the roadmap should leverage FAA's safety continuum (culture of safety). The Agency is working to define different levels of automation (low risk to high risk) – similar to what EASA developed. The bottom-up methodology is to work with a specific ML application at the beginning to develop a working structure before generalizing it to address a broad range of AI applications. Certification is focused on three overarching properties: intended functionality, correctness, and innocuity (unintended function in design). Additionally, another challenge (and lesson learned from EASA) is that AI/ML technologies are not uniformly defined. Dr. Pham proposed using basic engineering terminologies for broader acceptance.

For 2023, Dr. Pham's team will conduct a technology assessment, and then form a team to draft a report based on the assessment, with input from industry and the regulation community (and FAA review) before it is finalized. An initial draft is forthcoming next week. He stressed that it was important to work together with industry and EASA to ensure that regulations mesh. Dr. Pham noted that EASA's ML investment is four times the budget of the FAA. While the Agency is three years behind EASA on the AI/ML roadmap, Dr. Pham concluded that sometimes it is better to be second mover as there are lessons to be learned from the first; he gave examples (e.g., Microsoft, Apple).

Dr. Hansman thanked Dr. Pham for his presentation. He stressed that there are many places where AI/ML impact the FAA. As Chief Scientist, Dr. Hansman asked about his other areas of concern. Additionally, he urged Dr. Pham to focus on overarching properties (OP) 3 as OP 1 and OP2 deal with performance. Dr. Pham responded that he has regular meetings with industry and NASA. In Feb 2023, they collectively agreed that the current focus should be in OP3. However, they ran into a problem in computational efficiency for OP3. He is working with Boeing to form a consortium to share a cloud computing platform to confirm the OP3; this is extremely important. Dr. Hansman maintained that the core issue is the pass criteria for OP3. Dr. Pham agreed. Bob Pearce recommended putting the question out to academia/industry as a challenge: what criteria on OP3 is acceptable? The question is not limited by the processing and is the core question, according to Dr. Hansman. The original recommendation from the Subcommittees was to define levels of criticality – Dr. Pham stated that he is looking at testing requirements and is defining the levels now.

Presentation: Subcommittee Report – Human Factors | **Presenter:** Barbara Holder, Ph.D., *Embry-Riddle Aeronautical University (ERAU), FRAeS*

Dr. Barbara Holder began the Human Factors Subcommittee briefing by giving an overview of the agenda and topics discussed during the March 2023 hybrid meetings. During the meetings, the Subcommittee reviewed briefings from each program manager along with a budget update, including responses to the Findings and Recommendations (F&Rs) from the Spring meeting. Invited presentations included the AVS Human Factors Research Roadmap,

Augmented/Virtual/Extended Reality (AR/VR/ER) Research (what is being done at the WJHTC and the FAA Civil Aerospace Medical Institute (CAMI), Human Factors AR/VR/ER Research Updates, The Airline Pilots Association (ALPA) Views on Emerging Technologies (unfortunately, the Subcommittee got their official position, but actually wanted to understand the problems they are seeing and how to address them. This will be remedied in the next meeting), Infocentric NAS (there is lots of information here and the Subcommittee wants to understand it better), and FAA Advanced Air Mobility "Innovate 28" (again, the Subcommittee has more questions on this topic).

Dr. Holder presented the only Finding and Recommendation (F&R) from the Spring meetings: Advanced Vision Systems and Runway Safety. She stated that although there is lots of investment in this space, the main issue is that previous research and planned research is too technology-focused; it did not address impacts to other less vision-focused systems within the aircraft (and the integration with other systems that might alert pilots to runway safety issues – e.g., runway advisory systems). The Subcommittee recommended that the FAA research the effect of the use of Enhanced Vision Systems (EVS), Synthetic Vision Systems (SVS), and Augmented Reality systems (AR) on pilot attention to other queues (either environment-related or via runway warning systems that are presented to the pilot). The Subcommittee would like to ensure that the risk of runway incursion is not increased if these systems are deployed without an understanding of how they integrate with each other.

Dr. Holder then presented an Observation (the Subcommittee debated calling this a Finding and Recommendation (F&R), but the background briefings were not detailed enough to make a recommendation) on the Proactive Integration of Human Factors. It is unclear how the research looks at the human in the system interacting with the automation effectively. The Subcommittee encouraged early and proactive integration of Human Factors into these research efforts to proactively identify emerging issues. The Subcommittee then recommended two actions coming out of the briefings: for the first action, the Subcommittee requested more information on Advanced Air Mobility (AAM), one from the FAA to present a detailed CONOPS on AAM, and the other from NASA to present briefings on their concepts, particularly on Human Factors. Dr. Holder stated that briefings would occur during the next Subcommittee meetings in August 2023. The second action is focused on guidance on the Electronic Flight Bag, its operational use, and issues experienced in the field. Dr. Holder explained that the information density is leading to concerns about usability and the human factors impacts. The Subcommittee has requested a briefing on the connected aircraft concept (as these issues will be addressed under this program and the Subcommittee has not received a briefing on this program). The Subcommittee wants to understand the scope of the program (planned research, framework, etc.). The next Human Factors Subcommittee Summer/Fall meetings will be in August 2023; Winter/Spring meetings will be in March 2024. Dr. Holder then opened the floor for questions.

Dr. Hansman addressed the Finding and Recommendation (F&R); he wanted to elaborate on the Advanced Vision Systems concern. Dr. Holder stated that it is both that the pilots may miss things in the environment when using these systems, and how pilots are going to get other critical information when it comes through another visual information channel if the systems are not integrated. Dr. Hansman stated that he would like to drill down on what the Human Factors research issue is. Dr. Holder explained that AVS are visually intense systems and other visual system awareness could be negatively impacted when using both. No research is addressing these aspects of it, according to Dr. Holder. Dr. Hansman asked whether this is a research issue or a CONOPS issue; he stated that he was unsure of the answer to this question. Dr. Holder responded that it is both a research and CONOPS issue: how will these tools be operationally assessed and approved for use. Most research so far has been focused on the technological goal and not the human factors impact of the technology. In practice, pilots shift focus and attend to many things at once. Dr. Hansman recommended teasing out the embedded assumptions (awareness issue). He reiterated that he understands the Human Factors concern.

Presentation: Subcommittee Report – Aircraft Safety (SAS) | **Presenter:** Terry McVenes, *RTCA*

Mr. Terry McVenes started the discussion by stating that the Subcommittees are growing to include additional members that broaden the depth and breadth of the shared knowledge which is great. He briefed the Committee on the Subcommittee on Aircraft Safety hybrid meeting held in February/March 2023 at RTCA Headquarters. The meeting included a review of the FAA's Aircraft Certification Service Research Strategy, an overview of FAA responses to the August 2022 F&Rs (they were not yet final), a phased roadmap of Artificial Intelligence and Machine Learning (AI and ML), an update on the FY 2025 Portfolio revised process, an FAA Budget update, and a review of the FY2025 Portfolio domains. SAS also received two industry presentations on digital flight (the gap between Visual Flight Rules (VFR) and Instrument Flight Rules (IFR)), and on National Academy of Sciences safety culture research.

The Subcommittee made two General Observations and drafted various Findings and Recommendations (F&Rs), addressing Aircraft Automation Technology, Cyber Resiliency for Digital Safety Systems, Use of Digital Twins for the Development and Lifecycle Support of Aircraft Systems, and Hydrogen Powered Propulsion. Mr. McVenes mentioned that the Subcommittee is very pleased with adoption of the F&R on the AI/ML roadmap (and the hiring of the Chief Scientist.) He also emphasized the value of receiving read ahead material and early pre-meetings (to set priorities and do pre-work on F&Rs). More information needs to be obtained regarding wearable sensors and aircraft automation technology. There is a gap is in pilot performance monitoring and pilot health monitoring. The Subcommittee believes that there is an opportunity to gain more insight on this subject. The Subcommittee would like a briefing on the FAA's associated research plan at the Fall 2023 and Spring 2024 Subcommittee meetings.

Mr. McVenes then covered Cyber Resiliency for Digital Safety Systems. There is a lot of work going on to transition to new Air/Ground Data Link technologies and having Cyber protection in these areas is going to be important for safety. He said that there are unanswered questions needed to really understand this as standards are already being developed in this area (by ICAO, RTCA, EUROCAE, AEEC, etc.). The recommendation was that the FAA should expand the research currently being conducted on BLI A11DS, Digital Safety Systems with the inclusion of Data Link Communications Cyber Resiliency research. Additionally, relevant regulatory Cyber Resiliency requirements should concurrently be available when Internet Protocol Suite (IPS) technology information is available.

The next Finding involved the use of Digital Twins, which applies to many parts of an airplane. Mr. McVenes stated that there is much industry interest in the concept, and that it applies to lots of different parts of the airplane. The Recommendation asks the FAA to conduct further research on the application of Digital Twins to Aircraft Systems, including Propulsion and Fuel Systems, Flight Deck, CNS, and all other Onboard/Offboard networking and data communications. Ongoing airworthiness maintenance is a key factor here.

Mr. McVenes reviewed the final Subcommittee Recommendation involving further FAA research on Hydrogen Powered Propulsion. Industry is evaluating potential use cases for Hydrogen Powered Propulsion Systems. He stated that the Subcommittee wanted to emphasize areas that need more exploration, such as fire and leak detection and safety; storage capabilities, both on the ground and airborne; items applicable to aircraft health monitoring; carriage and transportation of hydrogen cells; future applications; and certification readiness. Dr. Hansman commented on this recommendation, stating that it was in the SOAR overview Ms. Yak presented earlier in the session; this is on the horizon. Ms. Yak commented that the question is how this fits into the priorities. Mr. McVenes concluded that the Subcommittee's next meeting would be August 2023, at the FAA William J. Hughes Technical Center.

Regarding wearable sensors and aircraft automation, Dr. Hansman asked about the concern or issues with this technology. Mr. McVenes explained that the discussion was Artificial Intelligence/Machine (AI/ML) centered; and what are some of the other applications. How will wearable sensors apply to the health monitoring of the aircraft itself? How it is all connected? Dr. Hansman asked what the CONOPS would be for this area (e.g., fitness for attention monitoring). The question was also asked how to monitor for a single pilot. Mr. McVenes used the example of pilot shortages – how do you get pilots back into the cockpit who are coming off a medical leave; technology can be used to help with this. Dr. Hansman recommended that the Subcommittee revisit and include more context for future discussions. Two Subcommittee members noted the value of wearables. Dr. Hansman stated that there needs to be a clear safety basis for the wearables.

Ms. Yak pointed out that the first Recommendation was very direct in recommending three years of FAA research. Ms. Yak reiterated the need for additional discussion at the Subcommittee level to come up with a clear safety basis to support this wearable sensor research. Dr. Hansman emphasized that the FAA has limited research dollars. The FAA is charged with determining operational implications of technology and safety benefits. Ms. Yak also mentioned that Human Factors may have a high interest in more discussion on this topic.

Presentation: Subcommittee Report – Airports | **Presenter:** Chris Oswald, *ACI-NA*

Mr. Chris Oswald began the Airports Subcommittee briefing by giving an overview of the agenda and topics discussed during the March 2023 meetings. Mr. Oswald stated that there are research aspects (enhancing learning systems/human factors dealing with ground vehicle operations) that were not in attendance at the Safety summit or other safety-related events. These are emerging areas for Subcommittee discussion in Fall 2023. He emphasized that Subcommittees need to be working together on areas of overlap such as this. Hydrogen research also has huge implications and challenges for Airports (will require new infrastructure/piping, chilling capability, etc.).

The Airports Subcommittee portfolio is a bit narrower than other REDAC Subcommittees. He stated that in March, the Airports Subcommittee received briefings on Airports Firefighting Research, Advanced Air Mobility Systems, Sustainable Airport Pavements, and Vertiports, among others. He then reviewed the Research and Development (R&D) topics that apply specifically to Airports. Mr. Oswald highlighted the new leadership team at FAA William J. Hughes Technical Center (WJHTC) in the Airports Division and that he is excited about both hires. There is rapid work going on in the Unmanned Aircraft Systems (UAS) side. Ongoing research has focused on detection and mitigation; it is a critical infrastructure. He stated that there is a need for longer-term succession planning with the WJHTC Airports Branch; the Subcommittee does not want to lose institutional knowledge and capabilities. Additional briefings included Wildlife Hazard mitigation, Visual Guidance, and Airport Safety Data Mining Research for incursion prevention and ramp incident prevention.

Mr. Oswald reviewed the Subcommittee's first Finding and Recommendation (F&R) regarding prioritizing certain Airports-related research: Green Pavement Technologies; and standards, requirements, and operating parameters for automated and autonomous ground vehicle operations. These initiatives should be revised in the SOAR Charts, with fast-tracking of select mid-term activities due to recent safety incidents and increasing demand. The second F&R recommended that the FAA continue to engage the Aircraft Rescue and Firefighting (ARFF) Advisory Group to discuss how to transition from aqueous film-forming foams to chlorine-free foams. Mr. Oswald concluded with the third and final F&R related to joint spacing and its impact on pavement lifecycles. Dr. Hansman had no questions about the Airports Subcommittee Report.

Presentation: Subcommittee Report – Environment and Energy | **Presenter:** Mr. Ian Redhead, Deputy Director, *Operations and Maintenance/COO, Kansas City International Airport*

Mr. Ian Redhead briefed the Committee on the Environment and Energy Subcommittee meetings held in March 2023. The Subcommittee was disappointed to lose their FAA Chief Scientist and Technical Advisor, Dr. Jim Hileman. He stated that his will be tough shoes to fill as Dr. Hileman really built and matured the program, including expanding the private/public partnerships to benefit the program. Mr. Redhead stated that one or two subject matter experts have also departed the Agency. Mr. Redhead reviewed five Findings and Recommendations (F&R) topics with the Committee: investment in Sustainable Aviation Fuels (SAFs), Public Private Partnerships, Global Leadership, Noise Research and Staffing.

Mr. Redhead reported that the program has received increased funding, which makes him confident that issues relevant to the Subcommittee will be addressed. Increased funding included a SAF tax credit and grant program ($297M). Additionally, the Eliminate Aviation Gasoline Lead Emissions (EAGLE) initiative will be significant for the environment, with the FAA's increased leadership at the International Civil Aviation Organization (ICAO) level. ICAO agreed with the Long-Term Aspiration Goal (LTAG) to meet zero emissions by 2050. This was predominantly led by FAA research and the U.S. contingent. Mr. Redhead spoke about the importance of investing in SAFs. He agreed with Mr. Oswald that the infrastructure challenges of hydrogen are many and that SAF is the best option to reach the Administration's environmental goals. Regarding public private partnerships, Mr. Redhead spoke to the significant work the FAA is doing with NASA and the Department of Defense (DOD), including more participation with EPA (the Subcommittee would like to see this continue). Regarding global leadership, he emphasized the importance of the U.S. maintaining leadership at International Civil Aviation Organization / Committee on Aviation Environmental Protection (ICAO/CAEP) in order to control its own destiny. Since noise is an ongoing issue, Mr. Redhead noted the importance of continuing Noise Research and associated staffing to support it, including research on noise types, sleep effects, etc. The Subcommittee's final F&R was to suggest the timely replacement of the Environment and Energy Chief Scientific Technical Advisor and add the necessary subject matter professionals and additional staff to support the research efforts. He then opened the floor to questions.

Dr. Holder stated that a lot of this Subcommittee's initiatives seem longer-term; she asked about the near-term interventions that the Subcommittee is considering. Mr. Redhead responded that SAF is a long-term solution yet is already being produced. In the near term, investments in SAF need to be made now. He also stated that another short-term initiative was a Noise study (conducted in Boston). The conclusion was that noise reductions can be obtained with operational changes in certain geographic areas. Mr. Redhead reiterated that SAF is a near-term solution, and gave the example that corporate aviation (e.g., Gulfstream) is already using SAF as a drop-in fuel. Dr. Hansman stated that there are also opportunities to reduce fuel use through more efficient routings and operational efficiencies.

Presentation: Subcommittee Report – NAS Operations | **Presenter:** Dr. Jim Kuchar, *MIT-Lincoln Laboratories*

Dr. James Kuchar began the NAS Operations Subcommittee briefing by providing an overview of the agenda and topics discussed during the March 2023 hybrid meetings. Dr. Kuchar described the Subcommittee's updates to the FAA's Research Landscape, and the Subcommittee's research program reviews. Dr. Kuchar indicated that the

Subcommittee received five deep dive briefings on several topics: connected Flight Management System (FMS) concept from Collins Aerospace (he will pass along the information to the Human Factors Subcommittee), Unmanned Aircraft Management (UAM) Airspace Demonstration Project, FAA Commercial Space (AST) R&D Portfolio update, industry case for Advanced Air Mobility (AAM) Acceleration via refined focus on integrated Communication, Navigation and Surveillance (CNSi) technologies and standards, and an update on remote tower development research. He then outlined two Subcommittee Observations and several Findings and Recommendations (F&Rs).

Dr. Kuchar outlined the first of two observations which dealt with the FAA's SOAR concept, which the NAS Ops Subcommittee greatly appreciated. He emphasized that the new messaging would enhance the Agency's ability to communicate existing and planned R&D efforts. The second observation made by the Subcommittee endorsed consolidation of the remote tower testbed at the WJHTC.

Dr. Kuchar then presented the Findings and Recommendations (F&Rs) to the Committee. The first one was acceleration of AAM CNS technology development. This articulated some near-term needs and reprioritization of FAA research surrounding UAM Maturity Level (UML-2) and UML-3 CNS-related efforts, in partnership with NASA. The Subcommittee asked for a briefing from the FAA on its new UAS/AAM Research Roadmap at their next meeting. Dr. Hansman asked if there was discussion of Separation Standards; Dr. Kuchar responded that this was not discussed explicitly.

The next Finding and Recommendation dealt with the Commercial Space Research Alliance. The Center of Excellence has ended, but there are plans to establish a planned public-private alliance or partnership (PPP). The Subcommittee encouraged this and urged the FAA to carefully design the PPP and apply best practices from benchmarking other perspectives.

The subsequent Findings and Recommendations pertained to the Wake Program – a sensor refresh and business case development. The FAA has been using Light Detection and Ranging (LIDAR) equipment to measure wakes near airports, but this technology is aging out and requires replacement. This is important for conventional Air Traffic Control (ATC) and for new entrants [e.g., Advanced Air Mobility (AAM)]. Dr. Kuchar stated that this presents the FAA with an opportunity to broaden its view of the program for potential applications with AAM. He suggested that the FAA review its research plan for sensor data collection. The next item urged the FAA to conduct and complete a comprehensive cost-benefit business case for the employment of a range of dynamic Wake Separation procedures that could be employed at different airports and operating environments, outlining cost/benefit tradeoffs for different types of wake solutions. Dr. Kuchar stated that the Subcommittee believes that there is disconnection with ANG efforts with the research and a transition to the AJV-S.

The Subcommittee's following proposal dealt with Remote Tower (RT) technology for AAM. There may be opportunities to leverage the remote tower testbed at the FAA William J. Hughes Technical Center (WJHTC), considering AAM operations in the planning. Coordination with other agencies is vital to mitigate incongruences. The Subcommittee requested a briefing on the FAA's strategy considering the value of the Remote Tower technologies in AAM operations, especially regarding higher density and mixed fleet airspace operations.

The final Finding and Recommendation was more abstract and focused on the availability and use of uncertainty information (e.g., weather forecast data). The Subcommittee believes it is important to manage the information properly for use by humans or machines (e.g., risk management decisions to hold or delay flights). The FAA was urged to begin Research, Engineering, and Development (RE&D) efforts related to uncertainty characterization,

quantification, communication, and exploitation, with an initial use case on demand/capacity balancing for air traffic management. Dr. Kuchar noted that this effort would involve standards connected to Human Factors studies, as well as, the certification and approval of systems that use uncertainty information.

With regard to the Subcommittee's discussion proposals, Dr. Hansman believed this recommendation regarding uncertainty information is a broader issue, and that quantifying the nature of the system (inputs/outputs) would be useful in multiple ways (e.g., system safety analysis). He was misdirected by the meaning of uncertainty and perhaps it would be more powerful to tighten the language (the Subcommittee was speaking in general terms about uncertainty) to make it more clear. Mr. Redhead said he has started to use remote towers in Kansas City. He invited the Subcommittee to come out and see how they operate.

Presentation: Committee Discussions: Findings and Recommendations, Future Actions, and Chairperson's Closing Remarks | **Presenter:** Dr. R. John Hansman and Committee Members

In the general discussion of Findings and Recommendations and global topics, Dr. Hansman stated that he appreciates that the FAA has made strides in Artificial Intelligence/Machine Learning (AI/ML) but is pushing the Agency to do more. Regarding the Strategic Outcomes for Aviation Research (SOAR) framework, Dr. Hansman believed that this framework is what REDAC and other stakeholders have been looking for to foster informed decision-making constructs. Dr. Hansman urged the Committee to think about Dr. Kuchar's comment on the Subcommittee structure; is the structure adequate or should a new Digital Systems Subcommittee be added.

Mr. Mark Orr brought up another topic which was the distinction between the certification of AI versus the Agency's use of AI. This distinction has been popping up in certification discussions. Dr. Hansman agreed and stated that there are also AI operational approval issues (like in Dr. Holder's discussion of visual systems). Lastly, Mr. Pearce wanted to appreciate Dr. Hileman's leadership over the years. Dr. Hansman concluded the Committee meeting by stating that he would share this Committee feedback in the letter to the FAA Administrator. Ms. Yak and Dr. Hansman concluded the meeting and thanked the Committee members for their participation.

Action Items for Follow Up:

Action Item	Person Responsible	Date (if applicable)
Prepare program-level SOAR charts for Subcommittee review at the next meeting(s).	Shelley Yak	
Discuss the concept of a Digital Systems Subcommittee at the next meeting(s).	Dr. R. John Hansman	
Create a prioritized list of Artificial Intelligence/Machine Learning areas of concern/vulnerability impacting the FAA for Committee review.	Dr. Trung Pham	
SAS Subcommittee requests a briefing on the status of the FAA's research plan to assess the potential applications of wearable sensors, physiological monitoring, and "scalable autonomy" to aviation operations and safety.	Mike Paglione	Summer/Fall 2023 and Winter/Spring 2024 SAS Meetings

Action Item	Person Responsible	Date (if applicable)
Discuss SAS Subcommittee perspective - (Assess the potential applications of wearable sensors, physiological monitoring, and "scalable autonomy" to aviation operations and safety) at the next meetings for the FAA to consider additional context.	Terry McVenes	Summer/Fall 2023 SAS Meeting - August 2023
NAS Operations Subcommittee requests a briefing on acceleration of the FAA's AAM CNS technology development, specifically regarding UML-2 and -3 CNS-related efforts in partnership with NASA.	Phil Yeung	Summer/Fall 2023 NAS Ops Meeting - August 2023
NAS Operations Subcommittee requests a briefing on the FAA's strategy considering the value of the Remote Tower technologies in AAM operations, especially regarding higher density and mixed fleet airspace operations.	Phil Yeung	August 2023
Provide the following documentation prior to the next NAS Operations Subcommittee meeting: (1) xTM ConOps 1.0, (2) NAS Integration of Transiting and Higher Airspace Operations (NITRO) Strategy and Roadmap document.	Phil Yeung	August 2023
NAS Operations Subcommittee requests a briefing(s) on NASA status and updates on their xTM and AAM projects.	Akbar Sultan, Bob Pearce, Phil Yeung	Fall 2023
NAS Operations Subcommittee requests a briefing on the "Innovate 28 program.	Phil Yeung	Fall 2023
NAS Operations Subcommittee requests an UAM demonstration status update.	Phil Yeung	Fall 2023

HYBRID SESSION
FAA Headquarters/Zoom
April 12, 2023

Final Agenda

FAA HQ (FOB 10A)
5TH Floor, Conference Room – 5AB

Time	Topic	Presenter(s)
9:30 AM	Welcome Address and Opening Remarks	R. John Hansman Shelley Yak
9:45 AM	Public Forum	Public Invitees
10:00 AM	Strategic Outlook for Aviation Research (SOAR) Overview	Shelley Yak
10:30 AM	NASA Update	Robert Pearce
11:00 AM	Unmanned Aircraft Systems (UAS) Integration Update	Jeffrey Vincent Sabrina Saunders-Hodge
11:30 AM	Artificial Intelligence/Machine Learning	Trung Pham
12:00 PM	*LUNCH*	
1:00 PM	Subcommittee Report – Human Factors	Barbara Holder
1:30 PM	Subcommittee Report – Aircraft Safety	Terry McVenes
2:00 PM	Subcommittee Report – Airports	Chris Oswald
2:30 PM	Subcommittee Report – Environment and Energy	Ian Redhead
3:00 PM	Subcommittee Report – NAS Operations	James Kuchar
3:30 PM	Committee Closing Discussion - Findings and Recommendations/Meta Topics - Future Actions	FULL Committee
	Chairperson's Closing Remarks	R. John Hansman
4:00 PM	Adjournment	

List of Attendees

First Name, Last Name	Affiliation
Kathy Abbott *(virtual)*	FAA
Okoineme Giwa-Agbomeirele	FAA
Ludovic Aron	EASA
Beth Arnz	Changeis
Rany Azzi *(virtual)*	FAA
Jodi Baker	FAA
Mary Ann Bernacki *(virtual)*	Diakon Solutions
Joseph Bertapelle	JB Consulting
Caprice Brown (*virtual*)	FAA
Cindy L. Christiansen *(virtual)*	Public Forum Participant (AICA)
Nancy Clarke	Changeis
Steve Clarke	NASA
Chinita Roundtree-Coleman	FAA
Mel Davis *(virtual)*	-
Bruce DeCleene	FAA
John Dermody	FAA
Colleen Donovan *(virtual)*	FAA
Hossein Eghbali *(virtual)*	FAA
Barbara Esker (*via telephone*)	NASA
Jorge Fernandez *(virtual)*	FAA
Jaime Figueroa	FigAero Consulting
Murphy Flynn *(virtual)*	FAA
Paul Fontaine	FAA
Jeff Gardlin *(virtual)*	FAA
Tara Holmes Gibson *(virtual)*	FAA
Rich Golden *(virtual)*	FAA
Fabio Grandi *(virtual)*	FAA
Carla Hackworth *(virtual)*	FAA
Mark Hale	Diakon Solutions
R. John Hansman	Massachusetts Institute of Technology (MIT)
Andrea Stevenson-Hardin	ARA
Sabrina Saunders-Hodge	FAA
Barbara Holder	Embry-Riddle Aeronautical University (ERAU)
Bill Kaliardos *(virtual)*	FAA
Dominique Khan *(virtual)*	Avyance
Patrick Kong	FAA
Jim Kuchar	MIT Lincoln Laboratory
Todd Lewis *(virtual)*	FAA
John Maffei *(virtual)*	FAA
Terry McVenes	RTCA
Monique Moore	FAA
Eric Neiderman	FAA
Kerin Olson	FAA

First Name, Last Name	Affiliation
Lee Olson	NASA
Mark Orr	FAA
Chris Oswald	ACI-NA
Mike Paglione *(virtual)*	FAA
Alexandra Papantoniou	FAA
Robert Pearce	NASA
Trung Pham	FAA
Al Pollard *(virtual)*	Chesapeake Chamber of Commerce
Ian Redhead	KCMO
Doug Rodzon *(virtual)*	FAA
Jon Schleifer	FAA
Morgan Sims *(virtual)*	FAA
Duncan Stafford *(virtual)*	FAA
Paul Strande *(virtual)*	FAA
Anthony Tvaryanas *(virtual)*	FAA
Jeffrey Vincent	FAA
Shelley Yak	FAA
Darlene Yaplee (*virtual*)	Public Forum Participant (AICA)
Phil Yeung *(virtual)*	FAA
Jimmy [*no last name*] *(virtual)*	