REDAC Subcommittee on Airports | MINUTES

Meeting date & time: March 7 – 8, 2023

Meeting location: Hybrid meeting (FAA William J. Hughes Technical Center & Zoom)

Purpose: To provide advice and recommendations to the FAA on its airport technology research and development program.

Facilitator / Chair: Chris Oswald

Note taker: Alex Tsalyuk

Timekeeper: Chris Oswald

DAY 1 – March 7, 2023

Presentations 1 & 2 Introduction & Opening Remarks **| Presenter** Chris Oswald & Eric Neiderman

Chris Oswald introduced the new hybrid approach for the sessions and walked the attendees through the conference agenda. He also welcomed introductions from subcommittee members and ATR personnel. Murphy Flynn was announced as the permanent manager of the Airport Pavement division at ATR.

Eric Neiderman presented a new strategic R&D messaging initiative aimed at improving communication of the FAA's R&D plans to various stakeholders, including senior management, REDAC, OST, the House Science Committee, congressional staffers, and others. He discussed the introduction of Strategic Outlook for Research (SOR) charts to present information more clearly and emphasized the importance of focusing on strategic goals when communicating. Mr. Neiderman illustrated how these charts can help connect current and near-term research to research areas of interest and anticipate future technologies and changes that have not yet materialized. Additionally, he mentioned the Eliminate Aviation Gas Lead Emissions (EAGLE) Initiative. Oswald noted that Subcommittee members should review the SOR charts focusing on whether they capture the range of needed research from an airport perspective.

Presentation 3 HQ Office of Airports (ARP) Update **| Presenter** John Dermody

John Dermody, Director of Airport Safety and Standards, provided an update on the Office of Airport Safety & Standards. He introduced staff changes in his office and other offices, including Ignacio Flores as Acting Deputy Assistant Administrator for Airports (ARP-2), Evelyn Martinez as Acting Director of Airport Planning and Programming (APP-1), and Lisa Holden as Acting Deputy Director of Airport Planning and Programming (APP-2).

As discussed at the last meeting, the AAS-200 Division has been established and will be led by Keri Lyons. Mr. Dermody also mentioned vacant positions for Chief of Staff for the Office of

Airports (ARP) and Administrative Officer. He reported on the budget situation, discussing funding for research in FY24 and FY25. He highlighted several research projects that are underway or planned, such as Unmanned Aircraft Systems (UAS) standards for airport applications, Fluorine-Free Foam (F3) transition for Aircraft Fire Fighting Foam – regarding the Per- and Polyfluorinated Substances (PFAS) issues - with the Department of Defense (DoD) led by Keith Bagot, electric Vertical Takeoff and Landing (eVTOL) research, and wrong surface landings.

Mr. Dermody talked about the environmental and sustainability aspects of the program, including hydrogen and electric fueling infrastructure at airports and airport resiliency research. He shared challenges and successes in addressing runway incursions and close calls, and how they are collaborating with industry partners to prevent accidents and determine root causes. He also discussed the progress and coordination of UAS detection and mitigation testing at five airports, and how they will be using the research results and the recommendations from the Aviation Rulemaking Committee (ARC) to develop standards for UAS detection and mitigation systems and technology. Mr. Dermody explained how their approach to testing differs from that of the Department of Homeland Security (DHS), which only includes detection. He added that DHS is coordinating with the FAA on their research as well.

Presentation 4 Airport Technology Program Update **| Presenter** Jim Layton

Jim Layton, Branch Manager of ATR, presented the "Airport Technology Program Update." He discussed recruitment efforts and ATR's alignment with DOT and FAA strategic plans. ATR currently has 26 authorized positions with 22 filled and is actively recruiting for the safety and pavement sections. Murphy Flynn was recently selected to permanently manage the Airport Pavement R&D section.

Mr. Layton stated that ATR aligns with DOT FY 22-26 Strategic Goals, FAA Flight Plan 21, FY 22-26 National Aviation Research Plan, ANG-E Strategy Map & ANG-E2 Research Drivers, and Office of Airports (ARP) Strategic Plans and Business Plan Goals. He also mentioned the following laboratory assets: National Airport Pavement Test Facility (NAPTF), National Airport Pavement and Materials Research Center (NAPMRC), Aircraft Rescue and Firefighting (ARFF) Facility, and Vehicle Simulator. The planned facilities include Vertiport Capability Research and Materials Pavement Lab. Mr. Layton acknowledged that the cost of the Materials Pavement Lab increased during the pandemic due to supply chain costs.

Mr. Layton also shared that ATR recently published five reports on the use of UAS combined with machine learning and other technologies to inspect pavement and enhance airport safety capabilities. Six additional pavement and safety reports will be published soon. He mentioned ATR’s involvement in various industry events, including International Civil Aviation Organization (ICAO) Friction Task Force, the ARFF Working Group Annual Symposium, the Bird Strike Committee Technical Session, the Airport Pavement Technical Workshop, and the Aviation Engineering Seminar.

Lastly, Mr. Layton highlighted various awards received by ATR staff. ATR's Small Unmanned Aircraft System (sUAS) team received a US DOT Secretary's Award, while Dr. Wesley Major won the Outstanding Young Professional award. Ryan Rutter was recognized for his Outstanding Contributions to Testing and Leadership at the NAPTF. Dr. Navneet Garg received the FAA Office of Airports Ellis A. Ohnstad Award for technical excellence.

Presentation 5 Review of Outstanding REDAC Recommendations **|**

Presenter Subcommittee Members and FAA

Jim Patterson presented an overview of the outstanding REDAC recommendations, focusing on three main findings and their respective recommendations made by the Subcommittee.

First, Mr. Patterson discussed a finding and recommendation from the previous session where the Subcommittee addressed the impact of rising construction and materials costs on planned pavement testing facility improvements and research schedules. The recommendation was posted online in January 2023.

The second finding emphasized the importance of airport climate change resiliency. The Subcommittee suggested an expansion of the resiliency portfolio to include factors beyond climate change and proposed a collaboration between themselves and the FAA on a research task. This task aims to clarify the definition of airport resiliency and integrate resiliency considerations into airport planning and development efforts.

Lastly, the Subcommittee acknowledged the progress made in transitioning from Aqueous Film Forming Foam (AFFF) to Fluorine Free Foam (F3) for aircraft rescue and firefighting. However, they emphasized the need for more research-driven information to support this transition. As a recommendation, the Subcommittee suggested engaging the ARFF Advisory Group to help develop an expedited F3 transition plan, providing necessary guidance to airport operators and ARFF personnel.

Throughout the presentation, Mr. Patterson highlighted the FAA's responses to these recommendations, indicating their agreement and commitment to addressing the concerns raised by the Subcommittee.

Presentation 6 REDAC Membership/Subcommittee Representation**| Presenter** Chris Oswald

Chris Oswald provided an update on the status of REDAC membership and subcommittee representation. The group discussed the need for appropriate subject matter experts to ensure the implementation, execution, and contribution of advice for the airport environment. The FAA executives have requested that REDAC maintain fair and open solicitation for membership, with membership renewals occurring every two years. In this discussion, there was consensus among Subcommittee members and FAA representatives that recruiting efforts for additional Subcommittee representatives should be deferred until ongoing efforts to add additional REDAC members are completed, expected within the coming 12 months. Chinita Roundtree-Coleman noted that potential Subcommittee members can attend Subcommittee meetings as observers.

Subcommittee members noted expertise needed on the subcommittee include general aviation operations, firefighting, and advanced air mobility (AAM)/other new entrant aircraft operational issues.

This year, the group discussed several key areas for research and oversight. The Airport Cooperative Research Program (ACRP) is collecting problem statements related to methodologies for analyzing, assessing, and collecting data, which will become a crucial area as airports move into the Safety Management System (SMS) era.

The group also discussed the rapid progress being made in automation and automated ground vehicle research, both driver-assisted and fully autonomous. A recent Tech Talk Tuesday hosted by the Tech Center found that the technology is not yet mature enough, but the results are very interesting, generating a lot of interest from vendors and airports.

Gary Mitchell discussed 3-4 panels on rapid set cement underway in North Carolina that could benefit from oversight from REDAC members. Dr. Navneet Garg had recently met with some of those involved in the project. Jim Mack mentioned that the cement industry is looking at new technologies and mixes that will require research to determine how they age and how strength requirements may need to change.

Mr. Mitchell also suggested that the aggregate industry and AAPTP/ACPTP should collaborate on their research together. Murphy Flynn mentioned that besides research contracts, universities and private entities are involved in research that occurs offsite at the Tech Center.

Finally, Chris Oswald requested that any additional research needs be sent to him so that he can include them along with any observations.

Presentation 7 Airport Cooperative Research Program (ACRP) Update **|**
Presenter Marci Greenberger

Marci Greenberger presented an update on the Airport Cooperative Research Program. She discussed several ongoing projects:

- Project 02-103: Guide for methods to transition and decontaminate PFAS from firefighting vehicles and equipment, and hangar fire suppression systems.
- Project 03-71: A planning guide for airports to inventory and assess electrification needs in vehicles, aircraft, and mobile equipment.
- Project 04-34: Merger of two projects to develop a guide for establishing and/or maintaining operational ARFF programs, inventory and assess current ARFF training facilities and capabilities, including mobile training operators, and identify what is needed to develop a national ARFF workforce that meets or exceeds requirements. Proposals have been received, and a contractor will be selected.
- Project 04-28: Identify viable systems for arresting aircraft that are not currently patented.

- Project 02-91: PFAS source differentiation guidebook for airports, a guidebook of recommended practices for determining PFAS source in soil and water near airports.

Murphy Flynn asked if arrest systems are passive systems as alternatives to current engineered material arrestor system (EMAS). Marci confirmed that they are looking for another competitive product and mentioned that the last project doing this (Project 04-29) was so successful that they are looking to do it again.

Brett Williams inquired if the PFAS decontamination studies look at facilities with contamination and expressed the need for research into dealing with contamination.

Presentation 8 Overview of Safety Projects Underway**| Presenter** Ryan King

Ryan King, Acting Manager of the Airport Safety Research Section for ATR, provided an overview of various safety projects underway. The projects included:

- Solar Lighting: This project features a test array installed at Penn Yan, NY, and is exploring test sites and candidates.
- Airport Safety Databases: This project focuses on databases such as the Airport Safety Database (ASD), a Foreign Object Debris (FOD) database, and a Wildlife Strike Database.
- Wildlife Research: This project aims to mitigate bird and mammal strikes and is working closely with the United States Department of Agriculture (USDA).
- Paint/Airport Marking Research: This research tracks how different technologies hold up over time, including a long-term study of embedded glass beads in airport markings.
- Lighted-X Research: This project experienced a pause during the pandemic but is now ramping up again.
- FOD Impact in Airport Environments: The project is examining gaps in current standards and technologies for managing FOD.
- Wildlife Detection Technologies: This project explores ways to detect wildlife in the airport environment.

These ongoing safety projects demonstrate ATR's commitment to enhancing airport safety through research and innovation.

Presentation 9 Alternative Aircraft Fire-Fighting Agent Research Update**| Presenter** Keith Bagot

Keith Bagot, an airport safety specialist at the FAA, presented updates on alternative aircraft firefighting research that aims to replace fluorinated chemicals with safer and more environmentally friendly agents. He explained the need to phase out the use of fluorinated chemicals and the challenges and progress of developing and testing new formulations that meet the MIL-F-24385F and ICAO Level C standards.

Mr. Bagot discussed the project timeline, which aims to have qualified products by October 2023, and the implications of the CertAlert 23-01, prohibiting the mixing of different fluorine foams and requiring pressurized containers for some vehicles. He compared the performance of the new fluorine-free foams (F3) with the existing aqueous film-forming foams AFFF). Although F3 takes longer to extinguish a fire on average, it still provides adequate safety margins.

He also mentioned ongoing work on developing nozzles and cleaning tanks containing fluorine foams. Mr. Bagot concluded by stating that the U.S. will maintain the most effective firefighting capabilities in the world before and after this transition due to the rigorous military specifications (MILSPEC) standards that filter out poor products.

Presentation 10 Emerging Entrant Update**| Presenter** Keri Lyons

Keri Lyons, AAS-200 Division Manager, discussed the latest developments and challenges in the field of emerging entrants, including advanced air mobility (AAM), commercial space transportation, electric and hydrogen aircraft, and unmanned aircraft systems (UAS). She highlighted the importance of communication and collaboration with industry, government, and community stakeholders to address issues such as noise, perception, and education.

Ms. Lyons explained that AAM involves using new types of vehicles, such as electric vertical takeoff and landing (eVTOL) aircraft, for urban and regional air transportation services. The FAA is working on guidance, standards, research, testing, and outreach to support the safe integration of these new technologies into the national airspace system. A multi-year project on vertiport design and operation is ongoing, with an engineering brief released in September 2022.

Ms. Lyons reported an uptick in airports interested in hosting commercial space launch, reentry, and related activities. The Office of Airports (ARP) is updating its internal guidance to address commercial space activities.

Ms. Lyons described the FAA's efforts in developing a research plan covering electric and hydrogen aircraft, pointing out that new standards are needed for electric aircraft and fighting lithium-ion battery fires. The FAA also needs to investigate the impact of hydrogen fuels on ARFF, fueling, and storage.

Regarding UAS at airports, Ms. Lyons described both positive and negative aspects. Positive uses include compliance, planning, construction, inspection, and wildlife hazard mitigation. Negative aspects involve detecting and responding to unauthorized or malicious UAS operations near airports. The FAA has worked with five airports to test UAS detection and response systems, which will help create standards for future response. The FAA has also issued a certification alert on incorporating UAS response plans into airport emergency plans.

Ms. Lyons announced the creation of a new and emerging entrants webpage on faa.gov, which will include links to various portfolios related to Advanced Air Mobility (AAM), commercial

space, electric aircraft, hydrogen aircraft, and UAS. This webpage will allow rapid delivery of information to airport sponsors and infrastructure stakeholders as it updates due to the fast-paced nature of the field. ARP is working with the Office of Communications (AOC) to ensure all information is available and up to date.

She emphasized that the level of coordination on emerging entrants is greater than she has seen in her 20 years at the FAA. There is a more inclusive process of engagement with manufacturers and operators to address issues related to emerging entrants. DOT is working to develop a framework for AAM, involving both a government-only working group and external stakeholders from industry and community. Ms. Lyons also noted the importance of addressing noise perception, rather than focusing solely on noise metrics, for emerging entrants. Some communities are starting to adopt good practices, such as Urban Movement Labs collaborating with sound labs for community engagement.

Presentation 11 Vertiport Design Layout**| Presenter** Russ Gorman

Russ Gorman, an airport safety specialist at the FAA, presented a multi-year project to design and test vertiports for eVTOL aircraft to address autonomy, propulsion, and flight rule compatibility and focused on four items:

Engineering Brief (EB)

Limited performance and design data was available for aircraft that will use facilities. The team collected performance data from the industry to develop an engineering brief and performed conceptual testing to evaluate the EB. The takeoff and landing area (TLOF), final approach and takeoff area (FATO), and safety area were defined.

Conceptual Testing

Mr. Gorman conducted a spreadsheet-based tabletop study to evaluate the released database. A generic capacity model was developed for six conceptual vertiports focused on eVTOL aircraft. However, there was a need for more research on the turn radius.

Upcoming Operational Testing

Mr. Gorman explained how the team planned to test how the aircraft interact with the vertiport infrastructure and each other. He described two phases of testing: Phase 1 will test up to three aircraft at a time, focusing on landing precision, taxiing procedures, and outwash/downwash effects; Phase 2 will test up to six eVTOL aircraft and possibly some Short Take-Off and Landing (STOL) aircraft, focusing on emergency procedures and autonomy. The team is also conducting a vertiport symbology testing to compare two different symbols for marking the TLOF: a V symbol and a broken wheel symbol.

Electrical Infrastructure Study

The team examined the electrical and hydrogen aspects of the vertiports. They covered topics such as cyber security, electrical hazards, grid impact, charging demand, and potential hydrogen

supply. They also provided recommendations for periodic assessments and updates to address its risks and challenges.

Presentation 12 Completed Evaluations of UAS Applications**| Presenter** Mike DiPilato

Mike DiPilato presented the conclusions on performance specification and technical/operational considerations for airport UAS applications. Research was conducted for performance specification and technical/operational considerations for several airport UAS applications, and 6 have been completed. The initial research has been concluded and will be used to inform a bulletin/engineering brief.

For obstruction analysis, Mr. DiPilato explained that UAS can be used for small obstruction analysis and generate obstacle measurement data that meets FAA accuracy standards. A final report is pending. When asked if the engineering brief is enough to do an aerial survey, Mr. DiPilato replied that they are putting together how-tos for this, but they don't think UAS will conduct full surveys for the time being.

Regarding perimeter security inspections, Mr. DiPilato shared how UAS can supplement existing inspections and inspect hard-to-reach locations, to detect persons and objects near the fence. It was tested at four airports with different environments.

For pavement inspections, Mr. DiPilato presented how UAS data compared to foot on ground surveys for these inspections, and they found tremendous promise in the technology despite some current limitations. UAS data was compared to foot on ground surveys, and there were cases where imagery was not enough to inspect certain distresses. Two final reports were published in CY 22; a third report is in progress and will be published by the end of this fiscal year.

Mr. DiPilato discussed that UAS provided significant situational awareness to incident commanders for Aircraft Rescue and Fire Fighting (ARFF) live monitoring. They tested it at ACY and received a great response to this. They also tested it at Dallas Fort Worth International Airport's Fire Training Research Center, during two of their 'advanced ARFF Training Classes'. During one of these classes ARFF personnel from the Hawaii DOT provided feedback to FAA researchers/DFW FTRC when using UAS aerial imagery when responding to various accident/incident scenarios.

Mr. DiPilato also explained how UAS can be used to generate overview maps for accident sites to document the scene for investigators and improve situational awareness and coordination for ARFF accident documentation.

Regarding wildlife hazard management, Mr. DiPilato presented that testing at four off airport locations demonstrated how UAS can examine bird response to UAS platforms. Test results varied based on bird species but has promise for removing birds from airports.

For ongoing applications, Mr. DiPilato presented how UAS combined with Artificial Intelligence/Machine Learning (AI/ML) can be used for FOD detection and wildlife monitoring. For FOD detection, FAA researchers were able to detect 48 of 53 FOD items for testing, but false positive rates were high for areas with pavement cracks. Additionally, he discussed how AI/ML

can assist with locating wildlife from UAS images/video and fuse thermal and visual data to improve results, but there is difficulty due to potentially low resolution of data. The FAA and USDA are conducting the UAS wildlife research under an Interagency Agreement. To date, the FAA/USDA team conduct a literature review/survey and field testing (off airport).

Lastly, Mr. DiPilato discussed a UAS wildlife dispersal pilot program at Atlantic City International Airport (ACY). Knowledge from the previous four off airport studies will be applied to the wildlife pilot program at ACY.

Presentation 13 UAS Detection & Mitigation Research Update **| Presenter** Jim Patterson

Jim Patterson, Safety Section Manager, provided an update on the UAS detection and mitigation program. This program is mandated by Section 383 of the 2018 FAA Reauthorization with the primary objective to evaluate and test UAS detection and mitigation technologies while collaborating with relevant federal agencies to prevent aviation disruptions. The program includes yearly briefings to congressional committees, testing and evaluation, certification, permitting, authorization, and deployment of UAS detection equipment.

ATR is concentrating on several UAS detection and mitigation systems, including dual radar, library-based RF, and camera-based systems. Over a dozen locations at ACY have been designated for installation and calibration, where ATR operates the system and drones. Forty drones have performed eight different flight patterns each (note over 6,000 flights have been conducted), resulting in a considerable test matrix with over 10 million data points.

In addition, the update included the vendor status of detection and mitigation systems, which involves five detection systems being complete, one undergoing testing, and four awaiting completion. A library-based radio frequency system was installed in Seattle to track drones, while small portable towers were procured to lift sensors in Huntsville due to a lack of sensor infrastructure. Syracuse had radar sensors installed temporarily to see how they impact operations.

The update also covered the ongoing testing and reports that are being developed with the sunset date of September 30 in mind. High power computing is required to develop visualizations due to the vast amount of data collected. Mr. Patterson highlighted that no other organization had done what ATR did concerning the level of detail involved.

Finally, Patterson noted that vendors' claims did not always match their expectations. The program stayed on track despite COVID-19, with draft reports and standards currently in development. The Transportation Safety Administration (TSA) is scheduled to tour the facility to witness how the testing is being conducted.

Presentation 14 Sustainable Pavement Update **| Presenter** Dr. Navneet Garg

Dr. Navneet Garg provided an update on sustainable pavement research at ATR. He started by discussing the efforts being made to generate performance data that would allow ATR to evaluate how recycled and sustainable materials perform under aircraft loading. This is an important area of research since sustainability is becoming a key factor in the aviation industry.

Dr. Garg went on to describe the tests that have been conducted on a variety of chemical additives applied at varying stages in mix production to test durability under high wheel load ranging from 63-72k lb. of pressure at a variety of temperatures. The tests have yielded valuable data that can be used to evaluate the durability of different mixes. In addition, extensive laboratory tests have been done on rutting performance of mixes, which have helped to identify areas of improvement.

Another area of focus has been the development of an aggregate layer characterization model for PANDA-AP to evaluate material performance using performance data from U.S. Army Engineer Research and Development Center (ERDC) test sections with thin hot mix asphalt (HMA) layers. This model has helped to improve the accuracy of material evaluations and allowed researchers to better identify promising sustainable materials.

Dr. Garg also provided an update on the ongoing work to develop a life cycle assessment (LCA) tool using Federal Commons data repositories. This tool will help ATR evaluate the environmental impact of different pavement materials and help identify sustainable alternatives.

Despite these promising developments, Dr. Garg mentioned that ATR is currently struggling to receive materials including a new pavement mix from France. France is also using a rejuvenator (for recycled asphalt pavement) produced from pine tree sap as a binder.

To address these challenges, Dr. Garg suggested that ATR could start an international working group since organizations all over the world are investigating sustainable pavement materials. The more ATR can collaborate with others in this area, the sooner sustainable materials can be implemented.

Dr. Garg also mentioned that ATR is actively trying to join International Union of Research Laboratories (RILEM), which could help address some of the challenges faced in the sustainable pavement research, and learn from others instead of re-inventing the wheel

In closing, Dr. Garg discussed the limitations of the current pavement simulation tool used by ATR, FAARFIELD 2.0. Although powerful, the tool is limited in the material characteristics it can simulate, which makes it difficult to evaluate how factors like temperature and moisture impact performance. However, Dr. Garg expressed optimism about the future of pavement simulation tools, particularly PANDA-AP, which will be able to predict pavement performance based on test results obtained from laboratory material characterization tests.

Presentation 15 Airport Environmental Projects **| Presenter** Lauren Vitagliano

Lauren Vitagliano presented updates on several airport environmental projects. She began by discussing the noise abatement charging project which aims to describe recommendations for noise abatement procedures. The project was delayed since fall 2021 but has recently reconvened. Ms. Vitagliano mentioned that a national sleep study is currently ongoing with 257 subjects enrolled, and 18.3k recruitment surveys were mailed. Fewer people were interested than expected, but there was greater eligibility than expected.

She then talked about the latest noise level reduction, which focused on a loudspeaker for measuring noise reduction. A drone with a mounted loudspeaker and inverter was used to conduct the test. She also mentioned a noise communication project underway for 5 months researching how to better communicate noise levels to the public.

Next, she discussed the FAA Influence on Local Land Use Decisions project which is due to kick off in May under the next-door contract. They are researching how the FAA and airports can be more influential in local land use decisions.

Ms. Vitagliano then moved onto the Climate Change: Resilience Challenge project which is investigating airports for case studies and finalizing airport selection. She highlighted that having a sustainability plan doesn't necessarily lead to results and that sustainability is different than resilience. She mentioned that sunny day coastal flooding, permafrost collapse in Alaska, and severe weather are all impacting airport resiliency. To prioritize airport resilience projects, tools need to be developed, and a framework needs to be established to conduct resilience assessments. Additionally, a prioritization framework is needed to assist the FAA in selecting systems to help airports with resiliency. Currently in month 17 of the project, Ms. Vitagliano emphasized the importance of continuing coordination and developing criteria and metrics for the Airport Resilience Analysis Framework (ARAF).

Following Vitagliano's presentations, Subcommittee members had a robust discussion about flooding impacts on airport pavement condition, including impacts flooding events have on pavement base and subbase layers, which can adversely affect pavement longevity.

DAY 2 – March 8, 2023

Presentation 1 Airport Pavement R&D Program Update **| Presenter** Murphy Flynn

Murphy Flynn, the Manager of the Airport Pavement Research Section, provided an update on recent accomplishments, contracts, 10-year plans, and ongoing projects.

Mr. Flynn stated that there are currently seven team members, but the goal for FY23 is to recruit two engineer positions. He also discussed the recent meetings with ICAO task force, an Italian university, and a Vietnamese delegation to rekindle relationships that dwindled during the pandemic. He mentioned the recent workshops and events, such as Mat Brynick speaking to the young professionals' group with The American Association of Airport Executives (AAAE) and Dr. Garg meeting with the Association of Indian Professors.

Flynn discussed the contracts, including the Pavement Consultant Contract, which is currently at the contract ceiling and needs a new contract with a more realistic contract ceiling. He also mentioned the Facilities O&M, NAPMRC, and Advanced Pavement Materials Lab O&M contracts.

He talked about the 10-year plans and a modular version of the plan, building on the research goals and outputs of the program. The plan is designed to be easy to modify as technologies change.

Flynn also provided updates on ongoing projects such as the NAPMRC Roof Repairs, Subgrade Process Facility Roof Replacement, Cape May Research Taxiway, and the Replacement of two Vehicles.

The NAPMRC Roof Repairs project involves a purchase of $60k worth of roof panels, with installation planned for FY23, and the Subgrade Process Facility Roof Replacement, which was built in 2008, will cost $180,000 to repair due to age.

The Cape May Research Taxiway project aims to serve as a lighting research testbed for safety research, paved with 5 asphalt mixes for a long-term durability study. However, it requires maintenance repairs. Lastly, Flynn mentioned a project focused on replacing a visual guidance pickup truck and a one-ton pavement truck.

Presentation 2 Section 744 Update – Airport Concrete Pavement Technology Program (ACPTP)**| Presenter** Gary Mitchell

Gary Mitchell, Chief of Engineering & Construction at the National Concrete Pavement Technology Center, provided an update on the ACPTP, which began in 2001 with a reauthorization bill. Mr. Mitchell explained that the program has a Pavement Coordinating Group (PCG) that identifies pavement issues and problems, creates a list of problems that need to be solved, reviews program findings, and makes recommendations while directing course corrections if necessary.

Mr. Mitchell provided an overview of the current projects in the program, including:

1. Mitigation Procedures for alkali–silica reaction (ASR) Expansion in Concrete Aggregate

2. Performance Engineered Mixtures for Airfield Pavements
3. Rapid Repair and Rehabilitation of Airport Pavements
4. Quality Control and Quality Acceptance of Airport Pavement
5. Rubber Removal Best Practices
6. Effects of Diamond Grinding on Airfield Pavements
7. Design and Performance of Thin Concrete Airfield Pavement

Additionally, Mr. Mitchell shared some topics that are currently in development, including start/stop practices, which aim to improve sustainability and resiliency by coordinating the paver with the plant and improving vibration speed to reduce roughness. A pavement technical panel is also being assembled to research the effects of flooding on pavement.

Mr. Mitchell also discussed upcoming topics, which include fatigue/stress measurement, what the program did right, and tech transfer products in development, such as limestone cements, strength measurement, admixtures, sustainability (reduced carbon footprint), EPD primer/life cycle analysis, current technologies, clinker reduction, electric vehicles, and recycled concrete aggregates.

Regarding funding, the program has received a total of $12 million, with $9.5 million obligated. Mr. Mitchell noted that FY23 is currently in the works, and there are no deadlines to spend the funds. However, there is concern that the program is not drawing down fast enough, but once the tech transfer program speeds up, there will be several places to conduct training.

Presentation 3 Section 744 Update – Airport Asphalt Pavement Technology Program (AAPTP)**| Presenter** Brett Williams

Brett Williams, Director of Engineering & Technical Support at the National Asphalt Pavement Association, provided an update on the AAPTP. He mentioned that the program's structure is similar to the ACPTP.

Mr. Williams highlighted several ongoing projects:

1. The Asphalt Mixture Paving Handbook - Revision project is aimed at updating the 2000 research board application. It received $200k in funding, with an additional $100k allocated for website development. The projected completion date is 12/31/23, and six engineers from the Asphalt Institute are working on the project. The project technical panel discussed the use of the handbook, and the website will be interactive, mobile-friendly, and easily accessible for field access.
2. The Guidance on Selection of Asphalt Binder Grade project aims to aid engineers in selecting proper asphalt binder grades for airfields. An online tool will be developed to recommend binder grades based on provided data. The project received $200k in funding, with completion expected by 12/31/23. The team is currently developing a database of available binders by interviewing agencies and collecting binder specifications from the FAA and other agencies.

3. The Balanced Mix Design: Cracking Tests project has the University of Illinois Urbana-Champaign (UIUC) selected for evaluation. The project focuses on evaluating current cracking tests for use in mixture design to resist cracking in airfields. Completion is planned for August 2025. Sample collection at various airports is ongoing, with selected airports offering diverse attributes for testing asphalt mix effects on cracking.
4. The Balanced Mix Design: Rutting Tests project involves researchers meeting biweekly and holding quarterly meetings. The project aims to harmonize rutting requirements within the FAA to improve consistency. Led by Elie Hajj from the University of Nevada, Reno, the project is reviewing literature, sample size, test temperature, testing criteria, and in-place densities to determine the optimal sample settings within the lab.

At the end of the presentation, Gary Mitchell and Dr. Navneet Garg made comments. Mr. Mitchell noted the increased collaboration between the FAA, industry, and the military, as the tri-services now recognize the value of the FAA's work in improving their technology. Dr. Garg suggested bringing students working on The National Asphalt Pavement Association (NAPA) Association, AAPTP, and ACPTP projects to Tech Center as summer interns to give them a perspective of FAA's whole pavement research program.

Presentation 4 FAARFIELD 2.0 Online Tools & PAVEAIR Integration**| Presenter** Dr. David Brill

Dr. David Brill, pavement program manager at ATR, presented an update on FAARFIELD 2.0 Online Tools and PAVEAIR Integration. He highlighted the updated UI/UX, modern graphical user interface (GUI), intuitive screen flow, new 3D finite element library (FAASR3D), and the updated aircraft library. The project timeline started in 2016 with an initial storyboard meeting on updating the FAARFIELD GUI, followed by the release of FAARFIELD 1.4 in 2017. In July 2020, ACR-PCR was launched, and FAARFIELD 2.0 was released in June 2021.

The software integration objectives include updating FAA software to the latest frameworks, technologies, and OS, following software best practices, separating UI from logic, and switching to object-oriented programming. The goal is to update all existing software to modern standards.

The Pavement Document Object Model (PDOM) library uses a Model-View-View-Model (MVVM) architecture and serves as a single shared library for all applications. The DOM is data agnostic and accepts any data meeting minimum requirements.

Dr. Brill provided an overview of FAARFIELD 2.1, which includes FAA PAVEAIR integration with the ability to load user owned PAVEAIR databases. Job information can be loaded from PAVEAIR data, and job files can be stored in PAVEAIR databases under corresponding network/branch/section. The software can display design stresses for rigid slabs and shows the most demanding aircraft for a given A-1 joint design. Currently, the software performs bottom-up analysis, but top-down analysis is being developed. The software can automatically perform reduced cross-section design, and future updates will allow for installation directly from the application interface. Users can upload, download, update, and delete jobs from the PAVEAIR database, with the same job being uploaded to multiple locations.

Gary Mitchell commented that the user interface has significantly improved, making it easier for engineers to work with. Dr. Brill agreed, noting that the state of the art is now to provide an environment for users to navigate more easily. Navneet Garg added that the fixed window sizes in previous versions were a limitation, and this update represents a huge improvement.

Presentation 5 CC-9 Fatigue Test & TC-2 Fatigue Test Updates**| Presenter** Dr. Navneet Garg

Dr. Navneet Garg provided updates on the Construction Cycle (CC)-9 Fatigue Test and the Test Cycle (TC)-2 Fatigue Test. Currently, they are testing CC-9 for flexible pavement. In the last session, the discussion focused on the performance of geosynthetics. Now, the focus is on investigating fatigue failure, improving the fatigue model, and examining the effect of aggregate and HMA thickness on pavement life. According to FAARFIELD, for 26-inch P-209 a 22% increase in HMA thickness leads to a 160% increase in life, and a 200% increase for a 30-inch pavement-209. For 11-inch thick HMA, 15 percent increase in P-209 thickness increases pavement life by 478 percent. However in full-scale tests (CC-9), these pavements show similar rutting performance.

The rut rate is similar for most pavement types, except for geosynthetics, which exhibit much higher rut rates. Dr. Garg noted that there is not a significant increase in stress with an increased P-209 thickness at the subgrade level.

The summary of findings from CC-7 showed no signs of fatigue cracking in the 12- and 15-inch sections. The 9-inch HMA shows higher rutting than the 11-inch HMA.

Dr. Garg mentioned that the PANDA-AP tool will help determine where deterioration will occur and how the mix will affect the results. Coil sensors provide some data on deformation within the P209 layer. In response to a question about PANDA-AP's ability to track pavement life, Dr. Garg confirmed that it will be able to track how different pavement materials will impact pavement life.

Jim Mack inquired whether albedo (light reflectivity) would be included in pavement simulation tools in the future. Dr. Garg responded that they plan on looking into additional factors like albedo after the first version of the LCA tool is complete.

Presentation 6 CC-10 Update**| Presenter** Mat Brynick

Mat Brynick presented a comprehensive update on the CC-10 project, discussing its purpose, objectives, and challenges. The primary goal of this project is to obtain failure data at high traffic levels for airport pavement, aiming to measure the damage of pavement before cracks become visible. To achieve this, sensors will be embedded throughout the pavement, and light fixtures will be strategically placed to evaluate the impact of lighting on the pavement.

The project will examine various subgrades, subbases, and overlays to gain a better understanding of the pavement's performance under different conditions. Beginning with CC-8, the project's complexity has increased to explore multiple objectives simultaneously.

An estimated 174,000 passes are expected for the CC-10 project, and it is planned to be completed by 2024. The construction timeline is estimated at 198 days, allowing time for the

design to be updated with additional sensors. The experiment will be crucial in determining if the rule of thumb regarding the impact of reducing pavement thickness on the pavement lifecycle holds up in practice.

During the presentation, several important topics were discussed, including joint spacing, sensor technology, and contractor consistency. Jim Mack and Dr. David Brill talked about the challenges of incorporating various joint spacings in the experiment due to limited space. However, it was suggested that different joint spacings could be designed and put on the shelf for future projects. Gary Mitchell pointed out that tighter joint spacing has been observed in 5-inch overlays carrying heavy traffic over many years.

Murphy Flynn mentioned the new sensors developed by Lucy Liu from Purdue University and emphasized the importance of avoiding sensor-reinforced pavement. He also highlighted the significance of finding contractors committed to the process and able to deliver consistent results. He shared that working with the same contractor for 13 years had made a positive impact on the project, as they had a deep understanding of the process and were able to consistently deliver high-quality work.

Key takeaways from Mat Brynick's presentation included the importance of obtaining failure data for 2D gear at 55,000 lb. wheel load, expecting 175,000 passes. The next steps for the project include construction, test traffic, analysis of results, publication of results, and updating relevant software.

Murphy Flynn also addressed the challenges associated with finding contractors who are invested in the process. He mentioned that the contracting process had recently changed, with contracts now being handled through the FAA Tech Center instead of HQ. This change should help improve consistency in contractor performance.

Presentation 7 National Airport Pavement Test Vehicle (NAPTV) Update**| Presenter** Ryan Rutter

Ryan Rutter's presentation provided an in-depth update on the NAPTV and the NAPTF, highlighting the facility's 24-year history and its unique status as the only facility of its kind in the world. Mr. Rutter shared details on the maintenance and improvements implemented to keep the facility operational.

Some of the major maintenance projects Mr. Rutter mentioned included changing all the wheels and fixing grooves in the wheel heads, which involved lifting the 300,000 to 400,000-pound machine and cost close to a million dollars. The facility also added new load controllers for improved load control, updated variable frequency drives to address issues, and installed SICK brand safety lasers for enhanced safety.

Furthermore, the facility implemented a safety camera system with eight cameras and a digital video recorder (DVR) to monitor the surroundings, as well as a fiber-optic network for more efficient data collection at each site. Other upgrades included server installations, signal processing unit upgrades, and the installation of an optical Ethernet bridge for reduced latency and improved data collection.

Despite these improvements, Mr. Rutter acknowledged ongoing challenges, such as outdated equipment and systems, including a machine that still runs on Windows XP. Additionally, the issue of workforce transition planning was raised by Chris Oswald, Jim Mack, and Jim Layton, who emphasized the importance of engaging students and exploring other strategies to address the facility's future workforce needs. Murphy Flynn acknowledged the high priority of addressing these concerns and the importance of developing a robust transition plan.

Ryan Rutter underscored the significance of the NAPTV and NAPTF to the airport pavement testing and research industry. Ensuring the facility's continued functionality and addressing workforce challenges will be crucial.

Presentation 8 Subcommittee Findings & Recommendations **|**
Presenter Subcommittee Members

During the discussion, subcommittee members shared their findings and recommendations for future airport technology program research and development:

- A possible recommendation to investigate short joint testing.
- Exploring LED technology for runway and taxiway lighting.
- Considering wildlife impacts and incorporating new methods to minimize bird interference.
- Addressing staffing needs to cope with the post-pandemic workload and new projects such as Innovate 28 and AAM.
- Investigating funding opportunities for hiring students and supporting research projects.
- Focusing on environmental and resiliency aspects in pavement research.
- Updating the SOR chart for carbon capture and embodied carbon research.
- Continuing collaborative efforts with airport ARFF and environmental subject matter experts to facilitate transition from ARFF to F3 fire fighting agents.

Chris Oswald, the subcommittee chair, encouraged members to contribute their ideas and recommendations for future discussions. He also expressed interest in a more in-depth analysis of embodied carbon in airport pavement materials and requested a presentation from Dr. Navneet Garg during the next session.

The key takeaway from the discussion was the need to address staffing challenges, particularly in light of new projects and an increased workload. Subcommittee members agreed that focusing on safety, environmental impact, and resiliency would be crucial for future airport technologies program research and development.

Next Meetings – Location & Agenda Items TBD

- September 6 - 7, 2023

- March 6 - 7, 2024

Adjourned at noon on Wednesday, March 8, 2023

Attachments (include meeting agenda and list of participants)

Minutes Attachment 1 – Meeting Agenda
Minutes Attachment 2 – Meeting Participants
Minutes Attachment 3 – Definitions of Acronyms and Technical Terms

Hybrid Meeting: *The REDAC Meeting will be held in person at the William J. Hughes Technical Center in New Jersey. Attendees can also join virtually via Zoom – see bottom of agenda for Zoom details.*

Day 1: March 7, 2023

Time	Session	Presenter
Introduction & Overview		
8:00 am - Arrive at Security Operations Center (SOC) + Transport to Building 296		
8:30 am	**1. Introduction**	Christopher Oswald ACI-NA, Subcommittee Chairperson
8:45 am	**2. Opening Remarks**	Eric Neiderman Deputy Director, WJHTC
9:00 am	**3. HQ ARP Update**	John Dermody Director, FAA Airport Safety & Standards
9:15 am	**4. Airport Technology Program Update** ○ 10 Year Plans updates ○ Personnel Recruiting	Jim Layton Branch Manager, FAA Airport Technology Research
9:30 am	**5. Review of Outstanding REDAC Recommendations**	Subcommittee Members and FAA
10:00 am	**Break**	
10:15 am	**6. REDAC Membership/Subcommittee Representation & Emerging Research Needs**	Chris Oswald
10:45 am	**7. Airport Cooperative Research Program (ACRP) Update**	Marci Greenberger Program Manager, ACRP
Program Focus: Safety and Equity		
11:00 am	**8. Overview of Safety Projects Underway**	Ryan King Acting Manager, Airport Safety Research Section
11:15 am	**9. Alternative Aircraft Fire-Fighting Agent Research Update**	Keith Bagot
11:45 am	**ARFF Advisory Group Recommendations – Fluorine Free Foam Transition -** Chris Oswald	
12:15 pm	**Lunch Break**	
12:45 pm	**10. Emerging Entrant Update**	Keri Lyons Emerging Entrants Division (AAS-200)
1:15 pm	**11. Vertiport Design Layout**	Russ Gorman
1:45 pm	**12. Completed Evaluations of UAS Applications**	Mike DiPilato
2:15 pm	**13. UAS Detection & Mitigation Research Update**	Jim Patterson
2:45 pm	**Break**	
Program Focus: Climate and Sustainability		
2:55 pm	**14. Sustainable Pavement Update**	Dr. Navneet Garg
3:15 pm	**15. Airport Environmental Projects**	Lauren Vitagliano
3:45 pm	**Adjourn**	
5:45-7:00pm No Host Subcommittee Dinner (Location TBD)		

Day 2: March 8, 2023

Time	Session	Presenter
Program Focus: Infrastructure Transformation		
8:00 am - Arrive at Security Operations Center (SOC) + Transport to Building 296		
8:30 am	**1. Airport Pavement R&D Program Update**	Murphy Flynn Acting Manager, Airport Pavement Research Section
9:00 am	**2. Section 744 Update – Airport Concrete Pavement Technology Program (ACPTP)**	Gary Mitchell Chief of Engineering & Construction, National Concrete Pavement Technology Center
9:30 am	**3. Section 744 Update – Airport Asphalt Pavement Technology Program (AAPTP)**	Brett Williams Director, Engineering & Technical Support, National Asphalt Pavement Association
10:00 am	**Break**	
10:15 am	**4. FAARFIELD 2.0 Online Tools & PAVEAIR Integration**	Dr. David Brill
10:35 am	**5. CC-9 Fatigue Test & TC-2 Fatigue Test Updates**	Dr. Navneet Garg
10:55 am	**Break**	
11:00 am	**6. CC-10 Update**	Mat Brynick
11:15 am	**7. National Airport Pavement Test Vehicle (NAPTV) Update**	Ryan Rutter
Program Focus: Conclusions		
11:30 am	**8. Subcommittee Findings & Recommendations**	Subcommittee Members
12:00 pm	**Adjourn – Subcommittee Working Lunch**	
OPTIONAL: Facility Tours		
1:15 – 2:15 pm	**Choose one facility tour:** 1. National Airport Pavement Test Facility, *Murphy Flynn* 2. National Airport Pavement & Materials Research Facility, *Dr. Navneet Garg* 3. UAS Hangar, *Jim Patterson & Mike DiPilato*	

HOW TO JOIN THE MEETING:

https://faavideo.zoomgov.com/j/16133330505
Meeting ID: 161 3333 0505 | Passcode: 473594

Phone Audio Only:
- Call 1-888-924-3239; enter Meeting ID: 161 3333 0505
- Passcode: 473594
- Unmute or mute yourself by pressing *6.

REDAC Subcommittee on Airports | Attendees

Meeting date & time: March 7-8, 2023

Meeting location: Hybrid meeting (FAA William J. Hughes Technical Center & Zoom)

DAY 1 – March 7, 2023

Name	Organization	Location
Adam Bouchard	Tampa International Airport	Tech Center
Alex Tsalyuk	Avyance	Tech Center
Brett Williams	National Asphalt Pavement Association	Zoom
Chinita Roundtree-Coleman	FAA	Zoom
Chris Oswald	Airports Council International - NA	Tech Center
Darian Byrd	FAA	Zoom
Darrell Pennington	ALPA	Tech Center
David Brill	FAA	Tech Center
Dominique Khan	Avyance	Tech Center
Eric Neiderman	FAA	Tech Center
Eric Plyler	ARA	Tech Center
Evanicio Costa	Boeing	Tech Center
Frank Fee	Asphalt Institute	Tech Center
Garrison Canter	FAA	Tech Center
Gary L Mitchel	ACPA	Tech Center
Jeff Sedin	ALPA	Tech Center
Jerry Crutchfield	FAA	Zoom
Jim Layton	FAA	Tech Center
Jim Mack	CEMEX	Tech Center
Jim Patterson	FAA	Tech Center
John McGrath	GDIT	Zoom
John R. Dermody	FAA	Tech Center
Jon Schleifer	FAA	Zoom

Name	Organization	Location
Jonathan Torres	FAA	Tech Center
Justin Barkowski	American Association of Airport Executives	Tech Center
Keith Bagot	FAA	Tech Center
Lara Van Nostrand	Avyance	Zoom
Lauren Vitagliano	FAA	Zoom
Lia Ricalde	Applied Research Associates	Zoom
Lisa Smith	FAA	Zoom
Marc Tonnacliff	FAA	Zoom
Marci Greenberger	Airport Cooperative Research Program	Zoom
Mark Hale	Diakon Solutions	Tech Center
Mat Brynick	FAA	Zoom
Nick Subbotin	FAA	Zoom
Okoineme Giwa Agbomeirele	FAA	Zoom
Qingge Jia	FAA	Tech Center
Richard Ji	FAA	Zoom
Ryan King	FAA	Tech Center
Ryan Rutter	FAA	Zoom
Sarah Brammell	Tampa International Airport	Zoom
Sarah Hubbard	Purdue University	Zoom
Scott Marsh	Port Authority of NY/NJ	Tech Center
Scott Murrell	Applied Research Associates	Zoom
Shailesh Gongal	Massport	Zoom
Thomas Van Dillen	FAA	Zoom
Tracy Streagle	FAA	Zoom
Trish Hiatt	FAA	Tech Center
Trish Young	RIVA Solutions, Inc	Zoom
Warren Sloop	Avyance	Zoom
Wilfredo Villafane	FAA	Zoom

DAY 2 – March 8, 2023

Name	Organization	Location
Alex Tsalyuk	Avyance	Tech Center
Brett Williams	National Asphalt Pavement Association	Zoom
Chris Oswald	Airports Council International - NA	Tech Center
Chris Tomlinson		Zoom
Darian Byrd	FAA	Tech Center
Darrell Pennington	ALPA	Tech Center
David Brill	FAA	Tech Center
Dominique Khan	Avyance	Tech Center
Evanicio Costa	Boeing	Tech Center
Frank Fee	Asphalt Institute	Tech Center
Garrison Canter	FAA	Zoom
Gary L. Mitchell	ACPA	Tech Center
Jeff Seoin	ALPA	Tech Center
Jim Layton	FAA	Tech Center
Jim Mack	CEMEX	Tech Center
Jim Patterson	FAA	Tech Center
John McGrath	GDIT	Zoom
John R. Dermody	FAA	Tech Center
John Tye		Zoom
Lara Van Nostrand	Avyance	Zoom
Lia Ricalde	Applied Research Associates	Zoom
Mark Hale	Diakon Solutions	Zoom
Matt Wilson		Zoom
Murphy Flynn	FAA	Tech Center
Okoineme Giwa Agbomeirele	FAA	Zoom
Richard Ji	FAA	Zoom
Ryan King	FAA	Tech Center

Name	Organization	Location
Sarah Hubbard	Purdue University	Zoom
Scott Marsh	Port Authority of NY/NJ	Tech Center
Scott Murrell	Applied Research Associates	Tech Center
Shailesh Gongal	Massport	Zoom
Tim Parsons	ARA	Tech Center
Trish Hiatt	FAA	Tech Center
Trish Young	RIVA Solutions, Inc	Zoom
Warren Sloop	Avyance	Zoom
Wilfredo Villafane	FAA	Tech Center

Acronym	Description
AAAE	The American Association of Airport Executives
AAM	Advanced Air Mobility
AAPTP	Airport Asphalt Pavement Technology Program
ACPTP	Airport Concrete Pavement Technology Program
ACRP	Airport Cooperative Research Program
ACY	Atlantic City International Airport
AFFF	Aqueous Film Forming Foam
AI/ML	Artificial Intelligence/Machine Learning
AOC	Office of Communications
APP	Airport Planning and Programming
ARAF	Airport Resilience Analysis Framework
ARFF	Aircraft Rescue and Firefighting
ARP	Office of Airports
ASD	Airport Safety Database
ASR	Alkali-silica reaction
CC	Construction Cycle
DHS	Department of Homeland Security
DoD	Department of Defense
DVR	Digital Video Recorder
EAGLE	Eliminate Aviation Gas Lead Emissions
EMAS	Engineered Material Arrestor System
ERDC	U.S. Army Engineer Research and Development Center
EVTOL	Electric Vertical Takeoff and Landing
FAARFIELD	FAA Rigid and Flexible Iterative Elastic Layered Design software
FAASR3d	3d Finite element library for FAARFIELD 2.0 and other programs
FATO	Final approach and takeoff area
FFF/F3	Fluorine Free Foam

Acronym	Description
FOD	Foreign Object Debris
GUI	Graphical user interface
HMA	Hot mix asphalt
ICAO	International Civil Aviation Organization
LCA	Life cycle assessment
MILSPEC	Military Specification
MVVM	Model-View-ViewModel, an application design architecture
NAPA	National Asphalt Pavement Association
NAPMRC	National Airport Pavement and Materials Research Center
NAPTF	National Airport Pavement Test Facility
NAPTV	National Airport Pavement Test Vehicle
PAVEAIR	A FAA web-based airport pavement management system that provides users with historic and current information about airport pavement construction, maintenance, and management
PCG	Pavement Coordinating Group
PFAS	Per- and Polyfluorinated Substances
RILEM	International Union of Research Laboratories
SMS	Safety Management System
SOR	Strategic Outlook for Research
STOL	Short takeoff and landing
sUAS	Small Unmanned Aircraft System
TC	Test Cycle
TLOF	Takeoff and landing area
TSA	Transportation Safety Administration
UAS	Unmanned Aircraft Systems
UIUC	University of Illinois Urbana-Champagne
USDA	United States Department of Agriculture