REDAC Read-Ahead

Submitted to the Subcommittee on Airports

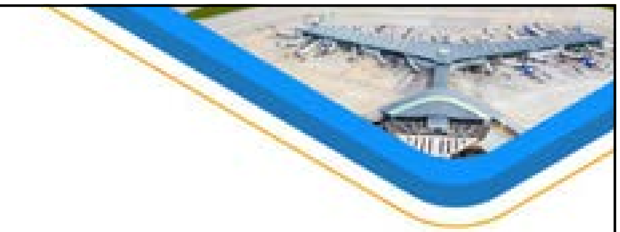
2/21/2023

CONTENTS FOR REVIEW

The following decks are current for Subcommittee review as of 2/21/23.

DAY 1: March 7, 2023

DAY 2: March 8, 2023



Program Update

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Agenda

- Safety Program Overview
  - Airport Safety Research Areas
- Research Projects & Updates
  - Solar Lighting
  - Airport Safety Databases
  - Wildlife Research
  - Paint Marking Research
  - Lighted X Research
  - FOD and Wildlife Detection Technologies
  - Other Safety Projects to be Briefed

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Safety Program Overview

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Airport Safety Research Project Areas (RPA)

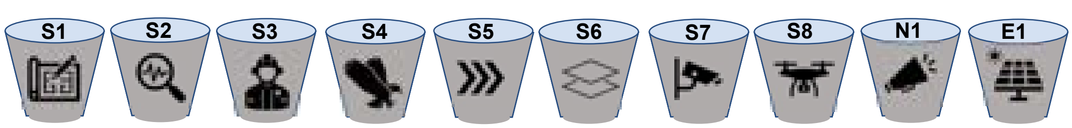
- S1 – Airport Planning and Design
- S2 – Airport Safety Data Mining
- S3 – Aircraft Rescue and Fire Fighting
- S4 – Wildlife Hazards
- S5 – Visual Guidance
- S6 – Runway Surface Safety Technology
- S7 – Airport Safety and Surveillance Sensors
- S8 – Unmanned Aircraft Systems Integration (*transitioning to UAS/New & Emerging Entrants*)
- N1 – Airport Noise
- E1 – Airport Environmental

RPA S3 - ARFF
Sub RPAs and Projects

S3.1 ARFF Technologies
Project: FFF CAFS Testing

S3.2 Firefighting Agents
Project: On Site Burn Testing

S3.3 ARFF Tactics for New Aircraft Design and Materials
Project: Thermal Balance



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Research Projects and Updates

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Solar Lighting

Test Array installed at Penn Yan, NY (PEO)

Prototype Test Array installed at Cape May (WWD)

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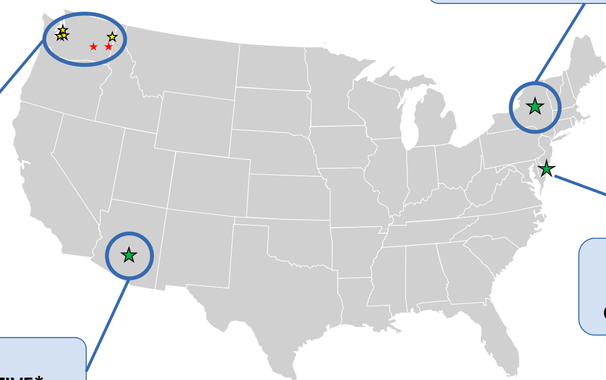
Test Sites and Candidate Airports for Solar Lights

Pacific Northwest (candidates)

- Olympia Regional
- Pierce County
- Puyallup
- Felts Field (SFF)
- Deer Park (DEW)
- Ephrata Municipal (EPH)

Upstate New York
Penn Yan (PEO) - ACTIVE



Cape May, NJ
Initial Prototype Site
Cape May (WWD) – ACTIVE

Central Arizona
Casa Grande (CGZ) – ACTIVE*

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Paint Marking Research

Retro-Reflectivity and Chromaticity

Collecting retro-reflectivity and chromaticity data on FAA approved paint and bead types in various climates (hot and dry, hot and humid, winter ops)

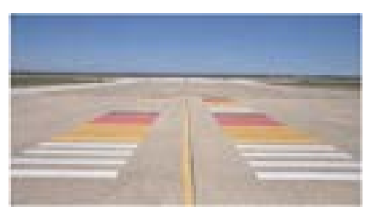
Status

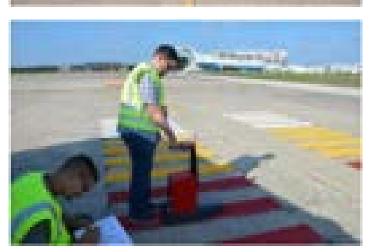
- Phase 0 – Baseline at ACY (continuing)
- Phase 1 – EWR (Complete/Test Report Complete)
- Phase 2 – PHX (Complete/Draft Test Report Complete)
- Phase 3 – FLL (Complete/ Draft Test Report In-Progress

Next Steps

Complete Review/Refinement of PHX Report
Complete FLL Report
Compile Summary Report comprising all phases including CBA

Section 146





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Lighted-X Research

Identified Ground Based Testing Location
- Naval Air Warfare Center Aircraft Division (NAWCAD) Lakehurst, NJ
- 40 miles north of Tech Center

- Conducted Site Survey to verify facility accommodations with requirements
  - Ground based viewing to filter down final scenarios for subsequent flight testing
  - Viewing distances, ambient light conditions etc.
- Currently establishing an Interagency Agreement (IAA) with NAWCAD

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Airport Safety Databases

Airport Safety Database
Data categorization for FY21 data is complete.

FY20 report has undergone review and is being finalized.

Foreign Object Debris Database
Manage and collect information about FOD found on airfield surfaces in the US. The software engineering team has completed an update to the user interfaces on the public web site.

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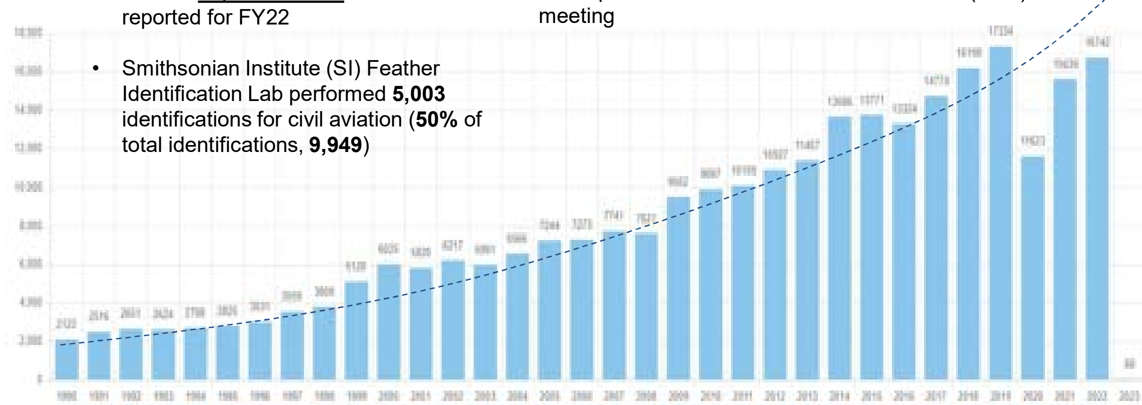
Airport Safety Databases - Wildlife Strike Database

- **285,000+** validated wildlife strikes publically available
- On pace for **300,000** by October 2023
- To date **16,724 strikes** have been reported for FY22
- Smithsonian Institute (SI) Feather Identification Lab performed **5,003** identifications for civil aviation (**50%** of total identifications, **9,949**)

The 2021 Annual Report was published in FY22 Q4.

Continue software and user interface improvements, on a continual basis e.g. enhanced data visualization

Participated in AAAE's Bird Strike Committee (BSC) winter meeting



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Wildlife Research

Avian Perception (pictured to right)

Ongoing work with Purdue University's biology department to analyze and map the visual system of the Canada Goose.

A prototype light was developed by Rensselaer Polytechnic Institute, and Purdue is currently testing responses of caged geese.

UAS Applications for Wildlife

Evaluating unmanned aircraft systems (UAS) technology for wildlife hazard management (surveillance/monitoring)

Developing standard procedures for UAS platform and sensor selection for airport wildlife monitoring

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Vertiports - Infrastructure

ATR continues to engage with VTOL OEMs, industry trade groups, NASA, National Renewable Energy Lab (NREL), and the research support contractor (Woolpert) to further investigate vertiport infrastructure needs. Identified six sites that could be viable locations for vertiport placement and to be used in capacity modeling.

Case studies explore vertiport sites at:

1. Large hub
2. Small/GA and converted heliport
3. Rural/suburban greenfield
4. Urban greenfield
5. Off-airport effecting ATC
6. Temporary facility

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Evaluations of FOD and Wildlife Detection Technologies

FOD Detection Technology

- Contact airline associations to determine their perspective/operational experience on FOD.
- Determine the impact of FOD on operations and their perception of the potential benefit of the FOD detection systems.
- Number, frequency, and severity of FOD incidents at the most impacted airports
- FOD source of origin, size, material, location (i.e., runway, taxiway, ramp, maintenance hangar, other), and date/time of detection
- Airline and airport-related costs and impact of airport complexity
- Perceived benefit of FOD detection technologies

Wildlife Detection Technology

- Literature review to ascertain state-of-the-art of all commercially available wildlife detection technologies.
- Avian radars, electro-optical systems (and other technologies), and foreign object debris (FOD) detection systems that can also be used to detect wildlife.
- Assess these systems against existing FAA standards (where standards exist), and/or the claims of respective manufacturers of such commercially available systems.

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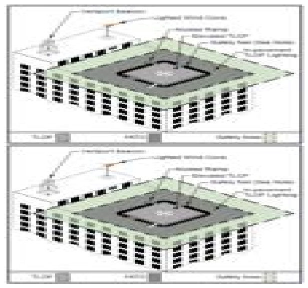
Other Safety Projects to be Briefed

UAS Applications on Airports
Mike DiPilato

Aircraft Rescue and Firefighting
Keith Bagot



Vertiports
Russ Gorman

Airport Environmental and Noise Projects
Lauren Vitagliano

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Questions?

Contact the FAA Program Manager

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FAA ARFF Research Program

Fluorine-Free Foam Research

Presented to:
REDAC Sub committee on Airports

Keith Bagot
March 7 8, 2023

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Agenda

- Project Background
  - Background
  - Program Status
  - Timeline
  - Transition

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Project Background

THE RESEARCH REQUEST:

Fluorinated aqueous film-forming foam (AFFF) agents effectively combat fires, but they also contain per-and polyfluoroalkyl substances (PFAS). These are "forever chemicals" that negatively impact the environment.

Therefore, alternative foams lacking PFAS chemicals must be identified. **The FAA Reauthorization Act of 2018** directed that FAA cease requiring fluorinated chemicals in AFFF to meet fire performance standards.

PROJECT DESCRIPTION:

- **Testing foam proportioning systems**
  - Eliminate the discharge of AFFF into the environment for any operations other than actual emergency responses
  - Meet acceptable means under NFPA 412 and Part 139
- **Researching and testing AFFF Replacements**
  - Conduct Live Fire Tests and Chemical Analyses of the potential replacements
  - Collaborate with Department of Defense (DOD), Environmental Protection Agency (EPA), foam manufacturers, and other industry partners

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AFFF Replacement Strategy

- **Conduct Live Fire Testing**
  - MIL-F-24385F (FAA requirement)
  - ICAO Level C
  - Product Selection Based on Lit Review
  - Perform assessments at manufacturer request
  - New, emerging extinguishing agents
  - Work with manufacturers on new formulations (Broad Agency Announcement - BAA)
  - Test impacts of changing variables in the protocols
- **Conduct chemical analysis of potential replacements**
  - Use existing Interagency Agreement between FAA & U.S. Air Force Civil Engineering Center (Tyndall Air Force Base)

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Test Summary

- 2 baseline fluorinated AFFF tested (1 MilSpec, 1 ICAO C)
- **49** Fluorine-Free Foams (FFF) evaluated
  - 11 Commercial off-the-shelf foams
  - **38 Prototype fluorine-free foam formulations**
  - New prototype agents from BAA and industry continue to be evaluated
- Over **750** fire tests conducted
  - Standard MilSpec and ICAO C tests
  - Modified MilSpec/ICAO Level C tests were conducted (eg. Fuels, active and stationary FF, flow rate & pre-burn times)
  - Conducted ICAO Level C tests both outside and inside because of test results
  - **Tested highest performing FFFs against new draft MilSpec test protocols**
  - **Conducting 28sqft pan fires using mixed FFF concentrates**
  - **Conducting 28sqft pan fires using two agent application (simulated mutual aid or dual-use fire attack)**
- **30' diameter ring fires**
  - **Same application density as 28 sqft. MilSpec fires**
  - **Testing fog nozzle, foam tube, CAFS and DC compatibility**

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Mixed FFF Concentrate Testing

Manufacturers recommend not mixing the concentrates from multiple manufacturers in one tank.

Mixed concentrates

- Test designed to simulate mixing concentrates in a foam tank.
  - Immediate use
  - Accelerated aging
  - 30 day bench aging
- Mixtures:
  - FFF concentrates used are top performers expected to pass qualification testing.
  - AFFF/FFF
  - FFF/FFF

Multi-agent application

- Designed to replicate discharges of different agents on the same fire attack (eg. dual-use airfields or mutual aid departments)
- Simultaneous foam discharges
- Mixtures:
  - FFF concentrates used are top performers expected to pass qualification testing.
  - AFFF/FFF
  - FFF/FFF

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30’ Diameter Ring Tests

Testing fog nozzle, foam tube, CAFS and DC compatibility

Test Status

- Completed 32 fire tests using 100 gallons of Jet A fuel
- Same application density as 28 sqft. MilSpec fires
- CAFS provided the best foam blanket with the foam tube a close second.
- DC entrainment negatively impacted both extinguishment times and foam quality.
- Fire reignition was most commonly observed in the standard discharge and foam tube discharges with FFFs.

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Department of Defense (DOD) Interaction

- Collaboration through DOD SERDP/ESTCP
  - Participating in monthly meetings with the SERDP/ESTCP Director and Program managers to discuss FAA and DOD research progress in AFFF replacement testing
  - Participating in the SERDP/ESTCP In-Progress Review and Annual Meetings as well as served as reviewers for research proposals submitted to SERDP
- Shared over 2 years of data from foam testing with counterparts at NRL Chesapeake Beach to aid in the development of the new FFF MilSpec.
- Participated in multiple meetings for the development of the new FFF MilSpec with the Navy and other DOD research organizations.
- Participated in the stakeholder and first draft reviews of the new FFF MilSpec.
- Participating in multiple FFF testing events with the DOD at Naval Air Weapons Station China Lake.

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Timeline

- DOD National Defense Authorization Act (NDAA) deadline of publishing new FFF MilSpec by Jan. 31, 2023. **RELEASED 1/12/23**
- Qualification testing expected to take 120 days per product (tested concurrently). **NDAA deadline 10/1/23**
- FAA and DOD continue to research new FFF formulation.
- FAA released CERTALERT 23-01 on 1/12/23 announcing new FFF MilSpec
- FAA focus on transition planning from legacy AFFF to new FFFs while additional research continues.
- Complete rewrite of the AC 150/5210-6D – Aircraft Fire Extinguishing Agents.
  - Both AFFF and FFF will be initially acceptable through transition period.

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CERTALERT 23-01

- Fluorine-free foams lack compatibility with other fluorine-free foams, so they cannot be mixed together.
- The new F3 firefighting agent is not available in a pre-mixed solution.
- When Certificated Part 139 airports transition to the new F3, the operator will find the MILSPEC F3 product identified on the QPL/QPD site.
- It is anticipated to take a minimum of 90-120 days from the issuance of the new F3 Military Specification, dated January 12, 2023, for the first products to complete their certification process and be listed on the QPL/QPD.
- Currently, Certificated Part 139 airports will not be required by the FAA to transition to the new F3. Airport operators are authorized to continue using Aqueous Film Forming Foam (AFFF) listed on the QPL for MIL-F-24385

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Transition to New FFF

- **Transition period**
  - Not defined
- **Environmental concerns**
  - EPA published guidance
  - Many decisions will be at the State level
- **Cleaning of vehicles**
  - States determine cleaning levels
  - FAA will provide informational assistance
  - Treatment of rinsate from cleaning
- **Training & Equipment**
  - Differences between AFFF and FFF
  - Tactics and techniques
  - Training facilities
- **Recommendations**
  - Transition all vehicles sequentially under the same program

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Research Timeline

2022 – 2023	2024 – 2029	2030 & Beyond
Fire Extinguishing Foam Research – Evaluate fluorine-free foams (FFFs), and develop standards for use at airports	**Thermal Balance -** Examine the impact of water discharge from aircraft skin penetrating nozzles (ASPN) on thermal balance of interior cabin fires	**Autonomous Extinguishing Systems**– Evaluate the performance of autonomous extinguishing systems
Compressed Air Foam Systems – Evaluate overall foam system and then test with aqueous film forming foam (AFFF) and FFF	**ARFF Methods for Alternative Powered Aircraft** – Identify and evaluate equipment and tactics for fires involving aircraft powered by electric batteries and hydrogen fuel cells	**ARFF Tactics for New Aircraft Design and Materials** – Examine strategies for firefighting in blended body aircraft configuration
	ARFF Technologies for Vertiports – Determine what firefighting equipment is needed for vertiports	
	ARFF Tactics for New Aircraft Design – Identify and evaluate firefighting tactics for emergencies involving horizontal takeoff and landing commercial space aircraft	
	ARFF Vehicle Technologies– Evaluate performance specification for ARFF vehicles powered by alternative fuel sources	

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Questions?

Contact the FAA Program Manager

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FAA Airport R&D Airport Safety Research Published Papers and Technical Notes:
https://www.airporttech.tc.faa.gov/Products/Airport-Safety-Papers-Publications

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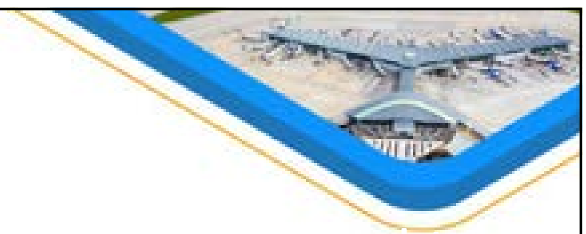

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Emerging Entrants Division (AAS-200) Mission

Responsible for advancing the needs of the nation's aviation system through the evaluation and development of policy for new technologies, infrastructure, and aircraft positioned to operate in the national airspace system (NAS).

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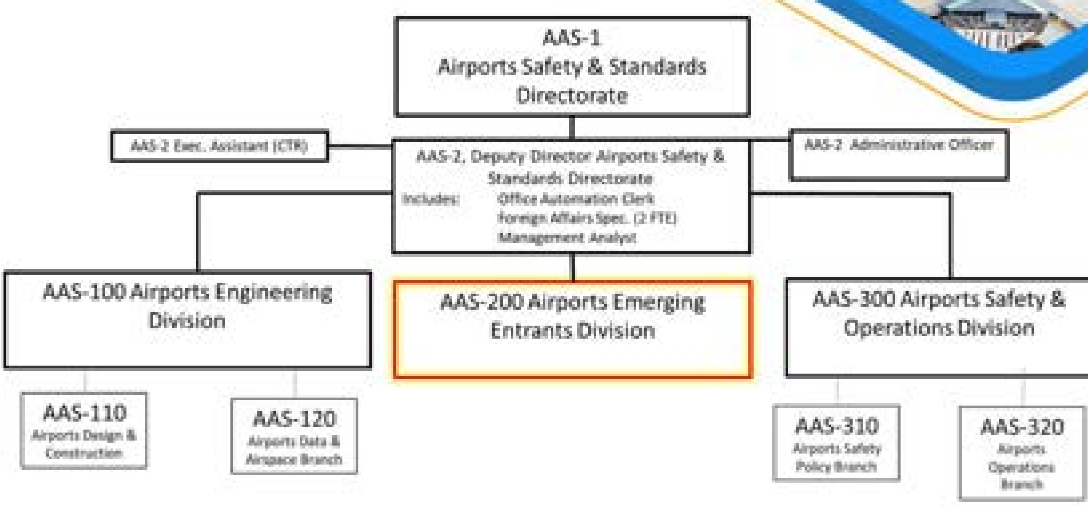

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REVIEW OF CURRENT EFFORTS

- VERTIPORTS FOR ADVANCED AIR MOBILITY
- UNMANNED AERIAL SYSTEMS (DRONES)
- COMMERCIAL SPACE

OVERVIEW OF NEW EFFORTS

- HYDROGEN INFRASTRUCTURE
- VERTIPORT/ELECTRIC AIRCRAFT FIREFIGHTING
- PUBLIC OUTREACH

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Current Efforts

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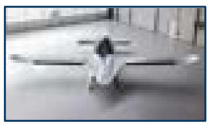
Advanced Air Mobility (AAM) Integration

Definition of Advanced Air Mobility

- AAM means "a transportation system that transports people and property by air between two points in the United States using aircraft with advanced technologies, including electric aircraft or electric vertical take-off and landing aircraft, in both controlled and uncontrolled airspace."
  - Established by the U.S. Congress in Senate Bill 516 (the AAM Coordination and Leadership Act).
- AAM is not a single technology, but rather a collection of new and emerging technologies being applied to the existing aviation system, particularly in new aircraft types.

Notional Use Cases Include:

Urban Air Mobility (intra city)	Regional Air Mobility (inter city)	Public Services (fire, air ambulance, search & rescue)	Cargo Movement (large aircraft)	Private & Recreational Vehicles
				

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Advanced Air Mobility (AAM) Infrastructure

- The majority of Vertical Takeoff and Landing (VTOL) and Short Takeoff and Landing (STOL) operators intend to begin operations using existing infrastructure. An increasing number of airports, municipalities, and AAM operators are planning for landing and take-off sites both on and off airports.
- As operators explore that interest, questions arise as to what standards to use in the siting, design, and operation of vertiports and supporting infrastructure.

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- FAA cancelled Advisory Circular (AC) 150/5390-3, Vertiport Design, in 2010 due to lack of compatible aircraft.
- FAA needs new standards to address facilities required for the boarding and discharging of passengers and cargo by VTOL and STOL aircraft.

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Advanced Air Mobility (AAM) Infrastructure

- To support the development of vertiport standards, ARP and the Airport Technology Research and Development Branch (ATR) began a multi-year research project on vertiport design and operation in 2019.
- In September 2022, FAA released Engineering Brief 105, *Vertiport Design*.
  - This is an early effort at prescriptive interim design guidance for vertiports, based on limited performance and design data for the types of aircraft that will use these facilities.
- FAA will develop a performance-based AC on vertiport design by 2025.
  - The future AC will address autonomy, different propulsion methods and alternative fuel sources, high tempo facilities, and instrument flight rules (IFR) capability.
- FAA is developing an agency-wide implementation plan to support future AAM operations.

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Unmanned Aircraft Systems (UAS/Drones)

- Integrating Unmanned Aircraft Systems (UAS), or "drones," into the National Airspace System (NAS) requires new regulations, updates to existing regulations, and new policies and procedures to safely and securely accommodate drones. This is a rapidly changing sector that will continue to see immense changes over the next decade.
- To meet industry and public demand, the FAA follows an integration strategy based on risk; that is, low risk operations are integrated first, followed by increasingly complex and higher-risk operations.
- We see continued interest in leveraging small UAS (sUAS) as a tool to supplement airport planning, construction, and operations.
  - ATR is evaluating how UAS can support various use cases (on-airport applications) such as Pavement Inspections, Obstruction Analysis, Aircraft Rescue and Firefighting (ARFF), Foreign Object Debris (FOD) Detection, Perimeter Surveillance, Wildlife Management and Lighting Inspection.
- Based on initial research findings and ongoing collaboration with industry, ARP published a letter to airport sponsors with information to further assist with the safe integration and use of sUAS on airports.
  - The November 22, 2022 *Letter to Airport Sponsors about Policies and General Best Practices for UAS Activities On Airports* is available at www.faa.gov/airports/new_entrants/on_airport_operations.

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UAS Detection and Response

- In August 2020, FAA announced plans to evaluate technologies and systems that could detect and mitigate potential safety risks posed by UAS. The effort is part of the agency's Airport UAS Detection and Mitigation Research Program authorized under the FAA Reauthorization Act of 2018 (Section 383). ATR is working with five airports selected to participate in this program:
    - Atlantic City International (ACY);
    - Syracuse Hancock International (SYR);
    - Rickenbacker International (LCK);
    - Huntsville International (HSC); and
    - Seattle-Tacoma International (SEA) Airports.
- Testing began mid 2022 and will continue in 2023. Once complete, the FAA will develop standards for future UAS detection and mitigation technologies at airports.

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- FAA issued Cert Alert 21-04, *Updated Guidance for Airport Emergency Plans (AEP) under 14 CFR Part 139.325(b)(7)*, in September 2021. The Cert Alert informed Part 139 airport operators that AEPs should include instructions for responding to unauthorized UAS operations.

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Commercial Space

- In the past decade, we've seen an uptick in the number of airports interested in hosting commercial space launch, reentry, and related activities (i.e., rocket engine testing) that support commercial space transportation.
- U.S. launch and reentry sites, also more commonly referred to as spaceports, play a critical role in the growing global commercial space transportation industry.
- Eight licensed spaceports co-exist on NPIAS airports. Of those 8 licensed spaceports, 4 are also Part 139 airports that host commercial air carrier service.

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Commercial Space

- FAA's Office of Commercial Space Transportation (AST) regulates the U.S. commercial space transportation industry to ensure compliance with international obligations of the U.S., and to protect the public health and safety, safety of property, and national security and foreign policy interests in the U.S.
- ARP works closely with AST to balance operational safety and the preservation of access to traditional aviation users at our nation's airports while supporting airports interest in offering innovative services to the growing commercial space industry.

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- In October 2014, ARP issued interim guidance via internal memo to our Regions and Airports District Offices. The memo provides summary-level guidance for FAA personnel and airport operators on requirements that airport operators must consider when evaluating commercial space related activities, in a manner consistent with existing statutes, regulations, and policy.

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New Efforts

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Hydrogen Infrastructure at Airports

- Over the past few decades, concerns have grown over the contributing effects that greenhouse gases produced from fossil fuels have on climate change. Currently, commercially available aircraft rely heavily on either jet fuel or leaded aviation gasoline.
- Due to these concerns, many aircraft manufacturers are pursuing development of new aircraft that can leverage alternative, renewable fuels. Hydrogen has become a fuel of interest because of its abundant availability and production of low emissions when used as an alternative fuel.
- With increased interest in hydrogen fueling, airports will need standards and guidance to support the safe storage and handing of hydrogen fuels.
  - In September 2022, ATR awarded the Department of Energy's National Renewable Energy Laboratory (NREL) a new task to support the development of hydrogen infrastructure guidance.

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Vertiport/Electric Aircraft Infrastructure

- Many VTOL/STOL/Conventional Takeoff and landing (CTOL) aircraft manufacturers are currently designing vehicles to be hybrid or fully electric, meaning that these aircraft will carry larger amounts of rechargeable batteries than traditional aircraft.
  - While lithium ion (Li-ion) batteries have previously posed hazards to aviation as cargo, these batteries will now be integrated into the design of the aircraft.
- Li-ion battery fires are different than traditional hydrocarbon fuel fires. It is unknown whether traditional firefighting agents will sufficiently suppress fires in electric and hybrid-type powered aircraft. Therefore, new strategies will need to be researched, tested, and developed.
- To support development of these strategies, in December 2022 ARP and ATR developed a new research project to determine firefighting/emergency response considerations for electric aircraft at airports and vertiports (e.g., tactics, firefighting agent type and quantity, equipment, etc.).

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Public Outreach

- To better inform the airport community about emerging entrants, ARP created the *New and Emerging Entrants on Airports* webpage, linked to www.faa.gov/airports.
- This new 'landing page' will feature links to each of the highlighted emerging entrant portfolios and provide a more centralized location for airport specific information as it relates to each of the portfolios.

https://www.faa.gov/airports/new_entrants

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Questions?

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Vertiport Design

RPA S1 – Airport Planning and Design

Presented to:
REDAC Sub committee on Airports

Russ Gorman
March 7 8, 2023

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Agenda – PLACEHOLDER DOES NOT MATCH THE CONTENTS OF THE DRAFT PRESENTATION YET

- Project Background
    - Purpose of the project
    - Accomplishments
    - In progress
- Technical Report
    - Updates, findings, or program accomplishments
    - Challenges
    - Key updates and next steps

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Purpose

- To support the development of vertiport standards, the Office of Airports (ARP) and the Airport Technology Research and Development Branch (ATR) began a multi-year research project in 2019 on vertiport design and operation
- Goal is to develop a performance-based AC on vertiport design by late 2025
  - Will address autonomy, different propulsion methods, high tempo facilities and instrument flight rules (IFR) capability.
  - AAM aircraft using alternative fuel sources

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Accomplishments

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Accomplishments - OEM Data Collection

- One challenge in creating the Vertiport Design AC is that limited performance and design data is available for the types of aircraft that will ultimately use these facilities
- Met with OEMs that have mature concepts of different types of related aircraft
  - Joby – vector thrust
  - Beta – lift and cruise
  - Moog – multi-copter
- Collection of aircraft dimensions and performance data from these OEMs
- Acquired data from industry is being used to determine the required Vertiport infrastructure
  - Vertiport design and geometry
  - Marking, lighting and visual aids
  - Charging and electrical infrastructure
  - On-airport vertiports
  - Site safety
- Draft Vertiport Engineering Brief (EB) was released in April 2022
- Conceptual testing was performed to help evaluate this draft EB

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Accomplishments – Conceptual Testing

- Six conceptual vertiports were modeled during the conceptual testing focused on eVTOL aircraft
- Identify information gaps and uncertainty in the draft guidance
- Develop operational concepts for standard arrival and departure operations
- Estimate TLOF occupancy times (seconds per operation)
- Estimate TLOF throughput (operations per hour)
- Maneuverability on and around the TLOF – FATO size evaluation
- EB recommendations and additional research topics identified
- In September 2022, the FAA published Engineering Brief No. 105, Vertiport Design
  - provides interim guidance for the design of vertiports for aircraft with vertical takeoff and landing (VTOL) capabilities

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Accomplishments – Vertiport Symbology Testing

- Simulations conducted at the Tech Center in September 2002
  - Simulations led by Human Factors Branch (ANG-E25)
  - Testing was performed in the helicopter simulation lab by the Air Mobility NextGen Organization Aviation Research Division
- Evaluation of broken wheel vs. "V" symbol
  - 35 runs performed per test subject using replay method to permit the examination of greater number of conditions in relatively short session
  - Symbol, time of day, approach angle, and approach direction
- Preliminary results released late October 2022 with final report in progress
- General findings
  - Pilot feedback regarding preference was about the same between the 2 symbols
  - V clearly communicates direction and was a larger target (i.e., "more paint on the ground")
  - Broken wheel looks the same in all directions but provides clearer center point
- Next steps
  - Awaiting final report
  - Continue evaluation of symbols and potential modifications
  - Allow for pilot to fly the approach themselves
  - More detailed lighting evaluation

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In Progress

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In Progress – Vertiport Electrical Infrastructure Study

- June 2021 – April 2023
- AAM Charging Infrastructure Energy Analysis/Assessment Study to determine AAM energy needs
- Site Assessments (2 to 3 scenarios)
  - Identify recommended electric vehicle support equipment (EVSE) locations for electric vehicle (EV) charging
  - EV parking area
  - Power availability, impact on circuit, and minimum space requirements with hazards identification
  - Rough order of magnitude cost of infrastructure
  - Cybersecurity needs
- JEDI
- Carbon and greenhouse emissions
  - Data collection
  - Hazard evaluation report
  - Cyber security assessment report
  - Site assessment report
  - Electrical infrastructure report

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In Progress – Vertiport Hydrogen Infrastructure Study

- December 2022 to December 2023
- Data collection
  - Aircraft manufacturers
    - Size and characteristics
    - On-board hydrogen power supply and storage tank
    - Hydrogen fueling methods and infrastructure
  - Fueling station designers
    - Fueling methods
    - Fueling infrastructure
- State of technology analysis report
- Site assessment report
- H2 infrastructure assessment
- Determine LCOH for delivery methods
- Analyze job and economic development
- Determine carbon and greenhouse emissions

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Upcoming Tasks

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Upcoming Tasks – Operational Testing

- Operational Testing
  - Test Phase 1 – planned for May 2023 to November 2023
    - Test interactions of up to 3 eVTOL aircraft with vertiport infrastructure during normal operations
    - DWOW
    - Landing precision/scatter
    - Approach and departure profile
    - Taxiing procedures and turning radius
  - Test Phase 2 – planned for November 2023 to September 2024
    - Test up to 6 eVTOL and STOL aircraft
    - Emergency procedures
    - Autonomy
    - STOL

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Questions?

Contact the FAA Program Manager

FAA POC Name
POC Title
POC contact info
POC.Name@faa.gov

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Backup Slides

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sUAS Airport Application Research Update

RPA S8: UAS Integration at Airports

Presented to:
REDAC Sub committee on Airports

Mike DiPilato
March 7, 2023

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Agenda

- Project Background
  - **Background**
  - **Completed Applications**
  - **Ongoing Applications**
  - **Summary – Completed Applications**

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Project Background

- The FAA is conducting research to determine minimum performance specifications and technical/operational considerations for the following airport UAS applications (use-cases).
  - Obstruction Analysis
  - Perimeter Security Inspections
  - Pavement Inspections
  - Aircraft Rescue and Firefighting (ARFF) – Live Monitoring
  - ARFF Accident Documentation
  - Wildlife Hazard Management – Dispersal

  Completed

  - Wildlife Hazard Management – Monitoring
  - FOD Detection
  - Construction Monitoring

  Ongoing
- The FAA has concluded their <u>initial research</u> (in the 'completed applications') and are preparing final reports that summarize the research results and findings.

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Completed UAS Airport Applications

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Obstruction Analysis

- **Purpose:** Evaluate the use of UAS for collecting obstacle data at airports.
- **Research Lifecycle:** 2019 - 2022
  - Testing at six airports with different natural/manmade obstructions.
  - Tested various types of UAS and optical cameras.
- **Findings:**
  - UAS aerial imagery, in conjunction with 3D stereo analysis, is capable of generating obstacle measurement data that meets current FAA Advisory Circular 150/5300-18 accuracy standards.
    - UAS imagery is significantly higher resolution than manned aircraft imagery
  - UAS collect a significant amount of images compared to manned aircraft.
- **Accomplishment:** Completed draft final report in December 2022 that is currently being reviewed by FAA leadership/SMEs and NOAA NGS.
  - Planned publication is Q3 FY 23.

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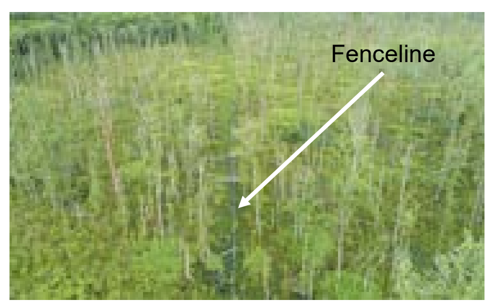
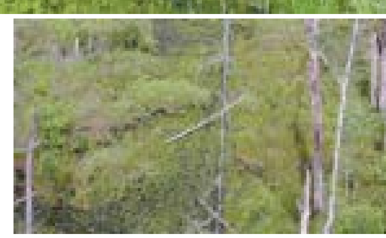
Perimeter Fenceline Inspections

- **Purpose:** Evaluate the use of UAS to conduct airport perimeter security inspections.
- **Research Lifecycle:** 2019 - 2022
  - Tested at four airports with different environments.
  - Tested various types of UAS and optical cameras.
- **Findings:**
  - The results from this research conclude that UAS are most effective for inspecting hard to reach locations and to detect persons and objects near the fence.
  - UAS are a suitable tool for supplementing traditional inspections.
- **Accomplishment:** Completed draft final report in January 2022 that is currently being prepared for management review/editing.
  - Planned publication is Q3 FY 23.





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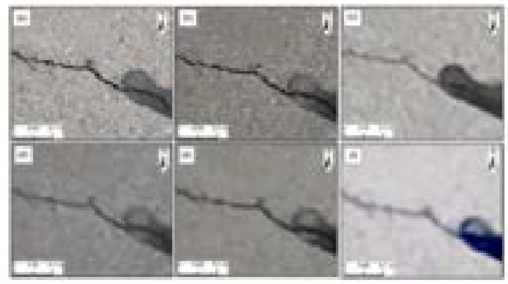
Pavement Inspections

- **Purpose:** Evaluate the use of sUAS to conduct airport pavement inspections.
- **Research Lifecycle:** 2020 - 2022
  - Tested at eight airports with different pavement types/severities.
  - Tested various types of sUAS and optical cameras.
  - UAS data was compared to traditional 'foot-on-ground' surveys.
- **Finding:** sUAS are a suitable tool for supplementing, but not replacing traditional pavement inspections.
- **Accomplishments:**
  - Published two final reports in November and December 2022.
  - A third final report is in editing with a planned publication in Q3 FY 23.
- **FAA SME:** Matthew Brynick



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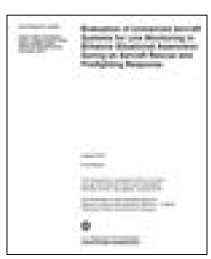
ARFF Live Monitoring

- **Purpose:** Explore the use of UAS to improve the situational awareness and effectiveness of ARFF personnel when monitoring the response to an ongoing ARFF accident/incident.
- **Research Lifecycle:** 2021 - 2022
  - Tested at ACY and DFW Fire Training Research Center.
  - Tested various types of UAS and optical/thermal cameras.
- **Finding:**
  - Based on analysis of footage and feedback collected during testing, UASs equipped with thermal and visual cameras were found to provide a **significant situational awareness benefit** to incident commanders in a variety of ARFF response scenarios.
- **Accomplishment:**
  - Published final report in August 2022

FAA SME: Keith Bagot



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ARFF Accident Documentation

- **Purpose:** Explore the use of UAS for generating overview maps of aircraft accident sites to document the scene for accident investigators and improve situational awareness and coordination of emergency response personnel.
- **Research Lifecycle:** 2021 - 2022
  - Tested at ACY and DFW Fire Training Research Center
  - Tested various types of sUAS and optical/thermal cameras
- **Findings:**
  - The results from this research conclude that sUAS can be a useful tool to provide rapidly generated high resolution maps of an accident/incident scene.
  - These maps provided the ability to make accurate linear and area measurements, as well as to label and annotate key details of the scene for situational awareness (e.g. ingress/egress routes, staging and triage areas, debris field(s), tire tracks, etc.).
- **Accomplishment:**
  - Completed interim report. Final report will be completed by March 2023.
    - Planned publication is Q4 FY 23.
- **FAA SME:** Keith Bagot

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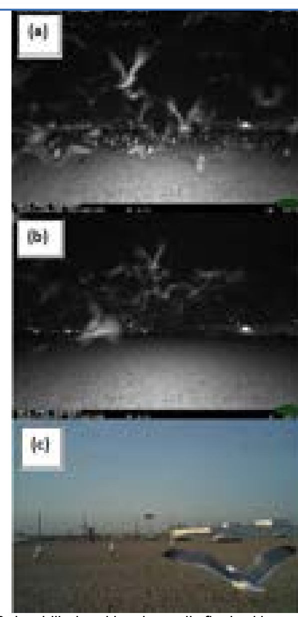
Wildlife Dispersal

- **Purpose:** The FAA and U.S. Department of Agriculture – National Wildlife Research Center are collaborating to examine bird responses to various sUAS platforms.
- **Research Lifecycle:** 2018 - 2021
  - Tested at four 'off-airport locations'
    - Controlled environment, landfill, two rooftop locations.
  - Tested various fixed wing, fixed wing 'predator model', quadcopter, and ornithopter (Robird®).
  - Subject birds: Turkey vultures, gulls, and red winged black birds.
- **Findings:**
  - The initial results from this research indicate that UAS can be used for dispersing specific species of birds.
    - Effectiveness varies between the bird species, UAS platform, and flight profile (direct v. overhead).
- **Accomplishments:**
  - Completed three peer reviewed journal articles (March 2020, November 2021, and October 2022).
- **FAA SME:** Wesley Major



About 130 ring-billed and herring gulls flushed in response to an UAS hazing treatment (a and b). No gulls returned to the roof until the following morning (c).

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Ongoing
UAS Airport Applications

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UAS for Construction Monitoring

- **Purpose:** Explore the use of UAS for monitoring and tracking various types of airport construction projects.
- **Research Lifecycle:** 2023
- **Accomplishments:**
  - The research team began an outreach effort in January, 2023, contacting an initial list of 13 airport operators and other entities to arrange informational interviews.
  - 6 interviews have been conducted to date.
- **Next Steps:**
  - Identify and reach out to additional airports and entities utilizing UAS for construction monitoring, which will include attending the AAAE Airport Planning, Design, and Construction Symposium.
  - Draft Final Report is planned for completion in June 2023.

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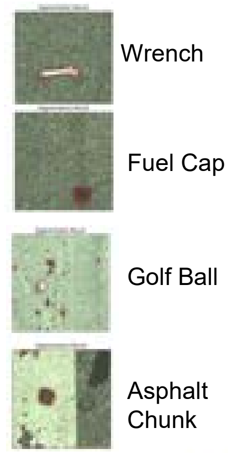
UAS for Foreign Object Debris (FOD) Detection

- **Purpose:** Explore the feasibility of using UAS and artificial intelligence (AI) / machine learning (ML) technologies to detect FOD on airport surfaces and determine whether these technologies can meet all, some, or none of the requirements in Advisory Circular (AC) 150/5220-24, Airport Foreign Object Debris (FOD) Detection Equipment.
- **Research Lifecycle**: 2022-2023
- **Accomplishments:**
  - Completed a literature review of 35 publications.
  - Conducted 3 stages of initial testing at Cape May County Airport (WWD), including preliminary, calibration, and full-scale testing of an entire runway.
- **Findings:**
  - The AI model was able to detect 48 of 53 (90%) FOD objects that were placed on the runway during full-scale testing.
  - False positive rates remained high for areas with cracks, chipped paint, and patched pavement—this could potentially be reduced with additional AI model training and post-processing techniques.
- **Next steps:**
  - Refine workflow based on initial test findings and conduct additional testing at WWD and a validation test at one additional airport.
  - Final report draft scheduled to be completed in September, 2023.



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Wildlife Dispersal 'Pilot Program' - ACY

- ACY Study – Applying knowledge from previous research to a vulture study

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Wildlife Monitoring

Research Approach

- Literature Review
  - Explore published literature on how others have used UAS to monitor wildlife.
- Survey
  - Get first information from first-hand experiences.
    - Information may not have been published.
- Conduct Field Testing
  - Isolate variables for testing

Typical methods to ey wildlife on airports is from a ground based perspective.

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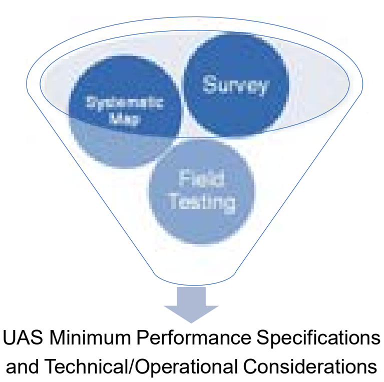
Literature Review & Survey

- Literature Review
  - Systematic map protocol
  - Over 3,500 articles, 384 for full text review
  - Execute systematic map
- Survey
  - Supplement to systematic map
  - Qualtrics survey for UAS pilots
  - Over 100 participants
    - Some agreed to share imagery
- **<u>Awaiting final publication of manuscript that summarizes this effort.</u>**



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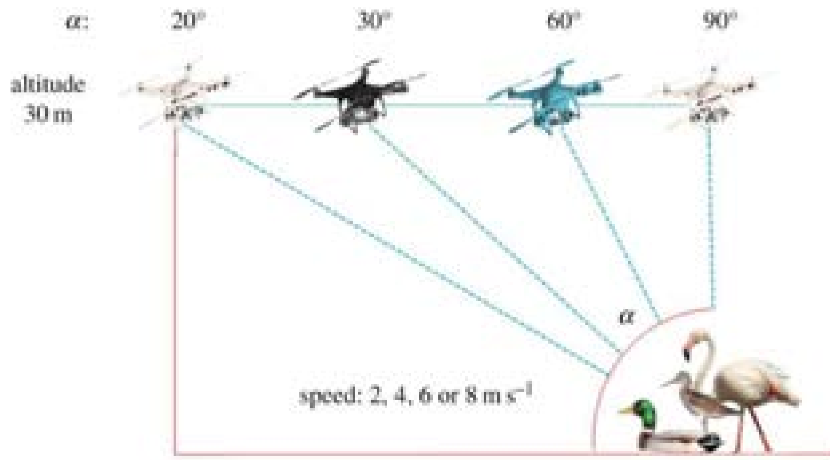
Field Testing Methods

Controllable UAS factors

- 4 altitudes
  - 50 feet (15m)
  - 100 feet (30 m)
  - 150 feet (46 m)
  - 200 feet (61 m)
- 2 camera angles
  - 45°
  - 90°
- 3 times of day (shadows)
  - Morning
  - Mid-day
  - Afternoon
- Various platforms/payloads



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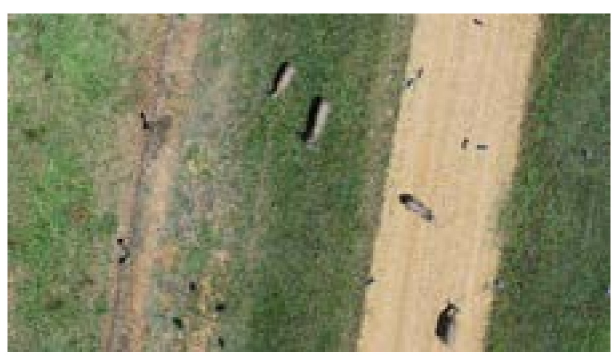
Camera Angle

- 45°
- 90°



Notice the shadows present at 45°, especially the birds perched on fence (possibility of double counts)

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AI & ML Component to Wildlife Monitoring

- Problem:
  - The images/video taken after flying a UAS needs to be analyzed post flight.
    - This can be time consuming
- Research Question:
  - Can artificial intelligence / machine learning be used to assist with locating wildlife from UAS images/video?
  - One step further - Can AI/ML identify the wildlife after locating?
- Secondary Problem:
  - Currently, there is limited imagery of wildlife from "top-down" perspective.
  - Will need to train AI/ML on what to identify.
- Publications:
  - Improving Animal Monitoring Using Small Unmanned Aircraft Systems (sUAS) and Deep Learning Networks (June 30, 2021)
  - Fusion of visible and thermal drone images for improving automated wildlife classification

Deer Horse Cow

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Completed UAS Airport Applications

Application/Use Case	Summary	Report(s) Sent to Editors	Actual/Planned Report Publication Date
ARFF Live Monitoring	• Explored how UAS can improve situational awareness/effectiveness during an ARFF response. • Testing was completed at two airports. • Published Report: Evaluation of UAS for Live Monitoring to Enhance Situational Awareness during an ARFF Response	August 3, 2022	August 23, 2022
ARFF Accident Documentation	• Explore the use of UAS for generating overview maps of aircraft accident sites to document the scene for accident investigators and improve situational awareness and coordination of emergency response personnel.	Q3 FY 23	Q4 FY 23
Wildlife Dispersal	• FAA/USDA examined bird responses to five UAS platforms. • Subject birds included: red-winged black birds, turkey vultures, and gulls.	N/A	Published three 'peer reviewed' journal articles.
Pavement Inspections	• Explored how UAS can be utilized for pavement inspections. • Testing was completed at eight airports. • UAS data was compared to foot-on-ground surveys. • Published two Reports: • Practical Lessons Learned from Planning, Collecting, Processing, and Analyzing Small Unmanned Aircraft System Data for Airfield Pavement Inspection • Small Unmanned Aircraft System for Pavement Inspection: Execute the Field Demonstration Plan and Analyze the Collected Data	Q3/Q4 FY 2022	• November 2, 2022 • December 16, 2022 • Additional report will be published by Q3 FY 23
Airport Obstacle Data Collection ('Obstruction Analysis')	• Explored how UAS can be used for airport obstacle data collection (surveys). • Testing was completed at five airports with different obstacle types. • UAS data was compared to ground and aerial (manned) surveys.	Q3 FY 23	Q4 FY 23
Perimeter Security Inspections	• Examined how UAS can be utilized for fence line inspections and surveillance. • Completed testing at four airports.	Q2 FY 23	Q4 FY 23
Tether Outreach/ Testing	• Addresses 'un-answered questions' regarding UAS tethering operations that were identified by the Memphis UAS Integration Pilot Program	Q3 FY 23	Q4 FY 23

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Questions?

Contact the FAA Program Managers

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Garrison Canter
Airport Research Specialist
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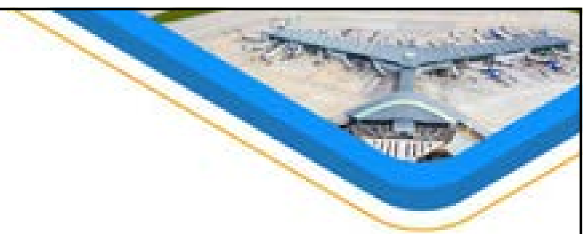

RPA 2 & 3

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Presentation Outline

- Introduction
- Full-scale Accelerated Pavement Tests
  - Evaluate environmentally friendly materials
  - Laboratory characterization
  - Structural model to evaluate material performance
- Life Cycle Assessment (LCA)
- Other Initiatives

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Introduction

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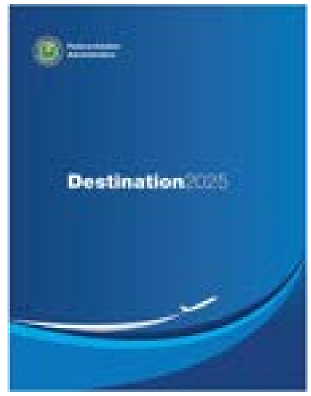
Introduction

Strategies

1. Improve scientific knowledge of environmental impacts.
2. Develop effective decision support tools.
3. Foster research and development.
4. Develop sustainable airport facilities.



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Introduction

OST's Embodied Carbon Working Group

1. Continue to participate in ECWG.
2. Other participants from FAA .

Embodied carbon refers to the GHG emissions arising from the manufacturing, transportation, installation, maintenance, and disposal of transportation infrastructure construction materials.

As embodied carbon is inherent to the process of constructing infrastructure, rather than something that could be addressed after a project is completed, there is an urgent need to address embodied carbon now, before significant Federal infrastructure dollars flow out through Bipartisan Infrastructure Law programs.

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Full-Scale Accelerated Pavement Tests

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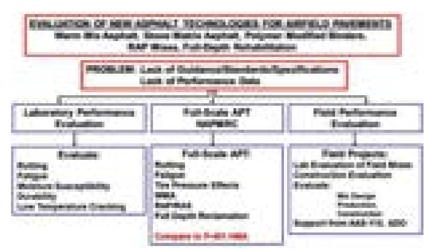
Full-Scale Accelerated Pavement Tests (APT) at FAA's National Airport Pavement & Materials Research Center (NAPMRC)

1. Generate performance data for recycled/sustainable materials under aircraft loading.
2. Develop standards/specifications for recycled/sustainable materials.
3. Update AC 150/5370-10



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Full-Scale Accelerated Pavement Tests (APT) at FAA's National Airport Pavement & Materials Research Center (NAPMRC)

1. Research continues to evaluate new asphalt material technologies for use on airport pavements. **Currently evaluating WMA & RAP.**
2. Reduces production fuel costs, increases the hauling distance, lengthen the paving season, is environmental friendly, and ensures safer working conditions.

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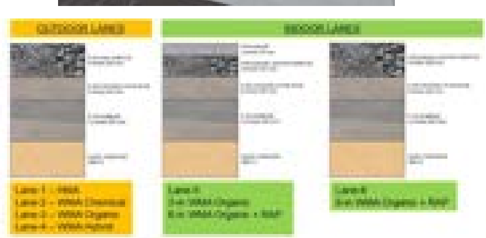
Full-Scale Accelerated Pavement Tests (APT) at FAA's National Airport Pavement & Materials Research Center (NAPMRC)

1. Fatigue tests are currently in progress.
2. All six lanes have been aged

AGING OF TEST AREA:

- Pavement Temperature: 120 deg. F measured at a depth of 2-inch below pavement surface.
- Test Lane will be subjected to these conditions for a period of 336 hours (14 days).
- After 336 hours of aging, heaters will be turned off and insulation panels removed.
- Wait till the pavement temperature stabilizes to ambient conditions.
- Place insulation panels back and prepare for Response Tests & Traffic Tests.
- Fatigue Test Pavement Temperature – 68 deg. F.



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Full-Scale Accelerated Pavement Tests (APT) at FAA's National Airport Pavement & Materials Research Center (NAPMRC)

1. Fatigue tests completed on Lane-6S (WMA+RAP), Lane-5S (WMA+RAP), and Lane-1S (P401 HMA).
   - No signs of fatigue cracking.
   - Testing stopped after 75,000 passes.

2. Fatigue tests are currently in progress on Lane-2S (WMA-Evotherm).
   - Traffic tests started at 72 kip wheel load
   - Passes completed – 26,000.

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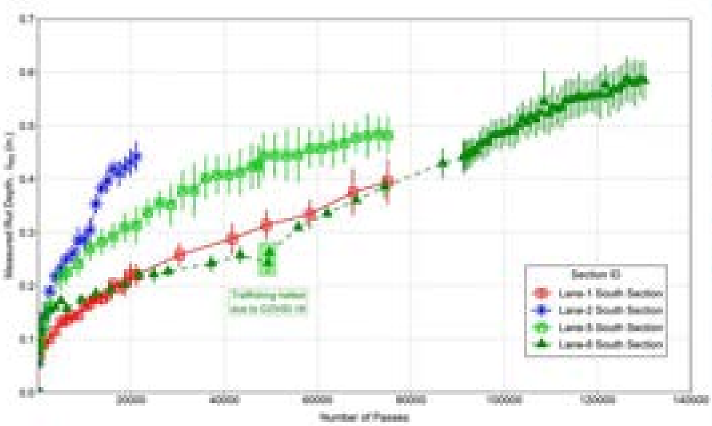
Full-Scale Accelerated Pavement Tests (APT) at FAA's National Airport Pavement & Materials Research Center (NAPMRC)



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Laboratory Characterization of NAPMRC Mixes (Rutting)

1. Samples
   - Plant Produced Lab Compacted (PPLC)
   - Plant Produced Field Compacted (PPFC)

2. Laboratory Tests
   - Dynamic Modulus (AASHTO T342)
   - Flow Number (AASHTO TP79)
   - APA (AASHTO T340)
   - Hamburg Wheel Test (AASHTO T324)
   - High Temperature IDT (ASTM D6931)

3. Tests at FAA lab – in-situ conditions

4. Tests at University of New Hampshire Lab (ACRP Student Grant) –
   Loose plant-produced asphalt mixtures provided by NAPMRC were compacted to a target air void content of 5%±0.5%

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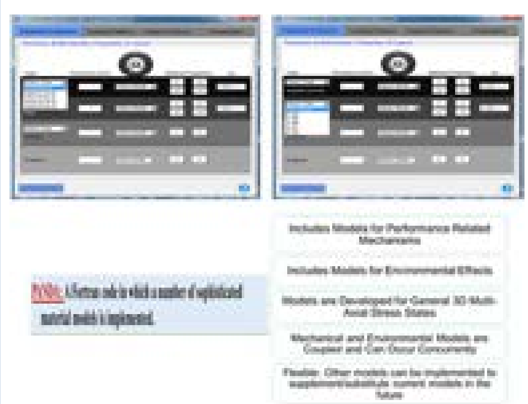
Structural Model to Evaluate Material Performance

Developing advanced pavement analysis tool PANDA-AP to use material characterization properties – <u>improved pavement life prediction</u>, <u>compare two materials before being placed on airport</u>.

1. Improvements made to aggregate layer characterization model.
2. Used performance data from ERDC test sections with thin HMA layer over aggregate layer.
3. Model TC-2 test sections
   - Use lab material properties
   - Compare predicted performance with APT performance



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Life Cycle Assessment (LCA)

Life Cycle Assessment (LCA) calculates environmental impacts, energy use, and finite resource depletion over life cycle

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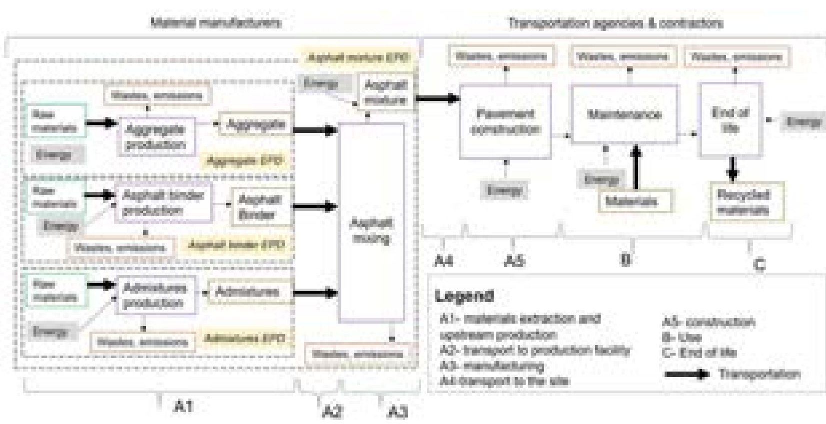
Life Cycle Assessment (LCA)



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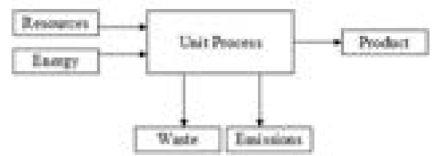
FAA Web-based LCA Tool

1. Determine data and models in FAA LCA Tool that could be replaced by data available in Federal Commons data repositories (100%)
2. Models and data (non-proprietary) not existing in Federal Commons data repositories to be developed and included in the repositories to be then included in the FAA LCA Tool (40%)
3. Update FAA LCA Tool to use Federal Flows and updated TRACI 2.1. (50%)

Basic Unit Process Used in LCA



- Example processes:
  - Produce one ton of asphalt concrete
  - Produce one cubic yard of concrete
  - Haul 25 tons of aggregate base
  - Place a slurry seal

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FAA Web-based LCA Tool

4. Replace proprietary models and data in FAA LCA Tool with Federal Commons data. (20%)
5. Update the FAA LCA Tool user interface. (10%)
6. FAA LCA Tool testing (no progress this quarter)

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Other Initiatives

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Other Initiatives

1. Working with French DGAC/STAC on
   - RAP in HMA mixes.
   - Bio-binders
   - BF mixed with 50% RAP.
   - STAC/EIFFAGE will send material samples to FAA for laboratory characterization.

(from Dr. Jean-Marie Roussel, STAC)

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DGAC/STAC RAP in HMA Mixes

Material characterization

French characterization (level 4):
→ Complex moduli
→ Fatigue

Air voids, maximum specific gravity, volumetric trials
Dynamic modulus, phase angle, flow number
Rut resistance
Fracture energy, flexibility index
Tensile strength
Cracking index, toughness
Fracture energy at low temperature
Fatigue resistance

US characterization:
→ In the frame of the STAC-FAA cooperation agreement

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French Materials

Materials are packed and ready to be shipped from France since late last year.

Struggling to figure out a way of receiving materials at US Customs in USA.

(from Dr. Simon Pouget EIFFAGE)

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Other Initiatives

2. AAPTP Project – Cold Central Plant Recycling
   - Design and specification by project panel.
   - Test sections to be constructed at NAPMRC.

3. FHWA BAA on "New Approaches to Reduce Embodied Carbon from Infrastructure Construction, Maintenance, and Operations"

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Something Possibilities to Consider

1. Learn from sustainable techniques used by airports on non-AIP funded projects in USA.
2. Form an international working group on use of sustainable material technologies in airport pavements. Share knowledge, and learn from each other.
3. Continue research emphasis on low embodied carbon materials.
4. Become organizational member of RILEM (yearly fee of $2300). RILEM is an International Union of Laboratories and Experts in Construction Materials, Systems and Structures. They are very active in pavement material research and are big on "greener materials". They have different Task Groups and Technical Committees and develop performance test methods. To do that they do round robin testing at different member labs before a test procedure is finalized.
5. Federal Highway Administration (FHWA) is already an organization member of RILEM. French DGAC/STAC joined RILEM last year in summer to participate in RILEM Technical Committee on Performance-based Asphalt Recycling (TC-PAR).

Developing international partnerships, involving aviation stakeholders, developing and sharing knowledge on performance of low embodied carbon materials.

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Program Accomplishments to Date

- High temperature rutting tests on HMA, WMA, and RAP completed. Fatigue tests completed on HMA and WMA+RAP test lanes (Lane 1S, 5S, and 6S). Currently testing Lane-2S.

  All “fatigue” test sections aged, ready for fatigue tests. Fatigue tests expected to be completed by end of August 2023. Draft Specification for WMA by end of FY23.

- LCA framework for airport pavements completed and technical report published.

- Web based LCA Tool to be completed by end of FY23.

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Questions?

Contact the FAA Program Manager

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RPA Environmental

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Agenda

- FY23 Noise Research Updates
  - Noise Abatement Charting
  - National Sleep Study
  - Innovative Methods for NLR Measurements
  - Best Practices on Communicating Noise to the Public
  - FAA Influence on Local Land-Use Decisions
  - Standardization of Noise Abatement Aircraft Operations
- Resilience at Vulnerable NPIAS Airports with Climate Change and Severe Weather

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FY 23 ARP Noise Research

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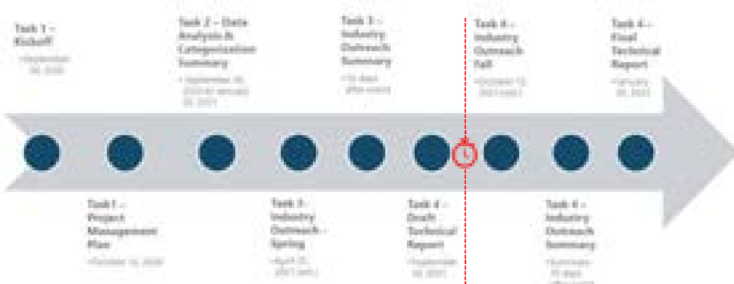
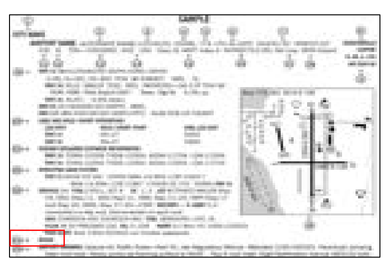
Noise Abatement Charting: Project Overview

FAA Objectives:

1. Develop best practice recommendations for charting airport noise abatement procedures in the Chart Supplement.
2. Develop standard nomenclature and taxonomy for describing noise abatement procedures for the pilot and operator community.



- Delayed since Fall 2021 due to FAA Reviews
- Will reconvene Spring 2023



Example of New Noise Section in Chart Supplement

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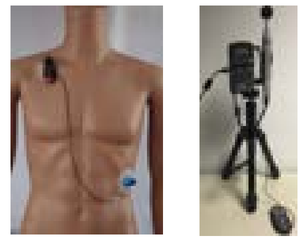
National Sleep Study: Project Overview

- **Generate a dose-response relationship between aircraft noise exposure and sleep disturbance.**
- **Develop and use a scientifically sound, yet inexpensive, study methodology to obtain objective measures of sleep disturbance.**
- **Study Scope**:
  - Recruit 400 eligible subjects.
    - Living adjacent to select runway ends
    - 21+ years of age, within a specified BMI, no sleep disorders, no sleep aids
    - No night shift, no dependents requiring frequent care, not pregnant



Physiological & body movement equipment (left)

Sound recording equipment (right)

Research team led by University of Pennsylvania School of Medicine

Team also includes Westat Corp and HMMH, Inc.

Methodology approved by University of Pennsylvania and Westat Corporation Institutional Review Boards; the Dept. of Transportation Bureau of Transportation Statistics; OMB Office of Information and Regulatory Affairs.

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National Sleep Study: Project Timeline

Research Program Goal: Generate a dose-response relationship between aircraft noise exposure and sleep disturbance

Dec 2017 – Sept 2021
Study Preparation

Sept 2021 – Sept 2023
Data Collection

FY24
Data Analysis

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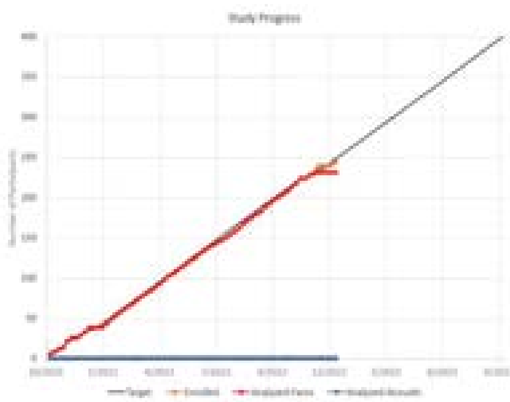
National Sleep Study: Data Collection Updates

17 months through 24mo data collection period

- 257/400 subject enrolled
- 18,300 recruitment surveys mailed, Wave #16, 16,836 deliverable
- 3042 Returned Surveys, 55% not interested, 44% interested
- Of those interested, 44% are eligible



113

Innovative Methods for NLR Measurement: Updates and Findings

Completed October 2022

I. **Feasibility of UAS-Mounted Loudspeaker for Measurement of Noise Reduction**

Hylio AG110 battery powered UAS + JBL 108BT loudspeaker + invertor

Successful application for:

I. Measuring NLR of complex structures with limited access
II. Validating corrections for roof contribution contained in ARP 6973
III. Investigating the difference between aircraft and loudspeaker NLR measurements
IV. Measurement of NLR in multi-story buildings where other methods are not possible

I. **Indoor-Outdoor Method for Measurement of Noise Reduction**

I. Eliminates adjustments to measurement levels and removes placement restrictions
II. Noise reduction from windows/doors can be measured
III. Eliminate noise complaints from neighbors during O-I measurements

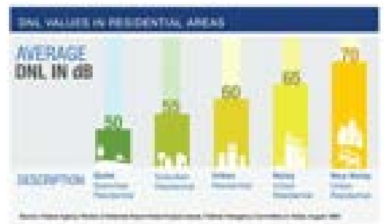
* Further validation so the method may be an alternate or supplemental method in a future update of the SAE Aerospace Recommended Practice (ARP) 6973 Aircraft NLR Measurement of Building Facades (FY23-FY24)

114

Improving & Standardizing Communication Strategies to Inform the Public about Aviation Noise

PROBLEM:

There is a lack of understanding of how to communicate effectively and clearly about aviation noise with the public.



OBJECTIVE:

Evaluate various methods and approaches to engage and educate the public on aviation noise topics to include how supplemental noise metrics can be used to present the information more clearly.

PERIOD OF PERFORMANCE: 18 months

KICKOFF – Oct 2022

Booz | Allen | Hamilton

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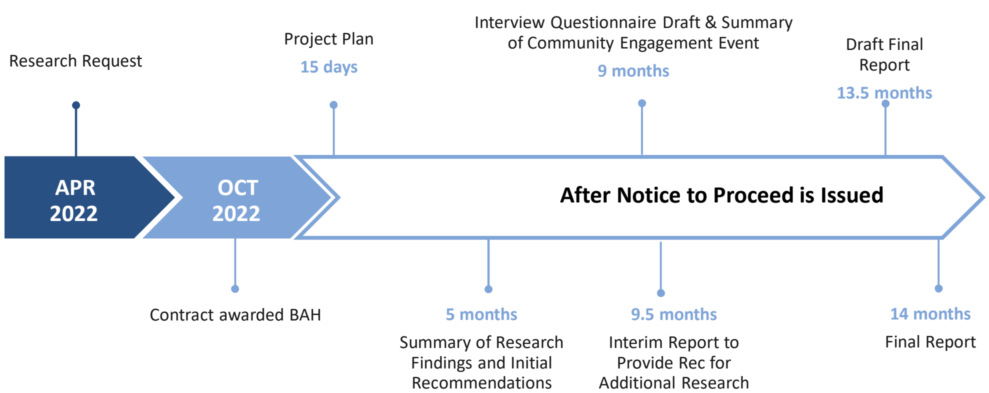
Communication Strategies: Project Timeline



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FAA Influence on Local Land-Use Decisions

PROBLEM:

- FAA has no influence on local land-use decision and planning around airports, yet FAA is often requested by public and political members to exert control over land-use.
- In anticipation of noise level threshold reduction, FAA will need to consider how to support noise mitigation and compatible land-use via Part 150.
  - Ex. Sound insulation may not be viable, so what are other options?

OBJECTIVE:

- Conduct an analysis of the current policies, practices and limitations on FAA's influence and/or control of land-use surrounding airports.
- Recommend changes to current policies or practices to encourage additional influence on local zoning and land-use decisions to improve compatibility around airports.

BUDGET & PERIOD OF PERFORMANCE: 12 – 18 months

Due to Kickoff in May 2023

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Resilience at Vulnerable NPIAS Airports with Climate Change and Severe Weather

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Climate Change: Resilience Challenge Overview

Climate Resilience: "a capacity to anticipate, prepare for, respond to and recover from significant multi-hazard threats with minimum damage to social well-being, the economy and the environment" (EPA, 2022)

- Solutions will need to address:
  - Systemic, consistent, straightforward application of risk assessment
  - Link risks to design (e.g., drainage, pavement, electrical)
  - Operational objective of resilience improvements: certain airports warrant maximum operational availability, while for others the objective is rapid recovery after severe weather clears
  - Collaborative project prioritization between airports and FAA

- FAA R&D to develop framework and tools to integrate resilience into typical master plans (via update to Master Plan AC)

https://www.faa.gov/airports/environmental/resiliency

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Airport Resiliency: Purpose of the Project

Develop prioritized, risk-based recommendations for how FAA and airport operators can address climate change and severe weather impacts.

Develop tools that will help FAA determine which airports are the most vulnerable.

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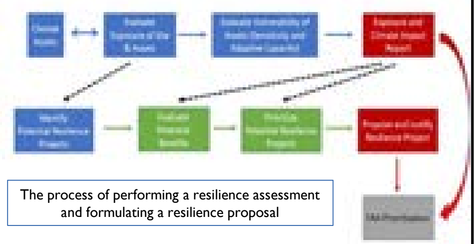
Airport Resiliency: Research Outcomes

1. Develop a framework airports and consultants can use when conducting resilience assessments – ARAF
(Airports Resilience Analysis Framework)
   - Standardize approach and repeatable approach for airports to:
     - collate information on climate-related hazards,
     - Evaluate vulnerability of assets,
     - Explore resilience-related infrastructure solutions,
     - Describe anticipated operational performance benefits of resilience projects



The process of performing a resilience assessment and formulating a resilience proposal

2. Develop a prioritization framework to assist FAA in selecting National Plan of Integrated Airport Systems (NPIAS) and other eligible AIP project proposals – RPPF (Resilience Project Prioritization Framework)
   - Integrate resilience criteria and standards into Orders/AC's

Resilience value of project
Climate impact mitigation
Cost-effectiveness

\+

Resilience value of airport
Role in NAS
Role in community

→ AIP Investment Prioritization

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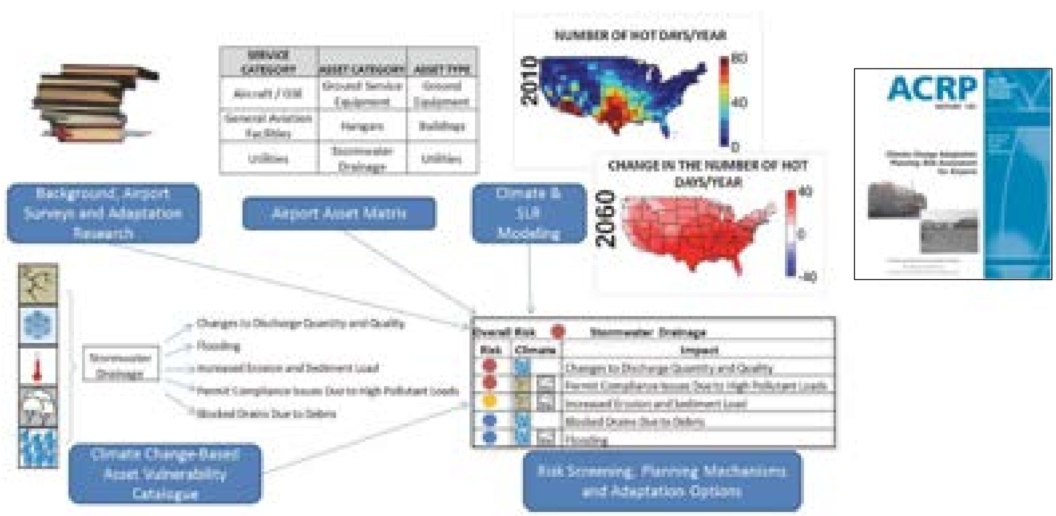
Airport Resiliency: Building on Existing Approaches:



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Airport Resiliency: Airport Study Areas

Location	Threats*	Criticality of Airports	Risk and Time	
			High	Low - Mod**
Rural Alaska	Erosion, Permafrost collapse, Flooding, SLR	Heavy reliance for passenger and freight	X	
Micronesia	Flooding, SLR	Heavy reliance for passenger and freight	X	
Continental U.S. TBD	Flooding, SLR, Heat, Wildfires	Various reliance for passenger and freight		X

* Includes assets and operational disruption
** Relative to AK and Micronesia at current time scales

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Project Timeline

Current Status

- ✓ **Case Study Airport Selection**
- ✓ **Defining Critical Assets**

Next Steps

- ✓ **Conduct Airport Case Study Coordination**

Months 1 – 4

- Project Management Plan
- Work Plan
- Annotated bibliography /summary document

Months 5 – 10

- Airport Resiliency Analysis Framework
- FAA Resiliency Project Prioritization Framework
- Case Study Selection

Months 11 – 18

- Airport Case Studies
- Framework finalization and testing

Follow On Research

POP ends Sept 2026

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Next Steps

- **Continue coordination with DOD**
- **Continue refining requirements for RPPF**
- **Continue developing criteria and metrics for ARAF and RPPF**
- **Select Airports for Case Studies**
  - Integrate Climate Exposure Tool output into ARAF
  - Refine RPPF for pilot testing
  - FAA Coordination with DOD

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Questions?

Contact the FAA Program Manager

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Airport Research Specialist
Lauren.Vitagliano@faa.gov

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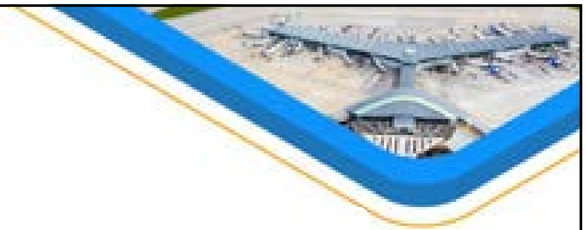

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Agenda

- ATR Personnel
  - ATR Personnel Updates
  - Recruiting – open position
- ATR Research
  - Research Contracts
  - Ten Year Plans
- Capital Expenditures
  - Buildings
  - Research Taxiway

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ATR PERSONNEL

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Airport Pavement R&D Staff

ANG-E26 - Airport Technology R&D Branch

Jim Layton, Branch Manager
Patricia (Trish) Young, Administrative Contact

ANG-E262 - Airport Pavement R&D Section

Murphy Flynn, Section Manager

- Dr. David Brill
- Qingge Jia
- Mat Brynick
- Ryan Rutter
- Dr. Navneet Garg
- Will Villafane
- Dr. Richard Ji
- General Pavement Engineer
- Pavement Laboratory Manager

LEGEND

- Vacant
- On detail
- Safety
- Pavement
- Program Level

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Open Position

- FY23 –Engineer
  - Civil Engineer FV-810-J
  - General Engineer FV-801-J

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ATR RESEARCH

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Recent Accomplishments

Meetings & Conferences

- **ICAO Friction Task Force/APEG-7 Meeting** at the WJHTC
- **Association of Asphalt Paving Technologists (AAPT) Annual Meeting** in San Antonio, TX
- **Academic delegation** to WJHTC from the **Department of Civil & Environmental Engineering and Architecture**, University of Cagliari in Italy
- **Vietnam SEA ACP delegation** to WJHTC
- **National Renewable Energy Laboratory** delegation at the WJHTC
- **Regional Airports Meeting** at the WJHTC

Publications

- **Published by ASCE:** "Small Uncrewed Aircraft Systems-Based Orthophoto and Digital Elevation Model Creation and Accuracy Evaluation for Airfield Portland Cement Concrete Pavement Distress Detection and Rating"
- **Published by TRB:** "Airport Pavement Stiffness Monitoring and Assessment of Mechanical Stabilization using Bender Element Field Sensor"
- **Published by TRB:** "Evaluation of Test Methods to Identify Asphalt Binders Prone to Surface Initiated Cracking"
- **Reports:**
  - Machine-Learning Solutions for Top-Down Cracking Design of Airport Rigid Pavement
  - Method to Identify and Quantify Multiple-Event Roughness

Teaching & Facilitation

- **Airport Pavement Technical Workshop** on invitation from the Asphalt Institute
- **Airport Pavement Design & Evaluation Workshop** in Anchorage, AK on invitation from Alaska DOT
- **Aviation Engineering Seminar** on invitation from Charlotte Douglass International Airport and University of North Carolina

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Pavement Research Program Areas

P1: National Airport Pavement Test Facility (NAPTF)

P2: National Airport Pavement And Materials Research Center (NAPMRC)

P3: Field Instrumentation & Testing

P4: Advanced Materials

P5: Pavement Design And Evaluation

P6: NDT Technology

P7: Software Program Development & Support

P8: Extended Pavement Life

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Contracts Overview

1. **Pavement Consultant Support**
   - 3 year T&M
   - 2021-2023
2. **Facilities O&M**
   - 5 Year Fixed price 2021-2025
   - T&M for Special projects
   - Covers NAPTF and related equipment and machinery
3. **NAPMRC Operation**
   - New 5 year Contract Awarded September 2022
4. **Advanced Pavement Materials Lab O&M**
   - 5 Year Fixed Price Contract
   - 2021-2025

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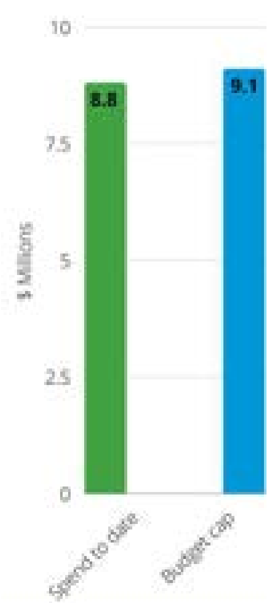
1. Pavement Consultant Support

- Awarded 3 year contract in April 2021
- Contract ceiling is nearly reached
- Developing new support contract - SOW is written and under review
  - 5 year contract with greater contract capacity



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Airport Asphalt Pavement Technology Program (AAPTP)

National Asphalt Pavement Association (NAPA)

- Funded in FY20 w/ $3.5 Million
- Funded in FY21 w/ $3 Million
- Funded in FY22 w/ $3 Million
- Funding in FY 23 w/ $3 Million – Pending

https://www.asphaltpavement.org/expertise/engineering/airports/request-for-proposals

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Airport Concrete Pavement Technology Program (ACPTP)

National Concrete Pavement Technology Center

- Funded in FY20 w/ $3.5 Million
- Funded in FY21 w/ $3 Million
- Funded in FY22 w/ $3 Million
- Funding in FY 23 w/ $3 Million – Pending

https://cptechcenter.org/airport-pavements/acptp/rfp/

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TEN YEAR PLANS

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Ten Year Plans

- Pavement 2030 Research Plan posted on ATR's website
- Modular version of Pavement Plan posted on ATR's website

Pavement 2030 Research Plan

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Examples: Modular version of Pavement Ten Year Plan

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Examples: Modular version of Pavement Ten Year Plan

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CAPITAL EXPENDITURES

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NAPMRC Roof Repairs

- NAMPRC - Replacing roof panels 3,4 & 6
- $60K Purchase roof panels
- Installation planned in FY 23

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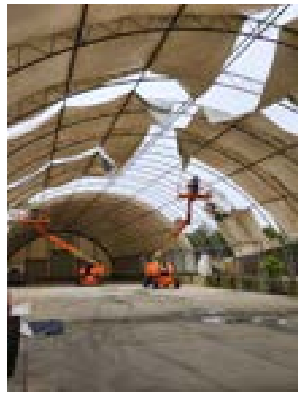
Subgrade Process Facility Roof Replacement

Full Roof Replacement

- Constructed in 2008
- $180,990 to repair
- Completed January 2023



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Cape May Research Taxiway

- Cape May Research Taxiway
  - Construction completed December 2016
  - 3200 feet long TW with advanced monitoring infrastructure for lighting systems evaluations.
  - Paved with 5 asphalt mixes for long term durability study.
    - PG-64-22 Marshall
    - PG 76-22 Marshall
    - PG 64-22 Super Pave
    - WMA PG 76-22 Marshall
    - Stone Matric Asphalt.
  - Opening joints needs to be sealed after about 6 years
  - <u>Developing bid documents</u>

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Questions?

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FAARFIELD 2.0 Online Tools & PAVEAIR Integration

RPA P5.1

Presented to:
REDAC Sub committee on Airports

David R. Brill, P.E., Ph.D.

March 7 8, 2023

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Agenda

- Background
  - FAARFIELD 2.0 current version
  - Software Integration Objectives
  - Pavement Document Object Model (PDOM)
  - Program status and timeline
- Technical Report
  - FAARFIELD 2.1 New Features
  - Library Versions and Updates
  - Using FAARFIELD 2.1 with PAVEAIR Integration (Examples)

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Background

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FAARFIELD 2.0 Background

- In June 2021, the FAA released **FAARFIELD 2.0**, a completely updated and overhauled version of its standard software for airport pavement thickness design and evaluation.
- **FAARFIELD 2.0** supports Advisory Circulars (AC) 150/5320-6G (Airport Pavement Design and Evaluation) and 150/5335-5D (Standardized Method of Reporting Airport Pavement Strength – PCR).
- **FAARFIELD 2.0** includes many new features and improvements over the previous version (FAARFIELD 1.4):
  - Modernized GUI
  - Intuitive screen flow
  - New 3D finite element library (FAASR3D)
  - Updated aircraft library
  - New vehicle editor
  - Support for ICAO ACR-PCR.
  - Ability to work with multiple jobs sections in the same instance.

FAARFIELD 2.0 is the end product of much of the R&D performed at the National Airport Pavement Test Facility.

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Key Program Milestones

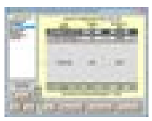
Current Status

Initial story board meeting on FAARFIELD GUI update

2016

2017

FAARFIELD 1.4 Released



2018

Develop FAARFIELD 2.0 Project Plan

FAARFIELD 2.0 DEVELOPMENT

Sept. 2019

FAASR3D 2.0 Library

July 2020

ACR-PCR Effective Date

June 2021

AC 150/5320-6G and FAARFIELD 2.0 Release

April 2022

AC 150/5335-5D PCR Guidance

2Q 2023

FAARFIELD 2.1 with PAVEAIR Link

4Q 2023

ML Model for Rigid Pavement Design

Future

FAARFIELD 3.0 Updates

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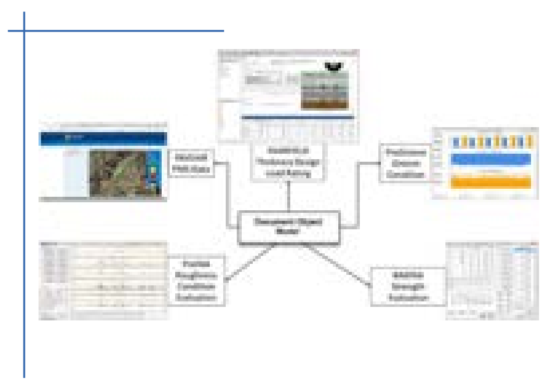
Software Integration Objectives

- ✓Upgrade FAA software programs to the latest framework, technologies, and operating system
- ✓Follow software standards and best practice
- ✓Separate user interface (UI) from logic
- ✓Upgrade to object-oriented (OO) programming
- ✓Establish communication between software programs
- ✓Make UI user-friendly, with a uniform look and feel throughout the software suite



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Pavement Document Object Model (PDOM)

- ✓ **Document Object Model (DOM) Defined – An Extended Markup Language (XML) representation of data**
  - Store data as a file
  - Transport data via a network stream
- ✓ **PDOM – Apply this concept to airfield pavement data to enable data exchange among our linked programs.**
- ✓ **Must add a single library to each software program to read/write PDOM**
- ✓ **Status:**
  - BAKFAA: added
  - ProFAA: added
  - FAARFIELD: in progress (discuss more below)
  - PAVEAIR: in progress
  - ProGroove: planning

Example of Airfield Pavement Data in XML

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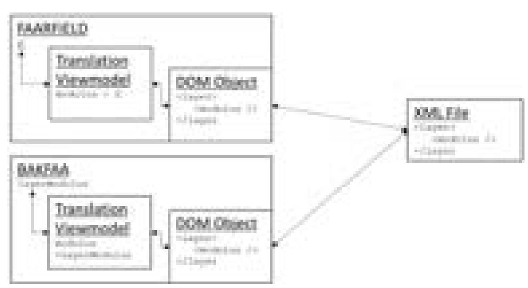
PDOM Library

- ✓ **Takes advantage of Model-View-Viewmodel (MVVM) architecture.**
- ✓ **Single library for all applications.**
- ✓ **In computing terms, the DOM class is "data agnostic," i.e.,**
  - ✓ **Accepts any well-formed XML data that contain the minimum data tags.**
  - ✓ **No need to update library or recompile each application as software packages as data are added to DOM.**
- ✓ **Viewmodel translates between DOM and software's internal representation of data.**



PDOM Concept

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Technical Report

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FAARFIELD 2.1 New Features

- ✓**Data Integration with FAA PAVEAIR**
  - Log in to PAVEAIR using PAVEAIR user credentials
  - Update to current library version (and eventually to current software version) online
  - Access user-owned PAVEAIR databases
  - Populate Job Information from PAVEAIR data
  - Upload/download/store FAARFIELD job files under appropriate PAVEAIR network/branch/section
- ✓**More New Features**
  - Display critical design stresses for rigid slabs (and most demanding aircraft for A-1 joint design).
  - Option to automatically perform reduced cross section design (1% of traffic).

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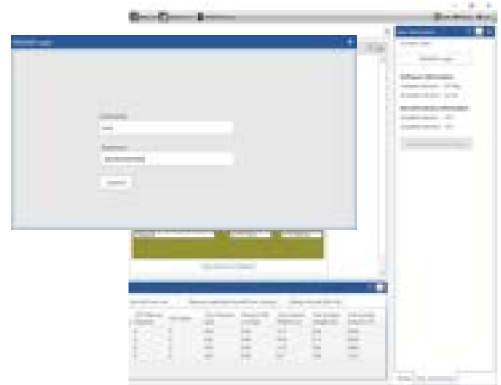
FAAIRFIELD User Sign-In

- ✓Select "User Information" tab at right
- ✓Sign in using existing PAVEAIR account login and password.
- ✓Panel displays installed and currently available versions of software and aircraft library.
- ✓If your aircraft library is out of date, you have the opportunity to download the latest version.
- ✓In the future, you will be able to update to a newer version of FAARFIELD, run software patches and bug fixes, etc.



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FAARFIELD – PAVEAIR Access Screen

- ✓Once signed in, you have access to all user-owned databases in PAVEAIR.
- ✓Navigate to Network/Branch/Section
- ✓Four possible actions:
  - **Upload Job** – Uploads the current FAARFIELD job to the selected PAVEAIR Network/Branch/Section
  - **Download Job** – Downloads and opens the selected job from the PAVEAIR list in FAARFIELD
  - **Update Job** – Overwrites the selected job
  - **Delete Job** – Deletes the selected job from the PAVEAIR database. (Does not delete from FAARFIELD or the FAARFIELD job file).

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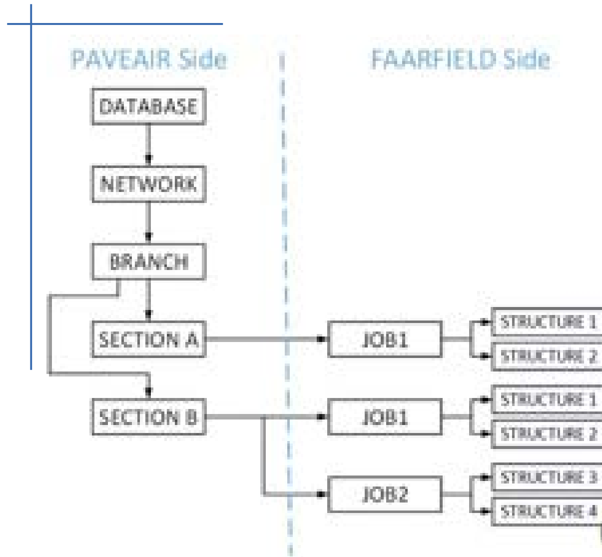
Data Organization

- ✓The same FAARFIELD job can be uploaded to multiple locations in a PAVEAIR database.
- ✓In future versions of FAARFIELD, “Sections” will be renamed to “Structures.” This is to avoid confusion with sections as defined in APMS.
- ✓For the PAVEAIR user, structures can represent:
  - ✓Asphalt vs. concrete options, for use in PAVEAIR LCCA tool
  - ✓Before/after overlay or replacement of section
  - ✓Different possible traffic mixes
  - ✓Etc.



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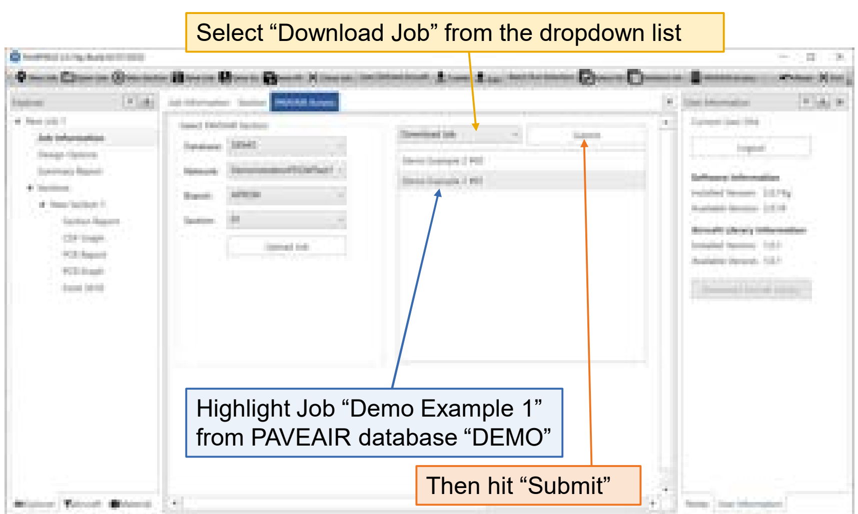
Example – Download Data from PAVEAIR



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Example – Download is Complete

Explorer displays downloaded job with 2 sections

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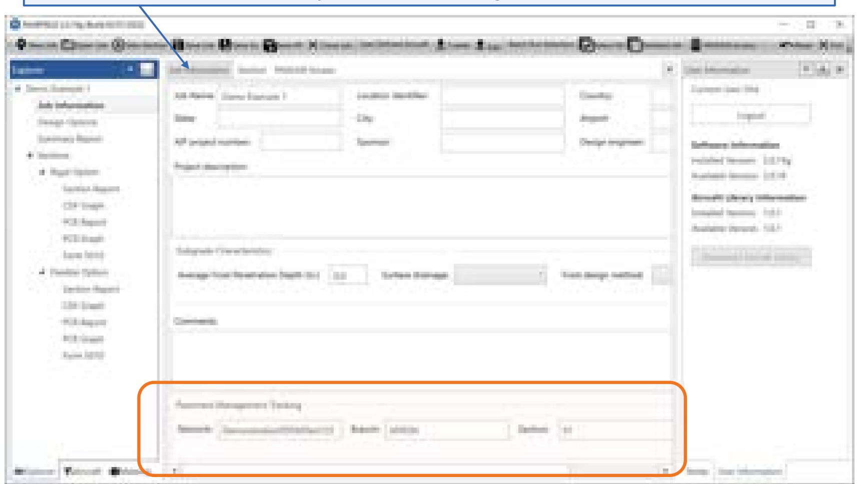
Example – Download is Complete

Job Information tab displays APMS tracking data imported from PAVEAIR



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Questions?

Contact the FAA Program Manager

David R. Brill, P.E., Ph.D.
Program Manager
Tel: (609) 485-5198 (office)
Tel: (609) 369-3516 (cell)
David.Brill@faa.gov

Questions About Software Integration

Qingge Jia
Computer Scientist
Tel: (609) 485-5427 (office)
Qingge.Jia@faa.gov

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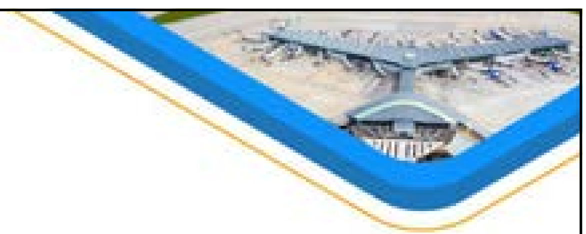

On-Going Projects

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Presentation Outline

- NAPTF
  - Construction Cycle 9 (CC-9) - Flexible Pavement
    - Fatigue Test Sections

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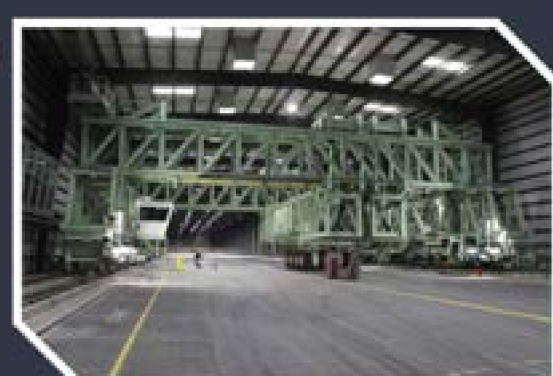
NAPTF



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Construction Cycle 9 (CC-9) - Asphalt

Objectives

- Verify/Refine/Modify fatigue model based on the ratio of dissipated energy change (RDEC)
- Effect of P-209 Layer Thickness on Pavement Life
- Effect of Geosynthetics use on Flexible Pavement Performance
- Cement Treated Permeable Base Performance
- Strain Criterion for Allowable Overload

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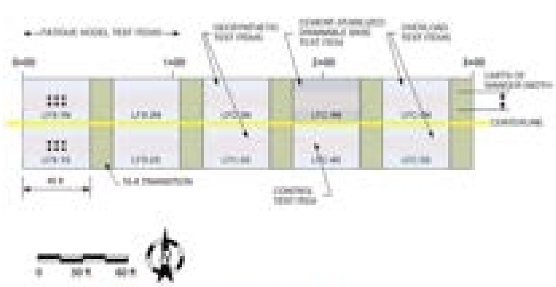
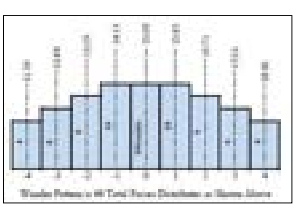
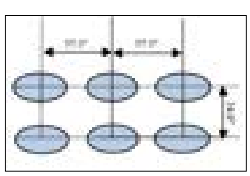
Construction Cycle 09 Layout



Started: April 5, 2021

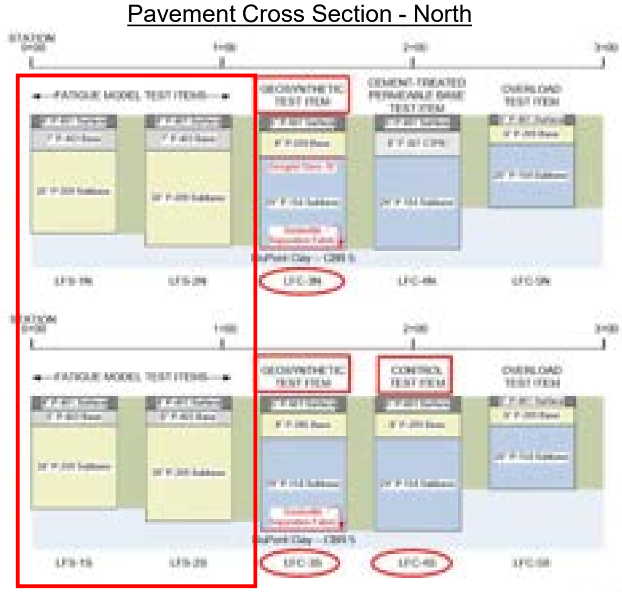


Standard NAPTV Wander Pattern



Standard NAPTV Gear Configuration 58,000 lbs/wheel

Pavement Cross Section - North



Pavement Cross Section - South

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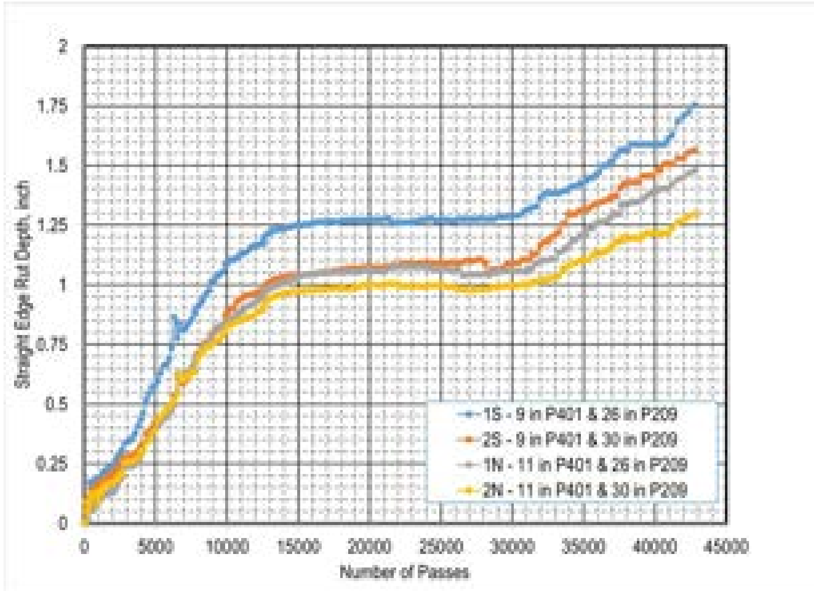
Performance of Test Sections



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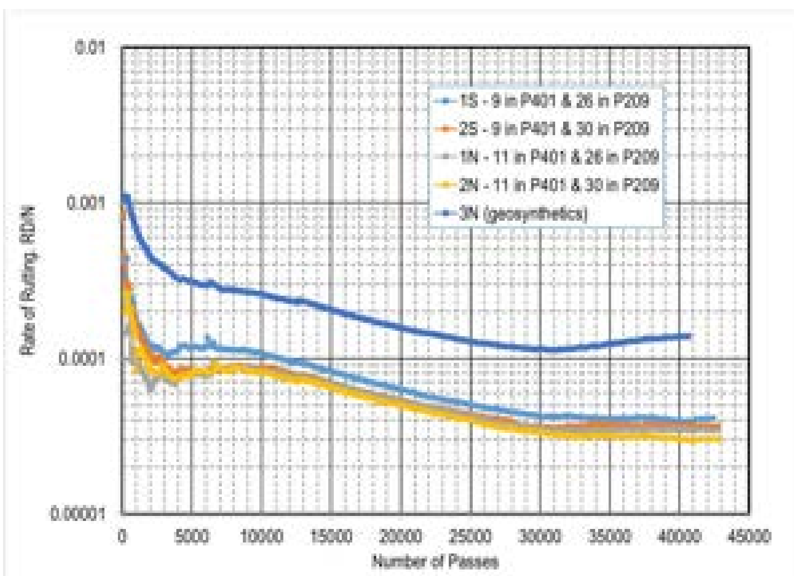
Performance of Test Sections



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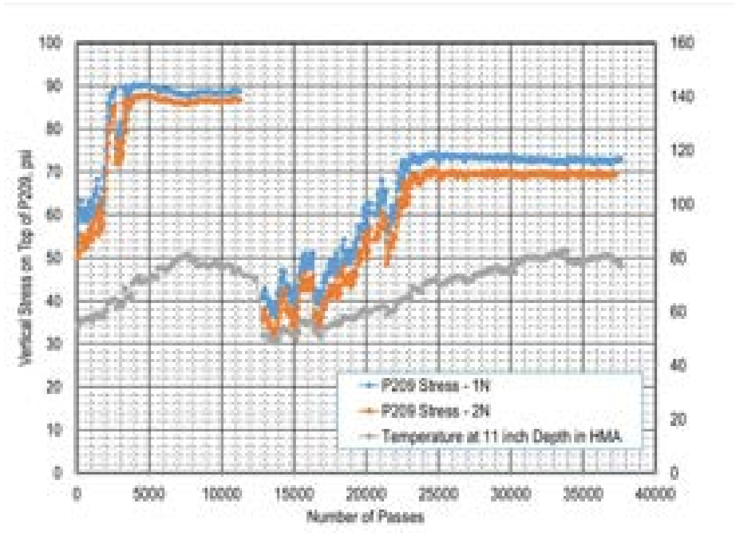
Vertical Stresses on Top of P209 Aggregate Base



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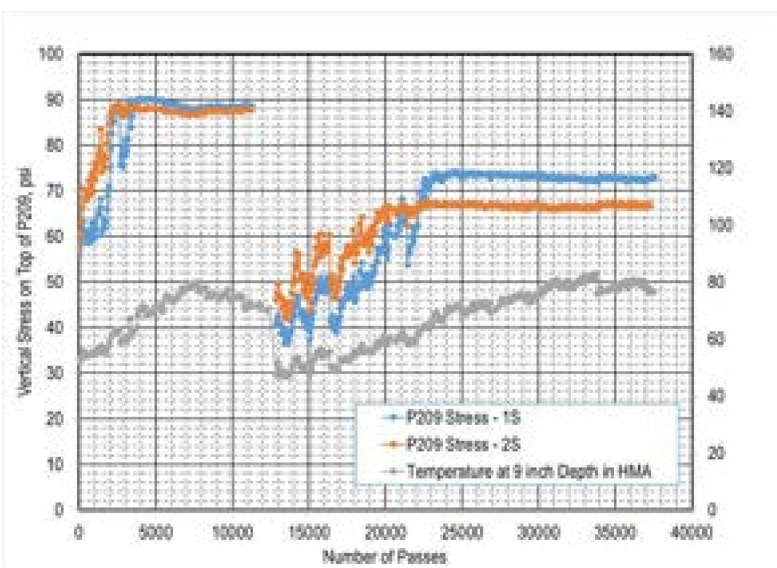
Vertical Stresses on Top of P209 Aggregate Base



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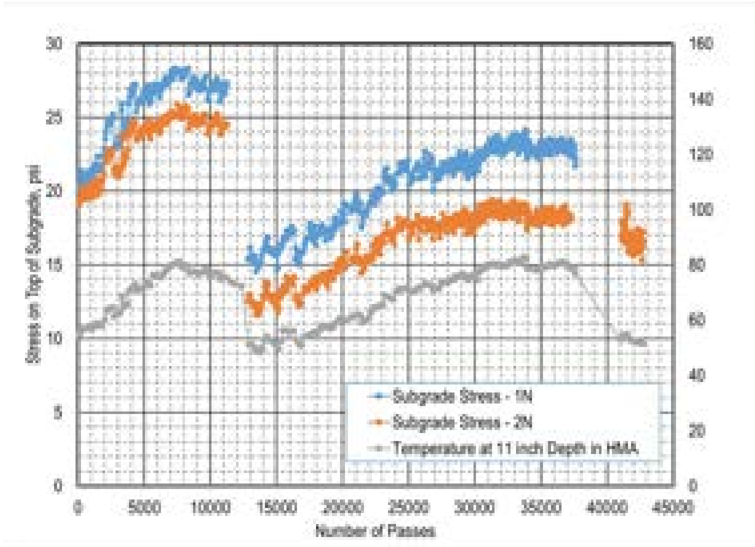
Vertical Stresses on Top of Subgrade



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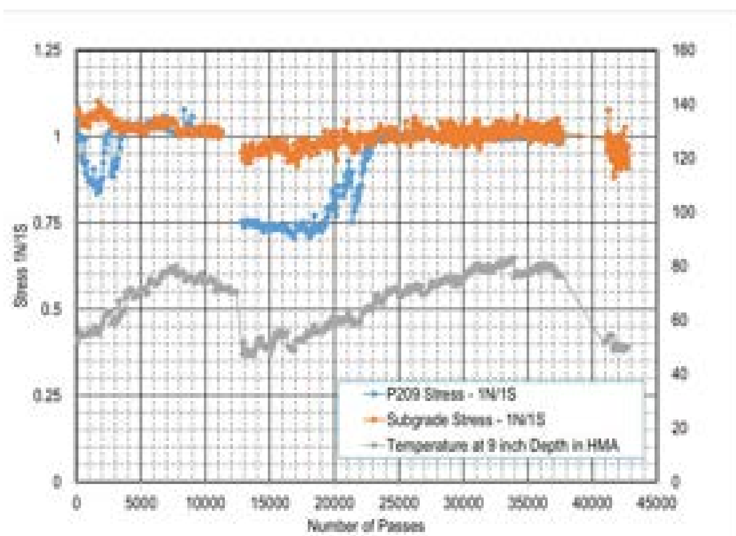
Vertical Stresses



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Summary of Findings

1. No signs of fatigue cracking
2. Test sections LFS-1S and LFS-2S (9 inch thick HMA surface) show higher rutting that LFS-1N and LFS-2N (11 inch thick HMA surface).
3. Rutting observed in test sections is more sensitive to P401 HMA thickness than P209 thickness.
4. Pavement performance in rutting is not as sensitive to subbase thickness as predicted by FAARFIELD design models.

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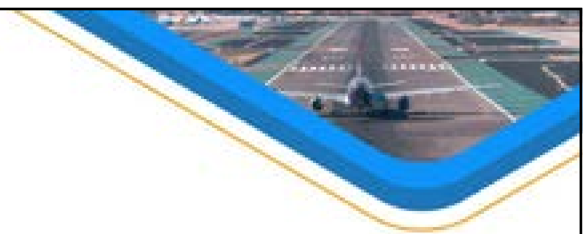
Questions?



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Acknowledgements:
Dr. Hasan Kazmee, ARA
Lia Ricalde, ARA

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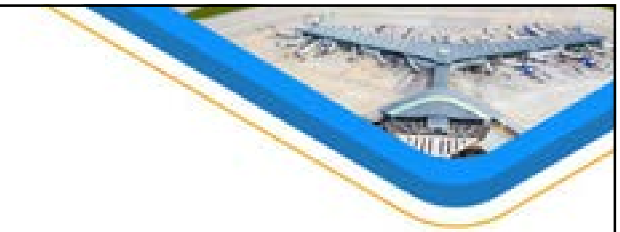

RPA P1 – NAPTF

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Agenda

- Project Background
  - Purpose of the project
  - Background
  - Program status and timeline
- Test Plan and Design Report
  - Scope and Layout
  - Sensors
  - NDT testing
  - Key takeaways and next steps

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Purpose of the Project

- Obtain failure data at higher traffic levels, over 5 years, to better represent extended life conditions
- Obtain data for realistic slab dimensions and joint spacing
- Directly evaluate the effect of increased slab thickness on life
- Investigate fatigue damage accumulation in the major phase of rigid pavement life before the appearance of significant cracks
- Test structural performance of slabs with light fixture penetrations
- Obtain data from instrumented light fixtures under load in rigid pavement
- Collaborate with leading researchers and research centers

CC10 Pavement Structure Initial Thickness Determination

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Project Background

Construction Cycle 1 – 1999

- Low-, Medium-, and High-Strength Subgrade

Construction Cycle 2 – 2004

- Rigid pavement with different subbase materials

Construction Cycle 3 – 2002

- Flexible pavement with varying subbase thickness

Construction Cycle 4 – 2006

- Rigid unbonded overlays

Construction Cycle 5 – 2008

- Effects of closely spaced multiple-wheel landing gears

Construction Cycle 6 – 2010

- Flexural strength on rigid pavement structural life

Construction Cycle 7 – 2014

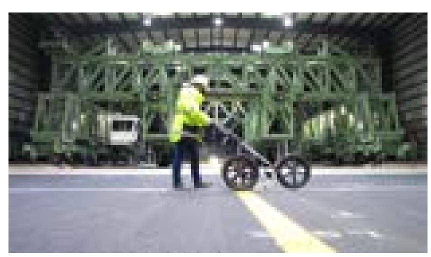
- Perpetual pavement and overload

Construction Cycle 8 – 2017

- Overload; Overlay; Joint Comparison; Strength & Fatigue

Construction Cycle 9 – 2019

- Fatigue Model and Base Thickness; Geosynthetics; Cement-Treated Permeable Base; Overload



CC10 Traffic Assumptions

Gear Configuration – 2D

Wheel Load – 55,000 lbs/wheel

Wander Pattern – Longitudinal Edge of Outside Slab

Estimating 174,700 passes

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FAA Moving Swiftly to Extend Pavement Life

Research Program Goal: higher traffic levels, over 5 years, to better represent extended life conditions

2022
Design

2023 - 2024
Construction

2024 - 2030
Traffic and Post-Traffic Analysis

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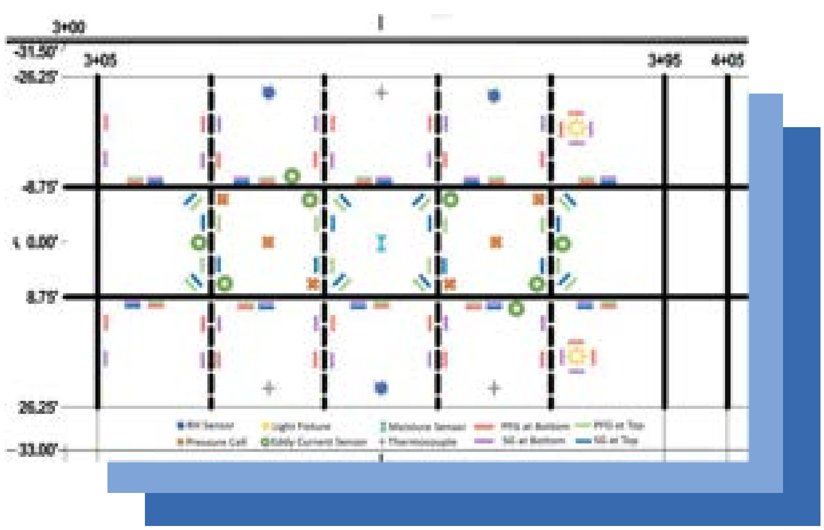
Scope

I. **Estimated 198 days of construction**

II. **82 CY P-152,**
820 CY P-154,
270 CY P-403,
727 CY P-501,
402 Sensors



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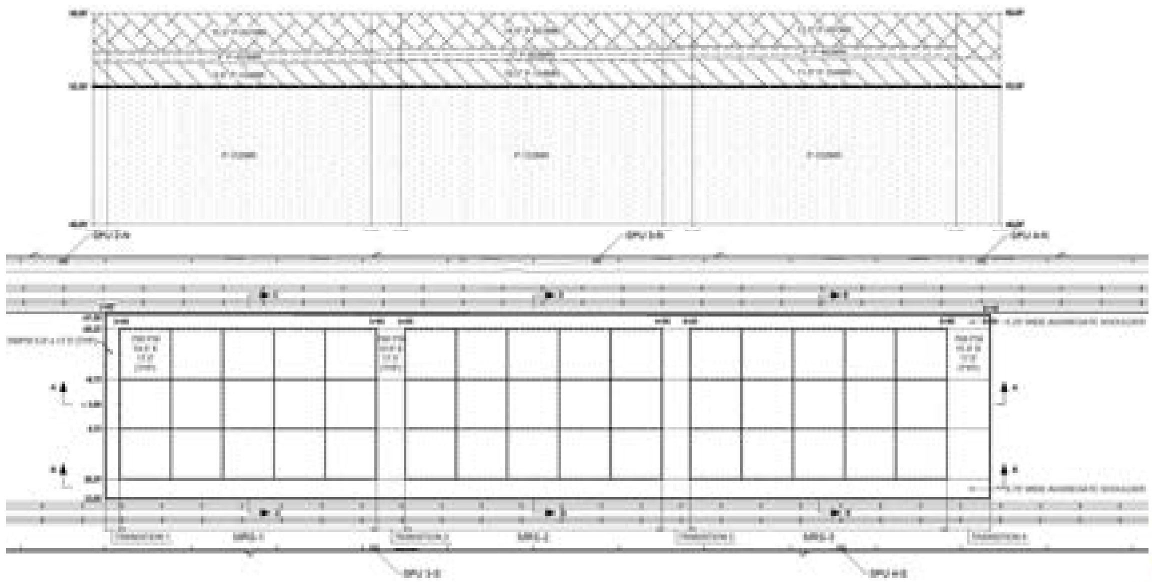
Proposed Cross Section and Plan View



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Sensors in the Test Pavements

Sensor Type	Measured Response	Purpose
Moisture Sensor	Measure volumetric water content (VWC) and temperature. 0-100% VWC	Determine the moisture and temperature variation at various depths throughout the project lifecycle
Pressure Cell	Vertical pressure, psi	Capture wheel load pressure at the bottom of the concrete
Thermocouple	Concrete temperature, ºF	Capture the environmental changes in the concrete at varying depths
Embedded Strain Gauge	Horizontal strain or deformation, με	Capture material strain at the bottom of the concrete layer due to trafficking
Piezo Energy Accumulators	Strain	Identify fatigue damage accumulation throughout pavement life
Relative Humidity Measuring System	Relative humidity, %	Monitor internal relative humidity within concrete
Eddy Current Sensor	Peak deflection, mils	Monitor corner displacement and deflections due to trafficking, curling, and warping

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NDT Testing in the Test Pavements

Device	Purpose	Locations
HWD	Elastic modulus, normalized deflections	Center of each slab; eddy current sensor locations; pressure cell locations; on top of light fixtures; longitudinal and transverse joint transfer
PSPA	Seismic modulus, stiffness	Center of each slab; eddy current sensor locations; pressure cell locations
GPR	Layer thickness	Ground coupled – two transverse lines at center of each slab per test item, MIRA locations in MRS-3 Air coupled (van) – longitudinal lines at Track 0, Track ±3, MIT Scan T2 Target locations, and centerline of pavement
Leica 3D Scanner	3D point cloud, rut depth, transverse and longitudinal pavement profiles	Full width
NDT Vehicle 2D/3D Imaging	2D/3D pavement surface images	Full width
Manual Pavement Survey	Crack mapping, pavement condition index	Full width
ELATextur	Mean profile depth, estimated texture depth	Three measurements in the wheel path, three measurements outside the wheel path per test item
SurPro	Transverse and longitudinal profiles	Transverse lines at STA 3+50, 4+50, and 5+50 Longitudinal lines at offsets ±9.75ft
MIT Scan	Determine dowel placement and thickness verification	All dowel locations and one target to be placed at Track ±3 for each test item at the bottom of the P-403MR and P-501MR layers (three targets required total for project)
MIRA	Detect defects in pavement	6in and 18in from joint locations – every 3 inches. Four slabs per test item.

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Key Takeaways

- Obtain failure data for 2D gear at 55,000 lbs wheel load; expecting 174,700 passes during 65 months
- Evaluate the effect 13.5”, 14.5”, and 15.5” P-501 portland cement concrete pavement
- Investigate fatigue damage accumulation with sensors and NDT testing before the appearance of significant cracks
- Study effect of light fixture intrusions
- Collaborate with leading researchers and research centers

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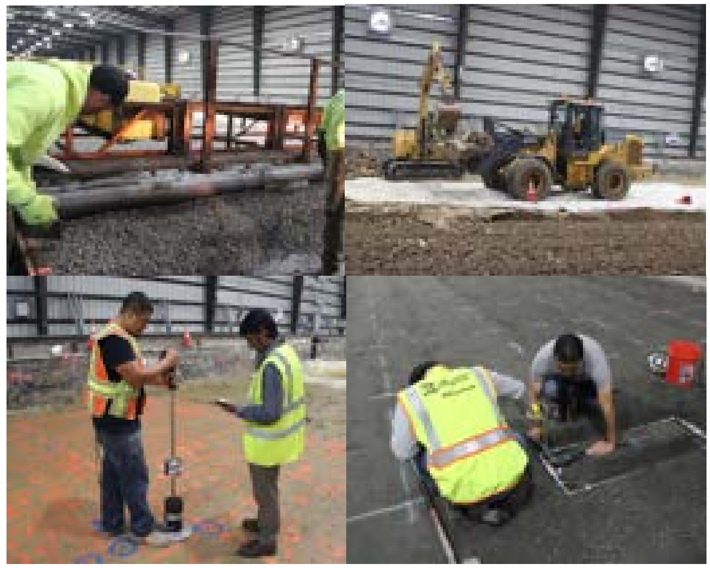
Next Step

- Construction
- Traffic
- Post-traffic analysis
- Publish reports and update software



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Questions?

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National Airport Pavement Test Vehicle (NAPTV) & National Airport Pavement Test Facility(NAPTF) Repairs/Updates

RPA-P1 NAPTF

Presented to:
REDAC Sub committee on Airports

Ryan Rutter
March 7 8, 2023

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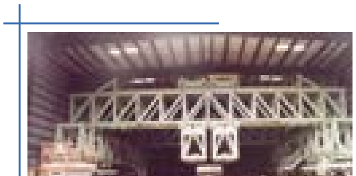
NAPTF and NAPTV History

- NAPTF dedication ceremony was April 12, 1999.
- NAPTV commissioned in March 1999
- NAPTF and NAPTV have been operational for **24 years!**
- **Still one of the only facilities like it in the WORLD!**



NAPTV prior to load module and control cab installation 10/1998

NAPTV in 2022

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NAPTV Recorded Passes Per Construction Cycle

Construction Cycle	Date	Number of Passes
CC1	Aug 1999 - Sept 2001	137,735
CC2	Apr 2004 - Dec 2004	131,354
CC3	Sept 2002 to Oct 2022	23,826
CC4	Jul 2006 to Apr 2008	43,525
CC5	2007 to 2012	64,096
CC6	Aug 2011 to Apr 2012	39,270
CC7	Sept 2014 to Dec 2016	65,538
CC8	Feb 2016 to Mar 2020	111,300
CC9	Apr 2021 - present	60,000
Total Passes		**676,644**

** Does not include passes made for system shakedown tests, or other special tests performed outside of those listed above.

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NAPTV Items Replaced/Updated

- **Bogey Wheel Sets** – 16 total wheelsets at $35K each plus installation - **$960K**
- **Load Controllers** – 10 load modules at $5K each - **$50K** (installed by me)
- **Variable Frequency Drives (VFD) Drives** – 4 – VFDs plus installation - **$324K**
- **SICK Safety Lasers** – 7 total at $7500 each - **$52.5K** (installed by me)
- **Safety Camera System** – 8 PTZ cameras and DVR plus install - **$53.8K**

Installation of cribbing to support test vehicle so old bogey wheel set can be removed.

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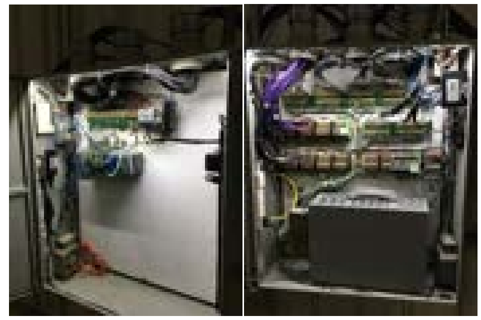
NAPTF Items Replaced/Updated

- **Safety Camera System** – 8 PTZ cameras and DVR plus install - **$50K**
- **Fiber Optic Network** – 12 individual fiber drops to each Signal Processing Unit (SPU) - **$80K**
- **SPU 1 Upgrade** – upgraded data collection system to National Instruments – **$50K**
- **Server Installation** – server and key components - **$35K**



SPU 1 Upgrade with National Instruments Data Collection Equipment versus original VXI System.

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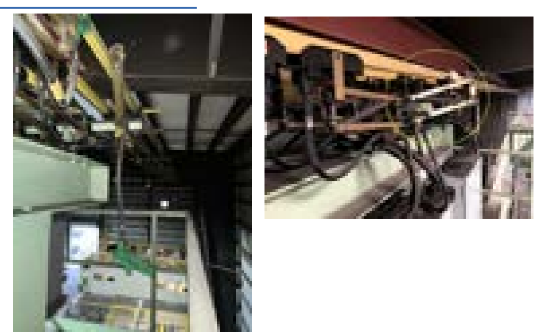
Recent NAPTV Repairs and Scheduled Updates

- **Overhead power rails** - Current conductor failure and inspection (2/23) - **$35K**
- **Structure Bushings** - 40 total bushings at $63K plus installation and materials (6/23)- **$623K**
- **Optical Ethernet Bridge** – 2 units at $50K each plus installation (Fall 2023) - **$150K**



NAPTV overhead rail current conductor failure

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NAPTF Scheduled and Planned Updates

- **<u>SPU upgrades</u> –** data collection systems in 3 SPUs for CC10 materials and labor (Fall 2023) **- $277K**
- **<u>Server upgrade</u> –** 1 new server plus labor (June 2023) **- $26K**
- **<u>Future SPU upgrades</u> –** plan for replacement of SPU2 in FY24 - **$70K**

Current NAPTF Server

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Recent Repairs and Scheduled Updates

<u>NAPTV Structure Bushing Replacement</u>-

- 40 bushings per side drive
- Purpose is so bogey trucks steer correctly
- Some disassembly required
- Entire side drive must be lifted and cribbed – 300Kips per corner
- Removal and installation of the existing structure bushings and the new
- Re-installation of all components
- Remove cribbing and repeat the process for the other side

NAPTV structure bushing replacement

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Recent Repairs and Scheduled Updates

Bent center control bearing (2)

Bushings are sitting on an angle (4)

Bogey wheel wear pattern (4)

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Questions?

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