REDAC Read-Ahead

Submitted to the Subcommittee on Airports

8/24/2022

CONTENTS FOR REVIEW

The following decks are current for Subcommittee review as of 8/23/22.

DAY 1: September 7, 2022

DAY 2: September 8, 2022

DRAFT

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Agenda

- ATR Resources
  - ATR Branch Staff
  - Recruiting Efforts
  - Laboratories and Assets
- ATR Research
  - Ten Year Plans
  - Research Categories
  - Research Focus
  - Recent Accomplishments

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ATR Resources

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ATR Branch Staff

ANG-E26 - Airport Technology R&D Branch
Jim Layton, Acting Manager
Susan Kaelin, Administrative Contact

Program Analyst - Tina Di Ilanni
AvSTEM - Holly Cyrus

UAS Detection & Mitigation
Jim Patterson
Garrison Canter
Mike DiPilato
Nick Subbotin

ANG-E261 - Airport Safety R&D Section
Ryan King, Acting Manager
Jim Patterson, Manager

- Keith Bagot
- Russ Gorman
- Darian Byrd
- Dr. Wesley Major
- Garrison Canter
- Nick Subbotin
- Mike DiPilato
- Lauren Vitagliano
- Airport Safety Specialist /General Engineer
- Airport Safety Specialist /General Engineer

ANG-E262 - Airport Pavement R&D Section
Murphy Flynn, Acting Manager
Jeffrey Gagnon, Manager

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

26 Authorized Positions

LEGEND

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

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Recruiting Efforts

ATR recruiting efforts include:

- New information on the ATR website:
  - Career page
  - Job benefits sheet based on perspectives gathered from current staff
- Intern project during June – August 2022 which created recruiting materials
- Article in Florida Institute of Technology (FIT) Alumni magazine

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Laboratories and Assets

- National Airport Pavement Test Facility (**NAPTF**) – 1999
- NextGen Pavement Materials Laboratory – 2010
- National Airport Pavement and Materials Research Center (**NAPMRC**) w/Heavy Vehicle Simulator for Airports (**HVS-A**) – 2015
- FAA B-727 Instrumented Research Aircraft
- Aircraft Rescue and Fire Fighting (**ARFF**) Test Facility – 2019

Planned

- eVTOL Vertiport capability (Rehab Helipad) – 2023-24
- ~~Materials Pavement Laboratory – 2023-25~~

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ATR Research

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Alignment with U.S. DOT FY22 – 26 Strategic Goals

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Ten Year Plans

- Pavement 2030 Research Plan posted on ATR's website
- Coming soon:
  - Modular version of Pavement Plan
  - Modular version of Safety Plan

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Airport Research Categories

Airport Pavement Research

Structural	Longevity	Environmentally Friendly
• Extended Pavement Life • FAARFIELD • Full Scale Testing • Stabilized Base Design	• Advanced Characterization • Life-Cycle Assessment (LCA)	• Additives & Nanoparticles • Recycled Materials • New Pavement Materials Technologies

Airport of the Future Research

Airport Safety	Data & Technology Integration	Sustainability & Resilience	Noise Studies
• ARFF • Wildlife • Visual Guidance • EMAS, etc.	• Databases (Wildlife, FOD, RIM, Runway, etc.) • AI/ML • Cybersecurity	• Solar Lighting • Weather Resilience	• Sleep Disturbance • Noise Abatement • Measuring Noise Level Reduction

Emerging Entrants Research

Advanced Air Mobility (AAM)	UAS on Airports
• VTOL and STOL • Supersonic and others	• Applications for Airports • Detection and Mitigation

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Research Focus

2022 to 2023

NEAR TERM

- **Pavement structures,** evolving design and materials
- **Airport safety** testing and evaluating latest technologies
- Use of **ML/AI** to analyze large amounts of airports data – pavements & safety **Electric and physical infrastructure** to support emerging entrants
- **UAS integration at airports** testing & evaluation and detection

2024 to 2029

MID TERM

- Using **novel and environmentally** friendly pavement materials
- Using **ML/AI** and autonomous systems for airport safety applications
- Implementing new Inspection techniques **(UAS/ML/AI)**
- Installing **new energy supply systems** for emerging entrants (electric, fuel cells)
- **Integrating** advanced air mobility vehicles and other UAS operations

2030 & beyond

LONG TERM

- **Smart Airports** using new safety technologies / inspection data in an integrated environment
- **Autonomous Airport Support Function -** xBOTS and **autonomous** airfield safety devices
- **Energy grids at airport** to support future users, in a sustainable way
- **Highly Automated Advanced Air Mobility (AAM) services and UAS** applications

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Recent Accomplishments (Part 1)

- **BCRRA International Conference Workshop:** Dr. David Brill and Dr. Navneet Garg facilitated the *Airport Pavement Workshop: Introduction to the ICAO ACR-PCR System Using FAARFIELD 2.0* in Trondheim, Norway on June 27, 2022, as part of the 2022 International Conference on the Bearing Capacity of Roads, Railways and Airfields (BCRRA).
- **Media Presentation on Solar Lighting:** ATR staff spoke with elected officials and media outlets at Pen Yan Airport (PEO) in New York about the significance of Solar Airport Lighting research at general aviation airports. Ryan King and Darian Byrd, explained the research objectives, showcased the installations at the airport, and made clear the positive implications this research has on creating safer airport environments through sustainable methods.
- **Government Engineer of the Year Award**: On May 26, 2022, Dr. David R. Brill was awarded Government Engineer of the Year by the NJ Section, American Society of Civil Engineers (ASCE). This Award is presented to an outstanding civil engineer in government service who has made substantial contributions to the profession.
- **ACY Emergency Response Exercise:** An ATR team worked with ACY Airport personnel to integrate small unmanned aircraft systems (sUAS) into the airport's triennial full-scale emergency response exercise on May 14, 2022. This exercise provided an opportunity to demonstrate the capability of sUAS to provide an "eye in the sky" view to enhance overall situational awareness for the incident commander and other aircraft rescue firefighting (ARFF) personnel during an incident.

Dr. David Brill presenting at BCRRA

Dr. Navneet Garg presenting at BCRRA

Atlantic City International Airport Triennial Emergency Response Exercise

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Recent Accomplishments (Part 2)

- **ICAO Meeting**: Dr. David R. Brill attended the 6th meeting of the ICAO Aerodrome Design and Operations Panel (ADOP) Airport Pavement Expert Group (APEG-6) in Washington, DC on May 2-5, 2022. The group was tasked with updating the airport pavement guidance in ICAO Aerodrome Design Manual (ADM) Part 3 and developing the new Aircraft Classification Rating-Pavement Classification Rating (ACR-PCR) standard.
- **ASCE Fellow:** Dr. Navneet Garg was selected as Fellow of the American Society of Civil Engineers (ASCE). Selection as an ASCE Fellow is a recognition of achievements, accomplishments, scholarship, and responsibility for engineering work of significant importance. Fellows comprise less than 3 percent of ASCE's professional membership.
- **Accelerated Pavement Test Workshop:** Dr. Navneet Garg presented at a workshop on "Simulation of ambient environment actions in Accelerated Pavement Tests (APT)." The main objective of this workshop was to highlight the importance of environmental conditions in APT and share techniques used by researchers around the world to simulate these environmental conditions. This hybrid workshop was part of the 6th International Conference on Accelerated Pavement Testing held in Nantes, France, on April 3, 2022.

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Recent Accomplishments (Part 3)

Published Reports

1. CC9 Construction Report
2. Reflective Crack Propagation Model - Part 2 - Mode II
3. RIM Data Management Tool User Guide
4. FAA Airport Pavement Research and Development Section 2030 Research Plan
5. Summary of Survey Responses of Airport Experience with Pavement Surface Treatments
6. Airport Pavement Surface Treatment: A Literature Review
7. Runway Incursion Mitigation Fiscal Year 2021 Annual Summary Report
8. Fluorine-Free Foam Testing
9. Airport-Related Potential Contributing Factors and Common Causes of Wrong Surface Landings

Soon to be Published Reports

- EMAS Signage Simulation Test Report Review
- Recommended Changes to FAA P-401/P-403 & P-404 Asphalt Mixture Design for Aircraft Loading Conditions
- Evaluation of sUAS for Live Monitoring to Enhance ARFF Situational Awareness

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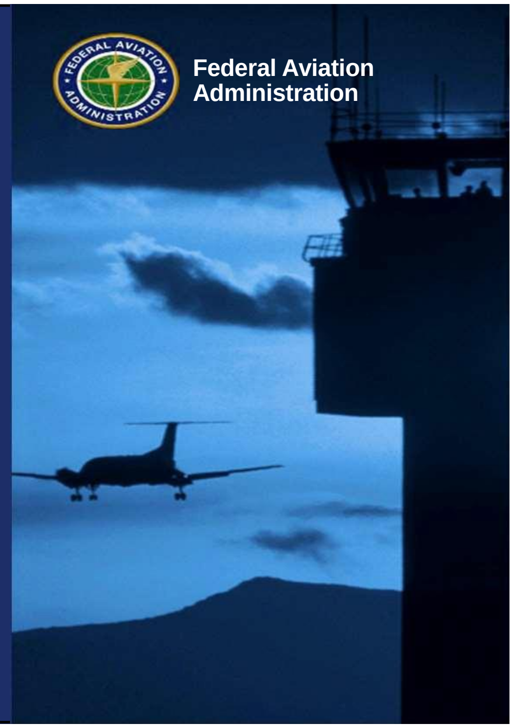
Airport Technology Research (ATR)



REDAC Recommendation Update

Presented to: Sub committee on Airports

By: Jim Patterson

Date: September 7, 2022

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REDAC Recommendations

ID #	Recommendation	Status	Open/Closed
Spring 2019 1	10 Year Airport Pavement Plan Update	Implemented	CLOSED 3/3/20
Spring 2019 2	Smart Airports	Implemented	CLOSED 3/3/20
Spring 2019 3	PFAS	Implemented	CLOSED 3/3/20
Fall 2019 1	FAA Research Landscape	Implemented	CLOSED 3/3/20
Fall 2019 2	UAS Detection System Research	Implemented	CLOSED 3/3/20
Fall 2019 3	AFFF/PFAS Alternatives Research - Urgency	Implemented	CLOSED 3/3/20
Fall 2019 4	AFFF/PFAS Alternatives Research – Industry Coordination	Implemented	CLOSED 3/3/20
Spring 2020 1	UAS Emerging Vehicle Types	Implemented	CLOSED 9/8/21
Spring 2020 2	Emerging Pavement Materials and Additives	Implemented	CLOSED 9/8/21

FAA Airport Technology R&D
September 7, 2022

Federal Aviation Administration

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REDAC Recommendations

ID #	Recommendation	Status	Open/Closed
Fall 2020 1	COVID-19 Research Impacts	Implemented	CLOSED 9/8/21
Fall 2020 2	Emerging Pavement Additives	Implemented	CLOSED 9/8/21
Fall 2020 3	Airport Technology Research Program – UAS/AAM	Implemented	CLOSED 9/8/21
Winter 2021 1	Alternative Firefighting Agent Research Project	Implemented	CLOSED 9/8/21
Winter 2021 2	Unmanned Aircraft Systems (UAS)	Implemented	CLOSED 9/8/21
Summer 2021 1	Alternative Firefighting Agent Research	DRAFT	OPEN
Summer 2021 2	Airport Sustainability and Resiliency	DRAFT	OPEN

FAA Airport Technology R&D
September 7, 2022

Federal Aviation Administration

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REDAC Recommendations

Summer 2021 – DRAFT for Discussion Purposes Only

Finding 1 – Alternative Firefighting Agent Research: As noted in our last two Subcommittee reports, the Program's Alternative Firefighting Agent Research project has been of concern to the Subcommittee because:

- The Project's findings were needed to support FAA action regarding Section 332 of the FAA Reauthorization Act of 2018. Section 332 included a three-year deadline—ending on October 4, 2020—for FAA to "not require the use of fluorinated chemicals to meet the performance standards referenced in chapter 6 of AC No: 150/5210-6D and acceptable under 139.319(l) of title 14, Code of Federal Regulations."
- Airport operators are under considerable pressure from state and local governments and local communities to reduce or eliminate use of PFAS at airports.
- There are significant and growing concerns about the human health impacts and associated liability associated with PFAS contamination on and near airports.

Per our Spring 2021 recommendations, the Subcommittee submitted a letter on August 18, 2021, supporting FAA's request to Congress to extend the Section 332 deadline. The U.S. Congress declined to approve this extension in late September. Without the extension, U.S. airports have been left in a challenging situation with fluorinated foams being the only firefighting agents that meet current FAA and DoD requirements, but under legislative provisions that do not allow FAA to require use of such foams.
The current pathway to approval of non-fluorinated firefighting foams for use at U.S. airports relies on DoD's introduction of a new performance standard for non-fluorinated/PFAS-free foams, which the U.S. Congress has mandated by January 31, 2023.

FAA Airport Technology R&D
September 7, 2022

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REDAC Recommendations

Summer 2021 – DRAFT for Discussion Purposes Only

Finding 1 – Alternative Firefighting Agent Research:

(CONTINUED)

Recommendation: Consistent with our Spring 2021 report, the Subcommittee recommends that the FAA prioritize assistance and support for DoDs research efforts regarding a new performance standard for non-fluorinated/PFAS-free foams. We also reiterate our recommendation from Spring 2021 that the FAA prioritize research associated with ARFF training, equipment requirements (including equipment cleaning), tactics, and other supporting guidance that will be needed to facilitate the transition from fluorinated to non-fluorinated foams.

FAA Response: The FAA concurs with the Committee's findings and recommendations and is taking the following actions to address it:

The FAA will continue to work closely with the DoD on the development of a new performance standard for non-fluorinated/PFAS-free foams. The FAA has established a roadmap that lays out a timeline for research efforts conducted by both the DoD and the FAA, as well as a transition phase from fluorinated to non-fluorinated foams. As a new performance standard emerges, the FAA will ensure that necessary research associated with application of that new standard is conducted. As appropriate, this might include ARFF training, equipment requirements, tactics, and supporting guidance.

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REDAC Recommendations

Summer 2021 – DRAFT for Discussion Purposes Only

Finding 2 – Airport Sustainability and Resiliency: As noted previously, the Subcommittee appreciated the categorization of several of the Program's projects in terms of airport sustainability and resiliency. U.S. airport operators are extremely interested in ways they can enhance both sustainability and resiliency through appropriate capital investment and changes in operating and maintenance practices.

Recommendation: The Subcommittee recommends that the FAA continue to prioritize research projects that enhance airport sustainability and resiliency particularly within the advanced pavement materials, extended pavement life, airport planning & design, and environmental tools & guidance Research Program Areas (RPAs).

FAA Response: The FAA concurs with the Committee's findings and recommendations and is taking the following actions to address it:

The FAA will conduct a review of the Airport Technology Research Portfolio and will ensure that research projects, that enhance airport sustainability and resiliency, are incorporated in the portfolio. The FAA concurs that a number of research program areas related to pavement longevity, physical infrastructure resilience, energy supplies, climate preparedness which includes planning and design, are well-suited for an enhanced focus in airport sustainability and resiliency.

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REDAC Recommendations

Winter 2022 – DRAFT for Discussion Purposes Only

Finding 1 – Construction Cost Inflation: Construction cost inflation is affecting planned pavement testing facility improvements, notably the new pavement materials laboratory, which the Subcommittee has supported in our past findings and recommendations. Additionally, costs of pavement materials have increased sharply in recent months as petroleum costs and construction demand have increased.

Recommendation: The Subcommittee recommends that FAA Program staff assess the impacts of construction and materials cost inflation on ongoing facility construction and pavement research schedules and brief the Subcommittee on these impacts at our Fall 2022 meeting. It is noted that the exorbitant increase in construction costs is extremely important as it impedes the FAA's capacity to efficiently conduct and apply research that is vital to the successful outcomes of various Airport programs areas.

FAA Response: The FAA concurs with the Committee's findings and recommendations and is taking the following actions to address it:

The Airport Technology Research Branch will track construction and materials cost inflation over the next few months (Spring-Summer 2022 and beyond), assess construction scheduling impacts, and will coordinate with the FAA Office of Airports on the construction planning and budgeting of the pavement research laboratory. Updates will be provided at the Fall 2022 meeting of the Airports Subcommittee.

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Airport Technology R&D

FAA William J. Hughes Technical Center

Airport Technology Research Branch

ANG-E26, Building 296

Atlantic City International Airport, NJ 08405

www.airporttech.tc.faa.gov

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FAA ARFF Research Program

Fluorine-Free Foam Research

Presented to:
REDAC Sub committee on Airports

Keith Bagot
September 7 8, 2022

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Agenda

- Project Background
  - Background
  - Program status
  - Draft MilSpec Highlights
  - Next Steps

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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)
- 36 Fluorine-Free Foams (FFF) evaluated
  - 11 Commercial off-the-shelf foams
  - 25 Prototype fluorine-free foam formulations
  - New prototype agents from BAA and industry continue to be evaluated
- Over 500 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
  - Currently testing FFFs against new draft MilSpec test protocols
- 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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Fluorine-Free Foam Testing Report

- In the majority of the cases, the products were tested to a higher performance standard than what they have been developed for or certified to (exception MilSpec AFFF and ICAO C certified foams).
- Report is a collection of all testing on commercially available FFF and protocol modifications.
- 7 of 11 commercially available products tested are included in the report.
- 4 foams did not have a high enough performance to include in a complete test series (two products at both 3 and 6% concentrations).
- None of the FFFs evaluated had an equivalent or better extinguishing performance to AFFF.
- Burnback protection of AFFF was superior to all but one FFF candidates by a significant margin.
- All the FFF candidates exhibited adverse effects from the application of dry chemical.
- Application techniques of FFFs were found to significantly alter the results of extinguishment times.


Fluorine-Free Foam Testing

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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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Draft FFF MilSpec Highlights

MIL-PRF-XX727 Draft Performance Specification - Fire Extinguishing Agent, Fluorine-free Foam (F3) Liquid Concentrate, For Land-based, Fresh Water Applications

F3 Specifications

- Type 3 and fresh water only.
- The concentrate shall not contain more than 1 part per billion (ppb) PFAS as determined by its total fluorine content.
- Similar refractive index and viscosity values.
- Corrosion requirement added metals more common to land-based fire systems (ARFF trucks).
- Mix of ethanol-free gasoline and Jet A fire extinguishing requirements.
- White pales with black lettering.

Testing Parameters

- Retention testing requirements every 4 years.
- A maximum of 4 tests may be performed to pass each requirement.
- If 2 successful tests cannot be achieved within the four allowed, the concentrate shall be rejected.

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Draft FFF MilSpec Highlights

TABLE II. Firefighting performance requirements.

Test Paragraph	Intent	Solution	Concentration	Fuel Type [1/]	Max. Ext. Time (sec)	Min. Burnback Time (sec)
28-ft² Fire Tests Unaged Products						
4.5.11.1	Capabilities	Unaged Conc.	Full-strength	Jet A	30	300
4.5.11.1 [2/, 3/]	Capabilities	Unaged Conc.	Full-strength	Gasoline	60	240
4.5.11.1 [2/, 3/]	Capabilities	Unaged Conc.	Half-strength	Jet A	30	300
4.5.11.1	Capabilities	Unaged Conc.	Double-strength	Jet A	30	300
4.5.8	Dry Chem Compatibility	Unaged Conc.	Full-strength	Jet A	30	240
50-ft² Fire Tests Unaged Products						
4.5.11.2 [3/, 4/]	Capabilities	Unaged Conc.	Full-strength	Jet A	60	270
28-ft² Fire Tests Aged Products						
4.5.9	Stability	Aged Conc.	Full-strength	Gasoline	60	240
4.5.9	Stability	Aged Conc.	Full-strength	Jet A	30	300
4.5.9	Stability	Aged Conc.	Half-strength	Jet A	30	300

NOTES:

1/ Unleaded gasoline in accordance ASTM D4814 that is ethanol-free and Jet A in accordance ASTM D1655 shall be used during testing.

2/ Fire test required for conformance inspection (see table III).

3/ Fire tests required for retention of qualification and approval of additional facilities (see table III).

4/ Products are required to achieve 75% extinguishment within 20 seconds of the start of foam application.

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Next Steps

- DOD on track for the National Defense Authorization Act (NDAA) deadline of publishing by Jan. 31, 2023.
- First approved and QPL listed products by April 2023.
- FAA and DOD continue to research new FFF formulation.
- FAA focus on transition planning from legacy AFFF to new FFFs while additional research continues.

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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 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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Office of Airports
New and Emerging Entrants

Federal Aviation Administration

By: Jonathan Torres

Date: September 2022

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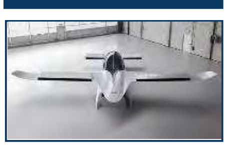
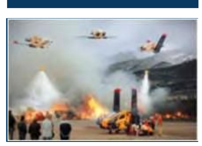
Advanced Air Mobility (AAM)

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/hybrid/hydrogen aircraft or electric/hybrid/hydrogen 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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AAM

- The majority of VTOL and 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 co-located and separate from airports.
- As operators explore that interest, questions arise as to what standards to use in the siting, design, and operation of those vertiports and support infrastructure.
- FAA Advisory Circular (AC) 150/5390-3, Vertiport Design, cancelled in 2010 due to lack of compatible aircraft.

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Unmanned Aircraft Systems (UAS)

- 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.
- Interest levels continue to emerge with leveraging UAS for on airport applications. The ATRD at the FAA William J. Hughes technical Center is evaluating how UAS can support various use cases such as Pavement Inspections, Obstruction Analysis, Aircraft Rescue and Firefighting (ARFF), FOD Detection, Perimeter Surveillance, Wildlife Management and Lighting Inspection.

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UAS

- On August 21, 2020, the FAA announced that it plans to evaluate technologies and systems that could detect and mitigate potential safety risks posed by unmanned aircraft. The effort will be part of the agency's Airport Unmanned Aircraft Systems Detection and Mitigation Research Program pursuant to the FAA Reauthorization Act of 2018. The ATRD is working with five airports selected to participate in this program which includes Atlantic City International (ACY), Syracuse Hancock International (SYR), Rickenbacker International (LCK), Huntsville International (HSC) and Seattle-Tacoma International (SEA) Airports.
- Researchers plan to test at least 10 technologies or systems at these airports. Testing began early in CY 2022 and will continue through CY 2023. Once complete, the FAA will develop standards for future UAS detection and mitigation technologies at airports.
- Office of Airports (ARP) is developing information for sponsors of federally obligated airports regarding UAS operations on airports to further assist with safely integrating these applications into the NAS.

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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 and reentries and the activities that support commercial space flight.
- 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.
- FAA's Office of Airports 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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Purpose of the Project

- The primary purpose of this project was to determine the optimal placement of an EMAS signage visual aid designed to reinforce the presence of EMAS during normal operations
- The secondary purpose was to evaluate the effectiveness of this signage during an overrun excursion

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Project Background

- Despite its proven effectiveness, there are occasional incidents where pilots choose to veer away from EMAS
- AAS tasked ATR with developing and testing information sign prototype concepts intended to alert or remind a pilot that an EMAS is present at the end of the runway
- 2013 Research Effort – Recommended that new information signs should be installed on both sides of a respective runway to improve pilot awareness of EMAS
- 2016 Research Effort – Optimal EMAS signage prototype was chosen among six different candidates

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Current Research Project (started in 2019)

- The signage prototype selected during the 2016 research was further evaluated
- Two separate but related research activities during the simulations:
  - Determine the optimal location of the EMAS signage to reinforce the presence of EMAS during normal operations
  - Determine the effectiveness of this signage during an emergency overrun
- Simulation was the selected approach versus live testing at airports

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Simulation Background and Preparation

- FedEx and FSI participated as industry partners
- Airport runway selection process
- Dry run findings and scenario adjustments
- Human Factors support was used throughout the process of designing the simulations

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FSI Simulation Runs

- 30 FSI participants completed feedback surveys about their experience during the overrun scenario as well as their opinions regarding the optimal signage locations.
- TEB Runway 6 is shown to the right.

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FedEx Simulation Runs

- 102 FedEx participants completed feedback surveys about their experience during the overrun scenario as well as their opinions regarding the optimal signage locations.
- MEM Runway 18R is shown at the top right and SFO Runway 1R is shown at the bottom right.

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Preliminary Findings

- Data Analysis is in progress and final report is expected to be completed by Q1 CY2023
- Discussion of some preliminary findings

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Questions?

FAA Project Contact

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Airport Pavement Design for Seasonal Frost and Permafrost Conditions

RPA P5.1

Presented to:
REDAC Sub committee on Airports

David R. Brill, P.E., Ph.D
September 7 8, 2022

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Agenda

- Project Background
  - Purpose of the project
  - Background
  - Program status and timeline
- Technical Report
  - Research Plan
  - Selected Airports - Example
  - Key Issues and Recommendations

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Purpose of the Project

- **AAS-100 Research Request dated 1/27/2020**
- **Scope: Investigate 3-4 runways in the Alaskan region with known performance issues.**
  - Design requirements for seasonal frost and/or permafrost. ***Was the design in accordance with FAA RD 74-30? Did the constructed pavement agree with the design?***
  - How much did accelerating warming trends contribute to early failures? ***Were the noted performance issues related to design, materials, maintenance, environment, or a combination?***
  - ***Are there any recommended updates to FAA design procedures for seasonal frost and permafrost conditions?***


Federal Aviation Administration

Memorandum

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Project Background

- Alaskan airports have been challenged by premature failure of flexible pavements. In many cases, the failure has been attributed to permafrost degradation.
- Global warming causes gradual loss of permafrost, but it is not necessarily the only reason for poor pavement performance at a specific airport. Failure in a permafrost area could be due to other factors such as improper design or construction, or substandard fill materials.
- AC 150/5320-6G addresses design for permafrost conditions, but the design method has not been substantially updated since the 1970's.

Examples of Permafrost-Related Distresses

Shoulder-Rotation Permafrost Failure

Non-uniform Settlement (Massive Ice)

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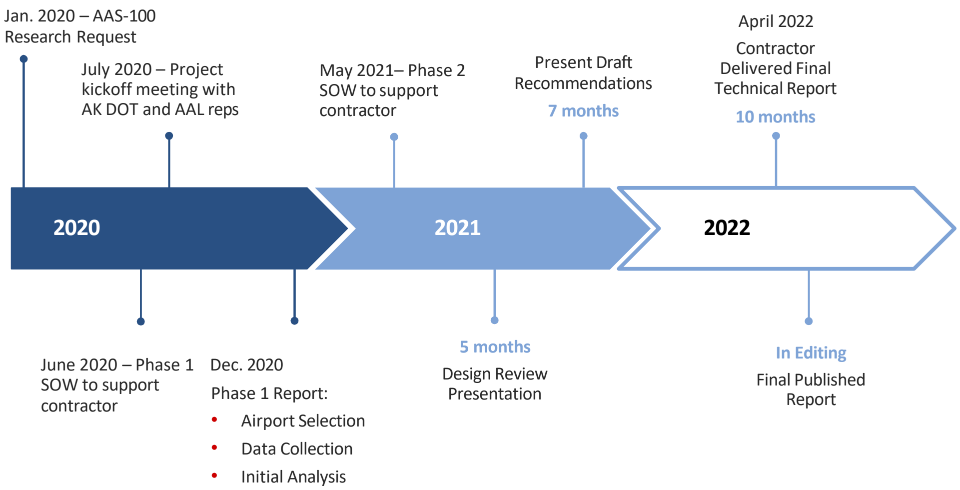
Project Timeline



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Research Plan

I. **Task 1 – Identify Subject Airports**
   - **In coordination with FAA Alaskan Region and Alaska DOT personnel.**
   - **Identify at least 2 flexible airports and one gravel-surfaced airport (in permafrost zones) with performance issues for further investigation.**

II. **Task 2 – Collect Relevant Documentation**
   - **Pavement Design Engineer's Report**
   - **Geotech reports, AIP documentation, MoS, standards & specs, PCI inspections, etc.**

III. **Task 3 – Conduct Interviews**
   - **Interview design engineers responsible for most recent rehabilitation and/or consultants familiar with pavement condition.**
   - **Intention is to gain insights not readily available from the design report.**

IV. **Task 4 – Design Review and Analysis**
   - **Review existing designs to determine conformity with FAA standards. (Or what alternate standards were applied?)**
   - **Compare to current FAA design requirements in AC 150/5320-6.**
   - **In each case, identify the probable reason(s) for performance issues.**

Design of Pavements for Seasonal Frost and Permafrost
DRAFT Project Plan

1. Introduction

FAA Advisory Circular (AC) 150/5320-6F includes requirements for design of airport pavements in seasonal frost and permafrost areas. These requirements are based on research done at the US Army Corps of Engineers (USACE) Cold Regions Research and Engineering Laboratory (CRREL) by Dr. Richard L. Berg, and published in FAA Technical Report FAA-RD-74-30 (1974). The Berg report is the source of the three standard design methods available in AC 150/5320-6F to control the detrimental effects of seasonal frost, which in order of effectiveness are: complete frost protection; limited frost protection; and reduced subgrade strength.

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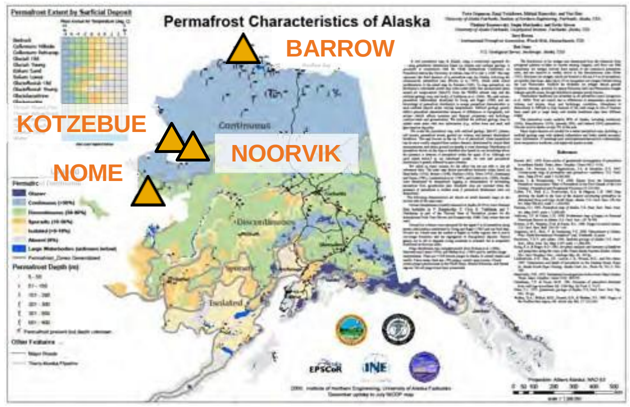
Selected Airports

Permafrost Zone Map of Alaska



I. **Nome**
   - Discontinuous Permafrost Zone
   - Persistent differential settlements, especially at transitions between sections.

II. **Kotzebue**
   - Continuous Permafrost Zone
   - Localized settlement; failure of polystyrene insulation boards

III. **Barrow**
   - Continuous Permafrost Zone
   - Large settlements; embankment failures

IV. **Noorvik**
   - Continuous Permafrost Zone
   - Gravel-surfaced runway
   - Shoulder rotation; embankment cracks

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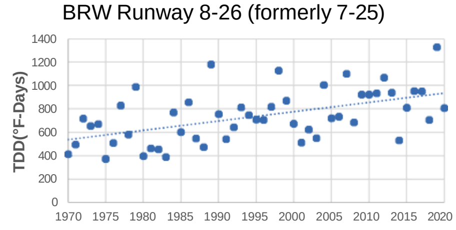
Example – Barrow (Utqiagvik) Wiley Post - Will Rogers Memorial Airport

- **New runway was opened in 2012 (design 2002)**
  - Flexible pavement: 3" asphalt / 6 " RAP / fill material
  - Borrow fill to depth 8'-11' below grade
  - Mill/fill after 2 years to correct distresses.
- **Permafrost Design**
  - Used a computer program (Mut1D) to estimate design thaw depth.
  - Thaw depth established new grade.
  - Completed frost protection design based on "10-or 20 year warm year." No indication that subgrade thaw into ice-rich soils contributed to initial surface settlement. However, future thaw due to warm years could change this.
- **Settlement distresses attributed to:**
  - Poorly compacted wet embankment fills.
  - Fills placed over more than one season.
  - Installation of MALSR may have caused permafrost degradation at one end.
- **2002 design deviated from FAA standards:**
  - Used AKO98 computer program for thickness.
  - MoS – Allowed RAP as base course; deleted crushing and max. natural sand requirements in P-401 to reflect available sources.
  - Surface and base layers inadequate thickness.
  - Embankment fill probably did not meet standards for non-frost susceptibility.

BRW Runway 8-26 (formerly 7-25)



Change in Thaw-Degree-Days in Barrow 1970-2020. Data from http://weather.gov/aprfc (Alaska-Pacific River Forecast Center)

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Main Issues Identified in Design Reviews

Design-Related Issues

- Designers did not follow the FAA design criteria in effect consistently.
- AC recommendations for thaw depth are based on the three warmest summers over the past 30 years. The FAA guidance did not capture the warming trend observed since the pavements were constructed.
- FAA guidance is silent or unclear about what subgrade strength should be used for the Limited Frost Protection method.
- Lack of standard procedures for pavement rehabilitation in frost and permafrost zones. In most cases, pavement distresses reappeared a few years after the rehabilitation efforts.

Construction-Related Issues

- Lack of standard procedures to address construction timing and sequence in frost/permafrost zones.
- Lack of standard methods for design and construction of insulation panels
- Unexpected events during construction negatively affected compaction and/or the thermal balance of subgrade.
- Scarcity of non-frost susceptible material in some areas led to MoS.

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Selected Recommendations for Improving FAA Guidance (Condensed)

Design Guidance (AC 150/5320-6)

- Account for warming trend in calculation of thaw depth. The current criterion (take average of three warmest years over the past 30) should be re-evaluated.
- Partial frost protection seems of limited value. Consider removing it from the guidance. Allow complete frost protection for FG-1 and FG-2.
- Clarify how much differential settlement can be expected when using Reduced Subgrade Strength. The recommended 50% reduction in AC 150/5320-6G for RSS is arbitrary and may not be realistic.

Construction and Maintenance Guidance (AC 150/5370-10)

- Insulating panels: Construction timing and sequence is critical. Soil must be frozen when installing panels. Panels must extend to the shoulders and embankment edge.
- Avoid piling snow on the embankment slope, because it may insulate this area from winter cold, preventing the subgrade from freezing.
- Delay paving over the winter to allow permafrost to restore in discontinuous permafrost zones, or pave after winter in continuous permafrost zones.

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Publications

- Ali Z. Ashtiani, *Evaluation of Airport Pavement Designs for Seasonal Frost and Permafrost Conditions*, Technical Report, July 2022 (in final editing)
- "Evaluation of Airport Pavement Designs for Seasonal Frost and Permafrost Conditions," Ali Z. Ashtiani, Timothy A. Parsons, David R. Brill, submitted to 2023 TRB Annual Meeting (in review).

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Questions?

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RPA Environmental

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Agenda

- Neighborhood Environmental Survey (NES)
- Resilience at Vulnerable NPIAS Airports with Climate Change and Severe Weather
  - Purpose of the project
  - Background
  - Updates since last REDAC meeting
  - Program status and timeline

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Neighborhood Environmental Survey (NES)

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Neighborhood Environmental Survey (NES)

Results were briefed in Sept 2021 – Updates since…

- Late 2021 - FAA initiated noise policy review, to further advance scientific understanding of noise impacts as well as the development of analytical tools and technologies.
- It will consider new evidence from the agency's noise research program, including from the Neighborhood Environmental Survey, and the distribution of environmental risks, tradeoffs, or externalities across communities.
- Goals
  - Identify and implement **well-reasoned, scientifically-grounded** noise policy updates that incorporate FAA's updated understanding of aviation noise and human response and the development of analytical tools and technologies to better manage and reduce the environmental impacts of aviation
  - Build out an inclusive, transparent, and participatory process that prioritizes input from substantially affected stakeholders, including local communities
- Timing
  - We do not have a firm date for completion yet, but it will be a thorough review with opportunity for stakeholder input.

A new National Curve was created by combining the Survey responses from the question on "Noise from Aircraft" with the modeled aircraft noise levels. Compared with the existing Schultz Curve, the new National Curve shows a substantial increase in the percentage of people who are highly annoyed by aircraft noise over the entire range of aircraft noise levels considered, including at lower noise levels.

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References

- **Public Webinar on NES and Noise Research Portfolio:**
  https://www.youtube.com/watch?v=Mku13gL0xGc
- **NES Technical Report and Public-Use Data:**
  https://www.airporttech.tc.faa.gov/Products/Airport-Safety-Papers-Publications/Airport-Safety-Detail/ArtMID/3682/ArticleID/2845/Analysis-of-NES
- **FAA NES Website and Information:**
  https://www.faa.gov/regulations_policies/policy_guidance/noise/survey

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Resilience at Vulnerable NPIAS Airports with Climate Change and Severe Weather

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Climate Change Actions: Policy

Executive Order 14008: Tackling the Climate Crisis at Home and Abroad (25 May 2021)

- Sec. 211 requires Federal agencies, including FAA, to develop a Climate Action Plan (CAP) to increase the *resilience* to the impacts of climate change of its facilities and operations
  - "Airport" impacts will be addressed in FAA's climate action plan

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Climate Change: Resilience Challenge Overview

<u>Climate Resilience</u> – "a capability 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."

Airports are experiencing :
- Sunny-day coastal flooding
- Permafrost collapse in Alaska, leading to 1 airport relocation
- Sea-Level Rise, increase in severe weather

How much protection is needed?

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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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Research Outcomes – Conceptual Approach

1. Develop a framework airports and consultants can use when conducting resilience assessments - ARAF
   - Standardize approach for airports to collate information on climate-related hazards, vulnerability of assets while offering high-level guidance on resilience-related infrastructure solutions
   - Assess projected impacts on the performance of pavement, drainage, and electrical systems over varying timescales and scenarios
   - Justify AIP funding requests for projects that have resilience benefits
2. Develop a prioritization framework to assist FAA in selecting National Plan of Integrated Airport Systems (NPIAS) and other eligible AIP project proposals – RPPF
   - Integrate resilience criteria and standards into Orders/AC's

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Resilience Research: 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

- ✓ **FAA Reviewing ARAF**

Next Steps

- Continue refining ARAF
- Outline of RPPF

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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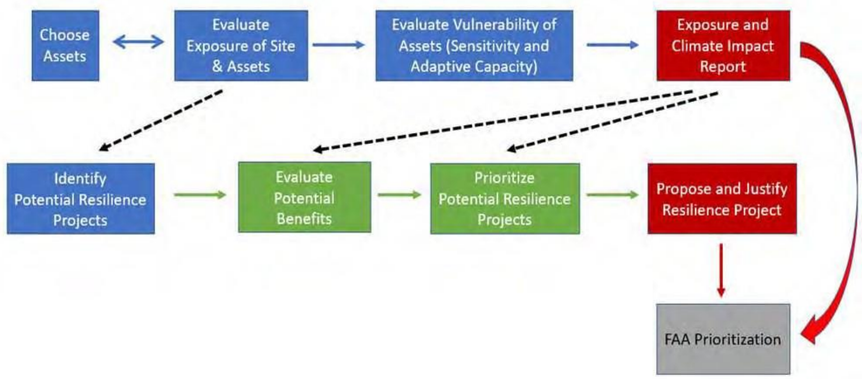
Airport Resilience Analysis Framework (ARAF)

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



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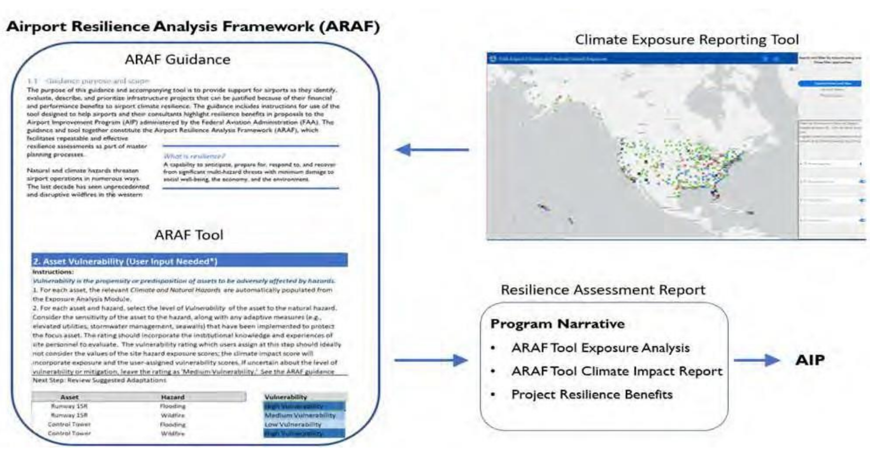
Airport Resilience Analysis Framework (ARAF)

Components of the ARAF (in box), ARAF outputs, and elements supporting the ARAF:



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Resilience Prioritization in AIP

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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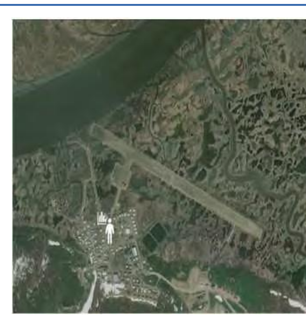
Next Steps

- Refining priority hazards and risk/benefits associated with AIP projects
- Complete Categorizing Airports for the RPPF
- Stakeholder Engagement
- Select Airports for Case Studies



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Questions?

Contact the FAA Program Manager

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Airport Pavement Design Update – FAARFIELD 2.0

RPA P5.1

Presented to:
REDAC Sub committee on Airports

David R. Brill, P.E., Ph.D.
September 7 8, 2022

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Agenda

- FAARFIELD 2.0 Background
  - AC 150/5320-6G and AC 150/5335-5D
  - Program status and timeline
- Technical Report
  - Updates from Spring Subcommittee Meeting
  - FAARFIELD 2.0 for PCR Reporting
  - Next Steps:
    - FAARFIELD / PAVEAIR Integration – Update
    - Machine Learning (ML) for Design Stresses – Update
    - Reflection Cracking Design
    - Remaining Life Prediction – PANDA-AP

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FAARFIELD 2.0 Background

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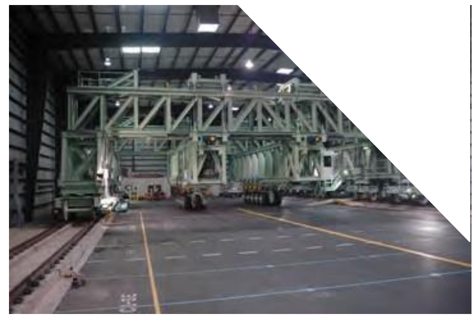
Purpose/Background

- 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

2016 — Initial story board meeting on FAARFIELD GUI update

2017 — FAARFIELD 1.4 Released

FAARFIELD 2.0 DEVELOPMENT

- 2018 — Develop FAARFIELD 2.0 Project Plan
- Sept. 2019 — FAASR3D 2.0 Library

- Jan. 2020 — FAARFIELD 2.0 Beta Release
- March 2020 — ICAO-ACR Library

- July 2020 — ACR-PCR Effective Date
- June 2021 — AC 150/5320-6G and FAARFIELD 2.0 Release

- AC 150/5335-5D **Released April 29, 2022**
- Future — FAARFIELD 2.0 Updates

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FAARFIELD 2.0 Technical Report

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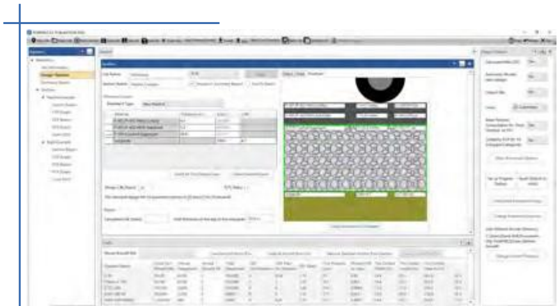
FAARFIELD 2.0 – Updates from Spring Subcommittee Meeting

- **Current version FAARFIELD 2.0.18**
  - **Posted May 18, 2022.**
  - **Improved graphics (PCR charts, CDF graph, etc.)**
  - **Added a placeholder for online PAVEAIR access.**
  - **Converted entire aircraft library to universal X gear format (consistent with user-defined gears).**
  - **UDA – Added gear orientation.**
  - **Many other improvements and bug fixes.**
- **Supports the new ICAO ACR-PCR system and AC 150/5335-5D (released April 29, 2022).**



FAARFIELD 2.0.18 Screen Shot

Download:
https://www.airporttech.tc.faa.gov/Products/Airport-Safety-Papers-Publications/Airport-Safety-Detail/ArtMID/3682/ArticleID/2841/FAARFIELD-20

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ACR-PCR Current Status

- ICAO Air Navigation Committee (ANC) approved an amendment to Annex 14 on ACR-PCR in 2020.
- Established four-year transition period from ACN-PCN to ACR-PCR.
  - Effective date July 2020 (currently effective).
  - Full applicability November 2024.
  - During transition, both systems will remain available.
- AC 150/5335-5D – Released April 29, 2022.
  - Adopts the ICAO Aircraft Classification Rating - Pavement Classification Rating (ACR-PCR) method to replace the current ACN-PCN method.
  - Covers the process for calculating pavement strength using the new ICAO ACR-PCR method and FAARFIELD 2.0.
  - Requires all public use paved runways at all 14 CFR Part 139 certificated airports be assigned gross weight and PCR data by September 30, 2024

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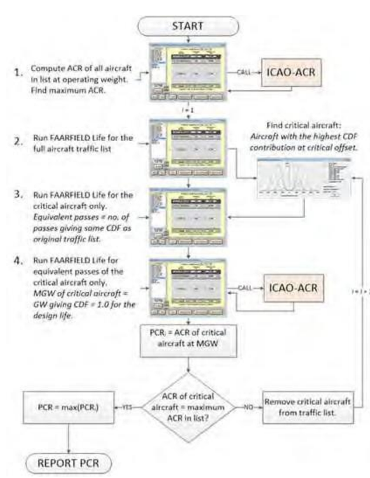
FAARFIELD 2.0 for PCR Reporting

- **Directly uses FAARFIELD structure and traffic list.**
- **Replacement for COMFAA 3.0 & support spreadsheets.**
- **Implemented in FAARFIELD 2.0.**
  - **One-step PCR procedure.**
  - **Method yields uniquely defined PCR – no more looping through all aircraft in the list.**
  - **Computes PCR for mixed traffic (narrow bodies and LR aircraft) without unnecessary operating weight restrictions.**
  - **Seamlessly handles HMA overlays on rigid pavements.**



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PCN-PCR Comparisons

Airport	Runway	PCN as reported on FAA Form 5010	AC 150/5335 5C PCN (COMFAA)	PCR (FAARFIELD 2.0)
A	10-28	105/F/A	Not Valid	6556/F/A
B	10L-28R	61/F/C	71/F/C	569/F/C
B	10R-28L	77/F/C	78/F/C	771/F/C
C	01-19	57/F/B	65/F/B	677/F/B
F	9-27	65/F/D	Not Valid	3770/F/D
D	10R-28L	74/R/B	77/R/B	835/R/B
E	10C-28C	96/R/C	103/R/B	1136/R/C
G	16L-34R	92/R/B	96/R/B	1689/R/C
I	17L-35R	N/A	29/R/A	263/R/A

- **As shown here, the PCR number is usually about 10 times PCN. This is due to how PCR is defined in the new system.**
- **Cannot directly convert PCN to PCR. Must use FAARFIELD 2.0 to compute PCR.**
- **Subgrade strength categories may not be the same in the new method.**
- **Technical report: PCN – PCR Comparisons for Large- and Medium-Hub Airport Runways (June 2022) currently in editing.**

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Next Steps

- Integration/data sharing with FAA PAVEAIR via web API.
- Additional internet support.
- New machine learning (ML) based models for concrete pavement top-down cracking and reflection cracking (asphalt overlays).
- Improved remaining life prediction using PANDA-AP (advanced modeling library)

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FAA PAVEAIR Integration

- **New online functionality:**
  - Use your PAVEAIR login for library updates
  - Perform data exchange with PAVEAIR via WebAPI.
- **Access to user-owned databases.**
  - Download: Job information, existing sections, NDT data.
  - Upload: FAARFIELD job files (alternate designs).
- **Tested on internal version of FAARFIELD. Placeholder added to release version 2.0.18.**

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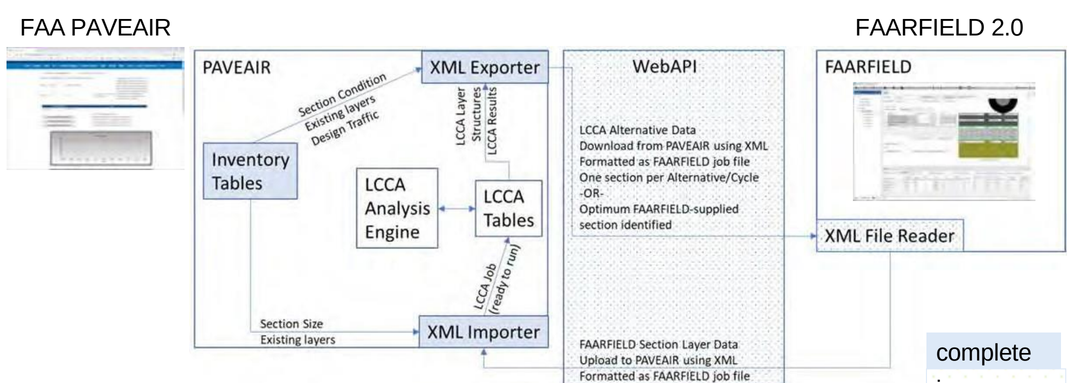
Improve Data Exchange via WebAPI in PAVEAIR



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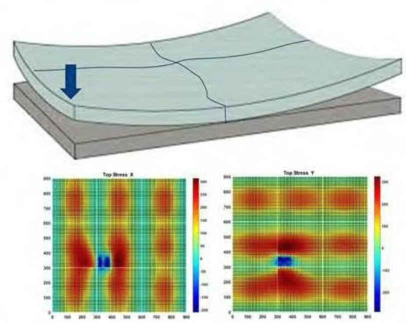
Machine Learning for Top-Down Cracking

- Rapidly compute stress for top-down cracks (rigid).
- Combined curling and aircraft loading.
- Replaces direct 3D-FEM computation for most gears.
- "Deep Learning" approach removes the need to train a separate neural network for each aircraft.
- General model is suitable for D, 2D and 3D gear configurations.



FEAFAA Response Model

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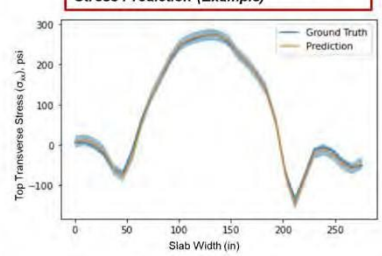
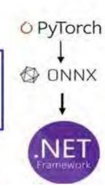
Machine Learning for Top-Down Cracking

- Step 1 – Training Database.
  - Contractor ran >125,000 combinations of structural, thermal, and aircraft gear parameters.
  - Used output matrix to train the deep ANN model.
- Step 2 – Machine Learning Model Development.
  - New modeling approach.
  - Models are significantly more accurate than previous ML techniques for similar problems.
- Step 3 – Implement ML Model.
- Phase 1 Complete. Final Report delivered 12/2021.
- Phase 2 contract awarded to ARA 5/25/2022. Phase 2 will expand training database to include light load aircraft and thinner slabs.
- Presentation at FHWA 1st International Data Science for Pavements Symposium, March 22-24, McLean, VA.

Estimated Uncertainty Envelope Around Stress Prediction (Example)



Next: Use Open Neural Network Exchange (ONNX) to port the developed Pytorch ML model to a .NET framework (so it will run in FAARFIELD).



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Reflection Cracking Model Development

- Contract to Arizona State University (ASU), with participation from University of Illinois. Project awarded May 2021.
- Three-year effort will produce a practical reflective cracking model using fracture mechanics principles, for implementation in FAARFIELD.
- Data from NAPTF reflection cracking rig and outdoor full-scale tests.
- Model inputs include both aircraft load and temperature cycling (joint opening/closing).

NAPTF Reflective Cracking Rig | The "Real World"

A key element in this project is the development of transfer functions to relate the theoretical crack growth (governed by Paris' Law) to the condition of the affected pavement (PCI). This project will make use of real-world data in FAA PAVEAIR and related databases.

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PANDA-AP
Pavement Analysis using Nonlinear Damage Approach

- Partners: Texas A&M Univ. and University of Kansas
- Standalone PANDA-AP:
  - Models failure mechanisms in asphalt and granular materials.
  - Supplement to FAARFIELD for remaining life analysis.
  - Allows user to define gear configurations, load types, and pavement structures.
  - User-friendly and customized for airfield pavements.
  - Independent of commercial FE software (will be free to public).
- Project Lead: Dr. Navneet Garg

PANDA: A Fortran code in which a number of sophisticated material models is implemented.

- Includes Models for Performance Related Mechanisms
- Includes Models for Environmental Effects
- Models are Developed for General 3D Multi-Axial Stress States
- Mechanical and Environmental Models are Coupled and Can Occur Concurrently
- Flexible: Other models can be implemented to supplement/substitute current models in the future

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Questions?

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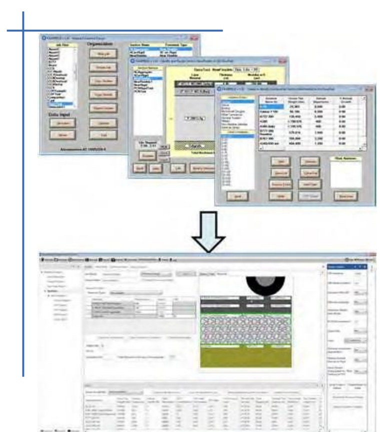
FAARFIELD 2.0 – Major Changes from Version 1.4

- **Modern Graphical User Interface (GUI) Features:**
  - **Easier job and section entry.**
  - **Explorer-based navigation.**
  - **Improved screen re-sizing and appearance.**
  - **Improved flow between screens.**
  - **Ability to store traffic mixes.**
  - **On-demand report generation.**
- **Supports the new ICAO ACR-PCR system.**
- **User-Defined Aircraft (UDA) editor.**
- **No change to thickness design requirements in this version.**



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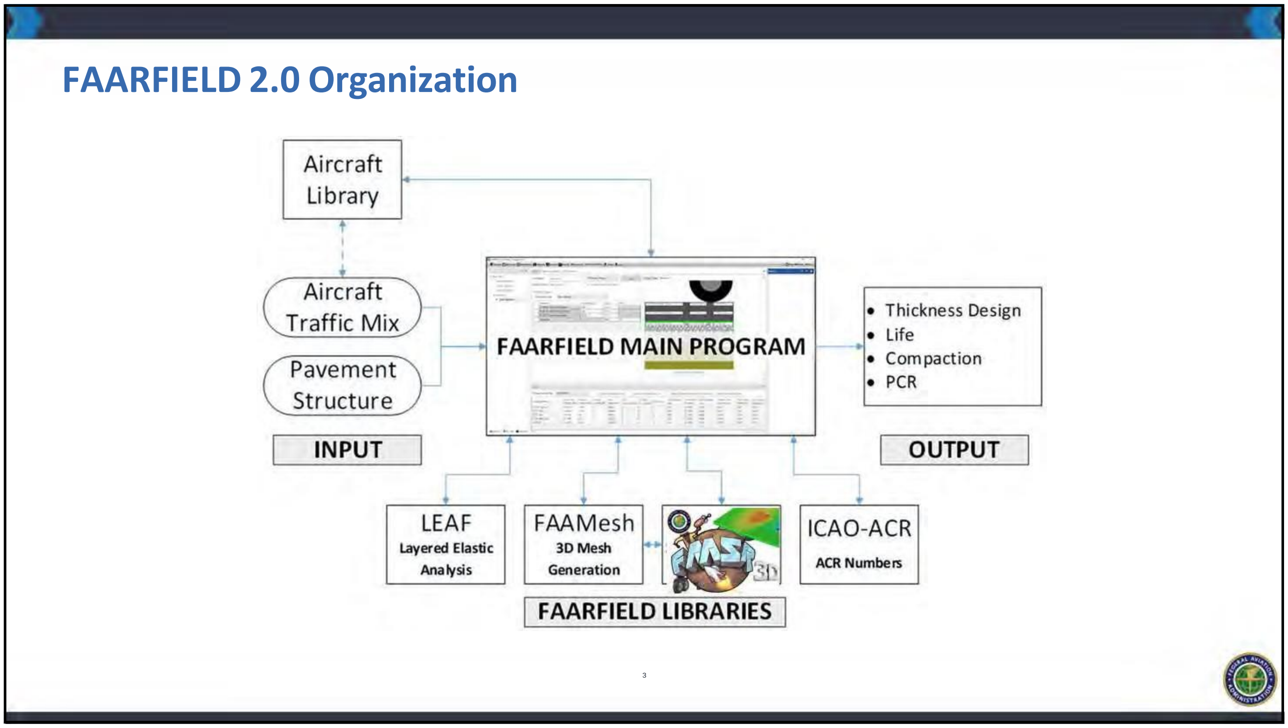
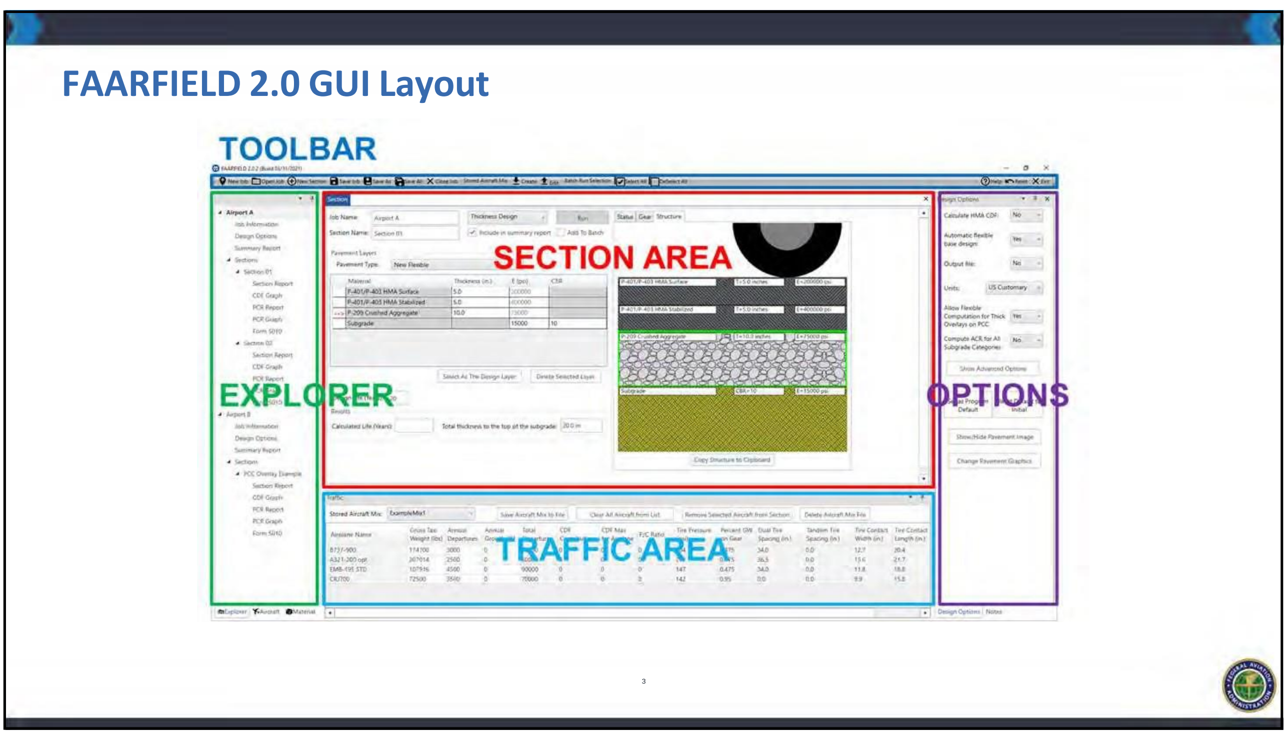

FAARFIELD 2.0 Organization
Aircraft Library
Aircraft Traffic Mix
Pavement Structure
INPUT
FAARFIELD MAIN PROGRAM
• Thickness Design
• Life
• Compaction
• PCR
OUTPUT
LEAF Layered Elastic Analysis
FAAMesh 3D Mesh Generation
ICAO-ACR ACR Numbers
FAARFIELD LIBRARIES

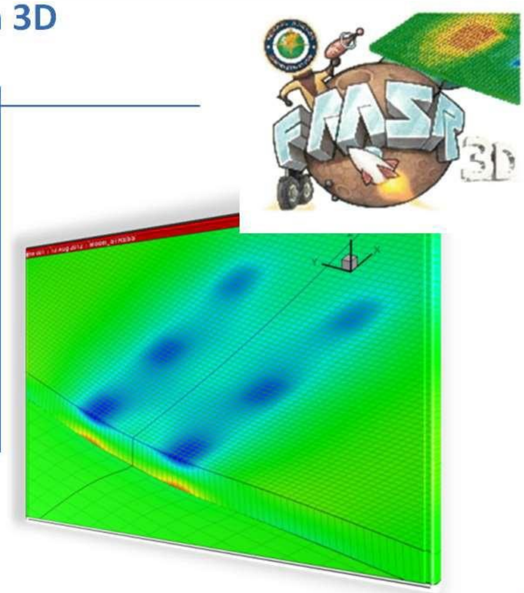
99


FAARFIELD 2.0 GUI Layout
TOOLBAR
SECTION AREA
EXPLORER
OPTIONS
TRAFFIC AREA

100

FAASR3D – FAA Structural Analysis i 3D

- Visual Basic.NET library.
- Replaces obsolete NIKE3D Fortran program.
- Managed Code - compatible with Microsoft .NET memory management services.
- Improves performance. Old code was subject to memory conflicts and crashing.
- Freely distributable code.
- Continued updates to improve speed & efficiency.



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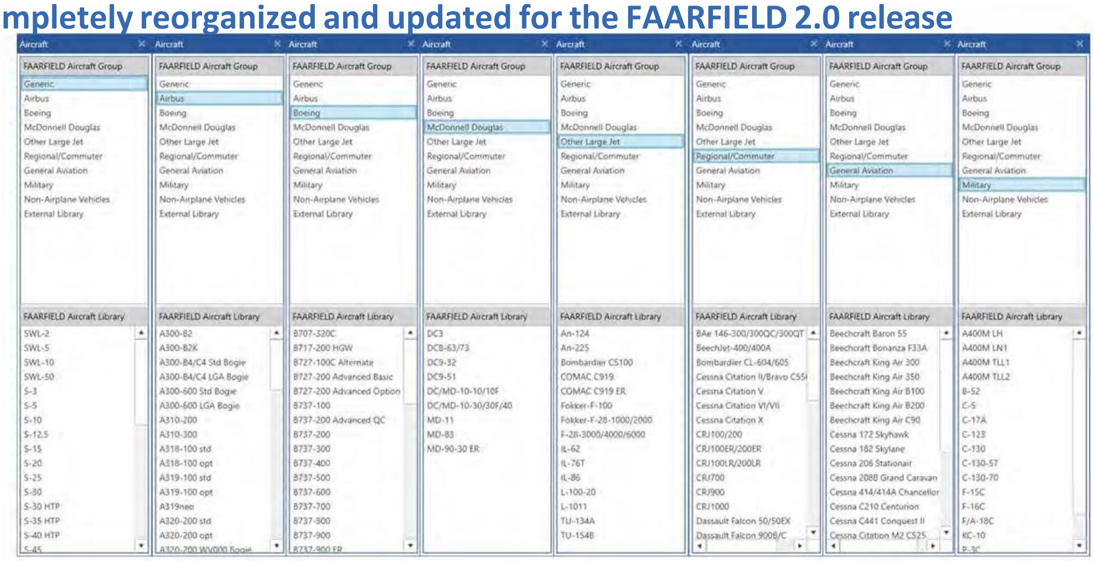
Aircraft Library – Completely reorganized and updated for the FAARFIELD 2.0 release



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On-Going Projects

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Presentation Outline

- NAPTF
  - Construction Cycle 9 (CC-9) - Flexible Pavement
- NAPMRC
  - Test Cycle 2 (TC-2) – WMA & RAP

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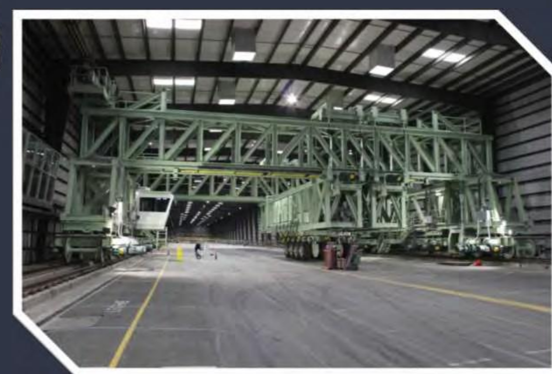
NAPTF



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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

106 3

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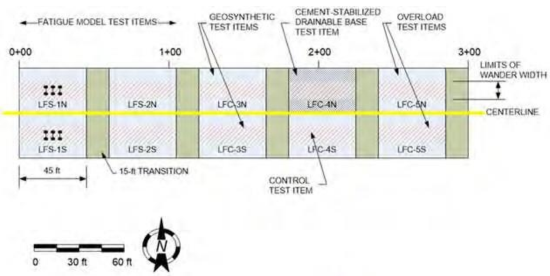
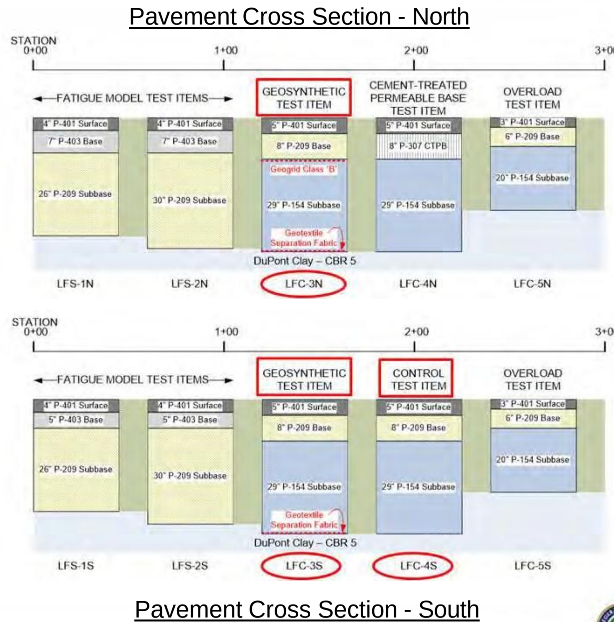
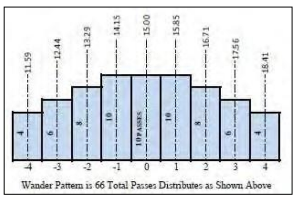
Construction Cycle 09 Layout

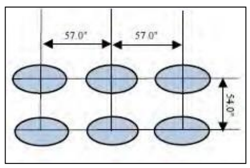


Started: April 5, 2021





Standard NAPTV Wander Pattern



Standard NAPTV Gear Configuration 58,000 lbs/wheel

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Construction Cycle 09 Testing History

- April 5. 2021 – Trafficking Started
- October 12, 2021 – Trafficking Stopped ("clunking" noise)
- October 15, 2021- Trafficking stopped ("clunking noise resurfaced)
- October 26, 2021 – NAPTV Serviced realignment
- October 27/28, 2021- A rail inspection was performed to try and solve the misalignment issue. Distresses were observed at the butt welds.
- January 28, 2022- WSP and Sperry rail performed ultra-sonic rail testing.
- February 16, 2022- Received rail inspection analysis report from WSP (no damage to the rails)
- February 22, 2022- Trafficking Restarted

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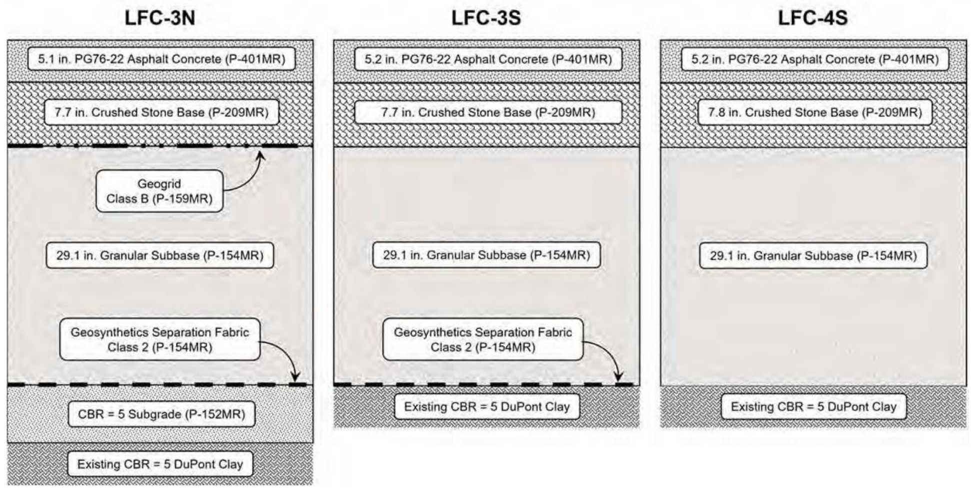
Performance of Test Section with Geogrids



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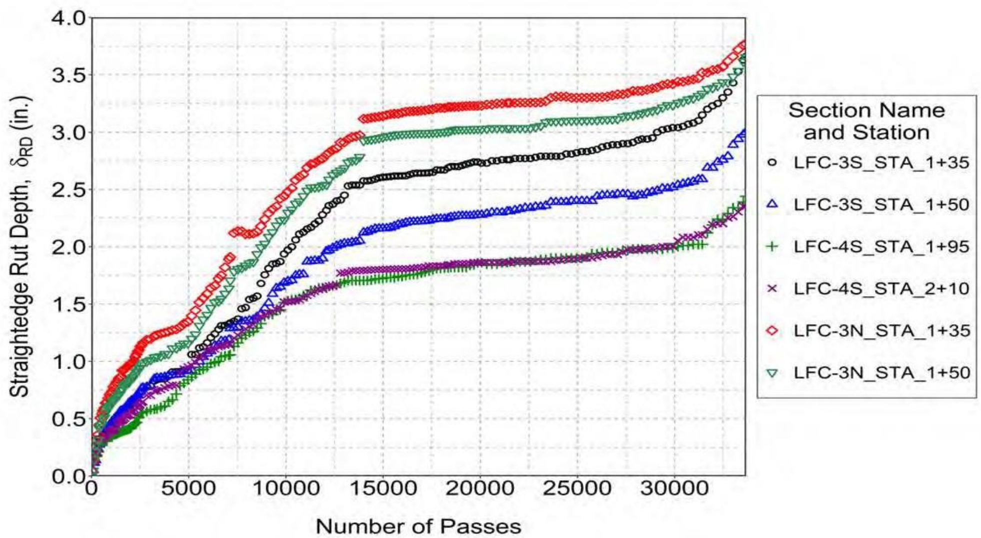
Performance of Test Section with Geogrids



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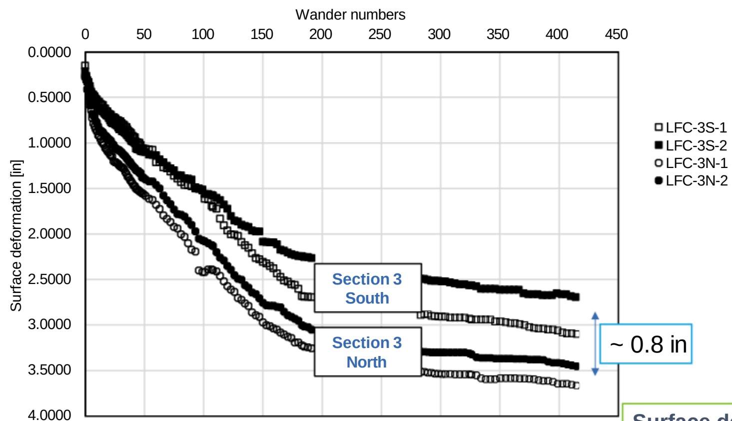
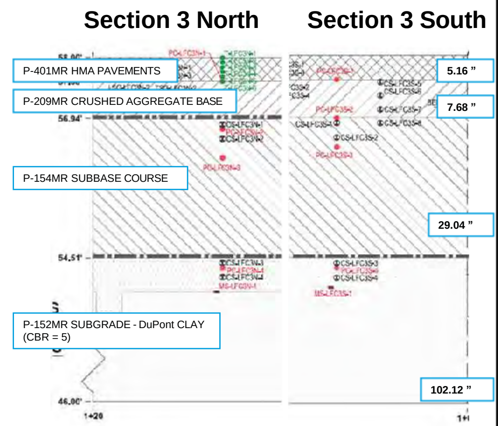
Comparison between Section 3S vs. 3N

Surface Rutting



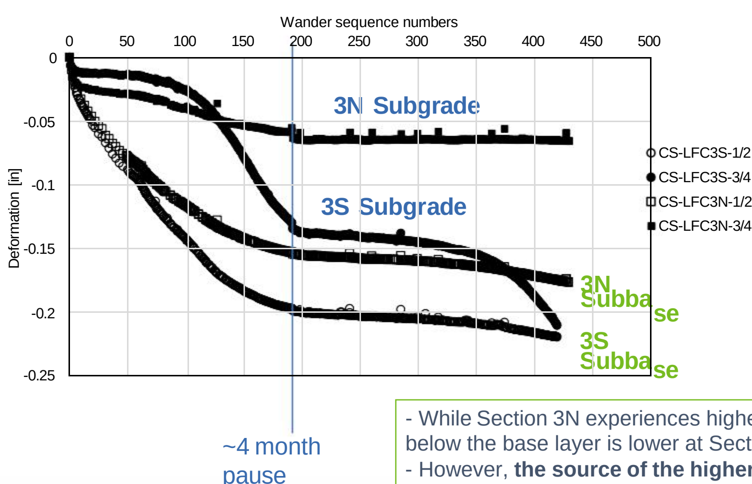


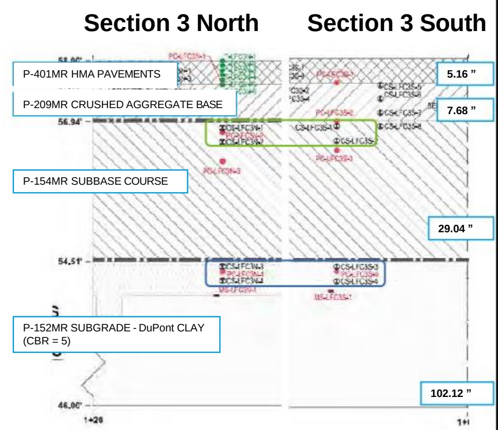
Surface deflection is higher in Section 3N with geogrid reinforcement. Is this is related to geogrid performance?

111

Comparison between Section 3S vs. 3N

Coil sensor data – Top of subbase & subgrade





- While Section 3N experiences higher surface deflection, the amount of deflection below the base layer is lower at Section 3N
- However, **the source of the higher deflection in Section 3N is the base layer**
- **What caused the difference?**

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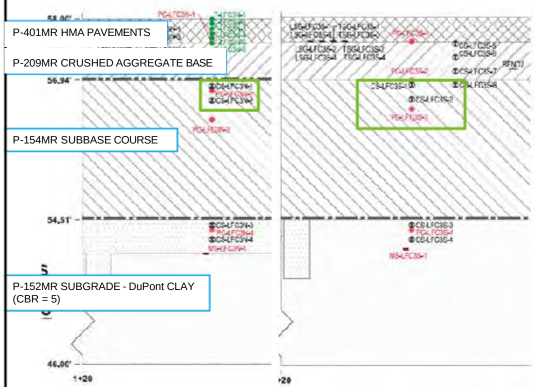
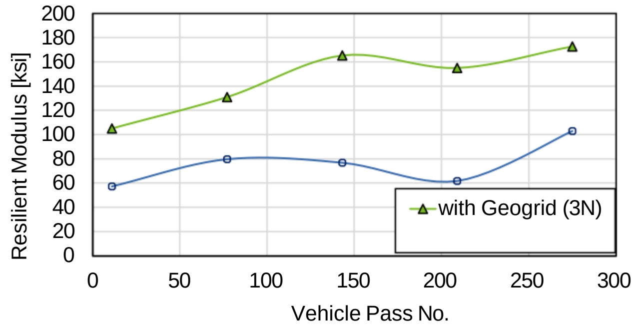
Comparison between Section 3S vs. 3N

Subbase layer stiffness near geogrid from coil sensor & pressure cell





$$M_R = \frac{\text{Vertical deviator stress } \sigma_d}{\text{Recoverable Strain } \varepsilon_R}$$

- Layer modulus (stiffness) was calculated using the Coil sensor and Pressure cell data
- Subbase stiffness calculated in Section 3N with geogrid was significantly higher than in Section 3S with no geogrid reinforcement
- **Higher stiffness due to geogrid resulted in low deflection below base**

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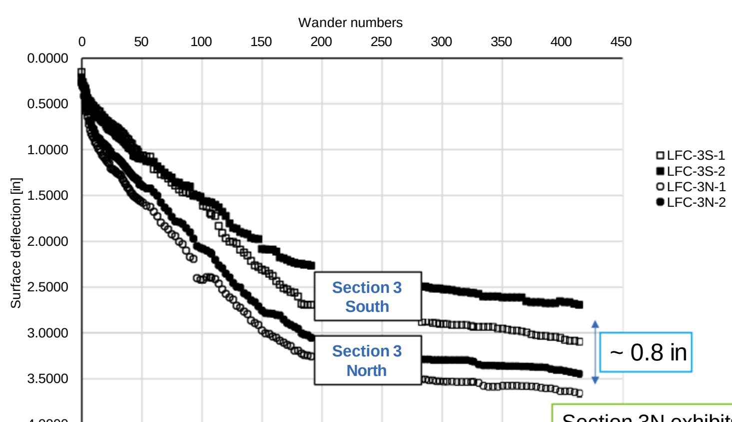
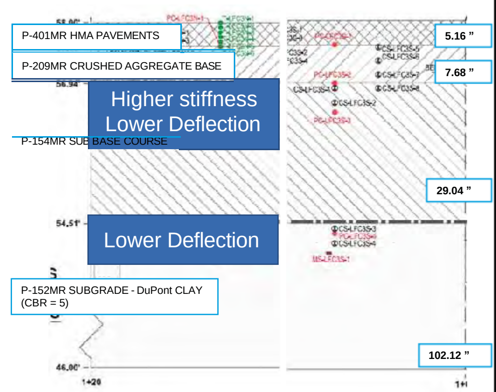
Comparison between Section 3S vs. 3N

Surface deformation





Section 3N exhibits
- Lower deflection below base layer
- Higher stiffness in the subbase (geogrid location)

Why 3N section has higher surface deformation then?

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Comparison between Section 3S vs. 3N

- The in-place moduli of CC9 test section unbound layers were measured during construction using Lightweight Deflectometer (LWD), Portable Seismic Pavement Analyzer (PSPA), and GeoGauge. **Results indicated lower moduli in the P-209 layer in test sections 3N compared to 3S and 4S.**
- Pavement deflection at 15 ft. offset is significantly higher in test section 3N compared to control test section (4S)
- While the same pattern is observed in test section 3S, the difference appears to be less significant
- The difference in deflections is mostly significant for the geophones at the D_0 and D_3 drop locations, especially at D_0. Thus, the low modulus issue is likely caused by a layer (P-209?) closer to the surface

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Comparison between Section 3S vs. 3N

Section 3N base course rework (from construction note and construction repo

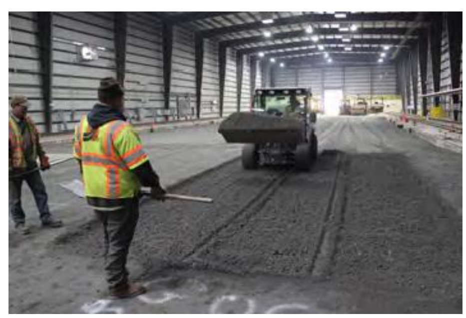
SITE ACTIVITIES

P-209MR Correcting Grade: 3N, 3S, 2N, 2S, 1S Based on Leica scans provided by Rodriguez, test areas 1, 2, and 3 had to have portions of the section corrected. In test item 3N, 2 low spots needed to be fixed. The Bobcat with tilling attachment was used to till these areas 3 inches and the additional P-209MR was added to the area. The additional material was spread with rakes and the area was then rolled in vibratory mode. The areas were then checked by Rodriguez with the Leica Total Station to determine if the area was at the correct elevation.

The low spots that were in the original Leica scan for 3S were checked with the Leica Total Station and it was found that these areas were actually within the target tolerance. Areas in 2N, 2S, and 1S were predominantly high. Material was removed from these areas with a rake, rolled with the steel drum roller, and then checked with the Leica Total Station. All areas in 3N, 3S, 2N, 2S, and 1S were fixed and verified by the end of the day. Tests: None Issues: None

DISCUSSIONS

[redacted] **and Chris U.:** The large low area in 3N required tilling and recompacting. Chris T. informed Chris U. that this area would need to be scarified and then rerolled prior to acceptance. [redacted] asked [redacted] if density testing would be required in this area and due to [redacted] unavailability and the tight schedule for paving, [redacted] decided that density testing would not be required. [redacted] indicated that at least 2 passes in vibratory mode would be required before any checking of grade.



- "If the area was low, the utility vehicle with a tilling attachment was used to till the area 3 inches and additional material was added. After adding additional material and smoothing with hand tools, the steel drum roller was used in vibratory mode to compact the area." *From Construction Cycle 9 Construction Report*
- "Due to the schedule restriction density testing was not performed to approve the reworked surface." *From construction notes*
- In conclusion, **the reworked area of the 3N section likely resulted in a lower stiffness zone in the upper lift of the base course layer**

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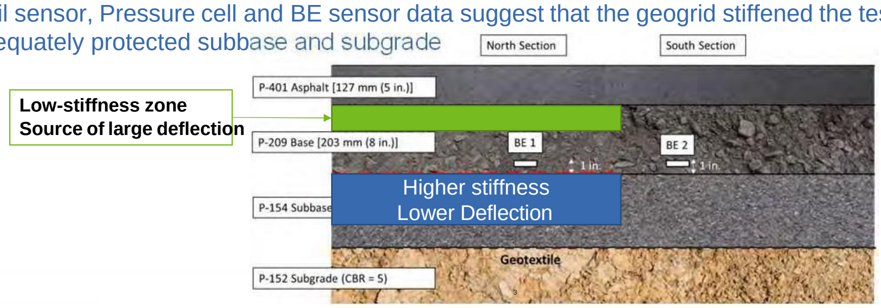
Comparison between Section 3S vs. 3N

Conclusions

- LWD, PSPA and GeoGauge test results show noticeably lower moduli in the P-209 layer for test section 3N compared to sections 3S and 4S
- HWD test data suggest that section 3N has an issue; likely in a layer close to the surface. While the same pattern is observed in test section 3S, the difference appears to be less significant
- The construction report and notes suggest that the upper 3-in. of a large area in section 3N had to be reworked, and there was no QA/QC (density) testing afterwards
- In conclusion, the reworked area in section 3N possibly generated a lower stiffness zone at the upper part of the base course layer
- Coil sensor, Pressure cell and BE sensor data suggest that the geogrid stiffened the test section and adequately protected subbase and subgrade



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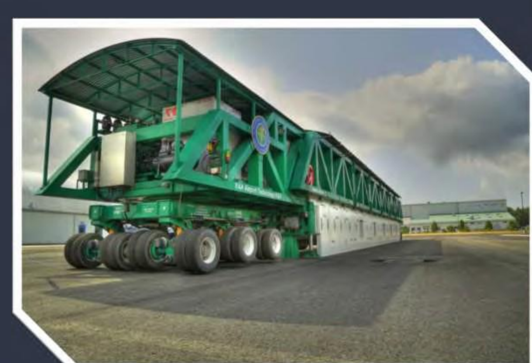
NAPMRC



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Test Cycle-2 (TC2)

- Construction May 2019
- Material
  - P-401 HMA
  - WMA (3)
  - RAP (2)
- Tire pressure 254 psi
- Failure criterion:
  - fatigue cracking & rutting
- Fatigue Testing in progress

OUTDOOR LANES | INDOOR LANES

Lane-1 – HMA
Lane-2 – WMA Chemical
Lane-3 – WMA Organic
Lane-4 – WMA Hybrid

Lane-5
3-in WMA Organic
6-in WMA Organic + RAP

Lane-6
9-in WMA Organic + RAP

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Test Cycle-2 (TC2) – Test Section Layout

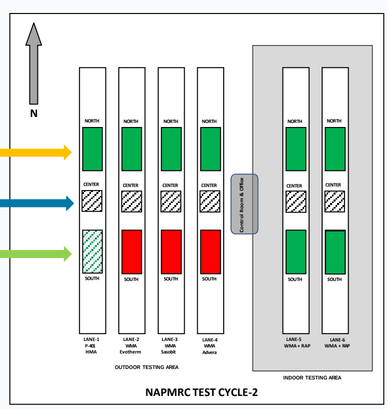
High Temperature (120 deg.F) Rutting Tests

Variable Temperature & High Temperature Rutting Tests

Low Temperature (68 deg.F) Fatigue Tests

Aged Test Section Ready for Fatigue Tests

Currently testing



OUTDOOR LANES | INDOOR LANES

Lane-1 – HMA
Lane-2 – WMA Chemical
Lane-3 – WMA Organic
Lane-4 – WMA Hybrid

Lane-5
3-in WMA Organic
6-in WMA Organic + RAP

Lane-6
9-in WMA Organic + RAP

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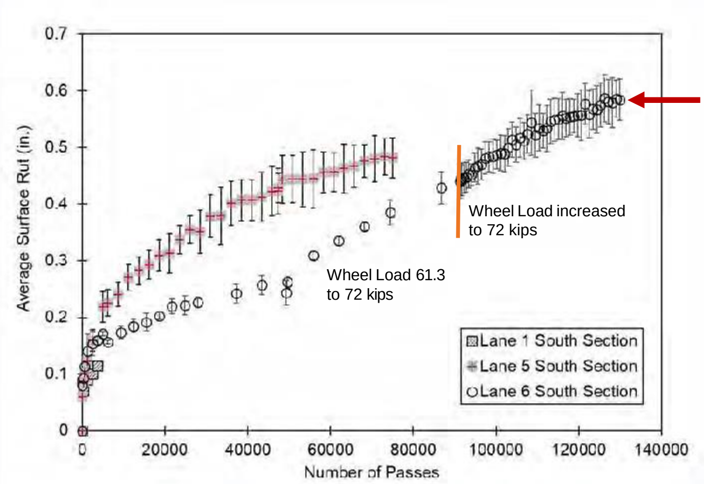
Test Cycle-2 (TC2) – Fatigue Tests



Trafficking stopped
No signs of cracks

For lanes 5S and 1S, tests were started with 72 kip wheel load

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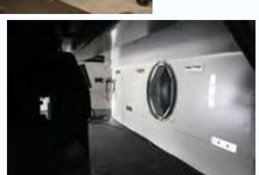
NAPMRC – Cooling System Installation



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NAPMRC – Cooling System Installed

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French Ovalization Device

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Development of the FAA LCA Tool

Goal: To develop an FAA LCA web-based tool that uses publicly available data and can be used by airports in the US for airfield pavements

Tasks:

1. Determine data and models in FAA LCA Tool that could be replaced by data available in Federal Commons data repositories
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
3. Update the FAA LCA Tool to use Federal Flows and updated TRACI 2.1.
4. Replace proprietary models and data in FAA LCA Tool with Federal Commons data.
5. Update the FAA LCA Tool user interface.
6. FAA LCA Tool testing

3

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Development of the FAA LCA Tool

1. Determine data and models in FAA LCA Tool that could be replaced by data available in Federal Commons data repositories (90%)
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 (10%)
3. Update FAA LCA Tool to use Federal Flows and updated TRACI 2.1. (40%)
4. Replace proprietary models and data in FAA LCA Tool with Federal Commons data. (no progress this quarter)
5. Update the FAA LCA Tool user interface. (5%)
6. FAA LCA Tool testing (no progress this quarter)

3

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Questions?

Contact:

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Program Manager, NAPMRC
(609) 485-4483
Navneet.Garg@faa.gov

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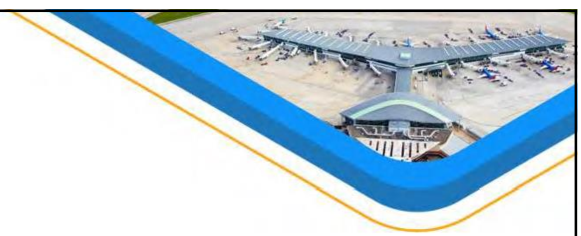

RPA P6.5

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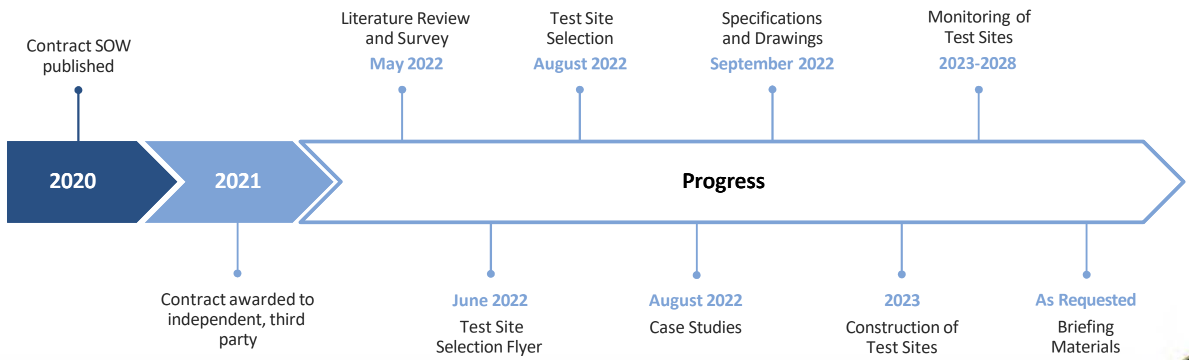
Responding to January 26, 2020 Request for Research

FAA to evaluate pavement surface treatment relative to airfield location:

1. Evaluate field performance of pavement protection and surface friction
2. Recommend performance restrictions



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May 2022 Survey Findings

73% **of respondents believe Treatments extended pavement life**

75% **of airports were satisfied with performance**

22% **of respondents were satisfied with FAA Guidance**

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Current Guidance Limited to FAA AC 150/5370-10H

I. Limited to runways less than 60,000lbs
II. Limited to taxiways and aprons
III. Very few published reports
IV. Limited amounts of case studies
V. Large variety of opinions

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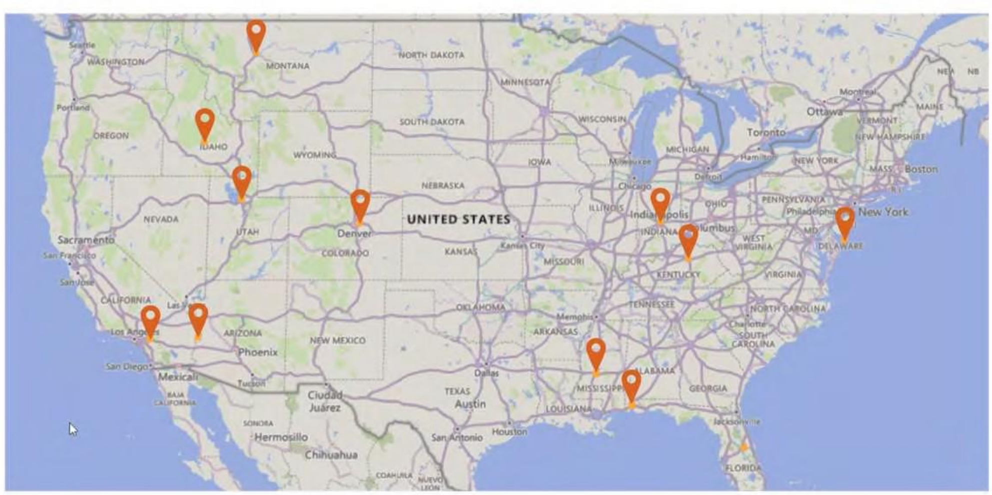
Constructing Test Sites



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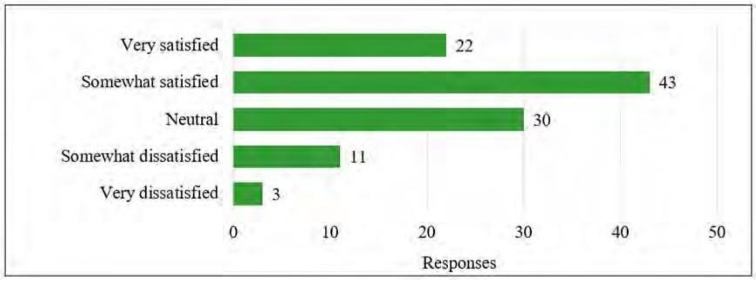
Monitoring Test Sites

- Traffic Effect
- Friction Effect
- Preservation Effect
- Constructability Issues



Remember the Survey Results:

- Additional guidance on surface treatment use (condition, location), applicability, and treatment re-use
- More options for applying surface treatments to pavements carrying heavier aircraft (> 60,000 lb)
- Greater detail about treatment benefits, including expected life
- Greater outreach, guidance, and training on surface treatments
- Additional research on surface treatments

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Questions?

Contact the FAA Program Manager

Matthew Brynick
Civil Engineer
609.485.8180
Matthew.t.brynick@faa.gov

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Closing

- Surface Treatments may extend pavement life
- FAA needs to provide better guidance
- Impacts federal spending
- Impacts environmental factors

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Reflective Cracking: Establish & Incorporate Reflective Cracking Model into FAARFIELD

Presented to:
REDAC Sub committee on Airports

Richard Ji, PE, Ph.D.
September 7 8, 2022

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Agenda

- Project Objective & Background
  - Indoor reflective cracking (IDRC) full scale testing overview
  - Outdoor reflective cracking (ODRC) full scale testing overview
  - Laboratory material characterization overview
- Ongoing work
  - Development of the RC prediction model (2021-2024)
  - Expected completion date

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Project Objective & Background

Objective

Develop a set of fully validated equations (the failure model) that can be directly implemented in the overlay design procedure in all future versions of FAARFIELD

Background

AC overlays are commonly designed in airport pavement. Currently, FAA pavement design lacks a reliable model of reflection cracking for airfield asphalt overlays.

- IDRC Full Scale Testing
- ODRC Full Scale Testing
- Material Characterization

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IDRC Full Scale Overview

- Phase 1 through 6 RC rig testing (2012 2019)
- Phase 7 and beyond (2022 2025)

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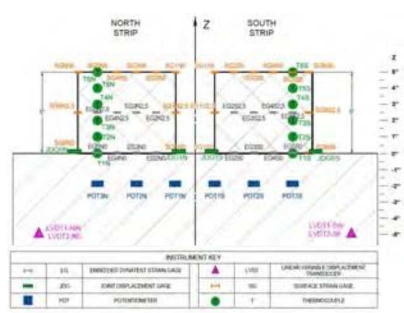
IDRC full scale testing Overview



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ODRC Full Scale Overview

- Phase 1 through 6 RC rig testing (2012 2019)
- Phase 7 and beyond (2022 2025)

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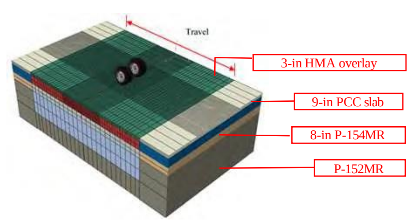
ODRC Full Scale Testing Overview

- FEM analysis for RC trafficking preparation (loading, failure passes)
- Phase 1 through 5 trafficking (2020-2024)
    - 40 kips wheel load
    - Tire pressure of 214 psi
    - Speed of 3 mph
    - 8-10 wanders daily
    - Phase 1 1-week (5 days) traffic test in February 11-18, 2020
    - Phase 2 1-week (5 days) traffic test in April 19-23, 2021
    - Phase 3 2-week (10 days) traffic test in March 4-17, 2022
- Post trafficking pavement distress monitoring



3-D FE ANALYSIS WITH HVS-A GEAR

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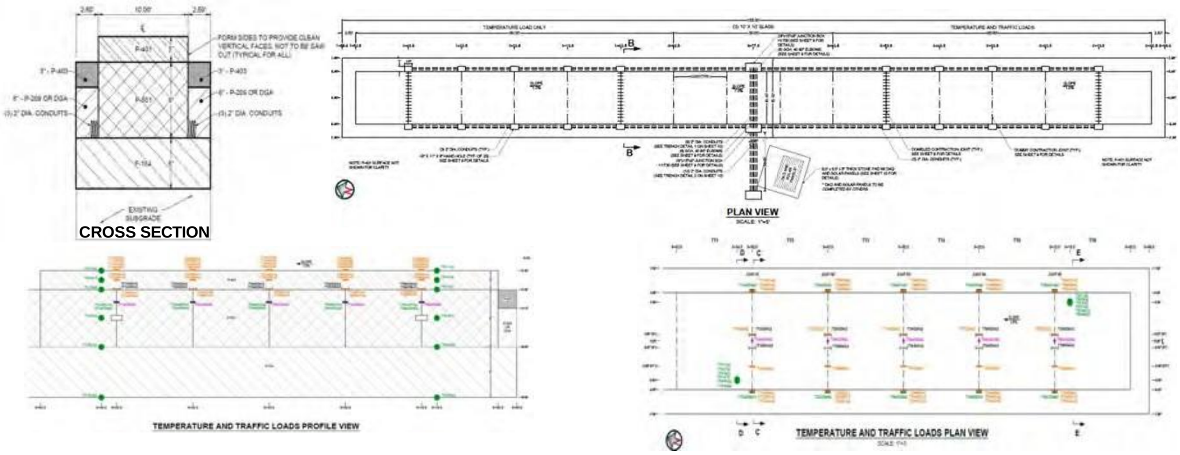
ODRC Construction Layout



INSTRUMENT KEY AND QUANTITY			
	EG	EMBEDDED DYNATEST STRAIN GAGE	5
	SG	SURFACE STRAIN GAGE	35
	JDG	JOINT DISPLACEMENT GAGE	10
	T	THERMOCOUPLE	12

3

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Material Characterization

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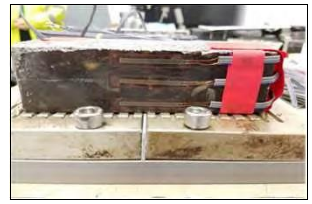
Material Characterization Overview

- Dynamic Modulus Test → E* master curves
- Customized Overlay Tester (OT) → Crack propagation
- Texas Overlay Test → Critical fracture energy and crack resistance
- DCT Test → Both fracture energy and strain energy captured the extreme cooling effect
- Tensile strength ratio test → Effect of moisture on the HMA mixture



Customized OT

DCT Test

3

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Ongoing Work

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Development of RC Prediction Model (2021-2024)

Achievements

- Full-scale test data base and report
- Laboratory test data base and report
- RC full scale distress survey
- GDIT RC propagation model (May 2020)

Ongoing BAA (ASU, 2021-2024)

- Laboratory testing
  - Advanced laboratory tests develop material properties needed to simulate reflection cracking
- Analytical/Numerical Model
  - Models apply fracture mechanical theory to predict crack growth

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Looking Ahead

Expected completion date for the RC model application in FAARFIELD: 2024-2025

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Questions?

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