FAA Airport Technology Research and Development Selected Updates

Presented to: 2018 ACC Airports Technical Workshop
By: Dr. Michel Hovan
Date: June 20-21, 2018
FAA Research & Development at a Glance

- UAS
- Aircraft Structures
- Propulsion and Fuel Systems
- Digital Systems
- Digital Technologies
- Cyber Security
- Weather
- Icing
- Environment & Energy/Fuels
- Fire Safety
- Airport and Terminal
- Pavement
- System Safety Management
- Air Traffic Management
- Commercial Space
- Human Performance & Aeromedical Factors
Airport Technology Research

➢ Airport Technology Research Program
➢ Airport Cooperative Research Program

• Research required to improve airport infrastructure and the safety and efficiency of airport operations

US Code Title 49, Section 44505
• analytical technology to predict airport safety and capacity problems
• problems shared by airport operating agencies
• airport design and operating procedures
Airport Technology Research
FAA Technical Center’s Airport Technology Research Program

Activities

Conduct research in the areas of airport safety, airport pavements and airport noise and environmental. These areas include:

- Airport planning and design
- Airport safety and surveillance sensors
- Airport visual guidance
- Airport pavement design and construction
- Airport pavement evaluation
- Runway surface safety technology
- Wildlife hazard mitigation
- Aircraft rescue and firefighting
- Airport Noise

Purpose

To provide technical data to support, modify, or create new advisory circulars in the areas of airport safety, airport capacity, and airport noise and environmental. This is done through long term research as well as quick evaluations and testing of new technology. This leads to increased airport safety, and reduction of airport pavement and maintenance costs.
Airport Cooperative Research Program (ACRP)

Activities
Develops near-term, practical solutions to problems faced by airport operators in addition to providing technical data to support and modify advisory circulars on topics including:
- Environment
- Policy & planning
- Safety
- Design & construction
- Maintenance
- Operations
- Legal aspects

Purpose
Conduct applied research on problems shared by airport operating agencies not adequately addressed by existing Federal research programs, To improve airport planning, design and operations

*Two Most Requested Published Reports*
## Research Program Areas

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**AIRPORT NOISE and AIRPORT ENVIRONMENTAL**

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# RPA S5 – Visual Guidance

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<td>Omni Direction LED HIRLs - REDAC Recommendation</td>
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<td>S5.2</td>
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<td>Tarmac Vehicle Painting, Lighting, Marking, Study - Congressional</td>
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<td>VGSI &amp; Approach Lighting Baffle Installations</td>
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<td>S5.9</td>
<td>Special Projects</td>
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</table>
Long Term Vision – Airport Safety Research
Report Publications (Last Year)

- DOT/FAA/TC-17/27 Thermal Imaging for Aircraft Rescue and Fire Fighting Applications 5/2017
- DOT/FAA/TC-17/28 Development of New Subgrade Failure Model for Flexible Pavements in FAARFIELD 5/2017
- DOT/FAA/TC-17/30 Performance Assessment of the Vestas InteliLight™ System as an Aircraft Detection Lighting System 6/2017
- DOT/FAA/TC-TN17/32 Runway Approach Hold Area Signage and Marking Study 6/2017
- DOT/FAA/TC-TN17/38 Effectiveness of Linear Elements for Taxiway and Runway Delineation 6/2017
Report Publications (Last Year)

- NEW! DOT/FAA/TC-17/49 Effective Intensity of Multiple-Pulse Flashing Signal Lights 10/2017
- NEW! DOT/FAA/TC-TN17/51 Elevated Runway Edge Light Fixture Intensity Measurement 11/2017
- NEW! DOT/FAA/TC-18/2 Problematic Taxiway Geometry Study Overview 1/2018

All Reports available at: http://www.airporttech.tc.faa.gov/safety/downloads/
UAS Airport Applications

1. Geo-analysis of obstacle clearance surfaces
2. Pavement Inspections
3. Perimeter Security
4. Wildlife Hazard Management
5. Airport Rescue and Fire Fighting (ARFF)
Geo-analysis of Obstacle Clearance Surfaces

Inspection of an airport’s imaginary surfaces to protect aircraft from hitting obstructions during the approach, landing, and departure of a runway
Pavement Inspections

• Inspect and monitor, and track pavement surfaces
Perimeter Security

- Remote monitoring of airport perimeter fences, patrolling remote areas, closed ramps, etc.
- Respond to security breaches
Airport Rescuing and Firefighting (ARFF)

- Investigate the use of UAS during ARFF response for immediate size-up and/or live imagery for better situational awareness.
Wildlife Hazard Management

• USDA is currently evaluating the effectiveness of a UAS as a hazing tool:
  – Various UAS platforms (quadcopter, fixed wing, and predator (eagle))
  – UAS approach (direct / overhead)
  – Alert distances
  – Controlled and free ranging environments

• Habitat monitoring
Wildlife Detection and Mitigation

- Wildlife at airports pose a danger of damaging aircraft and putting passenger lives at risk.

- Because of these dangers, airports invest in technologies and methods to mitigate the amount the wildlife airports.

- Currently, all stationary FOD detection system manufacturers have been marketing their systems as wildlife mitigation tool to airports at runways.
Bird Remains Identification

- Interagency Agreement with the Smithsonian Institute

The total number of expertise wildlife strike identifications conducted by the Smithsonian FIL for the FAA Wildlife Hazard Program (2013-2017). **Total = 17,754**
Aircraft Braking Research

• FAA Research, Engineering, & Development Advisory Committee (REDAAC) Subcommittee on Airports Recommended Establishing a Technical Working Group to Review Ongoing and Completed FAA Research Efforts on Aircraft Braking Friction.

• Technical Working Group Tasked with Assessing the Results of Completed FAA Research and to Make Recommendations on Direction of Future Efforts.
Background

- Southwest Airlines (SWA) Boeing 737-7H4 Airplane Accident at Chicago Midway International Airport (MDW) on Dec. 8, 2005
  - Airplane Ran Off the Departure End of MDW Runway 31C After Landing Under Heavy Snow Conditions.
  - Pilot Braking Action Reports on Runway 31C Received in Flight Varied From Fair to Poor Along Runway Length with an 8-Knot Tailwind.
NTSB Recommendations

• **Safety Recommendation A-16-23** – “Continue to work with industry to develop the technology to outfit transport-category airplanes with equipment and procedures to routinely calculate, record, and convey the airplane braking ability required and/or available to slow or stop the airplane during the landing roll.”

• **Safety Recommendation A-16-24** – “If the systems described in Safety Recommendation A-16-23 are shown to be technically and operationally feasible, work with operators and the system manufacturers to develop procedures that ensure that airplane-based braking ability results can be readily conveyed to, and easily interpreted by, arriving flight crews, airport operators, air traffic control personnel, and others with a safety need for this information.”
Gap Analysis

• Lack of Deterministic Correlation Between Runway Contamination Observation and Aircraft Performance.
• Lack of Effective Aircraft Designs in Measuring and Reporting Wheel Braking.
• Lack of Effective Standards for Correlating Braking Performance to FAA AC 25-32 Guidance.
• Absence of Adequate Testing Facilities for Certification and Research.
Technical Working Group Report and Recommendations

• A White Paper was Developed Including Recommendations of Technical Working Group.

• Presentation on White Paper has been made to the REDAC Subcommittee on Airports (3/20/18).

• Presentations are Planned for Other REDAC Subcommittee Meetings in Summer/Fall 2018.

• Consolidated Position of REDAC Subcommittees Relating to Recommendations to be Presented to REDAC Main Committee.
RPA S6.6

TALPA

RCAM Analysis
<table>
<thead>
<tr>
<th>Runway Condition Description</th>
<th>RwyCC</th>
<th>Deceleration or Directional Control Observation</th>
<th>Pilot Reported Braking Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry</td>
<td>6</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Frost (Includes damp and 1/8 inch depth or less of water)</td>
<td>5</td>
<td>Braking deceleration is normal for the wheel braking effort applied AND directional control is normal.</td>
<td>Good</td>
</tr>
<tr>
<td>1/8 inch (3mm) depth or less of:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slush</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry Snow</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wet Snow</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/8 inch (3mm) depth of;</td>
<td>4</td>
<td>Braking deceleration OR directional control is between Good and Medium.</td>
<td>Good to Medium</td>
</tr>
<tr>
<td>Greater than 1/8 inch (3 mm) depth of:</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Dry Snow</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Wet Snow</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-15°C and Colder outside air temperature:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compacted Snow</td>
<td>3</td>
<td>Braking deceleration is noticeably reduced for the wheel braking effort applied OR directional control is noticeably reduced.</td>
<td>Medium</td>
</tr>
<tr>
<td>Greater than 1/8 inch (3 mm) depth of:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>2</td>
<td>Braking deceleration OR directional control is between Medium and Poor.</td>
<td>Medium to Poor</td>
</tr>
<tr>
<td>Slush</td>
<td></td>
<td></td>
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<tr>
<td>Warmer than -15°C outside air temperature:</td>
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</tr>
<tr>
<td>Compacted Snow</td>
<td>1</td>
<td>Braking deceleration is significantly reduced for the wheel braking effort applied OR directional control is significantly reduced.</td>
<td>Poor</td>
</tr>
<tr>
<td>Greater than 1/8 inch (3 mm) depth of:</td>
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<td></td>
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</tr>
<tr>
<td>Ice</td>
<td>0</td>
<td>Braking deceleration is minimal to non-existent for the wheel braking effort applied OR directional control is uncertain.</td>
<td>Nil</td>
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<tr>
<td>Wet Ice</td>
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<tr>
<td>Slush over Ice</td>
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<tr>
<td>Water over Compacted Snow</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry Snow or Wet Snow over Ice</td>
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ATR TALPA RCAM History

2009, TALPA ARC – RCAM Developed

2009-2011 – ATR, ARP, AVS Validation Effort of RCAM

June 2013, Technical Note DOT/FAA/TC-TN13/22 - Takeoff and Landing Performance Assessment Validation Effort of the Runway Condition Assessment Matrix

2012-2016, TALPA Implementation by ARP, ATO, AVS

Oct 1, 2016, TALPA RCAM Official Implementation
Data Analysis of 2016-17 Airport Condition Reporting using TALPA RCAM

**Primary Objective** - Data analysis of 2016-17 implementation of the new Runway Condition Assessment Matrix (RCAM) and revised winter operations field condition reporting process.

- Acquired 136,428 FICONs from the NOTAM System
- Developed an analytical toolset/database to accomplish the objective and future studies.
- Imported METAR weather data into the toolset/database
- Performed statistical analysis of all available information (contaminants, RCCs, PIREPs, comparisons, etc.)
- In-depth analysis in key areas (Example: Nil PIREPs)
- Identify anomalies, areas of interest, and considerations for improvement
- Presented Data/Findings during TALPA Update Meeting in July 2017
- DRAFT Report - Runway Condition Assessment Matrix (RCAM) – 2016-17 Winter Season Implementation - Data Analysis, submitted to AAS-300
Comparison, but PIREP accuracy was an issue

RwyCC compared to PIREP

- Favorable condition coding: 1,142 (46%)
- Unfavorable condition coding: 759 (31%)
- PIREP match: 572 (23%)

Total: 2,473
EMAS

Contrast between 501 and 502 beds
Example Design for EMAS
EMAS Signage
FOD Detection System Benefit Study: Boston Logan International Airport (BOS)
Current Research Effort: Continuation of FOD Detection System Benefit Study

- After reviewing the results from the BOS study, it was decided to continue the study at BOS and expand the study to Seattle-Tacoma International Airport (SEA).
FOD Detection System Benefit Study: Seattle-Tacoma International Airport (SEA)
PFC Contamination Headlines

Air Force Studies Show Danger of Foam that Contaminated Water

Firefighters from the 7th Civil Engineer Squadron and the Abilene Fire Department participate in live fire training exercise April 2, 2014, at Dyess Air Force Base, Texas. (U.S. Air Force photo by Senior Airman Kia Atkins/Released)

The Gazette (Colorado Springs, Colo.) | Oct 24, 2016 | by Tom Roeder

The Air Force ignored decades of warnings from its own researchers in continuing to use a chemical-laden firefighting foam that is a leading
Environmental Effects of AFFF (Aqueous Film Forming Foam)

Brief History

Perfluorinated Surfactants

- **PFOS** – 3M stopped production around 2002.
  - Are all other AFFF’s going away?
  - Tech Center program for replacements initiated.

- **PFOA** – All other manufacturers.
  - EPA backed off these chemicals.
  - Tech Center program slowed.
Environmental Effects of AFFF

Carbon Chains

- Long-chain carbons – C8 and above, break down to PFOA
- Short-chain carbons – C6 and below, do not break down to PFOA
  - Not new, Ansul has 95% C6 AFFF since 1970’s
- EU 25ppb PFOA
- NavSea – considering limiting PFOA amounts in Mil Spec
- New C6 AFFFs do not have PFOA as an ingredient but may be evident as a “contaminant” of other chemicals in the process.
Environmental Effects of AFFF

What AFFF alternatives are currently available?

• None. Mil Spec requirement leads us to using AFFFs with trace amounts of PFCs.

• Changing the requirement for use of Mil Spec would mean a reduction in safety.
ARFF Fire Test Building

• Tests to be performed:
  – New FF Agents
    • Environmental
  – Alternative Fuels
    • Heat Release Rate (HRR)
  – Composite Materials
    • Agent Quantities
  – Mil Spec / ICAO Protocols
ARFF Fire Test Building Design
Airport Pavement R&D Section Facility Layout
National Airport Pavement Test Facility (NAPTF)

**Facility Facts:**
- FAA / Boeing (CRDA) Partnership at $21M
- Opened April 1999
- Fully Enclosed Facility
- Accelerated Traffic Testing
- 900 ft. x 65 ft. of Test Pavement Surface
- Full-scale Pavement Structures and Landing Gear Loads

**Test Vehicle Facts:**
- Fully Automated & Programmed Wander Patterns
- Up to 5-dual wheel configuration
- Roughly 1.3 Million lbs.
- Up to 75,000 lbs. per wheel
National Airport Pavement Materials Research Center (NAPMRC)

Facility Facts:

- Dedication Ceremony August 2015
- Indoor and Outdoor Testing Capability
- Accelerated Traffic Testing
- Outdoor: 150ft. x 300ft. & Indoor: 72ft. x 300ft.
- Accelerated resurfacing

Heavy Vehicle Simulator – (HVS-A) Facts:

- Temperature Control Capability
  - Up to 150°F
- Capacity 10,000 - 100,000 lbs.
- Single & Dual-Wheel Configuration
  - Dual (B737-800)
- Fully Automated & Programmed Wander Patterns up to 6 ft.
FAA NextGen Pavement Materials Lab

• 2010: Laboratory Opened
• 2013: AASHTO Material Reference Laboratory (AMRL)
• 2013: Cement and Concrete Reference Laboratory (CCRL)
• Full Test Capabilities: Asphalt, Concrete, Soils
• Advanced Test Capabilities:
  • Asphalt Pavement Analyzer (APA)
  • Asphalt and Concrete beam fatigue
  • Semi-Circular Beam (SCM)
  • Disk-Shaped Compact Tension (DCT)
• Benefits to the NAPTF:
  • Quality Control of Testing
  • Expedient Testing of Materials During Construction
  • Perform Advanced Materials Characterization On-site
  • Development of Performance Based Specification
NAPMRC testing – new materials and problems

No. of Passes to Failure: 870
Traffic Tests Terminated: 3906

No. of Passes to Failure: 250
Traffic Tests Terminated: 930

No. of Passes to Failure: 780
Traffic Tests Terminated: 3534

No. of Passes to Failure: 280
Traffic Tests Terminated: 992
**Airports Completed**
- Denver (DEN)
- Atlanta (ATL)
- Newark (EWR)
- New York (JKF)
- Boston (BOS)
- Cape May (WWD)

**Future Installation**
- Philadelphia (PHL)
- UC Davis, CA

**Current Discussions**
- Seattle-Tacoma (SEA-TAC)
- Phoenix (PHX)
- San Francisco (SFO)
Current FAA Airport Instrumentation Projects

- JKF: PCCP
- EWR: HMA Overlay
- PHL: HMA/PCCP
- BOS: HMA Overlay
- ATL: PCCP
- DEN: PCCP
- PHX: PCCP
- SFO: HMA
- SEA-TAC: PCCP
- UCD Airport: FDR
- WWD: HMA/SMA/WMA

= Completed
= Under Construction
= FAA Consideration
Philaephia International Airport (PLH)

Runway 27L Extension and Associated Taxiways
New Construction on Taxiway P2:
- 18” P-501
- 17” P-401
• Shoving/slippage is showing up at many airports
  • Newark
  • LaGuardia
  • Houston
  • Kahului Maui
  • Amsterdam
  • Australia
INNOVATIVE PAVEMENT INSTRUMENTATION?

Fiber Optic Strain Plate
FAA Research Taxiway
FAA Research Taxiway

- **Taxiway C**
  - Length – 3250’
  - Width – 50’
  - Pavement Width - 150’
- **Full array of Taxiway and Runway Lights**
- **State-of-the-art Lighting Vault**
- **Six Pavement Test Strips**
FAA Research Taxiway
FAA Research Taxiway – Paving Layout

Legend
- PG 76-22 Marshal P-410
- PG 64-22 Marshall P-401
- PG 64-22 Superpave P-401
- WMA (PG 76-22) P-401
- Stone Matrix Asphalt
- NJ State Mix

Pavement Sensor Strips
Electrical Vault
FAA Research Taxiway: Research Plans

Safety Projects
• Completed
  – Obstruction Light with IR Testing
• Ongoing
  – Electrical Infrastructure Testing – FY 18 Business Plan Milestone
  – Runway Surface Friction
• Planned
  – Future LED Research Efforts (e.g. solar airfield lighting, light output, etc.)
  – UAS Integration at Airports

Pavement Projects
• Ongoing
  – Nondestructive Testing
  – Field and Laboratory Characterization of Pavement Materials
  – Long Term Aging Study of Various Paving Mixes
Some Visual Guidance Accomplishments

- Evaluated Boston Logan International Airport Runway 4L and Taxiway B lighting system configurations, lighting intensity level settings and conducted flight tests to verify there are no visual cues that should cause a pilot to mistake Taxiway B for a runway.

- Conducted research to develop two prototype Light Emitting Diode (LED) High Intensity Runway Edge Lights (HIRL) fixtures with an infrared (IR) signature compatible with Enhanced Flight Vision Systems (EFVS).

- Conducted research to develop performance specifications for infrared (IR) emitters to be incorporated with LED L-810 and L-864 obstruction light fixtures, to ensure compatibility with Night Vision Goggles (NVG) currently in use. The results from this study were published in FAA Engineering Brief No. 98.
Development of LED High Intensity Runway Edge Light (HIRL) with Infrared (IR)

- **Objective:** Conducted research to develop two LED HIRL with an IR signature compatible with Enhanced Flight Vision Systems (EFVS)
- **Four phased project that started in February 2016 and concluded in April 2017**
  - Phase 1 – Broad Agency Announcement
  - Phase 2 – Technical Summary
  - Phase 3 – Request for Proposal
  - Phase 4 – Award (Development of HIRL with IR)

✓ **FY 2017 Office of Airports Business Plan Milestone Achieved!**
LED HIRL’s with IR: Next Steps

• The Office of Flight Standards will validate that the prototype fixtures have the necessary IR output for use with EFVS

• Testing will take place at Volpe Aviation Weather Research Facility (AWRF) at Joint Base Cape Cod (JBCC)
  • Offers real-world low visibility testing environment with a wide range of weather conditions
  • Testing will take place in 2018-2019.
  • Data will be collected by (1) Visible camera and (1) EFVS camera
Ongoing LED Research Efforts

• **Compatibility of LED-lit Obstruction lights with Night Vision Goggles**
  – Conduct research to determine performance specifications for IR emitters.

• **Loss of sight of LED airport lighting**
  - Conduct omnidirectional measurements of existing high and medium intensity runway edge lights.

• **Airfield Lighting Infrastructure for LEDs**
  - Conduct research to develop an alternative airfield electrical infrastructure to support the operation of LEDs.
Electrical Infrastructure Research Team (EIRT)

• The EIRT was formed to investigate optimal ways that power could be delivered to airfield fixtures that use Light Emitting Diode (LED) components.

• The EIRT is made up of the following:
  – FAA Researchers
  – Lighting Manufacturer Product Design Engineers
  – Academic Researchers
  – Airfield Lighting Subject Matter Experts
EIRT Electrical Infrastructure Concepts

• Two LED infrastructure concepts have been selected for further testing:

  – “Vault-centric”: Light intensity is controlled by a power source for the entire circuit. The fixtures are passive and directly track circuit current.
  – “Fixture-centric”: Each fixture controls its intensity level after digital intensity information is conveyed to it.
Project Approach

• Each LED lighting infrastructure concept currently being tested at the Cape May County Airport.
## EIRT Testing Schedule

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Completion Date</th>
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<tbody>
<tr>
<td>Complete Lighting System Installations</td>
<td>January 2018 Complete</td>
</tr>
<tr>
<td>Begin Data Collection</td>
<td>February 2018 Underway</td>
</tr>
<tr>
<td>Complete Data Collection</td>
<td>June 2018</td>
</tr>
<tr>
<td>Complete Data Analysis</td>
<td>June-August 2018</td>
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<tr>
<td>Complete Final Report</td>
<td>September 2018</td>
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Paint Marking Durability Study
FAA Technical Center “60 years”