Federal Aviation Administration's

R&D Review

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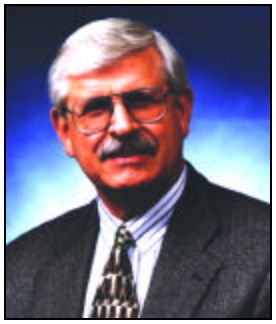
R&D Accomplishments: FY 2002

A Message from the Director of Aviation Research

Last year proved to be a very productive year for the research and development (R&D) program largely because of the hard work and dedication of the FAA's researchers and their external research partners. Because of the work of our researchers and scientists, critical new R&D products are improving aviation safety and efficiency.



Herm Rediess
Director of Aviation Research

I would like to take this opportunity to highlight just a few of the many FAA R&D accomplishments during Fiscal Year (FY) 2002.

As a result of the 1996 TWA Flight 800 accident, protecting fuel tanks has become a critical safety issue. The FAA is making significant progress in the development of an inerting system to prevent fuel tank explosions. In FY 2002, FAA researchers designed and installed a viable, low cost on-board inerting system in the FAA 747SP test aircraft. Although flight tests are planned in FY 2003, the combination of modeling predictions, air separation module (ASM) and ¼-scale altitude chamber tests, and demonstrations of the prototype inerting system in the 747SP convinced Boeing to formally apply to the FAA to retrofit some of its 737 models with inerting systems similar to the FAA design.

Bonded composite doublers offer airline maintenance facilities a cost-effective way to safely extend the lives of aircraft. Last year, researchers at the FAA's Airworthiness Assurance Nondestructive Inspection Validation Center completed an experimental project where they installed composite repair doublers on in-service commercial aircraft. The project validated a family of generic composite patches used to repair various types of damage to metallic structures caused by dents, dings, lightning strikes, corrosion, and certain cracks in non-pressurized areas. Researchers also identified necessary guidance data needed to assure the continued airworthiness of composite doublers.

During the fiscal year, researchers trained in the use of the JANUS taxonomy collected data from 79 operational errors at towers, TRACONs, and ARTCCs. JANUS is a technique for analyzing causal human factors in operational errors. Human factors researchers helped review the runway incursion at Linate Airport in Milan, Italy, using the JANUS technique to identify and classify potential human and contributing factors. The FAA completed a draft version of JANUS for ground operations and data from exist-

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Inside this Issue:

Critical Research for Aviation's Future

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If you are a researcher from industry, academe, or government and would like to submit any FAA research related articles/photographs for future publication in the R&D Review, or to be added to the R&D Review mailing list, please contact:

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ing FAA databases are currently being used to assess the sufficiency of the available human factors information.

The introduction of new aircraft types, such as the Airbus A380 and Boeing B-777, are expected to have a severe impact on the nation's airport pavements. The FAA's National Airport Pavement Test Facility (NAPTF) is a unique facility collecting full-scale traffic data under controlled loading conditions. In FY 2002, FAA researchers completed the first in a series of full-scale traffic tests at the NAPTF under simulated loading by B-777 and B-747 aircraft, and initiated an analysis of the pavement life data. Improved design standards based on these data will provide substantial cost savings by better predicting pavement life and reducing costly premature failures.

In FY 2002, human factors researchers completed a draft report titled, *Human Factors Considerations in the Design of Surface Map Displays*, which captures all the human factors issues relevant to the design and development of surface map applications. The report was used as source material for human factors guidance in the development of the RTCA SC-181 draft revision of the Minimum Operational Performance Standards for the Depiction of Navigational Information on Electronic Maps (DO-257).

The computerized Rapidly Reconfigurable Line Operational Simulation (RRLOS) scenario generation system logically combines pilot training event sets and creates training materials. RRLOS targets specific skill areas, thereby allowing the quick generation of scenarios customized to the trainee and his/her training needs. In the past year, researchers updated RRLOS twice and reengineered the tool to give it increased functionality. The FAA delivered the tool to over 40 air carriers and other aviation organizations, and provided training to multiple airlines in the use of the tool.

The 2002 Access to Egress Study was the largest cabin evacuation study ever conducted by the FAA. A total of 2,544 people participated in various group trials to determine passageway configuration, hatch disposal location, and aircraft evacuation through a Type III exit (over the wing). Findings indicate that hatch disposal location slowed egress in some access aisle width configurations but not in others. Waist size, gender, and age all affected individual exit time. The findings are consistent with prior research showing that passageway configuration has only minimal effects on emergency egress as long as ergonomic minimums involving hatch removal are respected. In contrast, differences in the physical characteristics and lack of knowledge of individual participants produce large differences in emergency evacuation performance.

On March 27, 2002, the FAA Current Icing Potential weather safety product became fully operational. This product generates around-the-clock support and provides information on current in-flight icing conditions enabling safer flight planning, determining route changes, and altitude selection. The FAA also completed development and implementation of a newly improved

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Innovations in Noise Reduction

New Flight Procedures Reduce Aircraft Noise

Louisville International Airport

For the first-time in the United States, the Louisville International Airport hosted a procedure for a Continuous Descent Approach (CDA) Study. Researchers recently released the results of this noise-reducing flight procedure, which offer hope for a reduction in aircraft noise for residents living approximately 10 - 30 miles off the end of airport runways.

The test, conducted by a team from the FAA, Boeing, the Massachusetts Institute of Technology (MIT), NASA, United Parcel Service (UPS), and the Regional Airport Authority, included eight fly-over noise measurements over a two-week period between October and November of 2002.

During the tests, 14 highly sensitive NASA and Boeing microphones at seven locations in southern Indiana recorded two UPS 767s, equipped with special on-board flight management systems. One aircraft flew a standard approach, which involves flying closer to the ground for as much as 30 miles before landing, while the other flew a never-before tested flight pattern that required the aircraft to stay at higher altitudes longer than is presently done when preparing for landing. Previously, the procedure had been modeled on computer simulations only.

Results show that the CDA procedure reduced noise between three and six decibels. A three-decibel difference is noticeably different to the average human ear, while a reduction of 10 decibels, for example, would be a 50 percent reduction in noise. As an added benefit, the CDA procedure is more fuel-efficient.

The research team chose Louisville as the test site because of its nighttime operations, available technology, newer UPS aircraft, and accessible resources. John-Paul Clarke, Associate Professor of Aeronautics and Astronautics at MIT and CDA Team Leader noted, "There would have been no trial run of the CDA without the significant contributions of UPS and the Louisville air traffic controllers. UPS provided aircraft, flight crews and its flight simulators, which were integral to the computer simulations, flight simulations, and actual flights."

Now that the anticipated and significant reduction in noise has been demonstrated, the next step is for airports, airlines, and air traffic controllers nationwide to incorporate the procedure into practical applications and flight patterns.

Implementing the procedure at Louisville International Airport could, for example, provide a significant reduction in aircraft noise to residents in Bullitt County, Kentucky and Clark and Floyd counties in southern Indiana.

In 2002, the FAA, with Kentucky's Congressional delegation, designated Louisville International Airport as the national model site for testing and integration of the next generation of aviation technology, of which the CDA procedure is one. The airport also served as a test site for the Automatic Dependant Surveillance - Broadcast (ADS-B) system and is scheduled to test moving map display technology later this year. ■

United Parcel Service B767-300

December 17, 2003, will mark the 100th anniversary of the Wright Brothers' achievement of controlled, powered flight in a heavier-than-air craft. The FAA's role in the observance of this anniversary includes support for the U.S. Centennial of Flight Commission, of which FAA's Administrator is a member. For additional educational material about the Wright Brothers, please visit: **www1.faa.gov/education/index.htm**.

Aircraft Certification Tools

Human Factors Certification Job Aid

FAA researchers and certification specialists are now testing a new computerized tool to help agency certification specialists and aircraft designers ensure aircraft flight deck technologies are user friendly. This prototype tool will enhance safety and offer potential savings in time and dollars for both industry and government by decreasing the time necessary for certification.

"Aircraft certification requires judgments about whether new aircraft designs will be safe to be flown in the global airspace by current and future pilots," said Mark Rogers, Director of the FAA's Human Factors Research and Engineering Program. "Although experience has shown that design-induced human performance errors have contributed to many aviation incidents and accidents, there is a lack of guidance describing what human performance areas should be evaluated and, until now, there have been only a few methods available to help certification personnel predict the future occurrence of such errors based on analysis of the aircraft design."

"Aircraft certification requires judgments about whether new aircraft designs will be safe to be flown in the global airspace by current and future pilots."

This decision support tool will assist certification and design personnel in identifying, assessing, and resolving potential design-induced human performance errors that could contribute to aviation incidents and accidents. In addition to enhancing the speed, accuracy, and repeatability with which certification engineers can access relevant regulatory and human factors information to make their decisions, this tool will also help designers identify possible design changes to alleviate human performance issues and will help researchers identify gaps in current human factors knowledge.

Designed by Research Integrations, Inc., under contract to the FAA, this PC-based software has three major databases addressing regulatory information, flight deck components, and human factors considerations. In the current version, the information in the databases is focused on flight deck displays. In the next versions, which will be completed in 2003, the databases will be expanded to address flight controls. ■

Job Aid Screen Shot

R&D Accomplishments - *continued from page 2*

version of the Rapid Update Cycle, which forecasts of jet-level winds and temperature, critical for U.S. flight routing and air traffic management.

During the fiscal year, the FAA released an enhanced version of the Emissions and Dispersion Modeling System (EDMS 4.1), which assesses the air quality impacts of airport emission sources, particularly aviation sources. EDMS, crucial for the FAA to perform the air quality analyses of aviation emission sources for airport expansion projects, has been accepted by the Environmental Protection Agency (EPA) accepts EDMS as a "Preferred Guideline" model.

The FAA also completed a first-time review and analysis of all available data and research findings on particulate matter emissions from aircraft engines. The effort enabled the FAA to develop a first-order approximation methodology to estimate particulate matter emissions from aircraft engines. Following peer review and EPA adoption for use, this methodology will fill the critical data gap that currently exists for aircraft engines particulate matter emissions and potentially remove constrains on airport capacity expansion by providing a presently nonexistent capability environmental assessment.

A more comprehensive listing of FAA's research accomplishments, FY 2002 R&D Annual Report, will soon be available on our website at http://research.faa.gov. ■

Developments in Air Quality

A Study of Exhaust Generates New Results

Aircraft emissions are a growing concern for the FAA, airports, and the community. U.S. and international air quality models were previously unable to accurately predict plume dispersion and the resulting emissions concentrations because the characteristics of the plume behavior were virtually unknown. Very little research had been done in this area and input values previously used were primarily based on the best available information and good engineering judgment.

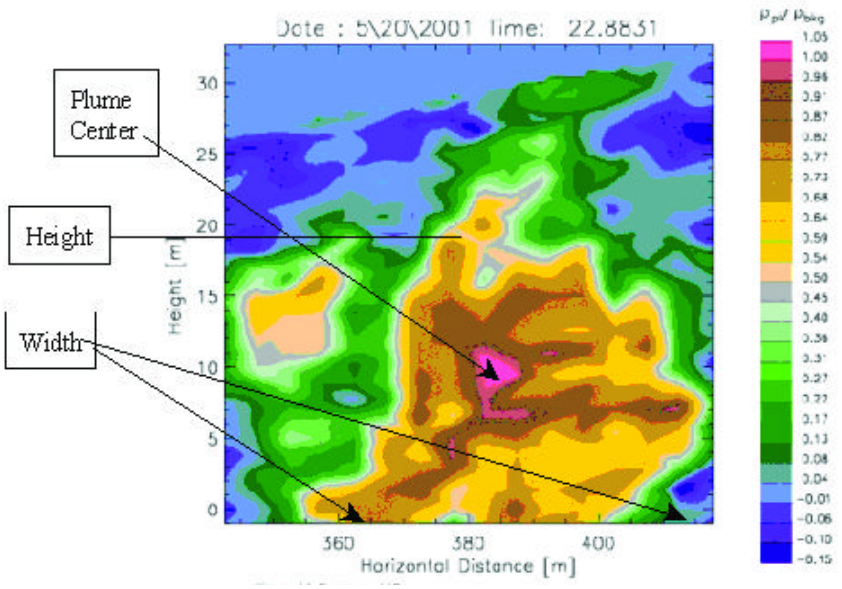
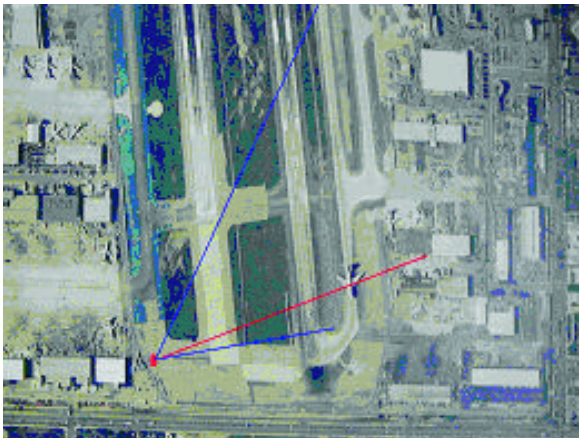


Illustration of a Lidar Scan

The FAA's Office of Environment and Energy conducted a study to create a picture of how the plume of an aircraft behaves, and better understand and model aviation's contribution to local air quality. The study used a remote-sensing instrument called a Lidar (Light Detection And Ranging), which uses laser pulses to measure atmospheric constituents and provide a profile. Using Lidar, researchers observed the time-varying position and geometry of the jet exhaust behind individual airplanes. The scanning Lidars (or laser radars) operate with eye safe, invisible beams.

This study resulted in significant insights into the initial plume characteristics from airplane exhaust, and can be used to greatly increase the accuracy of current airplane exhaust dispersion modeling. To date, this testing has produced the best information on dispersion models for airplanes.



Plume Scan Angles

Results show that plume rise does occur and that the initial standard deviations of the plume vary. These two findings may result in lower predicted concentrations from airplane sources for nearby ground level receptor locations. Generalization of the plume characteristics will allow model inputs to be altered to more accurately predict local concentrations of pollutants.

The initial study was conducted over a period of several days in 2001, with the technical support of the Department of Transportation's Volpe National Transportation System Center and the University of Central Florida. It was conducted in coordination with the Los Angeles International (LAX) airport and the National Oceanic and Atmospheric Administration (NOAA). LAX provided vital environmental impact analysis, contributed funds, shared technical expertise, and access to the airport. NOAA operated the Lidar instrument, which it specifically re-engineered for this project.

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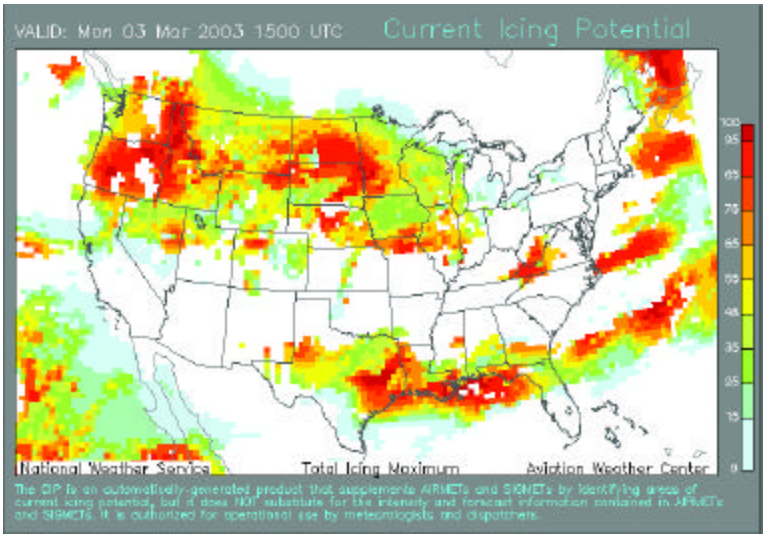
Current Icing Potential

Advancements in CIP

Aircraft icing has long been recognized as a significant hazard to aviation. Back in 1959, the small plane carrying 1950s rock 'n' roll legends Buddy Holly, Ritchie Valens, and The Big Bopper iced up and the pilot became disoriented. All three musicians and the pilot died when their plane crashed soon after take-off from Mason City, Iowa. In fact, it is estimated that 40 people a year die in icing-related crashes, however, these crashes do not get much notice, because they usually involve single individuals flying small planes.



Current Icing Potential Map

Icing affects aircraft in four major ways. The forces of flight-lift, drag, thrust, and weight-are all affected by a buildup of ice on an airplane. Ice distorts the flow of air over the wing. Wind tunnel and flight tests have shown that accumulations on the leading edge or upper surface of the wing - no thicker or rougher than a piece of sandpaper - can reduce lift by 30 percent, and increase drag 40 percent or more. When lift is reduced, the aircraft may not be able to maintain its desired altitude.

Increased drag requires more power from the engine to achieve the desired results.

"Ice adds drag to the aircraft, and the plane has to fly faster to maintain airspeed. The plane becomes harder to control and can go into a spin," explains National Center for Atmospheric Research's (NCAR) Marcia Politovich, head of the FAA's In-Flight Icing Product Development Team.

Surprisingly, the most dangerous icing conditions actually come from sheets of cold drizzle, rather than atmospheric ice. The drizzle droplets are small enough to freeze very quickly once they come into contact with the outside of the aircraft, forming a treacherous layer of ice.

Pilots can encounter winter icing anywhere in the country, with the most vulnerable geographic areas being Alaska, the Pacific Northwest, the Great Lakes, the Northeast, the Appalachians, and the Rocky Mountains. And icing can occur in all seasons, while more prevalent in winter, it can occur any time of year at altitudes from 10,000 to 20,000 feet and sometimes higher.

Even today, the determination of the severity and type of icing likely to occur in a given icing environment remains a challenge for aviation forecasters. For forecasters to make an accurate diagnosis of icing, they must be cognizant of the atmospheric parameters that influence its occurrence and character.

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Air Quality - *continued from page 5*

This Lidar study is part of a multi-year validation effort associated with FAA's airport air quality model, the Emissions and Dispersion Modeling System (EDMS - For more information on EDMS, please see page 14.). EDMS is the only model in the U.S. or abroad that is designed specifically for modeling emissions and dispersion from airport emission sources. Results of this study will ultimately refine and improve how the FAA complies with Clean Air Act requirements for proposed actions, such as airport expansions.

The preliminary report on the Lidar study results is available on the Office of Environment and Energy website at http://www.aee.faa.gov/emissions/airindex.htm. ■

Partners in Research

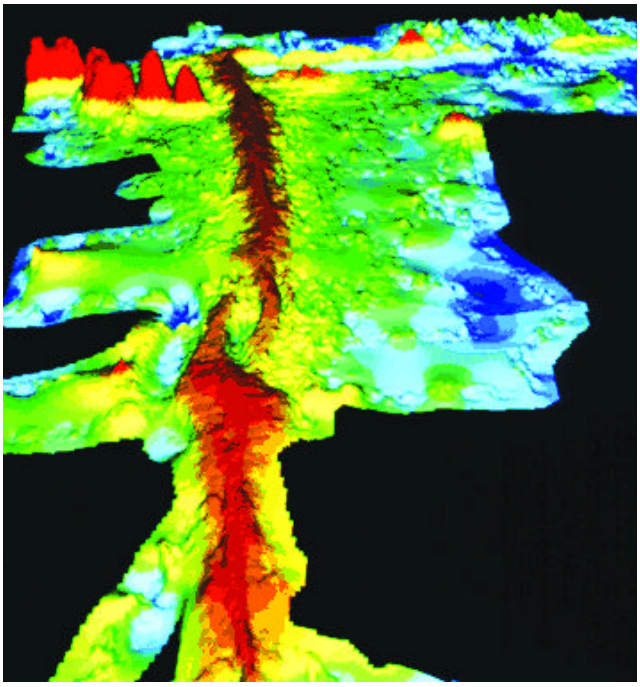
FAA Partners with MIT and the University of Iceland for Human Factors Research

The Massachusetts Institute of Technology (MIT) is the recipient of a recent FAA National Center of Excellence for Operations Research grant. The objective of the grant is to assess and provide human factors support to the Agency's current oceanic modernization efforts. A major component to planning and accomplishing this research involves collaborative studies with the University of Iceland.

"The oceanic air travel environment is expected to evolve and expand significantly over the next decade, and we will need to take advantage of enhanced communications, navigation, and surveillance capability to improve safety, efficiency, and security," said Mark Rodgers, Director of the FAA's Human Factors Research and Engineering Program. "It is critical to include human factors considerations in the evaluation and development of future oceanic air transportation systems that include these capabilities."

Under this grant, students at both MIT and the University of Iceland will work to identify and understand the key human factors challenges associated with future oceanic air transportation technologies, such as Automatic Dependent Surveillance (ADS) and Required Navigation Performance (RNP).

The operational emergence of ADS, RNP, and other advanced technologies in oceanic airspace raises a number of potential issues that will be addressed in the initial phase of this research effort. These issues include potential changes in the operational role of the controller and changes in procedures between controllers and pilots having a cockpit display of traffic information. This effort will also address issues such as the human performance costs and benefits associated with advanced technologies - changes in situation awareness, training, and skill maintenance and vigilance.



Iceland Topomap

The first steps toward oceanic modernization have already been taken with programs in the United States and Iceland. Within the United States, the FAA's Advanced Technologies and Oceanic Procedures Program is acquiring the automation and assessing other capability requirements for oceanic operations. In Iceland, a new flight data processing system and an integrated sensor situation display have already become operational. By joining research activities through the FAA's National Center of Excellence for Operations Research, human factors researchers can provide insight into information requirements for future oceanic operations, including a comparative analysis of future oceanic air transportation functional requirements, needs, and issues between the U.S. and Iceland as part of an integrated human-centered approach to ATC modernization.

Through its Center of Excellence Program the FAA partners with academia and industry to conduct research in mission-critical technology areas, allowing the FAA to gain immediate access to external resources. The FAA provides matching funds to its four Centers, which specialize in specific research areas. For additional information on the FAA's Center of Excellence program see www.coe.faa.gov. ■

1920s

The Air Commerce Act of 1926 gave the Federal Bureau of Commerce responsibility for regulating aviation, including carrying out aviation research and development.

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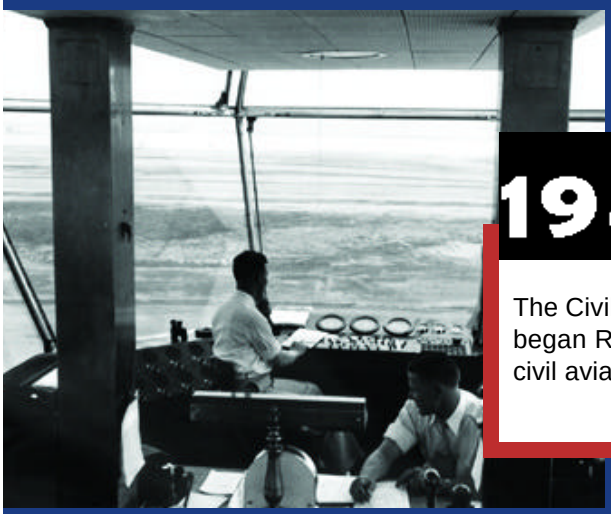
1930s

FAA predecessor, the Civil Aeronautics Authority, established the Indianapolis Experimental Station as its research and development facility.



1940s

The Civil Aeronautics Administration began R&D work to adapt radar for civil aviation use.

1950s

FAA began experimenting with the use of computers to aid air traffic controllers.

2000 ar

Through its visionary res program, the FAA is dev system for the 21st centu partnership with industry government agencies, th long-term vision for the Strong investment in the will make this vision a re

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1960s

FAA survivability research engenders new rules requiring airlines to increase emergency safety equipment. New research programs focused on postcrash fires, runway safety, and aircraft noise.

1970s

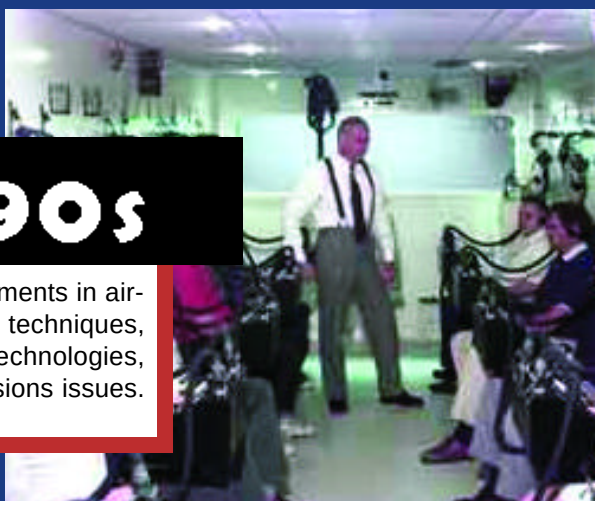
The FAA R&D program expands its focus to include intensive security research.

1980s

The FAA requires airlines to meet new safety requirements focused on cabin flammability, impact and emergency procedures and equipment. Fuel tank requirements are strengthened, and airlines are directed to reinforce cargo and baggage compartments with flame resistant materials.

1990s

FAA research empowers great improvements in aircraft safety through improved inspection techniques, human factors guidelines, new airport technologies, and aircraft noise and emissions issues.



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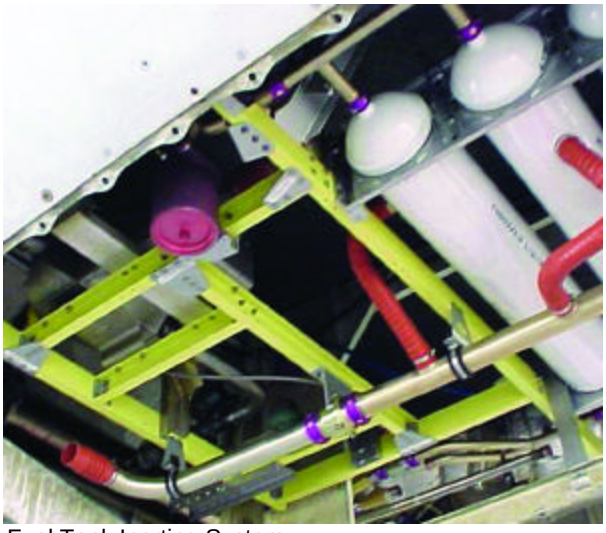
Safety First

Developments in Fuel Tank Inerting



Fuel Tank Inerting System

Following the TWA Flight 800 accident, fuel tanks have become a critical safety issue.

The FAA is making significant progress in the development of an inerting system to prevent fuel tank explosions. Continuing to build on this foundation, FAA researchers have designed and installed an on-board inerting system in the FAA 747SP test aircraft. The goal is to install this on-board system in commercial aircraft within the next several years

Through the collaborative efforts of the FAA fire safety researchers and the National Research Specialist for Fuel System Design, advancements have been made in producing a user-friendly dual flow design for generating nitrogen enriched air in flight.

The use of high- purity/low-flow nitrogen enriched air during ascent and cruise, and lower-purity/high-flow nitrogen enriched air (NEA) during descent, analytical modeling shows that most aircraft models and flight regimes would remain inert upon landing, deterring the need for system operation on the ground which could be costly and complex.

Although flight tests are planned in FY 2003, the development of the Agency's prototype inerting system in the 747SP has spurred the Boeing Company to formally apply to the the FAA to retrofit some of its 737 and 747 models with inerting systems similar to the FAA design. ■

JUST A MINUTE

We want to know what you think...

- **Are you a first time reader of the R&D Review?**
- **What do you think of the articles?**
- **What topics would you like to see in future newsletters?**
- **Would you like to be on our mailing list?**

Please submit your brief responses online to: http://research.faa.gov/aar/survey_info.asp

CIP - *continued from page 7*

Icing can vary from a relatively non-hazardous light accumulation of rime to a potentially disastrous severe accumulation of clear ice made up of supercooled large drops (SLD). Identification of the environments and factors that cause this variability will aid in improved icing forecast support to the aviation community.

Last year, airlines received a new tool for avoiding in-flight icing, which can especially threaten smaller commuter planes and delay larger commercial aircraft as they land or take off. Researchers at the National Center for Atmospheric Research (NCAR), with funding from the FAA, developed new methods and software for detecting and forecasting icing potential in the atmosphere. They then applied these methods to produce CIP, or fully named - Current Icing Potential, a warning system with a web-based display describing current icing conditions throughout the country. The online display offers high- precision maps and plots, updated hourly, to identify areas of potential aircraft icing produced by cloud droplets, freezing rain, and drizzle.

As a FAA approved tool, CIP enables dispatchers to make fly/no-fly decisions and for flight planning, route changes, and altitude selection. The on-line display is derived from surface observations, numerical models, satellite and radar data, and pilot reports.

"CIP helps dispatchers identify areas of potential icing so pilots can feel more confident about choosing a flight path," says Politovich.

The National Weather Service operates the new system from the Aviation Weather Center in Kansas City, Missouri. The system will not, however, replace the traditional forecast supplied on the NWS AIRMET, which provides a particularly detailed report of icing conditions issued at six-hour intervals. The two are best used together, with AIRMET giving a thorough assessment of conditions, and CIP giving less detailed, but more regular updates.

Ice forming on the wing of a plane

CIP will most benefit commuter planes and other propeller-driven aircraft, says Politovich. Smaller aircraft are more vulnerable to icing hazards because they cruise at lower, ice-prone altitudes. They also lack mechanisms common on jets that prevent ice buildup by heating the front edges of wings. Once approved for use by air traffic controllers, CIP will also benefit jet aircraft by enabling controllers to guide incoming flights so they avoid circling at altitudes where ice could accumulate.

For example, in 1994, a commuter aircraft went into a high-speed dive and crashed near Roselawn, Indiana, killing all 68 people on board. The probable cause was loss of control of the aircraft after formation of ice on the wings as the plane circled while waiting to land in Chicago.

Cancellations and delays due to icy weather can cost airlines millions of dollars in a single day. On March 20, 2000, icing conditions at Denver International Airport forced Air Wisconsin to cancel 152 flights. United cancelled 159 outbound and 140 inbound flights the same day, most because of weather.

A companion tool, called FIP (Forecast Icing Potential), which forecasts potential icing up to 12 hours ahead, is still in development at NCAR and classified as experimental by the FAA. "New technology is allowing better detection," says NCAR's Benjamin Bernstein, who developed FIP. "Combined with new forecasting methods and the timeliness and accessibility of the Web, these breakthroughs could significantly reduce icing tragedies and losses."

Please visit the following Aviation Weather Center Web site address to access the CIP display and additional information: http:/cdm.aviationweather.gov/cip/. ■

Call for Nominations

Sixth Annual FAA Excellence in Aviation Award

The FAA has issued a call for nominations for its annual Excellence in Aviation Award. Through this award, the FAA formally recognizes significant accomplishments as a result of aviation related research efforts. This special distinction is intended to augment the ability of the government to recognize superior research efforts and to highlight benefits of such activities.

The Excellence in Aviation designation is a highly competitive, non-monetary award that is presented annually to individuals and/or institutions following an evaluation of documentation which clearly shows how their past research benefits the aviation community today. Nominees must be able to show significant impact and benefit of extended aviation research efforts and application of improvements within the aviation industry.

This is the sixth year that the agency will be presenting this prestigious award. Each year the nominee pool has grown, reflecting a broad spectrum of aviation-related research activities. Nominations and supporting documentation for the 2003 Excellence in Aviation Award will be accepted through May 30, 2003. For additional information on the Award, please contact Dr. Terry Kraus at terry.kraus@faa.gov. To obtain a nomination form see the Office of AviationResearch's website at: http://research.faa.gov.

Last year, the FAA selected the laboratories and universities that support FAA's Aviation Weather Research Program. The recipients of the award included: the National Center for Atmospheric Research; Massachusetts Institute of Technology/Lincoln Laboratories; National Oceanic and Atmospheric Administration's Forecast Systems Laboratory, National Severe Storms Laboratory, Aviation Weather Center, and National Centers for Environmental Prediction; Naval Research Laboratory; University of Quebec at Montreal; University of Alaska Fairbanks; San Jose State University; and University of Oklahoma. These FAA-funded organizations are providing the applied research to solve critical operational aviation weather issues. Working as part of multi-discipline teams, the researcher's efforts are enhanced through collaboration with industry, other national laboratories, government agencies, academia and trade associations.

In 2001, the FAA selected Dr. Max Shauck of the Baylor University Institute for Air Science as the winner of the 2001 individual FAA Excellence in Aviation award for his critical environmental research that is helping to reduce harmful emissions through the use of renewable clean-burning aviation fuels. The National Institute for Aviation Research (NIAR) at Wichita State University received the institutional award for continued contributions in aviation research and education, especially in fields such as crashworthiness, composites and advanced materials, structures, aerodynamics, aircraft icing, propulsion, flight control, and human factors.

Stay Tuned...

The Office of Aviation Research will be releasing two new publications in the coming months:

The **2002 R&D Annual Report** which encompasses some of the milestones in research accomplished during the 2002 fiscal year.

The **R&D Research and Laboratory Facilities** brochure which provides a detailed description of the facilities that conduct *critical research for aviation's future*.

Dr. Christopher Wickens, University of Illinois Institute of Aviation, won the 2000 FAA Excellence in Aviation Award. Professor Wicken's leadership as head of the Aviation Research Laboratory at the University of Illinois has lead to significant research in aircraft flight operations, flight training, simulation technology, and aviation education, including theoretical and applied areas. His applied research has lead to changes in heads-up displays, while his theoretical research has investigated human attention and cognition.

In 1999, the FAA selected Embry-Riddle Aeronautical University to receive the Excellence in Aviation Award for its continued contributions in aviation research and education.

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Creative Solutions

FAA Researcher Awarded U.S. Patent

Sometimes great things emerge out of necessity. For an innovative Office of Aviation Research team lead by Bob Filipczak, that seemed to be the recent case. FAA regulations require aircraft to land if there appears to be smoke in the aircraft, since it could be an indicator of a fire. Historically, while there have been few fires reported in cargo compartments, false alarms are a more frequent event.

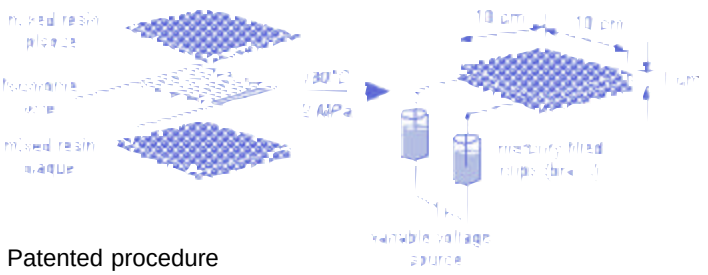
A recent study places the false alarm to smoke detection at 200:1 over the last five years. A significant fraction of false alarms probably stem from sources such as condensed water vapor, as well as other aerosol sources. These false positive situations are very costly. Aircraft must make an emergency landing, thus affecting a multitude of schedules as well as creating unnecessary time delays for passengers, other aircraft, and airport facilities.

Manufacturers of fire detectors for commercial aircraft seek to shorten detection times, improve reliability, and enhance specificity using multi-sensor arrays and advanced logic. To facilitate this effort in the area of aircraft cargo compartment fire detection, a FAA research team began testing a new certification procedure that would allow alarm manufacturers to make detectors that sense an array of variables so as to reduce and/or one day eliminate false alarms. These new, more robust alarms, would read, along with other variables, the compartment optical density, temperature, CO levels, and hydrocarbons simultaneously.

Specifically, the FAA developed and characterized a reproducible smoke generation source comprised of several pure polymers (plastics) found in luggage articles. They then ran heating wires through this plastic to thermally decompose it to smoke to create a realistic mixture of gases characteristic of the initial stage of a cabin fire. They created this fire and smoke in a very controlled fashion in an effort to measure the smoke generation rate. They achieved this by passing electrical current through a Nichrome™ wire heater embedded in the plastic sample. Researchers could then control the level and duration of smoke production by adjusting the electrical current to the heating wire in the specimen. However, they still encountered problems with accurately measuring the mass loss (smoke generation) rate of the plastics being thermally decomposed.

Initially mass loss measurements during the test became problematic because the bending stiffness and thermal expansion of the electrical wires connecting the plastic material to the voltage source produced large spurious forces on the load transducer, which were unrelated to the specimen mass loss history.

As the picture below reveals, researchers overcame the problem by connecting copper wires to the Nichrome™ heater leads and immersing the copper wires in a liquid metal (mercury) contained in separate brass cups electrically connected to the voltage supply. This arrangement produced an essentially frictionless, force-free electrical connection through the liquid mercury, which mechanically isolated the test specimen from the power supply. This arrangement prevented spurious loads or forces from being transferred to the transducer and the researchers observed negligible heating of the mercury or copper heater leads.



Patented procedure

Excited by this groundbreaking ability to isolate the sample from the electrical source, FAA researcher Bob Filipczak applied for and received his second U.S. Patent 6,467,950 titled, "Device and method to measure mass loss rate of an electrically heated sample." This is the forth patent awarded to the FAA since November 1999.

This technology enables the recreation of an artificial smoke source while providing precise measurement of material losses. It is hoped that this ability will further the objective of the cargo compartment fire detection project in developing certification guidelines that would enable the use of more sophisticated fire detectors that are not as prone to false alarms. For more information please contact Bob Filipczak (AAR-400) at 609-485-4529, or via email at filipczak.bob@faa.gov. ■

Development of a Portable Bird Detection Radar

Under a Partnership Between FAA, the U.S. Air Force, and Industry

Sharing both the sky and the airport environment with birds and other animals has been a concern to aviation personnel for several years and their impact on aviation safety has been documented over the past eighty-eight years. It is estimated that over $300 million dollars annually is lost due to wildlife strikes in the United States alone.

Annually, more than 6,000 bird strikes with civil aircrafts are reported to the FAA and the number of large birds is increasing exponentially in North America. As a result, serious concerns are being raised regarding the risk of severe bird strikes near airports.

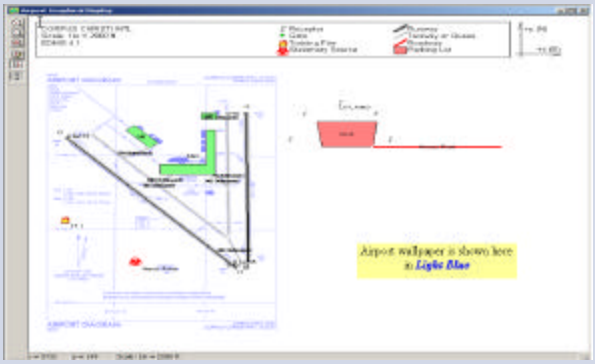
Bird strike damage

Radar is one solution that offers real-time detection of bird hazards and provides early warnings to pilots near airports. Ultimately, this FAA research project seeks to develop a low-cost bird detection radar for airports.

Some of the requirements used in the development of the bird detection radar are: near real-time scanning, close to 100% bird detection capability, portability, low-cost, and no interferences with existing air traffic equipment.

EDMS Version 4.1 Released

In late 2002, the FAA released version 4.1 of the Emissions and Dispersion Modeling System (EDMS). EDMS, originally designed in the mid 1980s, is one of the few air quality assessment tools specifically engineered for the aviation community. It evaluates the air quality impacts of aviation emission sources, which include aircraft, auxiliary power units, and ground support equipment. EDMS includes emission and dispersion calculations, the latest aircraft engine emission factors from the International Civil Aviation Organization (ICAO) Engine Exhaust Emissions Data Bank, vehicle emission factors from the Environmental Protection Agency's (EPA) MOBILE5a, and EPA-validated dispersion algorithms.



Airport Graphical Display for EDMS

Since 1993, EDMS has been an EPA Preferred Guideline model for use in civil airports and military air bases. In 1998, the FAA revised its policy on air quality modeling procedures to identify EDMS as the required model to perform air quality analyses for aviation sources instead of the preferred model. This revised policy ensures the consistency and quality of aviation analyses performed for the FAA. The FAA continues to enhance the model under the guidance of its government/industry advisory board to more effectively determine emission levels and concentrations generated by typical airport emission sources.

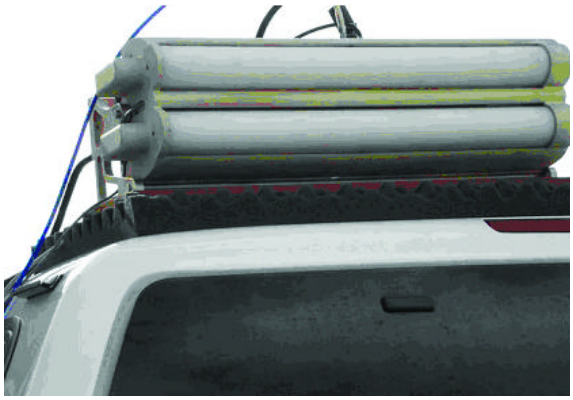
EDMS 4.1 incorporates substantial model enhancements including: the first phase of improvements to the ground support equipment component of the model, results from the recent Lidar study on aircraft plume behavior (summarized on page 5 of this newsletter), the ability to import airport diagrams, and an expanded data import and export utility. These enhancements will enable the user to more easily and accurately characterize emissions and dispersion, particularly from aircraft and ground support equipment.

The latest information about EDMS, including recent releases, is available on the Office of Environment and Energy website at http://www.aee.faa.gov. ■

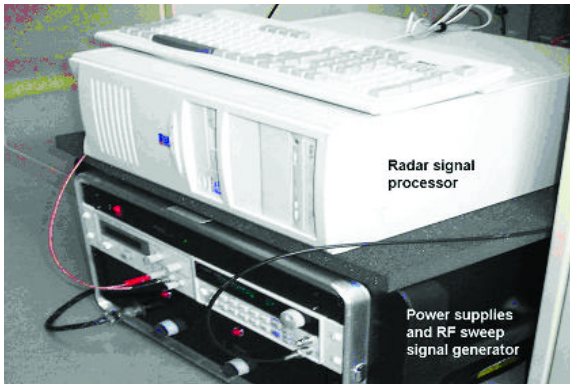
Bird Detection- *continued*

Reviews conducted in the previous years underscored the fact that existing radars at airports either do not cover critical areas of the airport airspace or do not have the ability (sensitivity, update rates, range) required to detect birds. Additionally, this existing radar is very expensive and already dedicated to the detection of weather and air traffic.

By design, the radar developed under this project will be highly sensitive to birds and will be used to cover limited, but critical, airspace, such as departure and final approach corridors. The selected design for prototype development uses a 94GHz pencil beam, has a range of up to 5 miles, can scan a 30 by 5 degree cone in 10 seconds, and of limited power (1 watt max.)



Transmit and Receive Antennas



Radar Signal Processor, Power Supply and RF Sweep Signal Generator

The technical phase of the project started in September of 2002 and a prototype radar unit will be ready in the spring of 2003. Field tests and comparisons to live observations by trained biologists are scheduled to be conducted at the JFK and DFW airports in the summer of 2003.

This project is funded under the auspices of the Air Force Dual Use Science and Technology program (DUST). Under DUST, the U.S Government forms partnerships with industry to co-share the development of technology that has applications in the civil and military markets.

For additional information on this subject please visit http://wildlife-mitigation.tc.faa.gov. or contact Dr. Michel Hovan at 609-485-5552. ■

Nominations - *continued from page 12*

For more than seven decades, Embry-Riddle has supported the FAA mission and the nation's aviation goals through its applied aviation research activities and ongoing academic programs. Working with both government and industry, the university has made valuable contributions in areas such as air traffic management, aviation human factors, pilot education and training, aircraft maintenance, and airframe design and technology.

The University of North Dakota's John D. Odegard School of Aerospace Sciences received the 1998 institutional award for its over 30 years of innovative aviation research, education and training programs. Dr. Satya N. Atluri, a professor at the University of California, Los Angeles, received the 1998 individual Excellence in Aviation award.

Dr. Atluri has had a significant impact on the aviation research community through his pioneering studies on structural integrity and damage tolerance of commercial and military aircraft, the establishment of widespread fatigue damage thresholds for aircraft, residual strength of aging aircraft with wide-spread fatigue damage, and life-enhancement of aging aircraft structural components through composite patch repairs.

In 1997, the agency selected the Joint University Program (JUP) on Air Transportation Research, a consortium comprised of the Massachusetts Institute of Technology, Ohio University, and Princeton University, to receive the agency's first Excellence in Aviation award. That year, the JUP celebrated its 25th year of research, providing both the FAA and NASA a high return on investments. The three universities are conducting cutting-edge research on a variety of aviation topics, such as intelligent flight control systems, weather hazard avoidance, satellite navigation, cockpit displays, and intelligent air traffic management. ■

Airport Visual Guidance

The Utilization of Wind Turbines

The FAA and the Department of Energy (DoE) have entered into an interagency agreement to conduct research on *Obstruction Lighting Requirements for Wind Turbine*, to enhance the safety of aircraft flying over Wind Turbine farms. Currently, all structures more than 200 feet in height must have aircraft warning lights in accordance with requirements specified by the FAA.

However, at this time, lighting requirements are determined by the regional FAA Obstruction Hazard Analyst. This is problematic for the industry, because requirements vary widely from region to region, and even within individual regions, depending upon which official oversees an individual project.

The purpose of this evaluation is to develop requirements for lighting large wind turbine farms as aviation obstructions. The challenge researchers face is that current obstruction specifications do not include provisions for large obstructions, such as wind-tunnel farms.

Currently, there are several turbines constructed in varying formations across the country. The patterns range from linear, clusters, grids, and at random. The challenge for the FAA is to establish guidelines that will protect aircraft in an array of turbine patterns.

To date, the FAA and DoE have conducted seven site visits to various farms, where airborne and ground testing has been done. From this testing, the Agency will be able to establish what the successes, limitations, and challenges will be. An interim report has been developed for review and comment by industry as a feedback mechanism for this research effort. In the near future, an evaluation is planned from an installation to light the structures. ■