Federal Aviation Administration's

R&D Review

News Source for the FAA Air Traffic Organization's Operations Planning Aviation Research and Development Office Fall 2004

A Message from the Director

The FAA's R&D Program -Critical Research for Aviation's Future

Our Mission: to conduct and support domestic and international research and development of products and services that will ensure a safe, efficient, and environmentally compatible global air transportation system.

Congratulations to the FAA research community and all our research partners for another year of outstanding accomplishments that have improved the performance of the nation's aviation system. Your achievements are leading the way to aviation's future. Your research and the development of innovative technologies are supporting a safe, efficient, and environmentally acceptable global aviation system.

FAA's R&D program is significantly enhanced by partnering with national and international organizations that have the technical capability to address mutual areas of interest and have the resources to commit to collaborative activities. By reaching out to the academic community through the Centers of Excellence and other sponsored university programs, we gain some of the newest thinking and innovation coming from this sector. The private sector and other government laboratories also provide FAA with expertise and promote the transfer of technology. Through these partnerships, everyone benefits from the exchange of information on R&D programs and the forums for technical dialogue.

The FAA's R&D program supports the FAA's strategic goals and mission as described in the Agency's *Flight Plan* 2005-2009 (http://www.faa.gov/aboutfaa/flightplan2005_2009.cfm). This links directly with the overarching strategic goals of the Department of Transportation (DOT) that are contained its strategic plan, *Safer, Simpler, Smarter Transportation Solution* (http://www.dot.gov/stratplan2008/strategic_plan.htm). By connecting with these strategic goals and reflecting them in the work we do, the FAA's R&D program supports an integrated plan for the future. Details of the projects that comprise the FAA's R&D program can be found in the 2005 annual FAA *National Aviation Research Plan*, the FAA budget submission, and other FAA planning documents. Annual program accomplishments are published each year in the FAA *R&D Annual Review*.

Our program is specifically directed toward the requirements of FAA organizations. It is largely through the activities of our sponsors and the direct impact of FAA R&D activities on the aerospace enterprise that the FAA goals are achieved. Activities supported by the R&D program include:

- Licensing, Regulation, Certification, and Standards Development
- Modernization, operation, and maintenance of the national airspace system.
- Aerospace policy formulation, planning, and analysis.
- Effective response to incidents, special situations, and emerging issues.
- Guidance, coordination, and collaboration across the global aerospace transportation community.

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- Identification, exploration, and assessment of emerging technological and operational concepts.

In addition to the guidance provided by the Department of Transportation and FAA strategic plans, two other plans provide direction for the R&D program. The FAA's *Operational Evolution Plan* (OEP, on-line at (http://www.faa.gov/programs/oep/) is the FAA's ongoing ten-year (2004-2015) plan to increase the capacity and efficiency of the national airspace system while enhancing safety and security. The commitments and decisions in the OEP have emerged from a close collaboration with the entire aviation community, including the airlines, cargo carriers, airports, manufacturers, general aviation, the Department of Defense (DoD), the Department of Commerce (DoC), and the National Aeronautics and Space Administration (NASA). Full implementation of many of the planned improvements described in the OEP will not occur until late in the 2004-2015 timeframe. A critical part of that effort will be R&D associated with design, development, and validation of the advanced technologies and new or revised procedures that will be needed.

Looking further into the future, where the challenge of increasing aviation services could become even greater, is the *Next Generation Air Transportation System Integrated Plan*, a joint effort by FAA, NASA, the Departments of Defense, Commerce, Homeland Security, and the White House Office of Science and Technology Policy. (For additional information on national planning activities, see http://www.jpo.aero.)

The *Integrated Plan* - the roadmap to the future aviation system - has six broad goals:

- Promote economic growth and create jobs;
- Expand system flexibility and deliver capacity to meet future demands;
- Tailor services to customer needs;
- Ensure national defense readiness;
- Promote aviation safety and environmental stewardship; and
- Retain and enhance U.S. leadership and economic competitiveness in global aviation.

The JPDO has the specific mandate of "coordinating goals and priorities and coordinating research activities within the Federal Government with United States aviation and aeronautical firms." To oversee planning, the agencies involved in the effort created the Joint Planning and Development Office (JPDO). We intend to continue working with the JPDO as they specify the wide range of supporting R&D that will be necessary to carry out the plan.

To ensure scare resources remain customer focused and targeted on the highest priorities, we have defined R&D strategies that address the major short- and long-term operational challenges facing the nation's air transportation system. These strategies are helping the FAA identify and bridge the gap between today's near-term safety and efficiency R&D needs and tomorrow's long-term research needs.

We formally seek advice through peer reviews of the research and regularly conducted reviews by the Research Engineering and Development Advisory Committee and its subcommittees. They also help ensure that there is no needless duplication of effort. Likewise, we are grateful to our international partners, in particular EUROCONTROL, who help us identify areas of mutual interest and concern, coordinate research programs, and share results.

Our approach to program planning, budgeting, and performance represents a major innovation in how public research funds and programs are derived and measured. The R&D program's success is directly attributable to the integration of input from out internal and external customers and improved processes to gain business efficiencies and collaborative advantages. We have also used Internet platforms to support program management and budget planning and execution and making priority setting and funding decisions transparent to out internal customers and external stakeholders. As a result of these activities, the Office of Aviation Research and Development now has a better means to work with other government agencies, such as NASA, to leverage research funds, partner in critical research projects, and conduct joint planning and priority-setting efforts.

Over the next year we welcome continued communications with our stakeholders who have become active participants engaged in the identification of critical research requirements. We look forward to working with them to assure that the public funds under our stewardship are targeted on the highest priorities and the best science and ultimately benefit the flying public.

-- Joan W. Bauerlein

A Look at the Year

2004 R&D Highlights

Every day, the aviation community faces challenges that range from ensuring the health and safety of passengers and crew, to protecting the environment, increasing capacity and efficiency, and creating an aviation system that is performance-based and human centered. As the FAA's approximately 38,000 controllers and maintenance specialists work 24/7 to keep the system operating safely, they retain the confidence that FAA researchers are working in the background to develop the next generation technologies and procedures that will help them keep the system safe and efficient.

FAA researchers had another very successful year in Fiscal Year (FY) 2004, working to advance scientific knowledge to ensure the safety of the flying public and enhance capacity in the national aviation system. The FAA's Office of Aviation Research and Development has long worked with its government and industry partners to address the needs of the aviation community. The Office of Management and Budget (OMB) recognizes the program as one of the government's most productive, proactive research programs. Using the Program Assessment Rating Tool it has developed to determine the effectiveness of federal programs, OMB concluded that the FAA's R,E&D program is "well managed and results-oriented," with a strategic plan that sets forth clear long-term goals that are tied to program performance measures. This OMB rating is the result of a two-year effort to create a focused, well-planned research program that ties together performance and budgets.

Aircraft certification requires judgments about whether new aircraft designs will be safe for current and future pilots. Although studies have shown that design-induced human performance errors have contributed to many aviation incidents and accidents, only a few methods have been available to help certification personnel predict the future occurrence of such errors based on analysis of the flight deck design. The FAA's Aircraft Certification Job Aid, a computerized decision-support tool, is now helping aircraft certification personnel ensure aircraft flight deck technologies are user friendly and safe. Funded by the FAA, Research Integrations, Inc., is developing the tool, which currently focuses on air transport category aircraft.

In 2004, researchers added an advanced search function to allow keyword searches of all Part 25 regulatory and guidance information, as well as all summaries of human factors information addressing the design of flight deck displays, controls, and systems. This greatly enhances the speed with which certification personnel can access the extensive human factors information found in this decision support tool. Researchers also reviewed FAA regulatory information and other human factors literature for human factors systems-related information to update the databases. They developed a hierarchy of human factors considerations pertinent to the design and certification of flight deck systems and expanded the three databases to address systems-related human factors. A limited number of certification personnel continue to use the fielded version of the job aid, providing researchers important feedback for future tool enhancements.

In 2004, the FAA issued Advisory Circular (AC) 120-76A to create a streamlined field approval process for electronic flight bags (EFBs). Although the AC addresses human factors considerations, it does not specify a procedure for conducting a human factors evaluation. To aid FAA aircraft certification specialists in conducting structured and comprehensive EFB usability evaluations in the field, aviation human-factors experts evaluated vendor supplied flight bags.

Researchers discovered that the language used in the assessment tools is especially important for evaluating EFB usability. The tools need to be understood by many types of users who may or may not have a human factors background. Results from several evaluations have yielded tools and procedures that show great promise for evaluating EFBs. Some manufacturers are beginning to test these tools and are considering how to fit them into existing design and development processes.

The Human Factors Workbench provides FAA employees, system developers, those working in human factors research, and other associated individuals easy access to human factors information that supports aviation-related activities. It presents a com-

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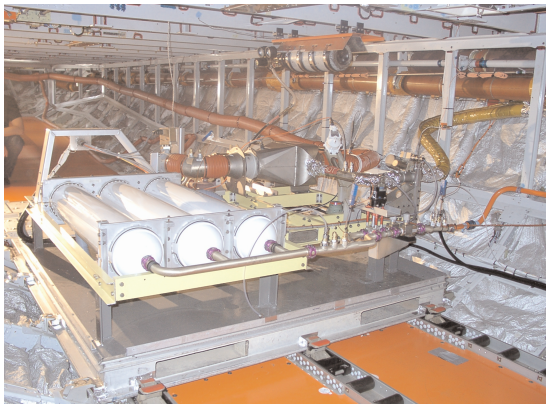
pendium of essential information in an easily accessible framework on the Internet. This information is categorized under four human factors components: (1) process descriptions; (2) more than 100 human factors tools; (3) Human Factors Awareness Course/Tool; and, (4) more than 1,200 publications, studies, and other papers with embedded search tools. To access the Human Factors Workbench online, please visit http://www.hf.faa.gov/Portal/default.aspx.

Last year, with the assistance of several industry partners, the FAA developed and tested an onboard inert gas generation system with air separation modules that use aircraft bleed air to



generate nitrogen-enriched air at varying flow and purity (oxygen concentration). In FY 2004, during a commercial transport airplane flight cycle researchers performed a series of ground and flight tests designed to prove the effectiveness of a simplified inerting concept.

They mounted the FAA-developed system in the cargo bay of an Airbus 320 that the manufacturer operates specifically for R&D testing and inerted the center-wing fuel tank. Then they used special instruments to analyze the system performance and its related inerting capability. The FAA's onboard oxygen analysis system continuously measured the oxygen concentration in the fuel tank during the test flights. The results of the tests proved the validity of the simplified inerting system concept.

The FAA currently has no means to measure quantitatively what improvement in air traffic controller visibility can be gained by changing the tower height and location on the airport surface. Because tower height and location strongly affects construction costs as well as airport safety, it is critical that the FAA develop a reliable means to determine optimal tower location prior to construction.

In FY 2004, a team of researchers from the FAA, U.S. Army Research Laboratory, and the University of Nevada-Reno conducted tests to quantify what improvements can be gained by increasing the height of the air traffic control tower at Deer Valley Airport in Phoenix, Arizona, from 110 feet to 130 or 150 feet. This and other investigations of tower siting procedures revealed that additional visibility analyses and criteria, such as those for observer line-of-sight and object obscuration, could enhance the objectivity of tower construction decisions. Many factors determine tower height and location, and visibility analyses provide additional quantitative data to assist in acquisition and construction decisions. Research results will be used in future tower construction projects, enhancing safety and protecting the nation's airport investments.

The University of Dayton Research Institute, funded by the FAA, completed the collection and analysis of flight loads data from 11,066 flights of Boeing 747-400 airplanes operated in overseas, commercial service. The data, consisting of 95,883 flight hours, included typical in-service flight and ground loads data - such as accelerations, air and ground speeds, altitudes, flight duration and distance, gross weights, speed brake and spoiler cycles, thrust reverser usage, and gust velocities. The 747-400 is the first heavy wide body model added to the FAA's operational loads monitoring research program. The International Aviation Rulemaking Advisory Committee has used these results extensively in their efforts to harmonize the rulemaking process for Airbus's new 380 airplanes. This research will also be used to provide the technical data to substantiate selected loads-related Federal Aviation Regulations.

The runway status light (RWSL) system is an array of red lights that can be deployed at taxiway entrances to warn pilots and vehicle operators that a runway is unsafe to enter. During the year, the FAA made great progress in assembling an operational, evaluation-ready RWSL system at Dallas/Ft. Worth International Airport. Working closely with Lincoln Laboratory and Sensis Corporation, the FAA developed key system improvements to address technical issues identified during initial field testing, completed construction and installation of Siemens' airfield lighting equipment for the RWSL system, and conducted a successful field re-test at the airport.

The Weather Support to Decision Making (WSDM) system, funded by the FAA, provides deicing decision makers

and airport plowing crews with up-to-the-minute information on potentially hazardous freezing precipitation. It uses data from Doppler radars, surface weather stations, and snow gauges located near the airport to measure accurately the amount of water in the snowfall. In FY 2004, researchers increased the two-hour WSDM precipitation forecast to four hours, allowing users longer lead times for more effective strategic decisions, and enhancing efficiency as well as safety. WSDM is currently operational at Denver International Airport and will be operational at New York airports later this year. An independent assessment estimated the annual benefit of an operational WSDM system at the New York airports to be $12.7M and $1.36M at Denver.

The FAA upgraded the Emissions and Dispersion Modeling System (EDMS) to permit assessment of the quantity of ground emissions that can be preventable by specific actions. EDMS calculates emissions from airport sources and models the air quality at an airport. The EDMS enhancements enable computation of on-road and off-road vehicle emission factors. The new version also includes more accurate techniques for computing Total Hydrocarbon and Volatile Organic Hydrocarbon emissions. These enhancements supported airport applications for FAA program funding and emissions reduction credits from the EPA.

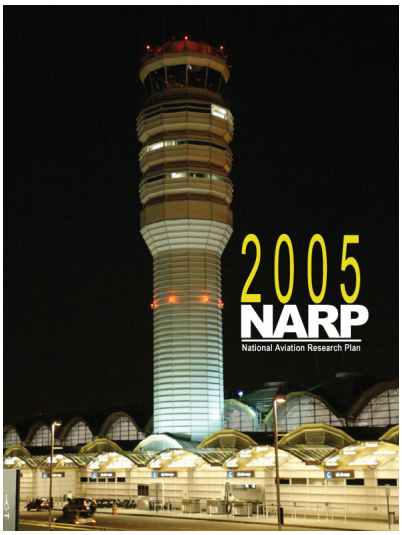
In collaboration with NASA, the FAA initiated a long-term, strategic effort to develop analytical tools to address the relationships between noise and emissions and between different types of emissions. Current analytical tools focus on noise or emissions; however, noise and emissions are interdependent phenomena. In FY 2004, at the request of the FAA, the Transportation Research Board of the National Research Council completed a study to assess the proposed aviation environmental design tool (AEDT) that will allow integrated assessment of noise and emissions impact at the local and global levels. The TRB assembled a committee to analyze the AEDT requirements and conducted a workshop in March/April 2004. The FAA and NASA used the comments from the workshop to refine the conceptual foundation of AEDT and formulate a comprehensive work plan. Together, the agencies are now fully engaged in developing this new product. The agencies also plan to develop the Aviation Environmental Portfolio Management Tool (APMT), an automated means to conduct cost-benefit analyses.

The En Route Descent Advisor (EDA) is an advanced decision support tool intended to help en route controllers to handle traffic operating within transition airspace. EDA builds on NASA's Center-TRACON Automation System (CTAS). In FY 2004, the FAA and NASA conducted a full evaluation of the prototype EDA system. FAA operational air traffic control personnel participated in the evaluation, providing system design reviews and recommendations periodically during the year. This successful evaluation marked the completion of a major development milestone. Although EDA is still in the early stages of development, it is rapidly maturing into a viable component of CTAS and may soon provide significant system capacity, fuel, and workload benefits. Future plans call for continued development with extensive validation through simulation, followed by shadow evaluations in the field and eventual deployment.

Commercial space transportation researchers completed the draft handbook, "Development of a Simplified Reentry Vehicle Hazard Model," providing launch and reentry vehicle developers a reference guide that they can use to estimate potential casualty for a given reusable launch vehicle mission. For this handbook, researchers developed a simplified method to estimate expected casualty for the aerothermal structural demise of a spacecraft.

In FY 2004, FAA's commercial space transportation and researchers completed aeromedical guidelines for environmental control and life support systems as well as medical guidelines for assuring human survival during commercial launch vehicle operations. The results of their research will be valuable both to those who propose to carry crew and passengers on reusable launch vehicles and to the FAA in its evaluation of such proposals.

For additional FY 2004 accomplishments, please visit http://research.faa.gov and click on *R&D Annual Review*. More information on the R&D program can be found in the *National Aviation Research Plan*.



Rewarding Aviation Research

FAA Excellence in Aviation Research Awards

In late November, FAA Administrator Marion Blakey announced the winners of the 7th annual FAA Excellence in Aviation Award: the Flight Safety Foundation for its research and publication of Waterproof Flight Operations; and Gulfstream Aerospace Corporation for the development and certification of their enhanced vision system.

"The work of both of these organizations has helped make flying even safer," said Administrator Blakey, adding: "The FAA will continue to encourage research and innovation in order to fulfill our mission to improve continuously the safety and efficiency of aviation." "These organizations have done exemplary research to further the needs of the aviation community. Their willingness to invest in critical research activities have led to exemplary products that are benefiting the flying public," echoed Joan Bauerlein, FAA's Director of Aviation Research and Development.

The Flight Safety Foundation's Waterproof Flight Operations fills a critical knowledge gap. This reference work synthesizes into one comprehensive document information on how to ditch an aircraft in the unlikely event of an accident, how to select life rafts, how to use the required equipment, and what might be expected from search-and-rescue resources in various parts of the world.

Noting that this type of information was not readily available for corporate, fractional, on-demand, and commuter operators, the Flight Safety Foundation staff studied the literature on ditching and post-ditching survival, helped conduct an in-the-water life raft evaluation, visited survival-equipment manufacturers, and examined safety-related equipment. In the course of this review, they also interviewed specialists in safety, survival and training, manufacturers of aircraft and equipment, regulatory authorities, and many others. This work has been distributed to over 1,625 professionals in 890 aviation organizations worldwide.

The Gulfstream Aerospace Corporation conceived the idea for its enhanced vision system (EVS) in 1994, formally began a development program in 1998, and received FAA certification for this technology in 2001. The Gulfstream EVS uses an infrared camera to create and project an image on a Head-Up Display (HUD) that precisely overlies the pilot's real-world view. At night or in low-light conditions, the EVS presents an image comparable to a visual scene in daylight, VFR operations.

The Gulfstream EVS proved so effective that in February 2004, the FAA revised FAR 91.175, revising the regulations for landing under instrument flight rules (IFRs), allowing use of FAA-certified enhanced flight vision systems (EFVS) to determine "enhanced flight visibility." Pilots using EFVS can now descend and operate aircraft below decision height, decision altitude, or minimum descent altitude by using the EFVS image to detect the required visual cues and to determine flight visibility.

This highly competitive Excellence in Aviation Research Award is presented annually to individuals and/or institutions whose contributions through aviation research have resulted in significant improvements to the National Airspace System. Through presentation of the award, the FAA formally acknowledges the value of aviation-related research efforts.

Making Winter Flying Safer

New Tools Forecast In-Flight Icing Severity

"Every year accidents occur due to ice accumulation on aircraft surfaces during flight," explains Gloria Kulesa, manager of FAA's Aviation Weather Research Program. "This is particularly true for general aviation, air taxi, and commuter aircraft that fly slower, spend more time 'in the weather' and are therefore vulnerable to the in-flight icing hazard. Those aircraft may not have sophisticated deicing equipment used by larger commercial aircraft." To address the problem, the Aviation Weather Research Program is funding and managing the development of new automated weather tools designed to warn users of potential areas of in-flight icing. One tool, the Current Icing Potential (CIP), give meteorologists and dispatchers information on current in-flight icing conditions. A companion tool, the Forecast Icing Potential (FIP), forecasts the potential for icing for up to twelve hours.

"One of the best ways to manage the risks of bad weather is to avoid it entirely. With information provided by the automated CIP and FIP, pilots flying aircraft below 18,000 feet can be warned of potential in-flight icing hazards," says Kulesa. These tools use data from satellites, radar, surface observations, a lightning detection network, pilot reports, and computer models to generate high-tech color weather maps and/or flight route displays of icing potential at flight levels from 3,000 to 18,000 feet. Using these tools, users can look at current conditions as well as select forecast times of three-, six-, nine-, and twelve-hours as they plan safe routes of travel.

Because CIP does not currently predict icing severity, the tool must now be used in conjunction with operational icing advisories, such as AIRMETs and SIGMETs, that still official forecast icing severity. AIRMETs forecast moderate icing for six-hour periods while SIGMETs forecast severe icing for four-hour periods. To ease this limitation, the aviation weather researchers are developing an in-flight icing severity algorithm. The icing severity algorithm takes advantage of current knowledge of the factors controlling severity of icing along with available information on atmospheric conditions. The CIP-Severity provides hourly updates, user-friendly graphics, and altitude specificity. After extensive testing, the Current Icing Potential with provision for icing severity was approved in August 2004 for experimental use on the Aviation Weather Center's Aviation Digital Data Service.

The Current and Forecast Icing Potential tools join the growing FAA-developed suite of advanced weather capabilities. All are available, on-line, to the public at: http://adds.aviationweather.gov. With funding from the FAA's Aviation Weather Research Program, the National Center for Atmospheric Research in Boulder, Colorado, is developing many of these new icing tools. When development is complete, the FAA will transfer the tools to the National Weather Service for operation and maintenance.

Ms. Kulesa explains: "We are working with the community to understand the science of weather better and to develop accurate, reliable forecasting tools that will ensure safety and efficiency of the national airspace system." She adds that: "Through user meetings, our scientists are working to ensure that we meet the needs of the flying public. We provide access to new tools, making sure they are publicly available during the experimental phase of research, so that we can get user feedback to make improvements prior to operational release."

For additional information on the FAA's aviation weather research program, please contact Gloria Kulesa at gloria.kulesa@faa.gov.

Protecting Passengers and Crew

New Center of Excellence Focuses on Cabin Air Quality

From left to right: Larry Benefield, Dean of Engineering, Auburn University, William F. Gale, COE Executive Director, Auburn University, Nicholas Sabatini, FAA Associate Administrator for Regulation and Certification, Barton C. Prorok, Co-Principal Investigator for PI for Auburn's COE team, Auburn University, C. Michael Moriarty, Associate Provost and Vice President for Research, Auburn University

The FAA recently established a new Air Transportation Center of Excellence. The Center of Excellence for Airliner Cabin Environment Research, led by Auburn University, will research cabin air quality and assess chemical and biological threats. Other universities taking part in the effort include Purdue University, Harvard University, Boise State University, Kansas State University, the University of California at Berkeley, and the University of Medicine and Dentistry of New Jersey.

In making the announcement FAA Administrator Marion Blakey stated: "We've brought together some of the brightest minds science has to offer to focus on cabin air quality and chemical and biological threats to protect passengers and crew members. This research will be of great benefit to the flying public." The FAA plans to invest at least $1 million in the Center the first year and $500,000 in each of the second and third years. Matching funds will be provided by the private sector.

Legislation passed in 1990 allows the FAA to partner with universities and industry to conduct research and development toward improving aviation safety, environmental impact and efficiency, and airspace and airport planning and design. Each of the seven previously established Centers of Excellence specializes in one of these vital areas of aviation research: computational modeling of aircraft structures, airport pavement technology, operations research, airworthiness assurance, general aviation, aircraft noise, aviation emissions mitigation, and advanced materials.

For more information about the FAA's Centers of Excellence program, please visit www.coe.faa.gov.

FAA Centers of Excellence 4th Annual Joint Meeting

"Global Leadership:

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Lighting the Way

Solar-Powered Lights for General Aviation Airports

A technology that helps guide military pilots in Iraq might someday show the way for private pilots at home. "Our researchers are installing and testing solar-powered taxiway lights at Cross Keys Airport in Gloucester County, New Jersey. This innovative program could eventually benefit thousands of small general aviation airports across the country. These are the same taxiway lights that guide pilots of U.S. fighter jets and cargo planes deployed in the Middle East," explains Dr. Satish Agrawal, manager of FAA's Airport Safety Technology Research program.

In early December, FAA visual guidance specialists began installing a total of 90 edge lights on the taxiways at Cross Keys. (The main runway will not require the lights.) The blue light-emitting diode lights will remain on from dusk to dawn. Over the next nine months, researchers will check the test lights for visibility, durability, and effectiveness.

According to Dr. Agrawal, "Many smaller general aviation airports have minimal, if any, lighted guidance for pilots taxiing from runways to parking areas. The solar-powered lights will add safety to remote sites that lack access to electricity, as well as those airports with limited resources to pay for power."

The FAA *Aerospace Forecasts* reports that general aviation operated in 19,000 different private or public airports last year. Cross Keys Airport, 14 miles southeast of Philadelphia, is representative of a typical general aviation airport that lacks taxiway edge lights. The solar-powered lighting system is one of many ways the FAA's Airport Safety Technology researchers are working to enhance safety at airports.

For information about the group's other projects, visit http://www.airporttech.tc.faa.gov

Detecting Birds Near Runways

Millimeter Wave Radar Tested at Dallas-Ft. Worth

Wildlife found on and near airports can create a hazard to operating aircraft. In recent years, the increase in passenger traffic, the introduction of much quieter engines on newer planes, and a large increase in wildlife population, have all contributed to an increasing risk of collision between aircraft and wildlife. In the year 2004, for example, over 6,000 strikes were reported. Annually, aircraft collisions with birds and animals cost the U.S. civilian aviation industry about $400 million in aircraft repair or replacement and associated costs, and almost 500,000 hour of aircraft down time.

"Besides cost concerns, bird strikes are a real safety risk," explains Dr. Michel Hovan, FAA's Wildlife Strike Mitigation Research program. "Bird strikes have resulted in engine failure, airframe penetration, and even crashes. To mitigate these increasing bird strikes, the FAA has a research program that is providing practical solutions and developing technologies that could, in the future, provide real-time information to pilots, air traffic controllers, and airport managers."

As part of this ongoing effort, the FAA recently tested a new prototype bird detection radar at Dallas Fort Worth International Airport (DFW). This type of radar uses very low power, operates in the millimeter range (MMW), and does not interfere with other airport and FAA communications, navigation, and surveillance equipment.

The FAA's Office of Aviation Research and Development developed the radar under the U.S. Air Force 's Dual Use Science and Technology program. This research project also received the full cooperation of DFW, along with support from the University of Illinois, and Waveband Corporation of Irvine, California. During prototype development, the FAA previously conducted limited tests of the radar at New York's John F. Kennedy International Airport and at wildlife refuges in California.

The DFW tests were successful, and large flocks of blackbirds were detected up at ranges up to 1.5 mile. Additional tests are required to acquire data to the designed range of 3 miles.

In the future, with additional hardware improvements and data processing software refinements, use of the radar will help the National Bird Strike Advisory System to provide real-time warnings of bird flocks near many more airports. This should enhance overall airspace safety and reduce aircraft damage and potential accidents due to bird strikes.

For more information on the FAA's wildlife strike mitigation research program, please visit http://wildlife-mitigation.tc.faa.gov or contact Dr. Michel Hovan at michel.hovan@faa.gov.

Forecasting Marine Stratus

New System Transferred to National Weather Service

The FAA has transferred a new technology that predicts the dissipation of fog at San Francisco International Airport to the National Weather Service for operational use. Developed by the FAA's aviation weather research program, the Marine Stratus Forecast system provides daily forecast guidance to aviation weather forecasters and air traffic managers for anticipating the precise time of cloud dissipation. With this information, controllers can now implement and cancel special delay programs to safely minimize overall air traffic delays.

"Marine stratus (low clouds typical along California coastal areas during the summer) in the approach zone prevents independent parallel approaches to San Francisco International Airport, reducing the number of aircraft that can land by a factor of two," explains Marion Blakey, FAA Administrator. "Until the development of this new tool, air traffic controllers had to impose delay programs nationwide to regulate the flow of traffic until the stratus dissipated."

The system relies on a suite of numerical forecast algorithms using information collected from special sensors deployed at the airport and near the approach zone, as well as standard weather observations and satellite data. The National Weather Service is assuming responsibility for continue operation and maintenance of the system as part of its mission to provide accurate and timely forecasts for the aviation community in the San Francisco Bay area.

The FAA funded MIT Lincoln Laboratory to develop this decision support system. Research team members included San Jose State University, the University of Quebec at Montreal, and the Center Weather Service Unit at the Oakland Air Route Traffic Control Center.

Increasing an Airport's Capacity

FAA/NASA Wake Turbulence Research

FAA/NASA Research is Developing Airport Capacity Enhancing Wake Turbulence Separation Procedures

The FAA and NASA have joined forces to find better ways to mitigate the risk of an aircraft wake turbulence encounter while, at the same time, permitting a greater number of airport runway operations. The program is working to identify and introduce new procedures and technologies that will accomplish this goal.

The Problem

All aircraft generate wake vortices during flight - these vortices can have an impact on a following aircraft. Detecting and tracking an aircraft's wake vortices are not simple tasks. Unless the air is very moist, the wake of a landing aircraft is invisible either to the eye or to present radar systems. Wake turbulence is a vortex of rapidly circulating air. As it approaches the ground, it begins to move laterally resembling the motion of a rolling log. Topography, and other conditions specific to an airport, in combination with highly variable weather conditions make the prediction of a wake's exact movement near the ground especially difficult. Away from the ground, the wake descends and moves laterally as it is slowly pushed around by the prevailing crosswind.

Many major U.S. airports conduct landing operations on "closely spaced" parallel runways - that is, runways having less than 2,500 feet of separation from the centerline of one runway to the centerline of its adjacent counterpart. Currently, when visibility at these airports is deemed too low to permit safe landing operations simultaneously on both the parallel runways, the FAA requires a fixed spacing to be imposed between approaching aircraft. The effect of this wake turbulence spacing, a spacing that will vary based on the type or types of aircraft involved, is to convert landing operations to a capacity equivalent to a single runway operation.

Because of current regulations applicable to many weather situations, wake separation requirements routinely require certain airports to operate at a capacity that is lower than their physical design would support. This change from parallel runway operation to "single runway operation" causes airports, such as Cleveland, Boston, and Philadelphia, to reduce the number of aircraft they can land per hour by as much as 50 percent. Wake turbulence separation restrictions also affects the number of departures from an airport. Major flight delays result, not only at the specific "capacity constrained" airports, but throughout the national airspace system.

The Solution

If the wake separations imposed by air traffic control restrictions could safely be reduced, the capacity of many airport operations would be increased. Advances in our knowledge of wake vortex behaviors and their tracking have the potential to do just that. The safer, more efficient spacing of arriving and departing aircraft would translate into a higher air traffic capacity for airports that are being stressed by increased traffic demands.

The Research

The FAA and NASA have complementary research and development programs to realize the common objective of making optimal, safe use of airport runways in all weather conditions. The FAA's program is gathering sufficient data on the wake vor-

tex behavior of specific landing and departing aircraft to determine whether the application of more efficient runway wake separation procedures might be feasible. Thus, the successful outcome of the FAA's research program would be a wake separation procedural change to allow greater use of runways without the risk of hazardous wake encounters. As this change is procedural, no system development hardware or software would be required, and implementation could occur within the relatively near future

NASA's research program is looking at a broader set of solutions for safely gaining more capacity from our existing airport runways. These solutions would be more technology intensive and would take longer both to develop and implement. FAA is partnering with NASA in this longer-term work. NASA will use wake vortex data collected by the FAA for its procedural changes in its development of airport capacity increasing tools/processes. As NASA proceeds in its development of solutions, FAA will provide system interface and implementation platform requirements. The FAA will also be involved in the evaluation of the NASA developments.

The Research Team

Steve Lang is the FAA program lead of the FAA/NASA Wake Turbulence Research Program. His "home" is the Terminal Service Unit Planning Directorate of the Air Traffic Organization, Washington, DC. Wayne Bryant is the NASA program lead and his "home" is the Efficient Aircraft Spacing Project, NASA Langley Research Center, Hampton, Virginia. "Home" has little meaning to these individuals since they are on the road much of the time, gathering and coordinating the resources to accomplish the joint program.

The program consists of the efforts of a number of organizations both within and external to FAA and NASA. Major program contributors include:

- Department of Transportation Volpe National Transportation Systems Center
- FAA/Flight Standards Service
- FAA Office of Aviation Research and Development
- NASA/Crew Systems and Operations Branch, NASA Langley Research Center
- MITRE/Center for Advanced Aviation Systems Development (CAASD)
- George Mason University
- Massachusetts Institute of Technology Lincoln Laboratory
- Air Line Pilots Association (ALPA)
- National Air Traffic Controllers Association (NATCA)
- Coherent Technologies Incorporated
- NorthWest Research Associates
- Scientific and Engineering Solutions Incorporated (SCENSI)
- Air Traffic Simulation, Incorporated

Data Collection

Researchers have installed an extensive array of instrumentation and data networks at Lambert-St. Louis International Airport to collect and analyze wake turbulence data. The instrumentation can determine for each aircraft landing on the airport's 12R and 12L closely spaced parallel runways: its identification; the approach path it is flying (height and lateral position); the tracks of its associated wakes; the strength of its associated wakes; and the weather conditions it is encountering when landing.

One of the instruments used by the researchers is a windline - a tool that tracks the position of vortices close to the ground. The windline consists of a line of anemometers mounted on vertical poles aligned perpendicular to the runway. The anemometers and mounting poles comprise a rather simple sensor suite. The real complexity in working with a windline is using the data outputs from all

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these anemometers and determining when a wake vortex is present. The Volpe National Transportation Systems Center has devised a difficult algorithm to make these determinations and is now providing vortex track and circulation data sets for aircraft landing on runways 12R and 12L.

A Light Detection and Ranging (LIDAR) system, developed by Coherent Technologies Incorporated, tracks aircraft wake vortices approximately 50 to 500 feet above the ground. The LIDAR works like as radar except at a much higher electromagnetic frequency. This higher frequency allows it to detect tiny particles that are always part the air (aerosol) even in cloudless skies. Sophisticated signal processing allows the LIDAR system to track an aircraft wake vortex by the movement of the aerosol within the wake vortex. There are two operational LIDAR systems at St. Louis, and a third is being readied for accurately measuring vortices of departing aircraft as well as the wind direction and speed at various altitudes above the airport.

The windline and LIDAR systems are linked into a data collection network specifically designed for St. Louis. Additional instrumentation to measure the atmospheric conditions at the airport, to identify the specific aircraft generating a vortex and chart its time of arrival and its height, and to provide a secondary means of validating the recorded wake vortex data has been put into place to support the primary wake vortex tracking.

Wake turbulence data collection with a LIDAR system has been ongoing at St. Louis since November 2003. The windline systems began data collection in March 2004. At a minimum, the data collection will continue until March 2005.

Research Results

For the past three years, the FAA/NASA Wake Turbulence Research Program has been collecting and analyzing wake turbulence data associated with landing aircraft. Data from over 300,000 aircraft landings has been collected and analyzed, first at San Francisco International Airport, and more recently at the Lambert - St. Louis International Airport. The FAA is using the results of the analyzed data to design air traffic control wake mitigation procedure changes that can be implemented without need for additional airport or aircraft equipment.

The wake turbulence data collected so far indicates that proposed changes to air traffic control's operation of St. Louis's 12R and 12L parallel runways in low visibility conditions would yield a more efficient handling of the airport's arriving air carrier traffic. Much more data analyses and human-in-the-loop experimentation will be required, however, for the FAA to approve a procedure change. That approval is expected in early 2006.

Modified procedures would produce some benefit almost immediately. No new supporting systems would have to be procured and installed to implement the modification. Since procedural changes could not allow the maximum use of airport runways, NASA is developing broader technology applications with applicability, and a resulting larger benefit, to more airports. The FAA is contributing the experimental data upon which NASA will base its future system modeling and design requirements. With this input, NASA is developing the wake turbulence behavior models that the FAA will use to evaluate potential new procedural changes.

MITRE/CAASD and Air Traffic Simulation, Inc., are developing data analysis tools that are assisting with the task. Representatives of the air carriers, ALPA, NATCA, and other interested aviation organizations are also reviewing the data analysis products.

For additional information on the FAA/NASA wake vortex research, please contact Steve Lang (steven.lang@faa.gov) or George Greene (george.c.greene@nasa.gov).

Finding Better Ways to Do Business

FAA Better Way Award

From left to right: Richard Anderson, Terry Kessler, Robert Pappas, Paul Swindell, Rick Lopez, Lisa Brasche, John Lively, Keith Griffiths, Lee Clements, Kevin Smith, Andy Kinney, Jeff Stevens

At the Air Transport Association's (ATA) 47th Non-destructive Testing Conference, the FAA and ATA recognized the extraordinary efforts and contributions of an industry/government team in advancing non-destructive test technology. The BETTER WAY AWARD recognizes a government-industry team that has developed and applied a technology, technique, process, or policy to achieve a more sensitive, more reliable, and/or more cost effective inspection of aircraft, aircraft components, or aircraft systems. Nominations are carefully evaluated with reference to technical effectiveness, efficiency and cost effectiveness, obstacles that stood in the way of success, and the associated novelty and innovation of the application. According to Dr. Christopher Smith, manager of FAA's Aging Aircraft Research program, "this award celebrates the accomplishments of the technical experts from across the aviation community who have joined forces to improve safety."

After careful consideration of this year's six nominations, the 2004 FAA-ATA Better Way Award went to the Engine Titanium Consortium's Engineering Studies of Cleaning and Drying Processes for Fluorescent Penetrant Inspection team. The team - consisting of the Engine Titanium Consortium (Iowa State University, General Electric, Pratt & Whitney, and Honeywell Engines), Rolls Royce, Delta Airlines, and FAA researchers - investigated how the cleaning and drying of parts prior to Fluorescent Penetrant Inspection (FPI) can affect overall process performance. This work was innovative in its approach to bringing together government, academia, an operator, and four major engine manufacturers so they could pool their data and carry out research based on a free interchange of ideas and hardware.

A variety of factors determined this year's award winner. The winning team reported on the detrimental effects of alkaline cleaners on penetrant indications, suggested size limitation for aluminum oxides used during grit blasting and pressure limits for various media blast cleaning, and recognized the significance of water as a contaminant (and the related need to keep water away from critical parts). Many of the results from this study are being used by the SAE Committee K to address updates to its Aerospace Materials Specification AMS 2647 rev. B, "Fluorescent Penetrant Inspection Aircraft and Engine Component Maintenance."

"This team overcame many obstacles and complex technical issues to produce landmark data that is already being used to improve FPI practices within the industry," said Smith.

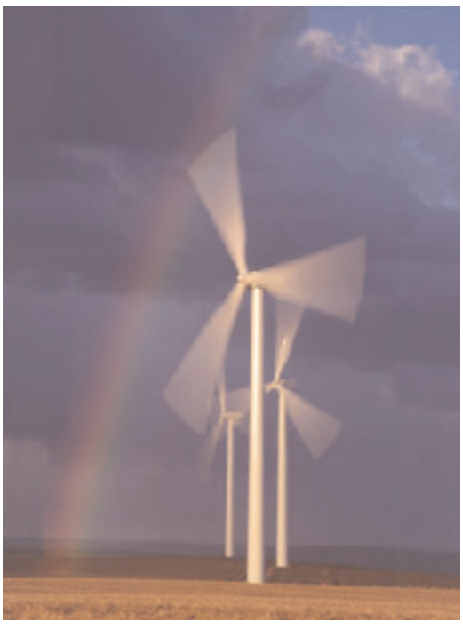
On December 1, Nicolas Sabatini, FAA Associate Administrator for Regulation and Certification, honored the recipients at a luncheon sponsored by the ATA. Sabatini noted the important value of teamwork in the continuing effort to make aviation even safer than it is today. He was especially impressed by the cooperative efforts of the four engine manufacturers in support of this project. The ATA and FAA renewed their commitment to continue this award program in the years to come.

Congratulations to team members:

Lee Clements, Delta Air Lines
Scott Vandiver, Delta Air Lines
Anne D'Orvilliers, Pratt & Whitney
Kevin Smith, Pratt & Whitney
Jeff Stevens, Pratt & Whitney
John Lively, Pratt & Whitney
Andy Kinney, Honeywell
Cu Nguyen, FAA
Paul Swindell, FAA
Terry Kessler, General Electric
Lisa Brasche, Iowa State
Rick Lopez, Iowa State
William Meeker, Iowa State
Brian Larson, Iowa State
Keith Griffiths, Rolls-Royce
William Griffiths, Rolls-Royce
Pramod Khandelwal, Rolls-Royce
Rick Micklos, FAA

Increasing Safety

Ensuring Energy Sources are Compatible with Aviation



Windmills have come a long way since the fictional Don Quixote mistook them for menacing giants. But the modern versions still pose threats to airplanes.

The U.S. Department of Energy reports, as of March 2004, wind power plants are operating in 32 states. Government experts hope wind will provide six percent of the nation's electricity by the year 2020. But standards must be established before the campaign to switch to alternative energy moves on.

FAA regulations require aircraft warning lights on all towers taller than 200 feet, but the turbines on most wind energy farms stand between 300 to 400 feet high. Landowners are concerned that illuminating every windmill in a farm could add annoying light pollution to remote areas. Engineers from the FAA's Airport Technology Research and Development have visited eleven sites to come up with recommendations. Their plan will enhance aviation safety while satisfying the concerns of neighbors.

FAA officials recently reviewed preliminary findings at Blue Canyon Wind Farm in south central Oklahoma and determined the test configuration should be sufficient to indicate the farm to pilots and still not create light pollution for surrounding communities. The facility consists of 43 turbines topped with lights, placed at each end of a row on towers a half-mile apart, for a total of only 17 lights.

The windmill lighting project could help realize the "impossible dream" of alternative energy sources for America, as well as assist in lighting the way for the rest of the world. European nations are among those currently monitoring the FAA's efforts on the wind farm project. The final report, expected in 2005, will likely result in an Advisory Circular determining the future of wind farm lighting in the United States.

The study is one of many ways the FAA Airport Safety Technology Section is working to enhance public safety.

For information about other projects involving our engineers, please visit http://www.airporttech.tc.faa.gov/

Editorial Notes

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