Federal Aviation Administration

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What's Ahead?

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Examining the Facts

Forensic Toxicology

In an era of increasing air traffic and technological advancements, the FAA is working to improve safety and efficiency in the aerospace system. Researchers are particularly focusing on how to increase airport and aircraft safety and how to improve human performance, Within this dynamic environment, a small group of dedicated medical researchers at the Civil Aerospace Medical Institute (CAMI) are quietly carrying out forensic toxicology studies to ensure the continued safety of aircrews.

The medical researchers in CAMI's Forensic Toxicology Laboratory routinely conduct toxicological analyses on specimens from victims of aircraft accident fatalities, investigate general aviation and air carrier accidents, and search for biomedical and clinical causes of the accidents, including evidence of chemical use. The results of their work support the regulatory process, making sure medical standards keep pace with other aviation improvements.

Forensic toxicology is a discipline of forensic science concerned with the study of toxic substances or poisons that are harmful to human beings. "FAA's toxicologists are concerned with identifying toxins, determining how toxins act within the body – and when harmful effects occur, isolating the symptoms of various toxins, and revealing how those toxins and symptoms affect the ability of pilots to fly their aircraft," explains Dr. Dennis Canfield, manager of the Bioaeronautical Sciences Research Lab. "Aviation forensic toxicology is a unique medical field, encompassing theoretical considerations, methods, and procedures from disciplines that may include analytical chemistry, biochemistry, molecular biology, epidemiology, pharmacodynamics, pathology, and physiology."

Through the FAA's role in toxicology and other biomedical research, the aviation community is broadening its understanding of biomedical, toxicological, and human performance factors that cause accidents. In particular, the FAA uses this research to:

- Understand the effects of drugs and alcohol on human performance and propose means to reduce the numbers of aviation accidents and major incidents caused by these human impairments;
- Identify medical conditions present in fatal aviation accidents and determine the effectiveness of present medical certification standards;
- Notify the FAA of possible incapacitating medical conditions not reported in pilots' medical histories that may have caused an accident; and
- Provide FAA regulatory authorities and the public with up-to-date information on the effects of drugs on pilot performance and the effectiveness of present and proposed medical certification standards.

Medical researchers play a unique and critical role in accident investigations of all types. CAMI's toxicology laboratory, located at the Mike Monroney Aeronautical Center in Oklahoma City, OK, has long served as the primary national testing site for aviation accidents. Working closely with investigators, the Institute's researchers are involved in every aviation accident, as well as in major highway, railroad, and boating accidents. Their services are used both by the FAA and the National Transportation Safety Board (NTSB), and – as the aviation community's only established resource assisting accident investigation teams - CAMI's Forensic Toxicology Team is frequently called upon to detect and identify the presence of drugs and poisons in bodily fluids and tissues from both national and international accidents.

NTSB investigators make the final decision on the submittal of specimens for analysis, and they typically send biological samples from the pilot and/or copilot to CAMI for toxicological analysis when a fatal aviation accident occurs. The specimens, coordinated through the FAA's Office of Accident Investigation and local coroner or medical examiner offices, are shipped in TOX-BOX evidence containers. Normally, only those specimens from the crewmembers are examined for the presence of drugs and alcohol. However, in cases when there is a fire, researchers may examine specimens from passengers (if available) for carboxyhemoglobin and cyanide to determine if they were exposed to fire or combustion gases.

The team carefully inventories each specimen to account for every piece of evidence received from an aviation accident. Detailed reports ensure that scientists account for every drop of sample used from a case. All batches submitted for analysis contain a blind positive control and a blind negative control to aid in monitoring test results. Further security measures prohibit analysts from accessing the receiving area. And, to maintain legal chain of custody requirements for evidence in the case of litigation, three levels of security are in place to ensure the integrity of the test results. Unless there is pending litigation, specimens of negative and positive bases are properly destroyed after two and five years, respectively, from the date of their receipt at CAMI.

Each aviation accident is different, and so is the postmortem toxicology of the accident-associated fatalities. Initially, however, all submitted biological samples are routinely analyzed for the presence of carbon monoxide and hydrogen cyanide, ethanol and other volatiles, and a wide range drugs. These drugs include many prescription, nonprescription, and illicit compounds. Accurate sample analysis depends greatly on the availability and amount, as well as the number and concentration of analytes. Analytes are substances of various types - such as caffeine (chemical), e. coli (bacterial), and glucose (biological) - that researchers can measure and test analytically.

Depending upon the distribution characteristics of certain substances, appreciable amounts of them may be present in some body parts or fluids, but not in others. Urine, for example, is generally an appropriate matrix for finding drug metabolites. The body creates metabolites from the drug that was originally taken so it can then eliminate the drug itself. Often, because the original drug does not completely come through the body unchanged, it is the metabolites of a drug that researchers test for. The rate of absorption of different substances is influenced by a variety of factors, including height, weight and frequency of use.

"Our forensic toxicology work," says Dr. Canfield, "encompasses the measurement of alcohol, drugs, and other toxic substances in biological specimens – all interpreted in a medicolegal context. The Forensic Toxicology Research Team, however, does more than simply detect and measure drugs, alcohol, toxic gases, and toxic industrial chemicals in victims of fatal aircraft accidents. They also study the conditions that affect the accuracy and validity of such measurements, and they adapt or develop improved methods for ensuring that such measurements are trustworthy indicators of accident causation."

The data from all toxicology research is stored in CAMI's Toxicology Database. This resource includes information from 1990 to the present. Researchers consult these records to compile studies and reports that are used for regulatory and educational purposes. In a recent study, for example, they examined the relationship of selective serotonin reuptake inhibitors (SSRI) to pilot error and accidents. SSRIs are popularly prescribed for treating depression, but these antidepressants are not currently approved for use by U.S. civilian aviators.

For this study, researchers turned to the FAA Medical Certification Database to retrieve elements of aeromedical history from 61 civil aviation accidents- involving pilot fatalities that occurred during 1990–2001. The 61 specimens had tested positive for four SSRIs – citalopram, fluoxetine, paroxetine, and sertraline. The NTSB Aviation Accident Database also supplied pilot medical information and possible causal factors related to the accidents. Fifty-nine of the 61 pilots had medical records on file in the FAA Certification Database. Medical records were unavailable for two pilots – one who had never received a medical certificate and another who had a Canadian pilot and medical certificate. During their past aeromedical examinations, 22 of the 59 pilots had self-reported having driven a vehicle while "under the influence." Seven of the pilots had reported disqualifying psychological conditions, and of these, only three had reported any use of an SSRI. During subsequent medical examinations, six of the previously disqualified pilots had indicated that they were free from the psychological conditions and - as they were no longer taking SSRIs- their medical certificates had been reissued.

Fifty-two of the pilots did not self-report psychological conditions and/or drug use. Nevertheless, the NTSB investigations revealed that 12 of the 61 pilots had a history of a psychological condition and/or an SSRI use, as suggested by their personal medical records. Investigators determined that psychological conditions and/or the use of drugs caused 19 of the 61 accidents. These findings reconfirm that the aviators actually used SSRIs but did not report that use in their last aeromedical examinations.

Researchers found that the problem of not reporting the use of SSRI and/or psychiatric diagnosis continues. As a result, they recommend that aviation medical examiners use caution in certifying airmen with vague psychological signs, particularly in light of the fact that the use of SSRIs is drastically increasing in the society.

Recent forensic toxicology research reports include:

- First-Generation H1 Antihistamines Found in Pilot Fatalities of Civil Aviation Accidents, 1990–2005 (DOT/FAA/AM-07/12, www.faa.gov/library/reports/medical/oamtechreports/2000s/media/200712.pdf).
- The Distribution of Fluoxetine and Norfluoxetine in Postmortem Fluids and Tissues (DOT/FAA/AM-07-15, www.faa.gov/library/reports/medical/oamtechreports/2000s/media/200715.pdf).
- Selective Serotonin Reuptake Inhibitors: Medical History of Fatally Injured Aviation Accident Pilots (DOT/FAA/AM-07-19, www.faa.gov/library/reports/medical/oamtechreports/2000s/media/200719.pdf).

Not only are these CAMI researchers doing groundbreaking aviation safety work, but other forensic toxicologists at the facility are also setting the standards for their profession. The laboratory has received accreditation from the American Board of Forensic Toxicology Accreditation. CAMI is one of only 23 accredited labs. The standards used in such accreditations are based on guidelines developed by the joint American Academy of Forensic Science and Society of Forensic Toxicologists Forensic Laboratory Guidelines Committee. This accreditation program is designed to "enhance and maintain standards of practice for the detection, identification and quantization of alcohol, drugs and other toxins in biological specimens."

In addition, CAMI's laboratory has completed its College of American Pathologists Inspection. This investigation includes a complete in-depth review of the processes, procedures, and capabilities of the Forensic Toxicology Research and Biochemistry Research/Bioinformatics Research Support functions within the Laboratory. Impressed with the caliber of the program and its scientists, the inspectors reported, "This is an excellent forensic laboratory." For two years in a row, the inspectors gave the laboratory an "Outstanding Rating with Distinction." CAMI is the only laboratory in the nation to be accredited by both the College of American Pathologists and the American Board of Forensic Toxicology. ■

For additional information on Forensic Toxicology, please contact Dr. Dennis V. Canfield at dennis.canfield@faa.gov.

Other Options

Alternative Fuels

Many in the aviation industry are now asking a perplexing question: If the world's supply of oil were to dry up, how could the industry survive? With the continuous rise in cost and unstable supply of crude oil, this question definitely bears asking. The world's economy is heavily dependent upon commercial aviation and, in turn, the world's airlines are heavily dependent upon oil to fuel their planes.

Administrator Blakey recently reminded an international audience in Paris, "We're the largest aviation market in the world. We moved 12 percent more passengers and 22 percent more freight in 2006 than we did at the turn of the century." Then, she urged America's global aviation partners to work together to meet a difficult and complex challenge: "Remember, this is in an industry that's very focused on controlling costs and operating more efficiently. In aviation, that means reducing fuel consumption and the emissions that go along with it."

With growth in air traffic predicted to double in the next 15 years, both the government and the aviation industry are concerned about fuel cost and efficiency. Together, they see the rising costs of petroleum as, perhaps, the single largest driver for the adoption of alternative fuels. Energy security and possible environmental benefits, however, are also powerful drivers. While Administrator Blakey points out that the aviation community contributes less than three percent of greenhouse gases, she stresses that it has "… an affirmative obligation to drive that number as low as it can go. Aviation does need to get greener. We need to build on our good record and make it better."

Commercial aircraft use a stringently regulated kerosene-type fuel, refined from oil. At roughly double their historical average, fuel costs now constitute 20 to 30 percent of total airline operating costs. Approximately 53.4 million gallons of jet fuel per day, or 19.5 billion gallons per year, are required to fuel U.S. airlines. When the price increases by just one penny per gallon, it costs the airline industry an additional $195 million in annual operating costs alone. As a way to reduce its expenses and reduce its environmental footprint, the airline industry is exploring its options for alternative fuels created from sources other than oil.

"Before alternative aviation fuels can be developed and adopted, a number of technical, environmental, and policy questions need to be answered," explains Dr. Lourdes Maurice, FAA Chief Scientist and Technical Advisor for Environment and Energy. "Before proceeding with a full-fledged development process, we must work with industry to examine which fuels are feasible and ask how they would affect current infrastructure. What are their environmental costs and benefits? What are the drivers for their adoption? And, what, if anything, should we do to promote alternative fuels?"

In the fall of 2005, the FAA Office of Environment and Energy took the lead in answering these questions when it hosted a long-term strategic brainstorming session with its Research and Engineering Development Advisory Committee (REDAC) subcommittee. Representatives of communities, airports, airlines, manufacturers, and government cited fuel-efficiency, cost, and supply availability as potentially the most challenging issues facing aviation. The committee drafted a series of "scoping" questions to look at the potential of alternative fuels to affect the environment and capacity in civil aviation. The committee also urged the FAA to start a modest investment to address this potentially critical issue.

In May 2006, experts from the FAA met in Seattle, WA, with other concerned groups for a one-day workshop exploring alternative fuels for aviation. Government participants represented the Department of Defense (DoD), Department of Energy (DOE), and NASA. Members of the national and international fuel supply, aircraft and engine manufacturers, and airline industries represented their organizations. Primarily sponsored by the FAA, the Air Transport Association of America, Inc. (ATA), and the Aerospace Industries Association (AIA), the workshop also received support from the Boeing Company and the Port of Seattle. Reflecting this broad base of support, the sessions provided a forum for all sectors of the commercial aviation community to raise issues, concerns, and talk about solutions. Workshop participants agreed that commercial aviation sponsors and stakeholders should work together with DoD and DOE to pursue alternative fuels for the purpose of securing a stable fuel supply, furthering research and analysis, and quantifying the ability to reduce environmental impacts and improve aircraft operations. A follow-up meeting,

held in October 2006, brought together approximately 80 representatives of airlines, aircraft and engine manufacturers, energy companies, and a number of U.S. government agencies. The Commercial Aviation Alternative Fuels Initiative (CAAFI) emerged from their discussions. Led by the FAA, AIA, ATA – along with the Airports Council International-North America (ACI-NA) – the membership of this new organization discussed the present state and future requirements of R&D, the process for certification and qualification, environmental benefits and costs, and business cases and policy needs for alternative fuels.

Over the course of two days, the CAAFI founders agreed on a set of high level goals and steps to pursue as they go forward. These objectives include:
– Securing a stable fuel supply
– Furthering research and analysis
– Quantifying the ability to reduce environmental impacts
– Improving aircraft operations

The new CAAFI group also created four sub-panels: research and development; environmental; economics, business and policy; and certification/qualification. The last panel regularly meets with the American Society for Testing and Materials (ASTM) Committee on Petroleum and Lubricants to ensure maximum compatibility of efforts within ASTM.

CAAFI has developed, and will continue to maintain, roadmaps for advancing and communicating details of alternative aviation fuels, including their adoption status. As part of this push, two major FAA funded studies are underway to complement efforts of the U.S. Air Force and others. One study is looking at the environmental benefits of adopting alternative fuels. The other is examining the feasibility, costs, barriers, and technical issues. Both efforts should be completed in the fall of 2007.

Additionally, the FAA has enlisted the aid of the Partnership for AiR Transportation Noise & Emissions Reduction (PARTNER), centered at the Massachusetts Institute of Technology and connected to ten universities, to go forward with relevant research.

The engine and commercial aircraft research and development communities have been investigating the practicality of using alternative fuels in near-, mid-, and far-term aircraft. Current research shows that the use of a “drop in” jet fuel replacement, a fuel alternative that mimics the properties of today’s kerosene jet fuel, will be possible with existing and near-term aircraft. Future mid-term aircraft may use bio- or synthetic blends to fuel new, or possibly existing, airplane designs. The long-term engines and aircraft of the future may be specifically designed to use a low or near zero-carbon fuel. (*continued on next page)*

Other Options *continued from page 5*

Of the current replacements for kerosene, synthetic liquid fuels manufactured from coal, biomass, or natural gas are not only viable, but they are already in limited use. They may also reduce serious air pollutants such as particulate matter. The DoD has embarked on an aggressive program to promote synthetic fuels and, in the summer and fall of 2006, conducted several successful tests with synthetic jet fuel. Since military jet fuel is almost identical to commercial jet fuel, the DoD efforts could stimulate alternative aviation fuel viability for the commercial sector.

For the mid-term, bio-fuels can be domestically produced and become a renewable fuel that can be manufactured from vegetable oils, animal fats, algae or even recycled restaurant greases. They are safe and biodegradable. However, weaknesses as well as strengths of some of these alternative fuels have already been identified. For example, they tend to freeze at normal cruise temperatures, and they would too readily absorb the heat produced by electronic and other airborne devices.

To be viable in the commercial aviation industry, bio-fuels may need to overcome several technical hurdles. In some cases, they may require some engine modifications to avoid maintenance and performance problems. In other instances, the alternative fuels themselves may need to be modified to improve their performance under normal operating conditions.

Options that blend multiple fuels are also being studied. By combining the properties of candidate sources, scientists may be able to achieve some improved or near carbon neutral environmental goals. At the same time, they may be able to address the limitations of individual fuels, as well as create a better match of the capabilities of a fuel producing region with the level of output desired from it. In all likelihood, there will not be a single fuel alternative "answer," but rather a series of working solutions whose common denominator provides safe and environmentally improved operations on commercial aircraft.

Hydrogen may be a very long-term option dependent on technological developments and potentially prohibitive infrastructure investment. The ability to create hydrogen from a variety of resources, together with its clean burning properties, make it a desirable alternative fuel. The element has been used effectively in a number of internal combustion engine vehicles when mixed with another natural gas. The use of hydrogen-based fuels for aviation purposes, however, would require a major redesign of aircraft engines and is thought unlikely.

Low carbon, liquefied gaseous fuels provide researchers another promising long term option. Liquid methane extracted from methane hydrates, or perhaps liquid hydrogen produced from nuclear (or preferably) solar power, are also being explored, primarily for ground applications. In combination with economically viable fuel saving technologies, these fuels might completely replace the current crude oil derived fuel sources. However, a number of technological challenges would need to be solved prior to their use in air transportation. Their low fuel volume density, even when stored onboard as cryogenic fuel, would result in a requirement for large, heavily insulated fuel tanks that could no longer be integrated into the airframe wings. Also, they would require an economic and environmentally sound way of producing the fuel, a process that still must be developed. The impact of in-flight environmental factors, such as increased water vapor emissions, would have to be better understood. Lastly, a complete, worldwide cryogenic fuel infrastructure would have to be established to make these options viable.

The FAA is focusing on near term "drop in" synthetic and renewable candidates. "Using these alternative fuels in vehicles," concludes Dr. Maurice, "may reduce harmful pollutants and exhaust emissions. In addition, most of these fuels can be domestically produced and derived from renewable sources. This will help the U.S. aviation community reduce its dependence on imported oil, protect public health and the environment, and pave the way for potentially carbon neutral aviation." ■

The New Frontier

Getting Ready for the Next Revolution in Flight: Personal Space Travel

Commercial manned space flights have become a reality with wealthy space travelers sparing no expense to rocket to the International Space Station. Still, the average citizen probably could not afford to journey to, and might not even know about, this new frontier. Creating a market for common-place spaceflight depends on price, trip description – and especially safety. To achieve reliable, safe, and affordable space travel and to interest the general public in it, private industry will have to invest heavily in technical research and launch a successful promotional campaign. But that process has begun as well. Many private companies are now trying to determine the commercial potential of space travel and the technological possibilities of reusable passenger spacecraft, orbital accommodations, and the economics of operating a commercial service.

The Commercial Space Launch Amendments Act of 2004 requires the FAA to promote the development of the nation's commercial space flight industry and to ensure public safety without undue burden of regulations. So, as activities surrounding space flight expand, so too does the work of FAA's Commercial Space Transportation Office. This organization is not only responsible for licensing commercial space launches and spaceports; they also regulate reusable space vehicle operations and commercial manned flight. (*continued on next page)*

Since 1996, the FAA has licensed six spaceports in the United States: California Spaceport at Vandenberg Air Force Base; Spaceport Florida at Cape Canaveral Air Force Station; the Virginia Space Flight Center, now known as the Mid-Atlantic Regional Spaceport (MARS), at Wallops Island; Kodiak Launch Complex on Kodiak Island, Alaska; the inland Mojave Spaceport in California; and the Oklahoma Spaceport run by the Oklahoma Space Industry Development Authority site at Burns Flat. The near certainty that scheduled spacecraft will soon be lifting off with ticketed passengers onboard is changing the spaceport scene.

A recent survey found that space tourism could generate more than $1 billion per year in revenues by 2021. The study also found that suborbital flights will constitute the biggest share of this emerging market, with the potential for 15,000 passengers and $700 million in revenues per year. The more rigorous orbital flights could possibly include up to 60 passengers and generate $300 million per year. Businessmen are alert to this potential, and some in New Mexico, for example, are already discussing the feasibility of constructing a large commercial spaceport that could house visiting passengers.

"Space flight, which has been almost exclusively a spectator sport since it began, is about to open the gates to public participation," said Patricia Grace Smith, FAA Associate Administrator, Office of Commercial Space Transportation at the Center for Strategic and International Studies. "People who are not pilots, not scientists, not military officers, not specialists, and – so far – not astronauts, will be able to take a ride into space."

As part of the Agency's safety mandate, FAA human factors and medical researchers are helping to determine how to keep space passengers and crews safe and healthy. Their work is being used to establish requirements for human space flight, including the formulation of rules governing crew qualifications and training, and the documentation of informed consent for voluntary space flight participants.

To meet the safety demands of this burgeoning industry, the FAA has issued medical guidelines for space travel. "We're making sure that passengers recognize their role in an ultra-hazardous activity," FAA Administrator Marion Blakey said in a speech at the ninth annual Commercial Space Transportation Conference. "They're engaging at their own risk, just the way they would climb a mountain or skydive."

"Space flight exposes individuals to an environment that is far more hazardous than what is experienced by passengers who fly onboard current airline transports," explains Dr. Melchor Antuñano, Director of the FAA Civil Aerospace Medical Institute. "With orbital and suborbital flights, pre-existing medical conditions can be aggravated or exacerbated by exposure to environmental and operational stressors such as acceleration, microgravity, and solar/cosmic radiation."

The FAA's "Guidance for Medical Screening of Commercial Aerospace Passengers" helps operators of space flights assess the health of prospective passengers. The guidance covers suborbital flights over 62 miles above sea level, as well as low earth orbital flights. It identifies pre-existing physical conditions that may result in an in-flight medical emergency, or may compromise the health and safety of other passengers or the crew aboard a commercial aerospace vehicle. Although much is known about how young, healthy individuals withstand the rigors of long duration spaceflights, the medical risks of short duration microgravity exposure are not well understood. In addition, the typical space tourist who boards a suborbital flight will not always be ideally young and healthy. Hence, the regulatory community needs to understand better the physiological challenges of manned space flight to ensure optimal performance and safety for a wide range of passengers.

Last year, FAA aerospace researchers completed a research project that may prepare commercial flight operators to collect voluntary medical data from commercial space flight crews and space flight participants.Researchers were able to define and recommend appropriate biomedical parameters for ad-

ditional pre-flight, in-flight, and post-flight monitoring that will further advance their understanding of the effects of suborbital flight on human physiology. This body of research has allowed the FAA to better specify the types of biomedical data that launch operators will need to monitor the physiological effects of short duration spaceflight. The Agency also offers guidance in selecting appropriate methodologies for the collection and processing of these data types.

In 2003-2004, as private industry raced to develop and test manned reusable launch vehicles in pursuit of the coveted $10 million Ansari X-Prize, the FAA worked to ensure the safety of this burgeoning industry. On April 1, 2004, the FAA Office of Commercial Space Transportation issued the first license for a manned reusable launch vehicle to Scaled Composites, a California-based firm. Seven days later, SpaceShipOne completed the first licensed private sector human piloted commercial rocket launch. Soon thereafter, Richard Branson announced his plans to develop the first commercial space flight operation. And, last September, the FAA issued its first experimental permit to Blue Origin, a private venture that started unmanned suborbital test flights in November.

To ensure the continued safety of prototype reusable craft – and to facilitate research, development, and testing of new design concepts, including vehicles that are intended to carry passengers into space – FAA and industry engineers and researchers are supporting regulatory actions designed to protect in-flight crews who are part of the flight safety system, as well as those on the ground. As a result of this work, the FAA recently issued requirements for obtaining experimental permits for the launching of reusable suborbital rockets.

With these new rules, the FAA hopes to streamline the launch authorization process during a launch vehicle's development phase. Modeled on the experimental airworthiness certificates used in more traditional aviation, the new experimental permits allow developers the opportunity to flight test suborbital space vehicles as many times as needed before applying for a launch license. As FAA Associate Administrator Patricia Grace Smith said in March, "The more you test, the more you learn and the greater the likelihood that your vehicle becomes better and safer."

Once issued, a single experimental permit will cover multiple launch vehicles of a particular design and allow an unlimited number of launches. The one-year permit is renewable following an FAA review. As part of the experimental permit application process, a vehicle developer will need to provide a program description, a flight test plan – and operational safety documentation, including a hazard analysis and a plan for response to a mishap.

FAA researchers also are looking into the feasibility of streamlining the environmental considerations associated with experimental permits. They are developing an environmental impact statement to analyze the impact of launch and reentry of a reusable suborbital rocket. The regulators say the statement will allow an applicant's environmental analysis to focus on specific experimental effects while the (*continued on next page)*

Researchers are studying the separation requirements that will allow certain aircraft and commercial spacecraft to operate safely together within the national aerospace system.

research design still provides the Agency the general data needed to comply with the National Environmental Policy Act and Clean Air Act.

Certainly the greatest challenge the FAA has with the advent of commercial space travel is how to ensure public safety. Researchers are currently conducting analysis and modeling in support of regulatory efforts. The Agency, for example, often uses computer-based models to anticipate public casualties related to commercial launch accidents. Researchers have examined how well current computer models can predict the hazards to humans inside of buildings subjected to external explosive forces. They compared model predictions to the outcomes of historic real-world incidents and to the results of explosive debris and blast forces on uninhabited test articles. They found a correlation between predicted and actual results that helps to reinforce the credibility of how insurance requirements and liability limits are currently established for commercial launch activities.

In a related project designed to further determine and refine the accuracy of debris dispersion models, FAA and NASA researchers studied characteristics of debris recovered from the Space Shuttle Columbia accident. As part of this study, researchers established a processing area and set up scales, cameras, computers, and other equipment for recording information into a database. Then they began to develop and optimize the procedures for the labor intensive task of processing the large quantity of debris. The debris collection, stored in the Vehicle Assembly Building at Kennedy Space Center, contains over 84,000 items, most of which are associated with GPS latitude and longitude impact coordinates. The coordinates, along with physical measurements and aerodynamic features such as shape and ballistic coefficient, can help analysts to develop and refine debris dispersion models that are used for establishing safety requirements and evaluating public risk associated with space operations.

With a focus on the rapid evolution and complexity of new launch vehicles, Agency researchers are leading efforts to establish new processes to evaluate and approve the safety of critical launch vehicle components, systems, and space vehicle traffic. Commercial space researchers are currently completing a historical database of failures and the reliability of rocket-powered vehicles. The goal of compiling and maintaining the database is to give the commercial space industry insight into what fails and why, which can hopefully lead to safer and more reliable operations. Other efforts this year involve a study of human spaceflight training preparation and an analysis of the duty and rest requirements applied to safety operations personnel conducting commercial space transportation operations.

Researchers are studying the separation requirements that will allow certain aircraft and commercial spacecraft to operate safely together within the national aerospace system. Researchers are looking at the vehicle and space mission characteristics and conducting general risk analyses to determine initial separation requirements based on the space vehicle and launch site characteristics. They may also conduct fast-time simulations to test the combination of mission and separation requirements within a high-fidelity model of the actual traffic environment. If they find that initial separation criteria and mission requirements result in unacceptable traffic impacts, they plan to propose alternative vehicle characteristics, mission characteristics, and/or risk analysis parameters to mitigate those impacts. ■

For more information on the FAA commercial space activities, visit http://www.faa.gov/about/office_org/headquarters_offices/ast/.

Eurocontrol

Taking a Look at Global Air Traffic Management

In a continuous effort to create a harmonized global air traffic management system (ATM), the FAA and the EUROCONTROL Organization for the Safety of Air Navigation host a joint air traffic management research and development symposium every two years. The seventh such seminar took place this past July in Barcelona, Spain.

"This meeting is unique in that it is the only forum that specifically focuses on ATM research and provides a venue for bringing ATM researchers together," says Barry Scott, the Acting Director of FAA Research and Technology Development. "We have been fortunate that for the past seven years, the seminar has attracted some of the best ATM researchers in the world. This four-day event has opened lines of communication, resulted in collaborative research, and provided a forum to discuss some very difficult R&D questions."

This year's USA/Europe Seminar on Air Traffic Management Research and Development focused on next generation ATM systems. Aviation authorities around the world are now defining and developing new, sophisticated technologies to improve safety and capacity. Fernando Palao, Spain's Transport Secretary of State; Victor Aguado, EUROCONTROL Director General; Bo Redeborn, EUROCONTROL Director of ATM Strategies; Luc Tytgat, European Commission, Single Sky and Modernisation of Air Traffic Control Unit; Carey Fagan, FAA Air Traffic Organization, Operations Planning Director of International; and Barry Scott provided opening remarks.

The 216 participants at this year's meeting hailed from 20 countries. Attendees presented 66 papers, which were categorized within a number of technical themes, including:

- Air Ground Integration
- Integrated Airport Management
- Dynamic Airspace Management
- Environmental Considerations in ATM System Design
- Finance, Deployment and Implementation Issues
- Human Factors in ATM
- Innovative ATM Concepts
- Network and Traffic Flow Optimization
- ATM Performance
- Safety in ATM

One paper in each of the categories earned a "best paper" award. Kevin Corker of San Jose State, Diana Liang of the FAA, Paul Lee of San Jose State, and Tom Prevot of NASA received recognition for submitting the best conference paper "New air traffic management concepts analysis methodology: application to a multi-sector planner in US airspace." All of the papers can be found online at http://www.atmseminar.org/all-seminars/atm-seminar-2007/papers_calendar. In addition to the formal program, the seminar featured a poster session to highlight cooperative FAA/EUROCONTROL research. This session included posters on operational concepts, validation & verification strategy, aviation's impact on environment, wake turbulence research, and safety R&D.

Christian Pusch, EUROCONTROL Experimental Centre, and Sabrina Saunders-Hodge, FAA Air Traffic Organization Operations Planning Research and Technology Development Office, chaired the seminar. Preliminary planning is now underway for the next conference, which will be held in the U.S. in June 2009. ■

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Taking the Initiative

The Aviation Safety Information Analysis and Sharing (ASIAS) Program

The FAA, along with other government and Industry partners are embarking on a major new initiative expected to improve aviation safety through the exchange of information among all segments of government and the civil aviation industry. The Aviation Safety Information Analysis and Sharing (ASIAS) program will provide a protected environment in which the FAA and ASIAS stakeholders can work together to identify emerging safety issues before they lead to serious incidents / accidents. ASIAS started as a collaborative effort with NASA and focused on electronic sharing of flight operations and pilot report data. The ASIAS Program expands upon this concept, integrating a wide-range of diverse data sets within and external to the FAA. ASIAS will include accident data from the National Transportation Safety Board, the voluntary Aviation Safety Reporting System (ASRS), the operational National Airspace System (NAS), as well as fielded flight standards and aircraft certification data sets and commercially available data sources.

The FAA's research project manager, Thomas N. Tessitore, points out that NASA has already developed the Voluntary Aviation Safety Information-sharing System (VASIS), a precursor to ASIAS, under the VASIP program. "NASA began developing the technical process to mine and merge deidentified safety data from participating Flight Operations Quality Assurance (FOQA) and Aviation Safety Action Program (ASAP) partners, and make these data accessible for analysis by industry and FAA stakeholders. The future challenge is to create an infrastructure to allow safety experts to connect additional safety data on a wider scale, and aid them in identifying potential issues and acting on them."

FAA researchers are determining the best methods and technologies to gather and disseminate safety data that will help mitigate the potential for serious incidents and accidents. ASIAS will provide a system by which all stakeholders can identify trends in safety reports over time, and determine common factors that may not be readily apparent.

"ASIAS will create that collaborative environment by bringing together the diverse sets of information containing digital, textual, and other forms of data," explains Tessitore. "By improving the sharing of information, we will enhance safety risk analysis and provide experts the aviation data to examine proactively – instead of reactively – so they will be able to interpret all the flight data, studies, and statistics merged at one central location, strengthen the safety culture of the entire aviation community, and reduce the risk of accidents and major incidents."

Tessitore predicts that, within the next few years, ASIAS will become the aviation community's one-stop reference for preparing risk assessment and safety management plans. Presently, most of the data exists in fragments with each agency, company, or research organization having information available only to its own experts. ASIAS will provide safety experts larger integrated data sets for analysis. The additional data could permit their analysts to better understand factors that contribute to incidents and anomalies, and form conclusions about causal relationships they could not draw right now.

FAA researchers are investigating the information technology infrastructure needed to assimilate the varied data sources and make ASIAS a reality. Tessitore believes end-users will get the most benefit from an enterprise-level computer service-oriented architecture powered by one of the world's leading business software providers. The design would allow different systems, hosted in very different platforms, written in different languages, protected by different firewalls, to communicate seamlessly with each other over net-centric infrastructure. .

Currently, the MITRE Corporation's Center for Advanced Aviation System Development is transitioning the VASIS system prototyped by NASA to the FAA. MITRE will help define operational concepts and architectures, to enable the development of ASIAS. This summer, researchers at the University of Texas are using archival data to conduct sample safety analyses. In the meantime, Tessitore is interviewing representatives of industry and government stakeholders in an effort to outline the IT architecture requirements and define the core services ASIAS would provide. The program is seeking initial approval from the Commercial Aviation Safety Team (CAST), a coalition of airlines, manufacturers, labor, and government working together to improve aviation safety.

"Governance is a main criterion," Tessitore states. "We are setting up standards and procedures so companies and government agencies can determine how and when to exchange information. Any privacy concerns must be eased to protect sensitive proprietary data. Using NASA as a third party provider, the FOQA and ASAP programs have been extremely successful at scrubbing identifying features from voluntary reports while retaining relevant safety data, clearly showing that a cooperative approach to safety can be achieved without sacrificing personal or propriety rights of individuals and organizations."

For fiscal year 2008, researchers will help define the technical processes required for ASIAS to extract de-identified safety data from airlines and integrate that information with data from FAA, ATC, and other aviation data sources. Research will aid in the development of automated vulnerability and discovery tools to monitor known safety issues and identify emerging safety threats. For FY 2009, the program will be expanded to include general aviation and other stakeholders such as rotorcraft and the Next Generation Air Transportation System.

"To handle the projected increase in air traffic safely," concludes Tessitore, "we need a culture shift to move from regulatory certification and oversight to a spirit of cooperative information-sharing. That atmosphere and technology will allow all of us to look for problems before they happen, as opposed to analyzing accidents after they happen." ■

Safety While Seated

Developing Fire-resistant Aircraft Seats

The FAA maintains an aggressive research and development program to improve aircraft safety and increase the chances passengers will survive both the initial impact of a crash and its aftermath, when fire and smoke can pose an additional hazard. Many significant changes to aircraft have resulted from the work of this program. Today's aircraft seats have been strengthened to withstand an impact of 16 Gs. Cabins must now be equipped with low heat release panels (sidewalls, stowage bins, ceilings, and partitions), fire extinguishers, heat-resistant slides, emergency floor lighting, and an independent power source for public address systems. Lavatories are protected with smoke detectors and automatic fire extinguishers. Fuel tanks have been strengthened to reduce the risk of rupture on impact, and cargo and baggage compartments have been reinforced with flame-resistant materials to prevent burn-through fires.

FAA fire safety researchers, with their ability to perform unique full-scale testing, proved that adding nontoxic fire-blocking material to urethane foam seat cushions would greatly reduce seat flammability. The resulting improvement was expected to prevent certain types of in-flight fires and add 40 to 60 seconds for passengers to escape during a severe fuel-fed postcrash fire. Further testing performed within the program became the basis for FAA regulations that were issued in 1984 to impose new flammability standards upon the manufacturers of seat cushions. As a direct result of this work, the airline industry retrofitted over 650,000 aircraft seats with fire-blocking layers. Today, all commercial aircraft worldwide adhere to these standards.

Seat manufacturers responded to the 1984 regulations by encapsulating the foamed polyurethane rubber cushions in a heavy fire-blocking layer of material, such as Nomex® or Kevlar®. Later, they introduced versions of a blocking layer made of polybenzimidazole (PBI), a felt material with excellent fire resistance. This extra layer, however, added as much as 200 pounds to a typical 150-seat aircraft like a Boeing 737-700. And, those 200 extra pounds resulted in consumption of an additional 20,000 gallons of fuel per year.

"In the aviation world, more weight translates to higher fuel costs," says Timothy R. Marker, FAA fire safety researcher. "With fuel prices skyrocketing, the airlines and manufacturers are looking for ways to reduce weight. Recent developments in material sciences have created newer lightweight materials that may work well in aircraft." Manufacturers already have developed materials that have dramatically reduced the weight of seats. The new foams, made from melamine resins, are more heat resistant than the polyurethane foams, and they can perform equally well in the required laboratory test. Furthermore, the manufacturers claim the melamine foams do not need the extra layer of fire-resistant material required to pass the FAA rule, thus greatly simplifying the construction.

FAA regulations require the cushion and its cover to meet a strict combination of criteria: they must resist burning to a minimal extent, and when they do burn, they must not lose more than a set percentage of their original weight. For testing, researchers routinely expose mockup aircraft seats to flames from a high-intensity kerosene oil burner for two minutes before evaluating both their burn resistance (or "char length") and their weight loss characteristics. To pass the current tests, 18-inch-wide specimens must not burn more than 17 inches across, and their average weight loss must not exceed 10 percent.

Manufacturers, however, argue that the current testing parameters do not provide valid contemporary results, for they were developed to evaluate a previous (much heavier) generation of materials. As already noted, the economic demands of aviation have led to the development and prevalent use of new "lightweight" foam seats. Because these seats lack the heavy outer layers of the old counterparts, a slightly greater overall percentage of their weight tends to be lost when they burn. The manufacturers argue that this slight percentage increase in weight loss does not pose a safety threat, and the FAA's safety standards, and related testing, should be revised accordingly.

Because of the concern expressed about the applicability of what manufacturers term the "10-percent criteria" to newer seat construction, the International Aircraft Material Fire Tests Working Group decided to conduct their own flammability tests on the new seat materials. The Working Group, headed by the FAA and comprised of government, industry, and trade association representatives from around the world, began working with the seat manufacturers and airlines to develop new test criteria for the lightweight seats. (*continued on next page)*

"Basically," explains Marker, "the lighter foams lose more than 10 percent of their weight when burned – even if the relative amounts of foam and fabric that burns remain the same. The manufacturers asked us if there's any way to offer some slippage in terms of the criteria because these materials are so light. So, we agreed to look at the new foams under realistic conditions."

Three manufacturers sent seat cushions made from four new materials to the FAA, where researchers first conducted a series of laboratory-scale oil burner tests and ascertained the samples did indeed fail the weight loss criteria. The researchers then submitted the seats to testing in the FAA's Full-Scale Fire Test Facility. They simulated a severe, but survivable, postimpact cabin fire inside the test article, a modified narrow-body aircraft fuselage with flames from an adjacent fuel pan.

"It turns out," Marker concludes, "the lightweight seat cushions performed as well as the heavier cushions with a fire-blocking layer that comply with the FAA weight loss standard. We found we can allow the use of the new 'lightweight' materials by imposing additional criteria based on the ratio of the outer dress cover to the interior foam and limiting the combined total weight to three pounds."

As a result, FAA researchers have developed new fire test criteria for these new materials, called Corrected Allowable Weight Loss. These criteria provide a sliding scale that specifies an increasing allowable percentage weight loss as the weight of the foam cushion decreases. In addition to the weight loss criteria, researchers also have suggested requiring a conservative surface burn length for the new cushions.

Marker describes the two-year testing process and development of Corrected Allowable Weight Loss criteria in the recently published final report, "Laboratory-Scale and Full-Scale Fire Testing of Lightweight Aircraft Seat Cushion Materials," (DOT/FAA/AR-06/49). As a result of this research, he expects the project's sponsor, the FAA Transport Airplane Directorate, to issue a policy letter soon that addresses fire test criteria for lightweight aircraft seat cushions.

"Weight reduction and flame resistance is critical to creating safer and more efficient aircraft," states Marker. "These are also important considerations for a number of non-aviation-related industries. We are now seeing that these newer lightweight foam materials, developed for aviation use, are being considered by other industries for use in building construction, other transportation modes, etc. This is a great example of technology transfer from the aviation industry to other commercial applications." ■

Information on the FAA fire materials research is available online at www.fire.tc.faa.gov. The report is available by clicking http://www.fire.tc.faa.gov/pdf/06-49.pdf.

Runway Status Lights

A Look at Things to Come

A new era for runway incursion prevention is about to begin at the nation's commercial airports. In July 2007, the FAA approved the initial deployment of runway status lights (RWSL) at 19 of the busiest airports in the U.S. FAA's Advanced Technology Development and Prototype Group developed this new system after more than five years of intensive design, evaluation, and field testing.

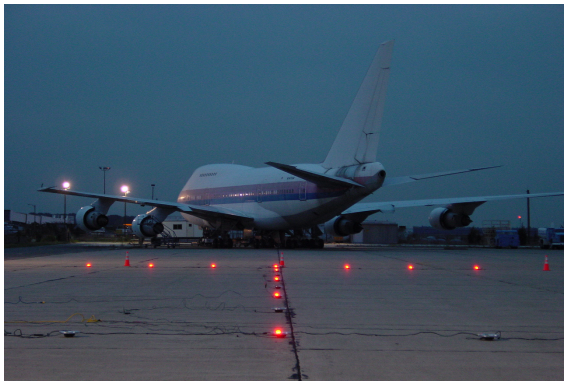
To maintain safe separation of aircraft on the airport surface, air traffic controllers issue verbal clearances to pilots to sequence aircraft arrivals, departures, and runway crossings. RWSL are an automated tool designed to further reduce the number of runway incursions and surface conflict accidents without interfering with the safe and orderly conduct of daily air traffic control (ATC) operations. The technology is designed to enhance runway safety without increasing controller workload or decreasing airport capacity.

"RWSL is an all-weather automatic system providing safety backup to controllers, pilots and vehicle operators," explains FAA program lead, Jaime Figueroa. "It offers a means to increase situational awareness by indicating that it is unsafe to enter, cross, or begin takeoff from a runway. The goal, of course, is to reduce runway incursions and help to prevent certain classes of runway accidents."

The RWSL system integrates commercial-off-the-shelf airport lighting equipment with existing airport approach and surface surveillance systems to provide a visual signal to pilots. When airport radar detects an incoming airplane within a mile of the airport or a departing airplane accelerating above 34 miles per hour, red lights switch on to provide a clear no-go signal to waiting pilots. The lights are driven automatically by computer software that processes the Airport Surface Detection Equipment, Model X (ASDE-X) and terminal surveillance information. These two contributing systems detect the presence and movement of aircraft and vehicles on or near the runways.

"In all cases, RWSL signals indicate runway status only; they do not communicate a clearance," reiterates Figueroa. "Clearance can only be provided by air traffic control. If for some reason ATC has issued a clearance, but a status light is illuminated, the pilot or vehicle operator are expected to stop and verify the clearance with ATC before proceeding. We have included this precautionary protocol in the RWSL training material for controllers, pilots, and vehicle operators." Designed to be an all-weather automatic system providing safety backup to controllers, pilots, and vehicle operators, RWSL improves situational awareness via a visual alert indication to virtually all of the safety-critical personnel operating upon, or responsible for, the runway environment. As currently configured, the system consists of runway entrance lights and takeoff-hold lights embedded in the taxiway pavement and positioned where taxiways feed onto or cross runways.

While FAA deploys the first 19 systems, Agency researchers continue to enhance the system and make it an even more effective safety tool. They are currently examining the feasibility of using runway intersection lights and final approach runway occupancy signals (FAROS) as additional features of RWSL. If these upgrades operate as planned, they will provide a warning signal to pilots that a runway is unsafe for landing because a high speed operation is in progress on an intersecting runway. Like runway entrance lights, FAROS signals would illuminate red to warn a pilot of conflicting traffic and disappear when it is safe to cross the intersection. If proven effective, enhanced runway intersection lights would be installed in the pavement at selected runway and runway intersections.



FAROS would piggy back onto a system already deployed at many airports. Precision Approach Path Indicator (PAPI) lights are used at airports to provide visual glide slope guidance in non-precision approach environments. A row of PAPI lights placed perpendicular to the approach path are seen by the pilot in combinations of red and white to indicate a path that is too high, too low, or correctly on slope. FAROS would flash the lights of the existing PAPI system to provide a visible indication to approaching pilots that the runway is occupied. FAA researchers believe that they can use the PAPI lights for what they call passive FAROS for low density airports and active FAROS for high density airports. Passive FAROS would indicate to the approaching pilot that the runway is occupied. However, if the approaching aircraft is below the FAROS execution height, making it impossible for the flight crew to verify safe separation visually from the traffic on the runway, the pilot would have to contact the tower to verify landing clearance – or be told to execute an immediate go-around. Active FAROS, on the other hand, would indicate to the approaching pilot that the runway is, indeed, unsafe for landing because of conflicting traffic on or near the runway.

The aviation community is awaiting installation of the first 19 RWSL systems with keen interest. Operational evaluations conducted at the Dallas Fort Worth and San Diego airports received praise from users, who said that the system substantially increased safety margins. "When fully implemented," says Figueroa, "RWSL will be a pivotal technology for preventing runway incursions and reducing the severity of runway incidents. Improving safety is our primary mission in the Runway Incursion Reduction Program, and RWSL is leading the way." ■

Q&A

A Few Words from Chuck Larsen

Q: Will you tell us a little about your background as a researcher manager?

A: I have been leading the FAA's Office of Commercial Space Transportation (AST) research and development (R&D) effort since early 2001. Prior to this, the Office had been doing research on an ad hoc basis. As the U.S. commercial space transportation industry grew, and with it a commensurate increase in our Office's responsibilities to oversee the public safety, it became evident that a more disciplined and focused approach to conduct safety research would be of paramount importance. I was tasked by our Associate Administrator, Patti Grace Smith, to put together an R&D Program that would further AST's and the FAA's mission of overseeing the safe, reliable operation of the nation's commercial space transportation activities. Within a year, we had developed a Charter and an AST Research and Development Plan that provided the structure and management oversight necessary for an effective R&D Program to support our mission.

Q: Why did you choose aviation/space and the FAA as a career?

A: I came here for a number of reasons. First, from an early age, I was fascinated by the speed and power of airplanes and fast cars, building models of fighter jets as a boy, and becoming a fan of sports car racing as a teenager. In school, math and science were my best subjects, and when it came to college, I chose Mechanical Engineering to major in (at U.C. Berkeley, Aerospace Engineering was in the M.E. Department). After the Soviet's launched Sputnik in 1957, I became an avid follower of our space program. I won a college scholarship from Aerojet-General Corporation and held summer jobs with them while in college – so I was sold on working in aerospace before I ever got my degree. I joined the DOT/FAA in 1994, after working my entire career in private industry up to that point, and brought some industry perspective to the Office.

Q: In what ways does your research program support the FAA mission?

A: The AST research program supports the FAA's mission primarily in the area of increased safety. For a number of years, we have had as our safety objective in the FAA's Flight Plan to "Ensure the safety of commercial space launches." AST is proud of its record of no fatalities, serious injuries, or significant property damage to the uninvolved public during licensed or permitted space launch and reentry activities. Other areas of the FAA'S mission where AST considers research projects would be to increase capacity, such as through automation, but with an equivalent level of safety.

Q: What kind of research projects is AST currently undertaking?

A: Research projects that we are just completing for this year are concerned with our regulations for human space flight. We have looked at flight crew training requirements and crew rest and duty cycles to ensure that commercial space transportation operations are conducted safely. We also have compiled a historical database of failures and the reliability of rocket-powered vehicles at the suggestion of our Reusable Launch Vehicle Working Group, which is part of our Commercial Space Transportation Advisory Committee (COMSTAC). This database will help the industry to know what fails and can, therefore, provide information on what areas to pay particular attention to in their designs and operations to prevent similar occurrences in the future. Next year, we plan to do research in the human space flight area on the ramifications of the requirements for informed consent of space flight participants. We will conduct projects that may contribute to the safety of launch operations and the ability to better predict high altitude wind profiles. Also, we will look at the feasibility of developing temporal winds databases for commercial launch sites. These activities may help us to find better ways to conduct flight safety analyses.

Q: What advances in commercial space transportation do you foresee over the next five to ten years?

A: Within the next five to ten years, I expect there will be considerable advances in licensed and permitted activities in commercial space transportation. Very soon, AST expects to permit the start of tests of reusable launch vehicles designed to carry space flight participants. Depending on these test results, licensed commercial space flights carrying space flight participants could follow soon thereafter, thus starting the era of space tourism. Within the next few years, we expect to see the testing of licensed commercial space transportation operations that will demonstrate the capability to transport cargo to and from the International Space Station (ISS). These tests will be conducted by commercial space transportation operators who are partially funded through Space Act Agreements with NASA. Pending the successful outcome of these tests, NASA may contract with commercial space transportation operators for resupply of the ISS, and possibly for crew transport. Early in the next decade, we may see the licensed launch and operation of commercial space stations that could be used for research facilities, for manufacturing operations, and as vacation destinations.

Q: What are some of the challenges we face in creating affordable, commercial manned space flights?

A: The biggest challenge is to keep commercial space transportation operations safe for the public. It is costly to provide for safe commercial space transportation, but you really cannot settle for anything less. Another challenge is an industry that will be transitioning from just a few launches per year, to hundreds and eventually thousands of launches and reentries per year. This will raise issues not only in vehicle design, but also in planning for safe operations in the National Airspace System, and eventually for international commercial space travel. The advertised price for commercial suborbital flights in the next few years is expensive—on the order of $200,000 per seat. Depending on the progress made in the research and development of commercial suborbital spacecraft, and the level of consumer interest, it is likely that the ticket price may drop significantly in the years ahead.

Q: What types of research do you think needs to be accomplished before commercial manned space travel becomes commonplace?

A: I believe reliable, safe reusable rocket propulsion systems and durable lightweight structures are both fertile areas for research and development. Offloading expensive labor intensive tasks in the improvement of computer hardware and software systems and avionics are other areas where further research may lead to dramatic breakthroughs that reduce costs while maintaining an equivalent level of safety. Space medicine is another area where research advances may help to attract a physically more diverse populace of travelers. We need to look more carefully at the physiological effects of space travel on human beings. Although this area of research has already been opened, we have just scratched the surface. Along the way, we will discover new questions that need to be answered. We are not only opening the door to space for private citizens. With regular and cost-effective access to space, we are also opening the door to a whole new way of conducting aerospace research, that will, hopefully, lead us to safer, more reliable commercial space transportation operations and reduce the risks of space travel.

Q: What advice would you share with people considering a career in aerospace?

A: I would say to our youth to follow their dreams and interests. It is not the most lucrative of careers, but with the challenges that it provides and the promise of being on the cutting edge of technology, it makes for a very rewarding career. If your aim is to advance the knowledge and the frontiers of mankind, and to have a lot of fun and excitement while you are at it, then a career in aerospace is the one for you. Also, never stop learning, as there is always knowledge to be gained in this profession, not just from our successes, but especially from our setbacks.

Q: Is there anything else you would like our readers to know about you?

A: I have a beautiful wife, Barbara. Together we have four grown children. I have a son and a daughter, and she has two daughters, my step daughters. And we have two beautiful grandchildren, a grandson and a granddaughter that we love greatly. I have a Bachelor of Science degree in Mechanical Engineering from the University of California at Berkeley. I have seen a lot of advances in aerospace, but I think the greatest advances are yet to come. I worked on the manned space program at NASA's Johnson Space Center in flight control and witnessed the last Man on the Moon, Gene Cernan, take his historic steps on that distant terrain. I believe that we will get back there, but we must remember that it takes a lot of time and effort to make that happen. And we must do it safely. ■

Operational Evolution Partnership

The history of aviation in this country is steeped in a rich tradition of innovation and success. From the first flight over Kitty Hawk, North Carolina, to the advent of jumbo jets, very light jets, and reusable launch vehicles, the continued development of new equipment and procedures is helping aviation grow at an incredible rate.

The FAA R&D program has developed critical new technologies that continue to improve and enhance a safe, secure, efficient, and environmentally friendly global aerospace system. This cutting-edge research is reducing commercial accident rates and building an air traffic control system capable of efficiently meeting future demand.

FAA researchers are working on solutions, both mid- and long-term, to improve aviation. The research program addresses a full range of activities needed to meet the FAA mission and goals. For example, in addition to the direction provided by the Department of Transportation and FAA strategic plans, the Operational Evolution Partnership (OEP) is guiding mid-term R&D activities necessary to transition to the Next Generation Air Transportation System (NextGen). Previously a planning document intended to improve capacity in the air traffic system, the OEP has been expanded into the implementation plan to guide the extensive NextGen effort. OEP Version 1 explains key concepts and provides a strategic timeline for introducing the full range of NextGen transformational changes.

"NextGen is our future. The OEP is FAA's plan to take us there."

The Operational Evolution Partnership is now the mechanism by which FAA holds itself accountable for progress towards the NextGen vision," explains FAA Administrator Marion Blakey. "To realize this vision, we need to make coordinated improvements on multiple fronts: research and development, budget formulation, policy, certification, airport planning, long-term performance analysis planning, integrated test and evaluation, and international inter-operability. The OEP will provide the integrated, 'big picture' perspective for the whole agency. This is critical, because we cannot afford a case where the right side of the agency doesn't know what the left side is doing – the stakes are too high."

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, and NASA. Full implementation of many of the planned improvements described in the OEP will not occur until the 2015 timeframe. A critical part of meeting OEP goals will be to provide the R&D associated with the design, development, and validation of the necessary advanced technologies and the new or revised procedures they entail.

"OEP and NextGen goals will not be achieved without an aggressive research program," says Barry Scott, FAA Acting Director of Research and Technology Development. "Our R&D programs are identifying challenges and barriers, whether existing or anticipated, to accomplishing our mission. Through OEP, the FAA will assess over-riding NextGen R&D requirements and prioritize new R&D initiatives before the projects are included in FAA budget planning."

The OEP is organized around: airport development, air traffic operations, and requirements specific to aircraft and their operators. In the context of these three key transformational emphases, the OEP describes ten solution sets needed to prepare to meet NextGen requirements. Individual "Smart Sheets" summarize these sets.

R&D will be needed to achieve the ten OEP objectives:

- Initiate Trajectory-Based Operations
- Increase Arrivals/Departures at High Density Airports
- Increase Flexibility in the Terminal Environment
- Improve Collaborative Air Traffic Management
- Reduce Weather Impact
- Increase Safety, Security, and Environmental Performance
- Transform Facilities
- Aircraft and Operator Requirements
- OEP 35 Airports
- OEP Metro Areas

Initiate Trajectory-Based Operations

This solution set focuses primarily on en-route cruise operations and shifts from basing control on the continual updating of clearances to allowing operators to negotiate trajectories for specific flights. Implementation of this transformational principle – and the associated redefinition of the traditional roles of the participants – will evolve as improvements emerge in automation and support, and as diverse efforts become better integrated.

Key FY 2008 R&D Activities:

Many risk factors involving pre-negotiated trajectories will result as automated inputs are integrated with human inputs. Analyses, modeling, and human-in-the-loop simulations will be conducted to assess the potential effects of these factors. This work will ensure that technical information is available to allow regulatory officials to develop the standards, procedures, and training needed to provide an effective transition from current national airspace system (NAS) operations to NextGen trajectory-based operations capabilities. FAA scientists and engineers also will conduct the research that will determine the infrastructure and mission support capabilities that will make the necessarily robust flow of information possible..

Increase Arrivals/Departures at High Density Airports

Increasing demand for air traffic services correspondingly increases the challenge to achieve and maintain peak throughput performance at the nation's busiest airports. Any lack of efficiency at a high density airport has a profound effect upon the airspace it serves. New inter-dependent procedures are urgently needed to facilitate airport surface movements, reduce spacing and separation requirements, and improve overall traffic flow management into and out of busy metropolitan airspace. The net effect of these innovations will not only improve airport usage, but also maximize overall system traffic flow.

Key FY 2008 R&D Activities:

- Researchers will concentrate on finding and perfecting means to mitigate the effects, at selected airports, of aircraft-generated wake vortices on closely spaced parallel runways. As part of this effort, they will work to develop the concepts of use, prototypes of applied technologies, system engineering improvements, and procurement requirements needed to safely implement a new Air Navigation Service Provider (ANSP) decision-support tool.
- The NextGen concept assumes that providing new technologies, for coordinated use both at the ANSP installation and on the flight deck, will allow regulators to safely reduce current aircraft separation standards. Initially, researchers will develop the concept of operations and the benefit feasibility study that will allow work to go ahead on a candidate ANSP decision-support tool. Their work will lay the foundation for requirements that will enable further study of these new flight deck capabilities.

Increase Flexibility in the Terminal Environment

In the future, the migration of some types of air traffic from major airports will require small satellite airports in high population areas to accommodate a new mix of commercial aircraft along with their traditional component of general aviation traffic. To impose the full range of commercial operational requirements upon such facilities at all times, however, would reduce the efficient use of their surrounding airspace. The concept of flexible terminal operations was developed to allow the maximum safe use of all facilities under variable conditions, for it also permits access to an expanded range of operators at very busy, largely commercial fields during times of lowered traffic demand. Flexible operations effectively mix the rigorous requirements of instrument flight rules (IFR) with the safely reduced demands of visual flight rules (VFR). The resulting construct can adapt to any foreseeable increase in the use of piston aircraft (for pleasure and business) and the emergence of on-demand air taxi services that call for the use of very light jets. .

Key FY 2008 R&D Activities:
Human factors specialists will continue to seek new solutions to ensure that the workstations of service providers in terminal and airport environments will support the operational improvements and productivity enhancements desired in the future NAS.

Improve Collaborative Air Traffic Management

When the NextGen goal is achieved, Collaborative Air Traffic Management (CATM) will allow all airspace stakeholders to exchange information, to come to a mutual understanding of a situation, and to influence final decision making. Envisioned CATM technologies range from a complete set of automation tools at a large-scale flight operations center to the hand-held or home personal computer that would be fitted to give an individual pilot collaborative access to the system.(*continued on next page)*

Key FY 2008 R&D Activities:

Human factors researchers will develop Human factors researchers will develop new communication and information display requirements to enable effective collaboration between traffic management specialists and airline operations centers. They will begin simulations to ensure that human-in-the-loop CATM system performance levels will meet the anticipated demands of NextGen traffic and the associated expectations of NAS operators. In addition, the research team will develop human-system performance metrics and design requirements for display design, human-automation interaction, and individual as well as team decisionmaking. Researchers will also develop new methodologies and engineer new systems to provide interfaces for advanced information exchange.

Reduce Adverse Weather Impact

Better anticipating the effects of adverse weather on the national airspace system will help to improve the overall performance of NAS operations. Consistent and accurate weather information will be collected and integrated into ATM, air traffic control, flight operations centers, and flight deck tactical and strategic operational decision-making tools. Sensor networks, forecasts, and operator access to consistent weather information will all be significantly improved. As new decision support systems directly incorporate weather data and define the weather impact, decision makers will be better able to determine the best response to weather's potential operational effects and minimize the level of traffic restrictions that must be made 2–6 hours ahead.

Key FY 2008 R&D Activities:

- *Consolidate Convective Weather Forecast: Demonstrate a* consolidated convective weather forecast capability.
- Improve Methods for Assessing Weather: Develop, or improve and validate, reliable methods to determine, in a timely manner, winter weather precipitation type and intensity. Based on better assessments, improve the accurate use of anti-icing fluids and reduce anti-icing holdover times. Plan a demonstration of the 4-dimensional weather data cube, a concept designed to provide common weather database development and access.
- Wake Vortex Prediction: Provide concepts of use, prototypes of applied technology, system engineering, and procurement requirements for Air Navigation Service Provider (ANSP) decision-support tools. Develop requirements and standards for the Flight Deck capability. Conduct the concept and benefit feasibility study for an ANSP decision-support tool that can reduce wake mitigation separations.
- Weather in the Cockpit: Develop an evaluation process that will result in operational approval of graphical weather products for use in the cockpit.
- Turbulence Forecast Capability: Implement a mid-level turbulence forecast capability on the Aviation Digital Data Service website.
- Improve Efficiency: Conduct simulations to identify the specific weather information needed to improve efficiency.

Increase Safety, Security and Environmental Performance

The NextGen system will employ an integrated Safety Management System (SMS) approach to identify and safely manage potential problems in a system, organization, or operation. This approach relies upon a carefully integrated framework of procedures, practices and policies.

Key FY 2008 R&D Activities:

Researchers will:

- Develop automated tools to monitor databases for potential safety issues.
- Develop a prototype Phase-1 Aviation Safety Information Analysis and Sharing (ASIAS) system and associated reports that show the benefit of using diverse textual and digital data sets to analyze commercial aviation safety metrics and enhancements.
- Conduct analytical studies using ASIAS and other aviation safety data to address hazards and risks of operating aircraft in the National Airspace System, and to determine the effectiveness of FAA recommended and industry implemented safety enhancements.
- Release a prototype decision-support system that provides the FAA improved certificate management and oversight capabilities.
- Assess how to integrate industry SMS with FAA's internal SMS and oversight responsibilities.

Transform Facilities

Flexible ground and air-ground communications networks do not require proximity of air navigation service provider facilities to the air traffic being managed. Facilities can be sited and staffed to provide infrastructure security, service continuity, and the best deployment and management of the workforce. Addressing these combined concerns may result in co-locating several functional facilities within a single physical facility.

Key FY 2008 Research Activities:

FAA researchers will develop critical displays for surveillance of the airport surface in the staffed virtual tower environment. Teams are currently collaborating with the U.S. Navy to determine the specific information controllers need to ensure safety during surface operations. They will also develop a simulation infrastructure that can demonstrate the staffed virtual tower concept and measure the benefits of integrated displays.(*continued on next page)*

Redefine Aircraft and Operator Requirements

Aircraft manufacturers and operators need clear and reliable indications of what is expected of them in the future. The FAA must ensure that adequate NextGen standards and policy are published to support the effective and safe implementation and operation of new systems. Additionally, the Agency must work to ensure that the manufacturers and operators who properly apply the standards and policy receive timely and equitable service.

Key FY 2008 Research Activities:

- Air-Ground Information Exchange: Perform research to determine information needs for ATC and flight crews to support trajectory based operations.
- Data Communications Requirements: Define air-ground data integrity requirements to support automated clearance messaging to aircraft.
- Aircraft Security: Determine the correct balance between safety and information security mitigation strategies.
- Collision Avoidance: Determine the warning system effectiveness of traffic alert and collision avoidance systems and terrain situational awareness systems in the NextGen environment.

OEP 35 Airports

The 35 airports included in the OEP account for about 75 percent of all passenger enplanements. Much of the current delay to air traffic can be traced to inadequate throughput (measured as arrival and departure rates) at these airports. The construction of new airfield infrastructure such new runways and taxiways and major runway extensions are currently the most effective method of increasing throughput.

Key FY 2008 Research Activities:

- Wake Vortex Prediction: Modify procedures to allow use of closely spaced parallel runways for arrival operations during non-visual conditions.
- Airport Cooperative Research Program (ACRP): FY 2008 activities include 13 different research areas relating to developing near-term solutions to problems facing airport-operating agencies, such as the Airports Council International. Among these projects are developing a guidebook for developing an airport performance measurement system; quantifying the contribution to local air quality impacts from airport-related emissions; and developing a comprehensive work plan for a multimodel noise and emissions model.

OEP Metropolitan Areas

Fifteen metropolitan areas account for 58 percent of all passenger activity and almost 15 percent of the aircraft based in the U.S. Over the next 20 years, these 15 metropolitan areas are expected to experience significant population gains and economic growth. Meeting the demand for aviation in these areas will require continued emphasis on airport expansion along with innovative approaches such as regional solutions and multi-modal planning.

Key FY 2008 Research Activities:

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"These and other research programs defined in the National Aviation Research Plan are necessary for the NextGen transformation," says Scott. "NextGen is our future. The R&D program will ensure the smooth transition to that future." ■

Looking to the Future

Projections of future air traffic call for exponential volume increases, and the aviation industry is determined to "modernize" itself to increase system capacity. In response to these pressures, the FAA is looking into changing the paper flight progress strips that air traffic controllers have long used to manage their workloads, communicate with others, and maintain situation awareness.

Generations of air traffic controllers have relied on small pieces of paper, about one inch high and eight inches long, to help them organize the flow of information from the moment they first start tracking an approaching or departing aircraft. These flight strips help the controller to coordinate aircraft and vehicle taxi instructions, determine arrival and departure sequences, and issue pilots the clearances that establish spacing between their aircraft. The strips contain details such as the type of aircraft being flown, its flight number, its destination, and its scheduled arrival or departure times. Controllers make notes on the strips, record instructions they issue on them, place them where colleagues can see instantly what is occurring with a flight, and use them to pass information on to colleagues who will control the next leg of the flight.

A strip is mounted in a plastic holder and placed with others on a board that represents all the flights at the airport. Its position indicates whether an aircraft is on the ground, on a runway, or in the air. Other strips may identify special circumstances, or indicate the presence of physical obstructions or ground vehicles. They may give controllers brief reminders of other pertinent information – such as weather, duties specific to the facility where the controller is working, or supplemental standard operating procedures that address local idiosyncrasies. Controllers also may write useful information on the paper strips depending on the phase of an aircraft's flight. Normally, they use standard symbols, but some towers can have unique marks and some controllers have individual preferences.

"Writing on paper flight progress strips takes cognitive and sensory resources, time and attention, that might be relieved by automation," says Dr. Todd R. Truitt, FAA engineering research psychologist. "Controllers now must manually update information, record clearances, and physically pass the paper from one to another in the tower. In addition to this internal communication, they still have to share flight data with other facilities. We want to reduce their task load, and the need for them to shift visual attention away from the aircraft, so we can improve their effective skills."

Truitt led the research that has resulted in a prototype electronic flight data interface he calls the Tower Operations Digital Data System (TODDS). The tool combines the various flight strip inputs onto a single touch-sensitive monitor that displays digital boxes containing aircraft location, flight data, and other information vital to tower controllers.

Admitting he went beyond his original task, Truitt says: "TODDS is more than just a solution for replacing paper flight progress strips in an electronic format. It provides benefits much greater than those afforded by an electronic version of paper strips. Working with paper, controllers first had to shift their attention between multiple tower displays and connect what they learned there with their out-the-window view. Then they had to find a strip to write on. They faced what I call a 'cognitive bottleneck' that may have contributed to a mental overload. Our goal with automation was to reduce the physical effort they put into jotting down their observations. When updating flight data with TODDS, they can concentrate on a single display that is linked to various legacy peripheral systems. This provides them new tools that help to reduce their workload and risk while improving their effectiveness."

The innovation has two versions. One, called Integrated TODDS, incorporates electronic flight information with the Airport Surface Detection Equipment - Model X (ASDE-X) or other surface surveillance system. The screen, which shows a map of the airport, combines flight data elements with actual aircraft positions indicated by surface radar. TODDS lets controllers mentally correlate the disparate sources of data they have always relied on without having to verify aircraft position and then move their eyes to deal with flight progress strips. Now they can look at the TODDS to gain aircraft position and flight data information at a single glance.

Another version, called the Perceptual-Spatial TODDS, was designed as an alternative for control towers that lack surface surveillance capability. This version shares most of the features of the Integrated version and still permits controllers to track, record, communicate, and organize flight data. The perceptual-spatial interface, however, presents electronic data blocks arranged on a touch screen that resembles a surface map of the airport. Controllers look out the window and listen to pilots on the radio to track aircraft physically. Then they use their fingertip to arrange the information blocks containing an aircraft's flight data directly on the screen without need for ASDE-X or other surface radar input.

Truitt credits the collaborative effort of multidisciplined FAA experts pursuing one goal for having achieved the unique insights and capabilities of these systems. At the various task analysis stages, the working group brought together human factors specialists, air traffic controllers and software developers. At first, the research focused on the true information requirements in the tower. They wanted to find out the data items that controllers need, when they need them, and both how and why they use them.

Researchers at the FAA Civil Aerospace Medical Institute (CAMI) also looked into how controllers use and mark paper flight strips. Last year, a CAMI team visited the airport at Daytona Beach, Florida. They

interviewed several tower controllers about flight progress strips, and studied the behavior of controllers taking notes on them. Truitt used the results of this and other related work in designing the functionality of the TODDS.

Truitt and his FAA human factors research team translated their assembled findings into functional computer software that operates with commercial-off-the-shelf monitors. FAA researchers built the software in-house, and tested the touch-sensitive screens in the advanced simulator called Distributed Environment for Simulation, Rapid Engineering, and Experimentation (DESIREE). This was the first time researchers adapted the platform – previously only used for testing airborne, terminal, and en route air traffic control systems – to handle a ground simulation.

For the initial TODDS usability experiment last year, researchers trained four controllers on each version of the interface, and had them monitor traffic and manage the flight data during multiple trials. Truitt reports that, despite some inaccuracies the controllers experienced in manipulating the screens, their feedback indicates the TODDS units provided them all the air traffic control information they needed. Human factors psychologists later tried to determine the cause of what Truitt calls the "fat finger" effect. Either, or a combination of two, possibilities might have been behind the errors: electronic data blocks that were simply too small for controllers to touch accurately, or just the need to build accuracy and familiarity through repetition.

The team is now enhancing both TODDS interfaces for a follow-on study scheduled for next year. In this simulation, pilots will join the loop to give controllers an opportunity to issue real-time commands and get to see representative airport traffic respond on the TODDS interfaces. Truitt says, "In the next simulations we want to compare the current paper strips process with both the Integrated TODDS and the Perceptual-Spatial version. We'll put controllers where there's no out-the-window view, so it would be like a staffed virtual tower or low-visibility conditions."

"We want to see if the controller has a better idea of where the aircraft physically are - especially if they can't see the airport surface," continues Truitt. "We think TODDS will help determine aircraft position for them, and they won't have to remember those positions. We're still preserving the controllers' interaction with the flight data, using the touch-screen flight data elements to move aircraft. I think that builds their memory and maintains situation awareness, as opposed to keeping track of the paper, updating the strip, and remembering to give lots of commands. We need empirical data to validate that the interface does indeed help them sustain the mental picture of airport traffic."

The FAA TODDS researchers are also working to include applications beyond the common tasks the initial interfaces handle. One possibility is a display box that presents weather data, the current Airport Traffic Information Service (ATIS) detailing wind direction, speed, gusts, altimeter, and runway visual range for touchdown, midpoint, and rollout. Members of the interface design team are also developing methods to indicate that a runway or taxiway segment is closed, a means to deliver digital taxi clearances, and a means to indicate to controllers whether wake turbulence separation rules are needed or not.

Already, TODDS contains timers that will help controllers schedule aircraft departures at busy airports. "You have a long string of aircraft," Truitt says, "and the timer lets you know how much time has elapsed and how much spacing to allow for wake turbulence. Today, that is something controllers work out manually. They have to write down the departure time on the paper strip, mentally calculate how much time has passed before releasing the next aircraft, and then remember to give it clearance. This interface does some of that work for them." (*continued on next page)*

Recognizing Excellence

The FAA and Air Transport Association of America (ATA) recently recognized the recipients of the 2007 FAA-ATA Non-Destructive Testing (NDT) Forum "Better Way" award.

The "Better Way" award recognizes a team of government and airline industry individuals who have collaborated to advance inspection or testing of aircraft structure, components or systems. This award, jointly sponsored by the FAA and ATA, was presented at the ATA Non-Destructive Testing (NDT) Forum on August 29, in Orlando, Florida.

Professionals from industry as well as government were recognized with this prestigious award. From Jentek Sensors: Todd Dunford, Dr. Neil Goldfine, Dr. Darrell Schlicker, Dr. Yanko Sheiretov, Vlad Tsukernik, Dr. Andrew Washabaugh, Dr. Mark Windoloski and Dr. Vladimir Zilberstein). From NAVAIR: Mark Thomas, Rob Sutor, Joe Price and Jack Fichter. Rick Micklos (retired) from FAA, and from the U.S. Air Force, Craig Neslen.

The team received recognition for its efforts using the Meandering Winding Magnetometer – Array (MWM®) technology in the inspection of engine disk slots. This process provides both a very low false alarm rate and a more efficient way to discover cracks and fatigue in turbine engines, with no documented false indications in more than 3,000 inspections. ■

Looking to the Future *continued from page 23*

The interfaces have "quick action" functions for the tasks controllers perform most often, such as telling pilots to hold short. The electronic system makes any change an immediate part of the flight data, and controllers in the tower and other air traffic control facilities can see the information as events are scheduled or happen. This way, a terminal controller can know ahead of time that a certain aircraft will take off from a changed runway and on a changed heading.

The FAA is attempting to secure two patents for its electronic touch-sensitive TODDS interfaces. Patents will help the FAA license the technology, begin the acquisition process, and find private partners to build and maintain the system. Truitt says the Perceptual-Spatial TODDS could also be a stand-alone system and serve as a backup to the design that integrates surface surveillance. With the capabilities of these new systems, Truitt envisions a controller at an airport that lacks ASDE-X could move the flight data blocks manually to manage flight data.

"We are trying to standardize the tasks," concludes Truitt, "and relieve controllers from what I consider nonessential 'housekeeping' responsibilities. As things now stand, each tower in the national airspace system has its own strip-marking guide. Even within one facility, some controllers work the strip bay from top to bottom, others work from bottom to top. A new controller taking over a new shift often has to reshuffle existing flight strips during a position relief briefing. This new application causes everyone to work with the same interface. But that interface doesn't contribute new 'glass' (unique purpose displays) to towers that already are too cluttered with systems that are not integrated. The bottom line is: standardization makes things easier for supervisors to know and double-check what's going on." ■

For more information, read the technical note entitled, "Concept Development and Design Description of Electronic Flight Data Interfaces for Airport Traffic Control Towers," available online at http://hf.tc.faa.gov/products/bibliographic/tctn0617.htm.

Staffed Virtual Tower

The FAA Aerospace Forecast Fiscal Years 2007-2020 predicts 768 million passengers will fly this fiscal year, more than one billion passengers by 2015, and 1.2 billion by 2020. The forecast also calls for 62.5 million takeoffs and landings at the nation's towered airports this fiscal year. By 2020, that number is expected to reach 81.1 million operations, growing by an average of 1.4 million per year during the forecast period. In addition, general aviation hours flown, including very light or microjets, is projected to increase an average of 3.4 percent per year through 2020. Next year, say the forecasters, 350 microjets will join the fleet – with that figure growing 400 to 500 annually through 2020.

To help controllers manage both the numbers and kinds of aircraft predicted to fill the skies in coming years, FAA human factors experts are investigating a number of innovative concepts. One new idea is the staffed virtual tower, an innovation that might enable traffic managers to provide air traffic control services from centralized locations rather than today's individual air traffic control towers.

Currently, controllers provide air traffic services from towers located directly on the airport grounds. They rely to a significant extent on out-the-window views to supplement the automated communication and surveillance information that helps them to direct incoming and departing aircraft – as well as the many vehicles that normally operate on the airport surface. However, recent advances in surveillance and other sensors, automation, and data sharing technologies show promise – a promise that researchers will need to explore – of revolutionizing the airport tower control paradigm. If this concept proves feasible, future controllers may staff "virtual towers" at locations that could be apart from the airports whose air and ground operations they control.

The primary difference between the tower environment of today and the staffed virtual tower concept of tomorrow is controller physical location and the tools used to gather information to control traffic. Under the new concept, surveillance capabilities and technologies not present in today's air traffic control towers might come together to strengthen operational safety and efficiency. Instead of out-the-window visuals, a controller would use a suite of displays, still being defined, that would include surface surveillance, closed-circuit video cameras, infrared imaging systems, and other computer information systems.

With the introduction of staffed virtual towers, controllers would still provide positive control of all aircraft and vehicles in the airport area. "The staffed virtual tower concept proposes that air traffic services could be provided from a facility other than an on-site tower," explains Dino Piccione, FAA human factors technical lead. "The facility might be located in a structure on the airport grounds or in a remote location. Instead of looking out the window for information, controllers would use a suite of displays that depicted the vital information needed to control traffic. Controllers would continue to issue clearances, traffic alerts, and taxi instructions to aircraft and vehicles as they do today."

The advantages to the new paradigm could be highly significant. If the staffing of virtual towers proves operationally feasible, the innovation might enable tomorrow's air traffic control organizations to: (*continued on next page*)

- Reduce substantially the costs of facility construction and maintenance,
- Provide tower services to more airports at a lower cost,
- Serve multiple airports from one remote location, and
- Eliminate some restrictions on traffic flow,
- Integrate ground vehicle and aircraft information on controller displays to enhance situational awareness.

Because the concept of staffing virtual towers might require changes in the interaction between pilots and air traffic controllers, it almost certainly would create a need for new procedures. While controllers would continue to perform their present duties, they would do so by viewing a suite of as yet undetermined displays that would depict the vital information needed to issue clearances, traffic alerts, and taxi instructions to aircraft and ground vehicles. FAA human factors researchers are investigating related performance issues to ensure the proper integration of people and systems.

Piccione says human factors research must find a solution that studies have yet to address. “The evidence we have now indicates a controller spends 70 percent of the time looking out the tower window – the window is the main display, and if I take that away, how does the controller perform the job? A major part of our research will be on restoring surface situation awareness to replace the previous dependency on that out-the-window view.”

To study new ways to provide surface situation awareness, FAA researchers joined their military counterparts this summer for a collaborative data collection research project conducted at the facilities of the Naval Air Systems Command in Patuxent River, Maryland. Researchers used an eye-tracking device to measure an air traffic controller’s eye movements on an active airport surface. They are now comparing those results with those from similar studies with eye-trackers performed in tower simulators.

“The Patuxent River effort is the initial step in a much larger effort to analyze and determine how much the controller relies upon looking out the window,” Piccione states. “We have to consider the window as a surveillance mechanism, which may not be so simple to replace with hanging a bunch of video cameras and having the controller check television screens. The functions of the human eye are hard to replicate – a camcorder can pick up everything in daylight, but go into a dark room and your eye will pick up what the camcorder doesn’t. Throw in Automatic Dependent Surveillance–Broadcast, possibly combined with radar, and they all may be an adequate replacement for the window. We’ll have to see and find the right mix to build situational awareness from a remote location.”

FAA human factors researchers are building additional ground capabilities into the Distributed Environment for Simulation, Rapid Engineering, and Experimentation simulator at the FAA Human Factors Laboratory in Atlantic City, New Jersey, to get ready for new air traffic simulations. The lab will serve as the simulation facility for the two-year research program that began this summer. FAA researchers are also examining how to help controllers transition to an environment in a staffed virtual tower. They will investigate what types and levels of service staffed virtual towers can offer, as well as which airports could qualify for the innovation. Once the investment decision is made on hardware components, researchers must conduct a performance/risk analysis. The FAA hopes to begin field testing of a staffed virtual tower prototype by 2009 and make the concept a reality by 2016.

“As researchers,” says Piccione, “we have to look into a crystal ball while we continually define advanced concepts to reach the optimal method of achieving the FAA’s capacity and safety objectives.” ■

For more on the FAA’s Human Factors Research and Engineering Group, visit http://www.hf.faa.gov/.

Hot off the Press!

FAA's Latest Technical Reports

Andrew J. Kornecki. SOFTWARE DEVELOPMENT TOOLS FOR SAFETY-CRITICAL, REAL-TIME SYSTEMS HANDBOOK (DOT/FAA/AR-06/35)

Programmers, system analysts, and software engineers have consistently sought ways to improve the efficiency of the development process. Software development tools used since the early years of computing have been programs that help these specialists to improve new programs or documentation. These tools automate mundane operations, and allow application engineers to concentrate on higher-level matters. In practice, they have been particularly vital to the work of safety-critical system developers. In addition to aviation, examples of such use include automotive, space, nuclear, railroad, medical, and military applications.

This Handbook is directed to the aviation industry and the Federal Aviation Administration to facilitate the use of software development tools on airborne projects developed under DO-178B certification criteria. It outlines the issues to be considered while using development tools on software-intensive airborne systems in a regulated industry and formulates questions applicable to related DO-178B objectives. It also summarizes the progress of modern software engineering and its impact on the safety-critical software development process and products.

Mike Keller, Andrei Degtyar, Jeff Umbach, and Lisa Brasche. INSPECTION DEVELOPMENT FOR LARGE-DIAMETER TITANIUM BILLET – ENGINE TITANIUM CONSORTIUM PHASE II (DOT/FAA/AR-05/47)

The titanium used in the production of jet engines is acquired in the form of billets –materials shaped into the form of metallic rods of specified thicknesses. The Engine Titanium Consortium Phase I program – comprised of Iowa State University; General Electric; Honeywell Engines, Systems & Services; and Pratt & Whitney – began in 1993 with a focus on improving the inspection of titanium billets used in the production of jet engines. The Phase II program began in 1999 and has focused on further enhancing the sensitivity of billet inspections. It has relied heavily on a multizone approach to improving titanium billets. The goal of the Phase II effort was to achieve a #1 flat-bottom hole sensitivity for a 10 diameter billet and assess the impact of attenuation compensation procedures. A supplemental task was later added to the Phase II effort that focused on titanium billet larger than 10 in diameter. This report documents the results for 13 and 14 diameter billets in laboratory and factory settings. While this assessment does not represent the detailed analysis of a full probability of detection study, it demonstrates that the results can be achieved in a laboratory setting and provide a limited survey of factory capability.

Stephen Ward, William McCarvill, and John Tomblin. GUIDELINES AND RECOMMENDED CRITERIA FOR THE DEVELOPMENT OF A MATERIAL SPECIFICATION FOR CARBON FIBER/EPOXY FABRIC PREPREGS (DOT/FAA/AR-06/10)

The building block approach is used within the composite aircraft industry for the substantiation of composite structure. A key element supporting this approach, is to interweave material and process specifications throughout the qualification and validation process. These requirements are used to define the material's attributes, and related qualification characterization tests. Once these details are established, the specifications are applied again to establish the purchasing requirements of potential aviation construction materials. It is critical to the success of the building block approach, throughout the various stages of selecting and fabricationg qualification specimens, that all processes be identical to those used in the actual fabrication of production aircraft and rotorcraft. (*continued on next page)*

Hot off the Press!

This document recommends guidance and criteria for the development of material specifications for carbon fiber/epoxy prepreg fabric materials to be used on aircraft structures and is intended to be a companion to previous Federal Aviation Administration reports which established methodology for developing material allowable data, control of the data, and sharing the resulting database. (See, DOT/FAA/AR-02/109 and DOT/FAA/AR-02/110.) The guidelines and recommendations are meant to be a documentation of current knowledge and practices, and recommend application of sound engineering principles applicable to the development and implementation of composite material procurement specifications. The A list of material control areas needing improvement and enhancement provided in the current document can also be used as the basis for further discussion. This document can also be used to develop common industry specifications.

Grace Balut Ostrom, Jeanne Mason, Sam Clark, and Steve Clark. INDICATIONS OF PROPULSION SYSTEM MALFUNCTIONS – SUSTAINED THRUST ANOMALY STUDY (DOT/FAA/AR-06/15)

Researchers performed a two-phase feasibility study of the benefits of alerting flight crews to the occurrence of propulsion system malfunctions (PSM). DOT/FAA/AR-03/72, "Indications of Propulsion System Malfunctions," reported the results of Phase 1 of the Boeing study. In that phase, researchers began to investigate the potential of announcing PSM occurrences to prevent an inappropriate crew response (ICR). The current report deals with Phase 2, and involves the development of new PSM detection and annunciation strategies. In this context, sustained thrust anomalies (STA) were shown to be the most common factor and significant contributor in PSM+ICR events. The research included propulsion system malfunction PSM detection criteria that were derived from various sources, including: propulsion system operational criteria, crew operational criteria, and new indication concept criteria. The research also included sets of potential detection strategies that were identified to meet the established propulsion and crew operational criteria; technology risk assessment and down selection of strategies; and the development, demonstration, and validation plan for the selected strategies.

Gregg Bogucki, John Bayldon, Larry Gintert, Stephen Ward, William McCarvill, and John Tomblin. PRELIMINARY GUIDELINES AND RECOMMENDATIONS FOR THE DEVELOPMENT OF MATERIAL AND PROCESS SPECIFICATIONS FOR CARBON FIBER-REINFORCED LIQUID RESIN MOLDED MATERIALS (DOT/FAA/AR-06/25)

This report recommends guidance and criteria for the development of material and process specifications and material acceptance documents for liquid resins and continuous carbon fiber reinforcement materials used in liquid molding processes to manufacture structures for aircraft and space structures. It also documents current knowledge and application of sound engineering principles to the development and implementation of composite material procurement and process specifications. The guidelines and recommendations contained here should not be viewed as Federal Aviation Administration policy or as the only acceptable method for composite material specifications and qualification procedures.

This document has been prepared with two inter-related principles in mind. The goal of any material procurement document is to provide the necessary controls to ensure the material used to establish the qualification data and certification data has not changed beyond its normal variability. The goal of any process specification is to ensure that the process remains in control and produces material consistent with specified requirements.

William McCarvill, Stephen Ward, Gregg Bogucki, and John Tomblin. GUIDELINES AND RECOMMENDED CRITERIA FOR THE DEVELOPMENT OF A MATERIAL SPECIFICATION FOR CARBON FIBER/EPOXY (DOT/FAA/AR-07/3)

This report builds upon previous work, done through FAA and NASA programs such as the Advanced General Aviation Transport Experiment, to design allowable data and then control and share the resulting information. The present work proposes a generalized approach to creating a shared composite material database and recommends guidance for developing new composite material specifications. Its findings should remove present restrictions placed on general aviation methods and allow a broader market to use the shared database.

Specifically, this document recommends guidance and criteria – prepared by a team of industry experts – for the development of material specifications for carbon fiber/epoxy unidirectional prepreg tape materials to be used on aircraft structures. It also documents current knowledge and application of sound engineering principles in these research areas and provides a list of material control areas needing improvement and enhancement. Additional guidance on the development of process specifications, instructions, and controls for making high-quality laminates can be found in the companion report, Guidelines for the Development of Process Specifications, Instructions, and Controls for the Fabrication of Fiber-Reinforced Polymer Composites, DOT/FAA/AR-02/110.

Andrew J. Kornecki, Nick Brixius, Janusz Zalewski Herman Lau, Jean-Philippe Linardon, Jonathan Labbe, Darryl Hearn, Kimberley Hall, Lazar Crawford, Celine Sanouillet, and Mathieu Milesi.

ASSESSMENT OF SOFTWARE DEVELOPMENT TOOLS FOR SAFETY-CRITICAL, REAL-TIME SYSTEMS (DOT/FAA/AR-06/36)

The objective of this research was to identify assessment criteria that would allow developers and certifying authorities to evaluate safety-critical, real-time software development tools from a system and software safety perspective. The report looks at how well available software development tools adhere to current aviation system certification guidelines as well as at the guidelines themselves. The research effort proceeded in two directions: (1) collecting data on tool qualification efforts to examine potential future modifications to the existing guidelines and (2) identifying tool categories, functionalities, concerns, factors, and evaluation methods to create a software development tool evaluation taxonomy.

The problem statement has four components: (1) industry view, (2) qualification, (3) quality assessment, and (4) tool evaluation taxonomy. The data collected from industry influenced the evaluation process and the recommendations for development tool practices. Selected methods used to evaluate tools have been described. The report presents different categories of tools identified in the course of the research. This categorization is limited to the research scope as guided by DO-178B. Finally, the report defines the structure and the organization of the tool evaluation taxonomy.

Arlene Beisswenger, Jean-Louis Laforte, Marc-Mario Trenblay, and Jean Perron. INVESTIGATION OF A NEW FORMULATION REFERENCE FLUID FOR USE IN AERODYNAMIC ACCEPTANCE EVALUATION OF AIRCRAFT GROUND DEICING AND ANTI-ICING FLUIDS (DOT/FAA/AR-06/50)

This report proposes a new formulation fluid for use as the reference fluid for aerodynamic testing and qualification of commercial aircraft deicing and anti-icing fluids. The new fluid would replace the one currently called for in MIL-A-8243D, a fluid that allowed for large variation in its composition and is no longer commercially available.

The measurements and validation testing accomplished in the present study support the adoption of the new fluid for use as the reference fluid for the high-speed ramp standard aerodynamic qualification test in place of the current MIL fluid. A mixture of 68% propylene, 20% tripropylene glycol, and 12% demineralized water, the new formulation fluid is chemically compatible with current glycol-based fluids. Furthermore, it can be produced more simply and accurately than the more complex formulation it replaces. The new formulation reference has been found to be essentially aerodynamically indistinguishable from the MIL fluid when both fluids were tested in comparison with a candidate fluid for high-speed ramp aerodynamic standard qualification. An investigation similar to the one described in this report could establish if the new fluid also can be used as the reference fluid for the low-speed ramp standard aerodynamic qualification test.

Viswa Santhanam, John Joseph Chilenski, Raymond Waldrop, Thomas Leavitt, and Kelly J. Hayhurst. SOFTWARE VERIFICATION TOOLS ASSESSMENT STUDY (DOT/FAA/AR-06/54)

The Software Verification Tools Assessment Study (SVTAS) investigated criteria for evaluating structural coverage analysis tools for use on projects intended to comply with RTCA/DO-178B, Software Considerations in Airborne Systems and Equipment. Its objective was to improve the accuracy and consistency of the qualification process for these tools. The study surveyed commercially available structural coverage analysis tools, performed literature searches to review policy and guidance relevant to structural coverage and tool qualification, and analyzed structural coverage definitions. Based on their findings, researchers proposed a test suite as an approach to increase objectivity and uniformity in the application of the tool qualification criteria, defined goals for a full test suite, and developed a prototype test suite. The prototype test suite was run on three different structural coverage analysis tools to evaluate the efficacy of the test suite approach. The prototype test suite identified anomalies in each of the three coverage analysis tools and demonstrated the potential for a test suite to help evaluate a tool's compatibility with the DO-178B requirements.

Tracy A. Fry. AGING MECHANICAL SYSTEMS PROGRAM (DOT/FAA/AR-07/1)

This report details the development and demonstration of an Aging Mechanical Systems Methodology designed to help ensure on-going system safety through the application of findings from the proactive study of commercial aging aircraft. The report provides a description of the methodology and documentation of an inaugural case study of the Embraer 120 pitch control system. It includes findings and recommendations resulting from both the development of the methodology and the execution of the case study.

Gil Wittlin and Max Gamon. THE DEVELOPMENT OF DITCHING AND WATER IMPACT DESIGN LIMIT CURVES FOR CIVIL ROTORCRAFT (DOT/FAA/AR-07/8)

This study follows two previous full-scale, fully instrumented water impact tests, performed on a Bell (BH) 205 helicopter, in which KRASH models were established and correlated with further test results. In the previous research, various results were correlated to validate the models and to help explain the significance of the test measurements and the analytical representation – as well as (*continued on next page)*

the differences between the two. Under this current effort, available data supported the development of a new set of KRASH BH-205 helicopter structural and occupant models that were used to test survivability under various sets of water impact conditions.

Rotorcraft impact velocity and attitude, rotorcraft weight, landing gear position, underside panel strength, mass item design load factors, fuel cell and surrounding structure, crash design load factors, flotation system performance, auxiliary fuel tanks, and water surface sea-state conditions were all taken into account. Acceptance criteria was established based on structural failure loads, occupant lumbar load, head injury, restraint system loads, underside panel failures, major mass item retention, interior structure impingement loads, and seat stroke limitations. A set of survivable water impact DLEs was presented. In addition, floor accelerations were provided for consideration and comparison with existing seat dynamic test requirements.

This study has increased scientific understanding of viable design requirements for different levels of water impacts as well as confidence in the ability of researchers both to represent and analyze the effects of all levels of water impacts and to evaluate related design changes.

Melinda Laubach, Dale Cope, Michael Shiao, and Marvin Nuss. TEARDOWN EVALUATION OF TWO T-34A WING SETS (DOT/FAA/AR-07/9)

To aid with the assessment of aging acrobatic aircraft, the FAA teamed with the National Institute for Aviation Research of Wichita State University to teardown and inspect two sets of high-time Beech T-34A wings. Following a recent history of fatigue cracking and failure with this type of aircraft, FAA researchers considered a destructive evaluation useful to address specific T-34A concerns, but also in a more general sense, to assess the condition of a high-time acrobatic category aircraft.

The teardown evaluation involved performing inspections prescribed in Airworthiness Directive 2001-13-18. As required, the team disassembled underlying primary structures to facilitate access to problem areas, removed paint and etched the wing primary structure to enhance damage detection, performed a range of post-disassembly nondestructive inspections, and examined primary structures in microscopic detail. They also analyzed selected cracks to determine their related failure modes.

Sonceré Woodford, Vasudeva Kolli, and Chuck Agava. 14 CFR PART 137 AVIATION SYSTEM FUNCTIONAL MODEL (DOT/FAA/AR-07/23)

A task was recently awarded to enhance risk management decision support for the General Aviation (GA) Research and Development Program. This task provides research, project planning, and program support to accomplish task GA-01, an effort that involves Title 14 Code of Federal Regulations Part 137 Aviation System Functional Model Development.

Jill Suo-Anttila, Walt Gill , Anay Luketa-Hanlin, and Carlos Gallegos. CARGO COMPARTMENT SMOKE TRANSPORT COMPUTATIONAL FLUID DYNAMICS CODE VALIDATION (DOT/FAA/AR-07/27)

This project tested the ability of an available computational model to predict smoke and gas transport within aircraft cargo compartments. Its simulations and experiments analyze the transport of smoke and combustion products under a variety of realistic conditions. The main variables that changed among the cases were fire location, compartment size, and ventilation. Validation metrics suitable for fire detection system response were selected and, overall, the model favorably predicted these metrics for the selected cases. The model can now be used with improved confidence to simulate certification scenarios to assist in designing the optimum detection systems for cargo compartments.

William M. Cavage. AN ANALYSIS OF FACTORS EFFECTING CARGO BAY FIRE SUPPRESSION USING A FUEL TANK INERTING SYSTEM (DOT/FAA/AR-07/28)

Researchers tested a single air separation module (ASM) of a fuel tank inerting system to determine its potential for use as a cargo bay fire suppression metered system. Based on the ASM performance data, the team calculated the time required to inert a single cargo bay with the experimental system and compared that result with the length of time it would take to a achieve the same result using the discharge of halon supplied by standard Onboard Inert Gas Generation System (OBIGGS). The findings indicated that the system being tested would perform to a standard consistent with the standard requirements for a cargo bay fire suppression metered agent system.

The researchers compared the abilities of two techniques to decrease the time required a cargo bay. They found it effective either to decrease the air rate of air leaking from the bay or to increase the amount of halon introduced into the bay. Both techniques, however, were very sensitive to the effects of the ASM feed pressure. The relative size of the cargo bay did not prove to be a major factor in the length of time in non-inert status, provided that the leakage rate was the same and the size of the halon discharge was maintained relative to the size of the cargo bay. Relatively fuller cargo bays also tended to become inert more quickly than less full bays of the same size. As expected, due to the decrease of gas mass in the compartment, it also proved easier to inert the cargo bay as pressure altitude increased.(*continued on next page)*

This project increased confidence that adding the capability of inert gas generation for fuel tank inerting to a commercial transport airplane can improve fire safety and reduce the weight and complexity of existing cargo bay fire suppression systems.

Xin Liu and J.G. Quintiere. FLAMMABILITY PROPERTIES OF CLAY-NYLON NANOCOMPOSITES (DOT/FAA/AR-07/29)

Researchers measured the chemical energy release rate, mass loss rate, and time to ignite (melt and char) to determine the flammability properties of nylon samples comprised of varying percentages of clay. This study consisted of samples of pure Nylon 6 and nylon that contained nanoclay additives at 2% and 5% by weight. In addition, the effect of sample thickness was considered for 1.6 to 24 mm. Data obtained over a range of radiant heat flux (17 to 55 kW/m2) were analyzed to illustrate the effect of sample clay loading and thickness on heat of combustion, heat of gasification, and ignition temperature.

The findings indicated that the heats of combustion based on mass loss did not change with clay loading, and were 28 ±1 kJ/g. The critical heat flux for ignition decreased from 17.7 for pure nylon to 16.0 with 5% clay addition, indicating that this property did not generally appear to be influenced by the amount of clay added. These values correspond roughly to an ignition temperature of 430o C, compared to a decomposition temperature range from a thermo gravimetric analyzer of 350° to 430oC. However, it appears that the addition of the clay could increase the ignition time by 30% to 100% over the pure nylon, due to the increased char residue and the decrease in the mass loss rate. The char-like residue yield was nearly identical to the clay loadings. The overall average mass loss rate was reduced by up to 50% with a 5% clay composition over pure nylon for a given heat flux and thickness. For the clay nanocomposites, the burning rate increased as the thickness decreased.

Skip Byrnes. JET A VOLATILITY SURVEY (DOT/FAA/AR-07/30)

In response to the July 1996 TWA Flight 800 disaster, the FAA collected samples from the fuel tanks of aircraft returning from domestic and international flights to determine the actual flash point of jet fuel in service. This data was collected to help determine whether the use of such flammability assessments might support revisions to the ASTM D1655 turbine fuel specification that would help prevent any future such incident. This report details the flash point results from 293 jet fuel samples collected from April 1998 through September 1999.

The results found no fuel samples to be out of specification and no change in the turbine fuel specification was required. Samples were retrieved before the refueling of flights that ended in Philadelphia, PA; New York, NY (JFK); and Newark, NJ. These airports provided convenient locations for FAA technicians to obtain fuel samples from flights originating all over the US and abroad. The flashpoint distribution resulting from the survey was used in preparing the FAA special conditions issued for the B-747 and B-737 fuel tank flammability reduction means. It also helped in preparing the proposed Title 14 Code of Federal Regulations Part 25 Appendix L that was published in the Notice of Proposed Rulemaking titled, Reduction of Fuel Tank Flammability in Transport Category Airplanes (docket number FAA-2005-22997).

Timothy R. Marker. A PRELIMINARY EXAMINATION OF THE EFFECTIVENESS OF HAND-HELD EXTINGUISHERS AGAINST HIDDEN FIRES IN THE CABIN OVERHEAD AREA OF NARROW-BODY AND WIDE-BODY TRANSPORT AIRCRAFT (DOT/FAA/AR-TN04/33)

Researchers tested the capabilities of hand-held devices in twenty separate experiments to determine how well FAA-required, hand-held Halon 1211 extinguishers would perform against fires in the inaccessible area above the cabin ceilings of wide-body and narrow-body aircraft. A number of controllable candle lanterns were used to simulate typical hidden fires in these hidden overhead spaces. Twenty hand-held extinguisher tests were performed in the overhead space in both narrow- and wide-body aircraft. These tests simulated a typical hidden fire in the inaccessible area above the cabin ceiling by using a number of small, controllable candle lanterns. The extinguishers were discharged through ports permanently mounted in the aircraft ceilings. The ceiling mountings were frequently modified during tests to maximize performance of the fire suppression agent's performance.

Regardless of port design, individual hand held extinguishers failed to put out fires predictably. The tests did indicate, however, that these devices appear to be more effective against fires in the more confined and smaller-volume overhead area typical of a narrow-body aircraft. Additional work will be needed to further develop and optimize this concept.

James W. Patterson, Jr. MODIFICATION OF VISUAL APPROACH SLOPE INDICATOR BAFFLES AT PEARSON FIELD AIRPARK, VANCOUVER, WA (DOT/FAA/AR-TN07/12)

Researchers successfully corrected a safety deficiency with a Visual Approach Slope Indicator (VASI) system at the Pearson Field Airpark in Vancouver, Washington. The facility's VASI system had been emitting signals that potentially could have drawn an approaching aircraft dangerously close to an obstruction near the final approach path. As a result, the system was shutdown. Existing baffles on the system were configured to allow only the signal from selected units to be visible near an obstruction.

Engineers from the Airport Technology Research and Development Branch first analyzed the problem; collected data on the geometry of the obstruction, the baffles, and the (*continued on next page)*
general layout of the airport. (*continued on next page)*

Hot off the Press!

Then they designed, constructed, and installed aluminum baffles that blocked the signal from the obstruction area, and provided a two-degree margin of safety between the obstruction and the visible signal of the VASI. Subsequent testing verified that the installed baffles had eliminated the hazard.

Andrew Cheng, Ph.D. DISCUSSION OF APPROACHES TO ESTIMATE THE AIRCRAFT STOPPING DISTANCES UNDER STANDARD OPERATING PROCEDURES (DOT/FAA/AR-TN07/21)

An FAA research team is currently studying aircraft operational landing performance, aiming to increase the safety and efficiency of aircraft operations in terminal areas. A primary research objective has been to identify the operational "landing distances" achieved in line operations under standard operating procedures. The total distance, from the runway threshold, needed for an arriving aircraft to come to a full stop consists of the touchdown point (i.e., airborne distance) from runway threshold and the stopping distance after touchdown. Although several algorithms have been recently developed to identify aircraft touchdown points via available landing parameters, solutions to adequately determine the aircraft stopping distance are still needed.

This technical note proposes a new method to estimate the aircraft stopping distance based on an understanding of the deceleration pattern during rollout. The deceleration pattern reflects the pilot's decision and command under the specific landing conditions, including the piloting techniques, weather conditions, runway situation, air traffic control demands, etc. No troublesome noise-filtering process is needed to determine this pattern, and other external factors generally do not affect it. Most importantly, this approach is simple and straightforward. The document demonstrates key assumptions and investigation results with operational landing examples.

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