SECTION 2

OBJECTIVES OF THE FAA's R,E&D PROGRAM

2.1 Research, Engineering and Development Program Objectives

The Federal Aviation Administration's (FAA) mission is to provide a safe, secure, and efficient aerospace system that contributes to the national security and the promotion of U.S. aerospace safety. As the leading authority in the international aerospace community, the FAA is responsive to the dynamic nature of customer needs, economic conditions, and environmental concerns. Key elements of that mission are: (1) the regulation of civil aviation and commercial space transportation to promote safety; and (2) the safe and efficient use of the airspace by both civil and military aircraft. To accomplish this mission, the FAA's Research, Engineering and Development (R,E&D) program develops and validates technology, systems, design, and procedures that directly support six of the agency's principal operational and regulatory responsibilities: acquisition, air traffic services, certification of aircraft and aviation personnel, certification of airports, civil aviation security, and environmental standards for civil aviation.

The FAA's R,E&D program has made significant contributions to assure the safety, efficiency, capacity, and cost effectiveness of the national aviation system. Today, that system is under pressure to keep pace with rising traffic demand, needs for essential safety and security improvements, airspace user requirements for more flexible and efficient air traffic management operations, and demands for further mitigation of the environmental impacts of aircraft operations. As air travel increases, the agency's R&D work will take on added significance. To meet those future challenges, the FAA employs a comprehensive, agency wide R,E&D investment analysis process to assure that available resources remain customer focused and targeted on the highest priority activities.

The R,E&D program supports the goals and objectives of the agency's strategic plan. First in priority in those goals and objectives is safety. The accident rate has dropped dramatically over the past 20 years because of the introduction of new technologies and procedures based on R&D contributions from the FAA, NASA, and, to a lesser extent, DOD. As traffic doubles over the next 15 to 20 years, it will be necessary to reduce the current accident rate by 50 percent to hold the annual number of accidents at today's level. The R,E&D program supports essential initiatives in pursuit of the goal to reduce the fatal accident rate by 80% by the year 2007.

Another major challenge facing the FAA today and one of our strategic goals is the modernization of an aging infrastructure of air navigation facilities. A major infusion of new technology and new procedures that take advantage of the opportunities that new technology provides is essential if air traffic services are to continue to support safe and efficient flight operations in the future. The system architecture provides the road map for this continuing modernization process, and the R,E&D program provides the necessary system development initiatives.

A safe and efficient air transportation system also is essential to both the nation's economic prosperity and for national defense. In 1993, aviation and related industries contributed almost $700 billion to the U.S. economy (6 percent of our gross domestic product) and encompass over 8 million jobs. Aviation is the largest export sector of our economy, with a $25 billion trade surplus in 1994. The industry expects to deliver over 14,000 transport aircraft valued at $1 trillion over the next 20 years. A viable FAA R,E&D program is critical to assure the continued safety and efficiency of the air transportation system and continued U.S. technical and economic leadership in aviation.

The FAA's R,E&D program is functionally divided into six areas: air traffic services, aircraft safety, system security, human factors, environment and energy, and R,E&D program direction. Section 2 explains the composition of these research emphasis areas, what has been achieved from the research program, and future products that will be funded by the FY 2001 R,E&D budget request.

SECTION 3

PLANS AND ACCOMPLISHMENTS

3.1 Air Traffic Services

Air traffic services research is directly supported by the following FY 2001 R,E&D budget items: Technical Laboratory Facilities, Center for Advanced Aviation System Development, and Aviation Weather Research.

R,E&D initiatives related to air traffic services focus on increasing system safety and capacity and enhancing the flexibility and efficiency of air traffic management operations. The FAA with the participation of the Center for Advanced Aviation System Development (CAASD) is developing an air traffic control automation system that will accommodate more traffic and provide users with the flexibility and efficiency that their operations demand. A key element in achieving these outcomes is the development of automated decision support tools that will enable air traffic controllers to strategically manage traffic flows more efficiently, while collaborating with the user community in making decisions that affect operations. Additionally, the agency is working to reduce the risk of hazardous weather. Other activities are focused on the development and validation of tactical automated decision support tools for air traffic controllers and cost-effective aviation weather services.

The Center for Advanced Aviation System Development (CAASD) provides resources to air traffic service research to produce a safer, more efficient global air transportation system. CAASD is an essential component of the FAA's research program since it augments the agency's in-house resources in conducting research for the Air Traffic Services (ATS) line of business. The CAASD research program provides detailed reports, briefings, and concept demonstration systems used in the evaluation of new air traffic management (ATM) and control operating concepts and/or infrastructure replacements. These products are the beginning critical elements in the development of a more efficient, more available, and safer next generation ATM and control system.

The William J. Hughes Technical Center provides the core capabilities for evaluation of future operations concepts through testing of advanced prototypes. This reduces associated risks with the introduction of new operating procedures and equipment into the NAS. The WJHTC maintains and operates agency test bed laboratories utilized by R,E&D programs in evaluating these procedures and equipment. These centralized test beds consist of NAS systems, aircraft, simulation facilities, communication systems, and a Human Factors Laboratory.

The Aviation Weather Research Program (AWRP) is developing aviation weather products that will enhance the safety, capacity, and efficiency of flight operations. As a result of the FAA's research investments, the Aviation Gridded Forecast System (AGFS) has been developed and is now operational at the Aviation Weather Center in Kansas City. AGFS provides users access to gridded aviation weather data including winds, temperature, and icing as well as Airman's Meteorological Information (AIRMET) and Significant Meteorological Information (SIGMET). The program has produced a 30 minute storm growth and decay forecast capability, a process of utilizing aircraft mounted humidity sensors to provide humidity data for forecast models, improved identification of in-flight icing, enhanced NEXRAD tornado detection algorithms, and many other forecast products. The FAA's AWRP will continue to develop a wide range of new forecast algorithms and models to predict more accurately the timing, location, and severity of weather events, such as in-flight icing, thunderstorms, low ceiling and visibility, in-flight turbulence, snow, and high winds. These products are being developed in collaboration with the National Weather Service. The National Weather Service plans to use this technology for the benefit of the entire aviation community. Derivatives of these products also will be incorporated into the FAA's integrated terminal weather system and air traffic automation systems to aid in air traffic planning at both the major airports and at the national level. Additionally, the AWRP is performing research to determine the feasibility of developing a ground-based turbulence warning system for implementation at the Juneau, Alaska Airport.

3.2 Aircraft Safety Technology

Aircraft safety technology research is directly supported by the following FY 2001 R,E&D budget items: fire research and safety, advanced materials/structural safety, propulsion and fuel systems, flight safety/atmospheric hazards research, aging aircraft, aircraft catastrophic failure prevention, and aviation safety risk analysis.

The expected outcome of FAA's investment in this area is aircraft operations conducted at lower risk, without damage to property or harm to individuals. Recent investments have produced improvement in the ability to detect hazardous ice accumulations on aircraft. A plan to address the aging of non-structural systems has been developed, and research has begun. An example of this is a joint effort with the U.S. Navy to develop, test and evaluate an arc-fault circuit breaker, which will ensure that wiring and wiring insulation damage does not result in potentially catastrophic onboard fires. FY 2001 investments provide for continued development of an advanced safety performance analysis system (SPAS) that can spot adverse safety trends for corrective action before an accident occurs. Research is continuing to advance and improve turbine engine design methodologies that reduce the likelihood of failure of rotating titanium components and to develop improved inspection techniques that identify material, manufacturing, and in-service anomalies in these components.

Catastrophic failure prevention research has been completed on a characterization of advanced material barriers to protect critical aircraft structural areas from engine debris in the event of an uncontained engine failure and candidate materials have been identified.

The FAA Airworthiness Assurance Center of Excellence (AACE), established in 1997, continues to conduct research in the areas of maintenance, inspection, and repair, propulsion and fuel system safety, crashworthiness, and advanced materials. AACE is composed of a core team of 8 universities and the FAA Airworthiness Assurance Nondestructive Inspection Validation Center located at Sandia National Laboratories, and has over 30 university affiliate members and over 60 industry partners.

A full-scale curved panel test facility was completed at the William J. Hughes Technical Center and testing is ongoing to validate computational methods to predict the onset of widespread fatigue damage. Research continues in occupant restraint methods and passenger survivability in crashworthiness. Research is ongoing for the development of technical approaches and related databases for more reliable, efficient and cost effective certification procedures for advanced material structures.

Research will also continue to reduce the risk of fire-related injuries and increase the survival rates for occupants during in-flight and post-crash fires. For example, the FAA is working with the Civil Aviation Authority in the United Kingdom to improve the resistance of aircraft fuselages to burn-through by external fuel fires. Tests have demonstrated the effectiveness of a new insulation material that more than doubles the time passengers have to evacuate the cabin before external fire penetrates the fuselage. Research is ongoing to address fuel and fire safety issues identified in the TWA 800 investigation.

3.3 System Security

The FY 2001 R,E&D budget items that directly support aviation system security research include explosives and weapons detection, airport security technology integration, aviation security human factors, and aircraft hardening.

The system security research goal focuses on the elimination of criminal civil aviation security incidents perpetrated by terrorists. To accomplish this goal, research engineers strive to develop technologies and standards to counter traditional as well as nontraditional threats. Recent investments produced improved performance and additional capabilities in the detection of explosives in checked bags. The need for advanced research to improve detection capability, performance, and efficiency to inspect more bags, and counter emerging threats continues. The development and certification of affordable detection equipment for smaller airports remains a major thrust for FY 2001.

Research focuses on the detection of threats on both people and carryon items at the screening checkpoint. The importance of the screening checkpoint as a top priority prevails. As passenger numbers increase, researchers must

develop new technologies to accurately counter the threat while maintaining a high screening rate. To accomplish this, research to combine technologies into a capable, efficient, and integrated system continues.

Because of the size and variety of materials, detection of explosives in air cargo remains a challenging problem. Previous research identified and evaluated a number of alternative technologies. FY 2001 research efforts concentrate on completing guidelines for matching explosives detection technologies to cargo types and on completing the training protocols for the manual search of cargo.

The Airport Security Technology Integration program proceeds to develop models for predicting the operational effects of inserting security measures into the existing aviation system. In striving to block terrorist access to aircraft through analysis of airport vulnerabilities, researchers investigate the use of advanced perimeter-control surveillance systems and develop systems providing strict passenger-luggage accountability.

The human factors research program continues to address the issues of man-machine integration, operator training, and technologies to measure and assess their combined performance. Aiming for better screener selection and performance, the program researchers developed a Screener Readiness Test that determines when screeners have received sufficient initial training.

Finally, ongoing research continues to reduce and eliminate aircraft structural damage due to on-board explosions. Successful testing of hardened containers validates this research effort including the hardening of overhead compartments.

All of the research activities, that combine technology, procedures and people, are critical to an effective, efficient aviation security system.

3.4 Human Factors and Aviation Medicine

Human factors research is directly supported by the following FY 2001 R,E&D budget items: flight deck/maintenance/system integration human factors, aeromedical research, and air traffic control/airway facilities human factors.

Human factors research investments provide technology, information, and guidelines which directly support two of the FAA's performance goals for system safety: (1) Through research, identify methods that, when implemented, would reduce the fatal aviation accident rate by 80%; and (2) Ensure that critical human factors policies, processes, and best practices are integrated in the research and acquisition of 100 percent of FAA aviation systems and applications. To reach these goals, human factors research utilizes FAA in-house facilities, partnerships with other agencies and industry, and research grants with universities.

The human factors research program is fully integrated with related FAA activities. For example, in the area of Human Performance Assessment, human factors research is expanding the Automated Performance Measurement System (APMS) to allow air carriers to analyze increasing amounts of flight data. This follow-on to the initial version of APMS allows air carriers to evaluate aircrew skills in line operations and in simulators to identify potential safety threats. This system also allows FAA oversight offices to determine the effectiveness of training programs, in particular, the Advanced Qualification Program, In Flight Deck Automation/Technology, human factors researchers will provide a job aid to help certification personnel and designers assess modern flight decks for susceptibility to design induced human performance errors and the consequences of those errors. In addition, human factors research will identify antecedents to cockpit human error in order to tailor pilot training to address these vulnerabilities.

Selection and Training research will provide other methodologies and tools to assess flight crew performance, as well as the tools required to analyze this data. Line check airmen or instructors in the training centers which certify crews on a continuing basis, use these tools. Several research efforts will concentrate on analyzing performance in automated cockpits and designing improved training to avoid human error in the use of these systems. Aviation Maintenance human factors research efforts are exploring the application of human factors interventions to improve aviation inspection performance, evaluating the effects of Maintenance Resource Management, and examining human error risk analyses in aviation maintenance and flightline operations. Research is also producing programs used for

improving aviation maintenance and inspector team communication to prevent shift change communication errors. Shift change error identification and mitigation processes will be integrated into the aircraft maintenance error detection and reporting system.

Aeromedical Research is developing bioengineering criteria to support aircraft seat and restraint system certification, human performance and ergonomic data to support emergency evacuation regulations and standards, biomedical criteria to support protective breathing equipment and operational procedures certification, and biochemical and toxicological criteria for aircraft interior fire, smoke, and toxicity limits. The joint FAA-National Institute of Occupational Safety and Health research program is examining aircraft cabin environment and occupant health issues.

Air Traffic Control/Airway Facilities (ATC/AF) research products are enhancing the performance of Air Traffic Control Specialists and National Airspace System (NAS) maintenance technicians. ATC/AF research is focused on areas which will provide near-term results: developing guidelines for information display and interface design; providing human-centered design guidelines for Decision Support System capabilities; providing documentation of human factors requirements associated with system integration of new airspace design concepts; providing human performance metrics to support evaluation of NAS maintainability; developing selection methodologies, guidelines, and criteria for NAS personnel; and, based on human performance capabilities and limitations, developing guidelines for the implementation of new procedures and technologies associated with aircraft and ground shared separation authority.

3.5 Environment and Energy

The FAA environment and energy program is directly supported by the following RE&D budget items: aircraft noise control, engine exhaust emissions control, and aviation environmental analysis. This program develops standards and procedures to mitigate the environmental impacts of aircraft operations, in particular, noise and air pollution emissions, and technical information to understand and better manage the impacts of aviation operations.

As a major part of the research program, FAA is working with NASA to identify abatement technologies for aircraft noise and engine exhaust emissions and to assess the effects of aviation upon global climate change and the ozone layer. In addition, FAA continues to work with the European Joint Aviation Authorities to harmonize certification procedures to produce unambiguous and cost-effective requirements for the aviation industry. Recent success includes the harmonization of the noise certification standards and measurement procedures for commuter and other small propeller driven airplanes and emission standards for turbine engine powered airplanes.

The FAA investment in environmental research also has made significant advancements in developing and using computer tools to assess airport noise and air quality; thus gaining insight into the system-wide consequences of alternative courses of action. An FAA/NASA sponsored effort for assessing global noise exposure was endorsed by the International Civil Aviation Organization for analyzing policy initiatives. The FAA Integrated Noise Model was updated to assess local conditions for scenarios outside the airport environment. It is now distributed to over 650 organizations, making it the most widely used model of its kind. And publication of the Intergovernmental Panel on Climate Change (IPCC) Special Report on Aviation and the Global Atmosphere, largely based on U.S. government sponsored research, is providing a policy framework for addressing aviation's contribution to climate change.

3.6 R,E&D Program Direction

R,E&D program direction is directly supported by the following FY 2001 R,E&D budget items: R&D plans and programs, and R&D partnerships.

The focus of this R,E&D program area is coordinating, supporting, and facilitating the research being conducted by the other areas of the program with the expected outcome of more productive research accomplished per dollar invested. This program area provides the scheduling and budget preparation for the R,E&D program, the drafting and publication of the 'National Aviation Research Plan,' the financial support for the Radio Technical Commission for Aeronautics (RTCA) Advisory Committee, and funding for the committee and subcommittee work by the FAA R,E&D Advisory Committee in support of the FAA Administrator.

The strategic partnership portion of the R,E&D program direction area aggressively pursues and accomplishes R&D partnerships with industry, universities, and other government agencies. These essential partnerships are obtained by

offering a variety of funding options, such as grants to colleges and universities, selecting and funding university centers of excellence, signing cooperative research and development agreements with industry, and cooperative agreements with other government agencies. The objectives of these partnerships are to leverage the agency's R&D investment with contributions from other sectors, to exploit unique outside research facilities and capabilities as an alternative to creating these capabilities in-house, and to foster the introduction of outside perspectives and research ideas into agency R&D initiatives. The FAA has established R&D partnerships with more than 250 outside organizations. The value of the contributions from these partners is estimated to exceed $25 million annually.

SECTION 4

SUPPORT FOR NATIONAL SCIENCE AND TECHNOLOGY PRIORITIES

4.1 National Science and Technology Council (NSTC) Priorities

President Clinton established the National Science and Technology Council (NSTC) by Executive Order on November 23, 1993. This cabinet-level council is the principal means for the President to coordinate R&D policies across the Federal Government.

The NSTC Committee on Transportation Research and Development chaired by Deputy Secretary of Transportation Mort Downey has developed the rationale and framework for guiding Federal initiatives that will make our transportation system safer, more productive and more efficient. Considering the likely future, the Transportation R&D Committee has defined the following set of strategic goals for transportation R&D ("National Transportation Science and Technology Strategy", April, 1999) in the following areas:

- Safety
- Mobility and Access
- Economic Growth and Trade
- Human and Natural Environment
- National Security

The FY 2001 FAA R&D budget is designed to support these strategic goals for transportation R&D. The FAA is a uniquely visible member of the transportation community, and these investments are critical to meeting the national goals and ensuring the prosperity of the national economy.

The President has announced a number of strategic initiatives for R&D. The following table shows FAA support for these initiatives.