2.0 PROGRAM INFORMATION

2.1 Air Traffic Services Program Area Description

Mission

The overall mission of Air Traffic Services (ATS) is to ensure the safe and efficient operation, maintenance, and use of the air transportation system today and to meet tomorrow's challenges to increase system safety, capacity, and productivity. ATS continually seeks to improve its services by undertaking initiatives to meet current and future demands. The ATS R,E&D program is an overt initiative to ensure a structured and evolutionary improvement of services that keeps pace with the global growth in aviation. The mission of the R,E&D program is to develop technology, practices, and procedures to ensure continued improvement in delivery of air traffic services.

Intended Outcomes

The ATS R,E&D program is one part of an integrated strategy to increase the value of the air traffic services. The ATS R,E&D program is a vehicle for making long-term investments in improving services, procedures, and infrastructure, and integrating new concepts and technology to meet the increasing demands of safety, capacity, efficiency, and productivity. Human factors considerations are central to all program outcomes for a totally effective solution. The ATS R,E&D program contributes to the ATS performance outcomes contained in the *Air Traffic Services Performance Plan* and the strategic goals of the Government Performance and Results Acts (GPRA). The program is also consistent with the goals delineated in the *FAA Strategic Plan*, the *Research and Acquisitions Performance Plan*, and the *Regulation and Certification Performance Plan.*

The ATS R,E&D program contributes to the seven ATS performance outcomes described below and represents increased value to system users and the American public.

Increase System Safety. Safety is the FAA's foremost priority, and the ATS R,E&D program plays a critical role in the development of procedures and technologies for safety improvement.

Aircraft separation based on a well-defined set of standards is the keystone of ATS' safety-related service. The ATS R,E&D program invests in projects to determine safe separation distances under varying conditions and ways to more accurately determine and predict aircraft positions and to reduce weather-related accidents and passenger injuries. The effects of weather phenomena on the aircraft, including clear-air turbulence, cause a large percentage of aviation accidents and passenger injuries. Additionally, an investment in airborne collision avoidance systems is included to provide a safety net beyond traditional separation methods.

Overall technological improvements in information displays, automation tools, decision support systems, communications, navigation, and surveillance will support better determination of aircraft position and resolution of potential conflicts both in the air and on the airport surface.

Decrease System Delays. A traditional measure of the efficiency of the Air Traffic Management (ATM) system is delay. Delays can be caused by various factors; however, weather is recognized as a chief cause. The ATS R,E&D program is addressing the effects of weather-caused delays by investigating better weather-detection and forecasting tools. The program also addresses throughput of airways and airport infrastructure, as well as the accuracy of information exchanged by ATM systems.

Increase System Flexibility. National Airspace System (NAS) users expect more from the ATM system than reduction of delay. Users want to optimize their operations through increased flexibility during the flight planning process. Flight management and enhanced flight planning systems using new technologies have enabled users to dramatically improve the efficiency of air transportation by allowing them to operate at the altitudes, speeds, and routes that they desire. As ATS services evolve toward Free Flight, the ATS R,E&D program supports development of technologies and procedures in support of Free Flight and initiatives such as Flight 2000.

Increase System Predictability. Predictability represents the variation in the ATM system experienced by the user. Improving predictability is

one of the most effective ways to add value to the ATM system. Weather is a significant contributor to the uncertainty in the ATM system. Sixty-five percent of the flight delays and 30 percent of aircraft accidents and incidents can be attributed to weather.

The ATS R,E&D program seeks improvements in acquiring and disseminating weather products. High-resolution weather forecasts in both space and time are feasible; but to be of use, it requires rapid, effective graphical display of the associated information to the users. Manual analysis and identification of specific aviation weather impacts, such as icing and turbulence, cannot provide the information quickly enough or with sufficient clarity to significantly reduce related delays. Research in this area is intended to improve system responsiveness by increasing user accessibility to weather observations, warnings, and forecasts. Any reduction in the impact of weather on operations results in a fundamental increase in the predictability of the system.

Increase User Access. Access to the NAS and ATS services is the basic need of all airspace users. The fundamental point through which most users gain access to the NAS is airports. Navigation and Landing are core services allowing access to airspace and airports under varying conditions. The ATS R,E&D program includes initiatives to provide access to airspace, airports, and landing services available to a wide variety of users under varying conditions. Thousands of airports and runways become inaccessible when weather conditions prohibit visual navigation. The widespread availability of the Global Positioning System (GPS) signal-in-space, along with published GPS instrument approach procedures, will enhance access to these capital assets.

Research will ensure that the GPS-derived Wide Area Augmentation System (WAAS) and Local Area Augmentation System (LAAS) services will have high availability. The expanded use of satellite-based navigation systems will result in precision approaches being available at more airports, which will increase all-weather access to an increasing number of airports.

Additionally, research into the integration of flight-deck state, intent, and weather data with ground systems can reduce excess spacing buffers between arriving aircraft.

Increase Availability of Critical Systems. ATS has traditionally used an overall equipment availability rate as an indicator to represent basic trends of NAS equipment. While this indicator consistently runs over 99 percent and offers some insight into the quality of operational services, ATS is taking a more detailed look at overall service availability. Increasing service availability results from taking a multifaceted approach that requires improvements in the aging NAS infrastructure and better methods of system operation and maintenance. A modernized ATC system is critical to the aviation community, and a significant growth in aviation cannot be safely accommodated without significant breakthroughs in modernization. The ATS R,E&D program is responsive to these goals in that the key elements of NAS modernization are addressed in several areas by research into technology improvements, such as the effective use of modern displays, automation tools, and decision support tools.

Increase Productivity. Given the increasing level of services demanded and the decreasing number of scarce resources at the disposal of ATS, it is more important than ever to make more effective use of available resources and to undertake cost savings and containment initiatives. R,E&D investments allow for better use of personnel through initiatives that provide ATC personnel with support tools to enhance their level of control and decrease their workload. Productivity improvements are expected through automation, improved decision support systems, and procedural and process improvements. Current cost savings and productivity initiatives include investments in human factors, modeling and simulation, and software engineering activities.

Program Area Outputs

The outputs of the ATS R,E&D program vary, from development of operational prototype equipment to development of operational concepts, modeling and simulation studies, emergent technology evaluations, to development of procedures, standards and guidance. Examples of expected program outputs are:

- Timely delivery of high-resolution information for icing, winds, temperature, and turbulence to improve aviation advisories and forecasts used by the National Weather Service
- Human factors guidelines for shared information displays in air-to-ground communications
- Selection criteria and training methods for operators and maintainers that reflect changes in the operational environment and automation
- Support to industry development of advanced avionics for small airplane and rotorcraft single pilot instrument flight rules (IFR) to meet FAA requirements
- Improved processes and practices in software development for the aviation industry and the FAA
- Guidelines for an effective, accelerated system/software to production process
- Refinement of airborne collision avoidance technologies and procedures.

Program Area Structure

The ATS R,E&D program has been structured to systematically support these intended outcomes:

- Increase system safety
- Decrease system delays
- Increase system flexibility
- Increase system predictability
- Increase user access
- Increase availability of critical systems
- Increase productivity.

The ATS R,E&D program addresses these outcomes with the objective of making efficient and effective use of R,E&D resources by adding value that benefits NAS users, operators, and the American public.

Customer and Stakeholder Involvement

The ATS R,E&D program reaches a broad spectrum of the aviation community and supports several aviation community interests, including Challenge 2000, the *Aviation Safety Plan*, the *RTCA Free Flight Action Plan*, the NAS System Architecture Development, and the *ATS Concept of Operations for the National Airspace System in 2005*. Specific examples of customer and stakeholder involvement include:

- The R,E&D Advisory Committee (REDAC) provides guidance on the FAA's ATS investments. The REDAC Subcommittee for ATS reviews the ATS program and provides recommendations on ATS R,E&D investments. This program has seriously considered the Subcommittee's recommendations and has adopted much of its advice.
- The National Plan for Aviation Human Factors represents a cooperative effort between the FAA, National Aeronautics and Space Administration (NASA), and Department of Defense (DOD) to establish a coherent national agenda for human factors research and development to improve NAS safety and efficiency.
- The National Aviation Weather Users' Forum provides a process to develop a Federal/industry consensus on the needs and priorities for aviation weather information. Forum participants are from:
  - The Airline Pilots Association (ALPA)
  - Airline Dispatchers Federation (ADF)
  - Air Transport Association of America (ATA)
  - Aircraft Owners and Pilots Association (AOPA)
  - Experimental Aircraft Association (EAA)
  - Helicopter Association International (HAI)
  - National Air Transportation Association (NATA)
  - National Association of State Aviation Officials (NASAO)
  - National Business Aircraft Association (NBAA)
  - Regional Airline Association (RAA)
  - American Airlines
  - Delta Airlines
  - Industry.

The forum serves as a basis to set research and development priorities.

Accomplishments

Following is a partial listing of recent past accomplishments of the ATS R,E&D program:

- Developed numerous tools and information exchange mechanisms (e.g., the Center TRACON Automation System (CTAS), User Request Evaluation Tool (URET), and Surface Movement Advisor (SMA) research projects) by the Traffic Flow Management Research and Development program. These resources, embodied in collaborative decision making (CDM) packages #1 and #2, facilitate the dissemination of information to industry and establish CDM processes
- Developed and implemented GPS nonprecision IFR Helicopter approaches at the Mayo Clinic, Wisconsin Medical Center, Erlanger Medical Center, and western Pennsylvania, which has been attributed to saving over 500 lives in medical emergencies
- Conducted a comprehensive human factors study of controller-pilot communications
- Achieved Aviation Gridded Forecast System (AGFS) initial operating capability at the Aviation Weather Center (AWC) to improve advisories and forecast capability
- Evaluated convective weather storm growth and decay algorithm at Memphis testbed
- Completed a significant upgrade to the Traffic Alert and Collision Avoidance System (TCAS) program (TCAS II). The upgrade, known as Version 7, will make TCAS II fully compliant with international standards and will improve system safety by 5 percent while reducing the nuisance alert rates by 30 percent
- Implemented traffic information service (TIS), providing Mode S data link cockpit displays of aircraft traffic based on terminal ground radar surveillance
- Completed a joint FAA/NASA Runway Incursion/Low Visibility Surface Operations demonstration at Atlanta Hartsfield International Airport
- Evaluated two commercially available low-cost airport surface detection sensors for runway incursion reduction
- Developed ionosphere algorithms that meet WAAS availability requirements
- Implemented first phase of Reduced Vertical Separation Minima (RVSM) in the North Atlantic between FL330 through FL370
- Completed initial SMA operational assessment

R&D Partnerships

The ATS R,E&D program has established and continues to maintain and pursue the establishment of partnerships with U.S. Government agencies, international organizations, academic institutions, the airline industry, industry and industry user groups, and non-profit organizations. Following is a list of some of the current partnerships.

- U.S. Government Agencies:
  - Department of Commerce
  - DOD
  - NASA
  - National Science Foundation
  - National Weather Service (NWS)
- International Organizations:
  - British Civil Aviation Authority
  - European Organization for Safety of Air Navigation (EUROCONTROL)
  - French DGAC
  - International Civil Aviation Organization (ICAO)
- Academic Institutions:
  - Embry Riddle Aeronautical University
  - Massachusetts Institute of Technology
  - Ohio State University
  - Pennsylvania State University
  - San Jose State University
  - University of Maryland
  - University of Oklahoma
  - University of Quebec at Montreal
- Nonprofit Organizations:
  - Advanced General Aviation Transport Experiment (AGATE) Consortium
  - RTCA

- Airline Industry:
  - America West
  - American
  - Continental
  - Delta
  - Northwest
  - Southwest
  - Trans States
  - TWA
  - US Airways
  - United
- Industry and Industry User Groups:
  - ALPA
  - AOPA
  - ATA
  - NBAA
  - SAMA.

Long-Range View

The essence of the ATS R,E&D program is to maintain a long-term view of the research requirements for continued safe and efficient operation, maintenance, and use of the air transportation system today and in increasing system safety, capacity, and productivity.

The ATS R,E&D program is a continuing effort that will have continuing funding expectations at or beyond the current level. Although the composition of the R,E&D program portfolio will change over time as some efforts come to fruition and transition to a relevant F&E or O&M environment, continued investment in ATS R,E&D will ensure that the FAA stays current with the ever-increasing demands on the air traffic system. Further, continued investment in the ATS R,E&D will ensure that the FAA has an effective risk-identification/mitigation strategy for the high-risk areas of the future NAS architecture.

A02a Traffic Flow Management — [*Program moved to 1999 Aviation System Capital Investment Plan (CIP) as A05 Air Traffic Management Program*]

GOALS:

Intended Outcomes: The FAA intends to improve flexibility and reduce delays while maintaining or improving the level of safety through new traffic flow management (TFM) capabilities. The following capabilities will enable NAS users to optimize operational schedules and reduce operating costs associated with system constraints:

- FAA/industry data exchange capabilities enabling implementation of collaborative TFM operational concepts.
- Collaborative decisionmaking (CDM) methods and procedures that give NAS users greater flexibility and control over operational decisions and improved flexibility for NAS users operating in the ground delay program.
- NAS flow analysis tools offering traffic managers expanded decisionmaking support, performance assessment, and compliance monitoring capabilities.

Each of the above contributes to cost reductions for NAS users, as follows:

- Reduced routine flying times, departure delays, and better responses to system disruptions; reduced scheduled block times; and saved airlines $360 million a year in operating costs (crew and equipment) for the scheduled domestic jet fleet (reference: RTCA Task Force 3 final report, page 92).
- Increased information flow and more CDM; reduced delays during national ground delay programs; and saved airlines $221 million a year in crew costs (reference RTCA Task Force 3 final report, page 94, sum of “most likely” entries”). Savings realized from reduced missed connections/cancellations and improved on-time performance, etc., further increases the savings.

Agency Outputs:

FAA/industry data exchange

- Users and service provider requirements are identified and operational concepts are demonstrated to incorporate emerging technologies. These actions have resulted in improved, more timely electronic distribution and display of user and service provider operational data and better support for FAA/industry collaborative traffic flow planning and decisionmaking.

CDM

- Based on the new information exchange, TFM explores and identifies effective methods and procedures for FAA/industry CDM. This results in automation applications, algorithms, and procedures to reach operational traffic flow planning decisions. These decisions respond to both user and service provider objectives.

NAS flow analysis tools

- TFM researches analytical tools and approaches used in analyzing historical flow patterns and NAS performance data. This provides real-time operational analyses to users and service providers. It also results in near real-time analyses for use in distributed environments for joint user and service provider traffic flow planning.

Customer/Stakeholder Involvement: The TFM R&D program directly supports the following community initiatives:

- Air Traffic Service Plan (ATSP). The plan was created with a 5-year, forward-looking window and with participation from all entities of the aviation community. The need for better operational communications with users is a prominent theme throughout the ATSP.
- Free Flight Action Plan. This Plan includes the following initiatives directly related to the research planned in this area:
  - Recommendation 6. Develop mechanisms to provide predeparture feedback to flight planners on potential impacts of flight plan request changes and on system constraints causing those changes.
  - Recommendation 7. Implement rationing-by-schedule during ground delay programs.

  - – Recommendation 8. Establish more flexible ground delay program procedures and decision support systems.
  - – Recommendation 9. Coordinate military, FAA, and NAS users to define the information and capabilities needed to improve civil use of special use airspace (SUA) during periods when SUA is not used by DOD.
  - – Recommendation 10. Conduct operational trials in one or more SUA's to demonstrate how improved SUA status information exchange can improve civil use during periods when SUA is not used by DOD.
  - – Recommendation 11. Develop and implement real-time SUA notification between DOD and FAA and between FAA and flight planners.
  - – Recommendation 14. Improve telecommunication devices to enhance information flow between users and the TFM system on a machine-to-machine basis.
  - – Recommendation 15. Incorporate airline schedule information (e.g., company delays and cancellations) into FAA decision support systems and decision processes.
  - – Recommendation 16. Enhance or replace the ATM monitor alert function, including, but not limited to, ways to measure controller workload and function complexity.
  - – Recommendation 24. Develop a methodology and tools to measure and predict dynamic density.
  - – Recommendation 25. Develop and implement TFM capability for information exchange among users and the FAA. This enables users to be involved in the FAA's TFM decisionmaking process.
- NAS architecture development. The NAS architecture development effort has produced a target operational concept for the NAS. This concept supports the collaborative partnership philosophy between NAS users and service providers. In principle, the concept states that the responsibility for safe and efficient NAS management should be a collaborative effort between air traffic managers and flight operators.

Accomplishments: The TFM R&D effort accomplished the following during FY 1998:

FAA/industry data exchange

- Aircraft Situational Display for Industry (ASDI) became operational in June 1998
- Completed prototype development and evaluation of initial data exchange for GDP enhancements (CDM Package #1)
- Completed concept development and evaluation of Daily Download and Simplified Substitutions (CDM Package #2)
- Completed the prototype development and evaluation of FSM, ration-by-schedule, and schedule compression capabilities (CDM Package #1) and made investment decision
- Completed concept development and evaluation of Control Time of Arrival capabilities (CDM Package #2)

NAS flow analysis tools

- Completed Prototype Development and evaluation of System Impact Analysis; Schedules (CDM Package #1)

R&D Partnerships:

Airline industry

- The following airlines are actively engaged in the TFM R&D program. They are full partners in determining new CDM functionality, priorities, design, testing, and evaluation:
  - – America WestMidwest Express
  - – American
  - – Southwest
  - – Continental
  - – TWA
  - – Delta
  - – United
  - – Federal Express
  - – USAirways
  - – Northwest
  - – 35 Affiliated Subcarriers

Center of excellence (COE) for Aviation Transportation

- The COE—composed of the University of Maryland; Massachusetts Institute of Tech-

nology; the University of California, Berkeley; and their industry partners—are key players in CDM technologies development and evaluation. In addition, the COE provides an opportunity to explore the potential application of game theory, decisionmaking under uncertainty, and artificial intelligence.

Academia

The TFM R&D group has a long-standing relationship with aviation transportation, operations research, and human factors academic personnel from the following universities:

- University of California, Berkeley
- Massachusetts Institute of Technology
- University of Maryland
- Ohio State University.

MAJOR ACTIVITIES AND ANTICIPATED FY 1999 ACCOMPLISHMENTS:

FAA/industry data exchange

- Complete prototype development and evaluation of the data exchange for the initial NAS status information (runway visual range (RVR) data) (CDM Package #2)
- Complete concept exploration for dynamic SUA information capabilities

Collaborative decisionmaking.

- Complete prototype development and evaluation of Control by Time of Arrival capabilities (CDM Package #2)
- Complete prototype development of Post Operations Evaluation Tool (POET)
- Complete concept development and evaluation for Collaborative Routing Coordination Tool (CRCT)
- Complete concept exploration phase of the Dynamic Density analysis function

NAS flow analysis tools

- Complete concept development for System Impact Assessment (Miles in Trail and Routing)
- Complete concept exploration for the performance assessment and Compliance Monitoring capabilities

KEY FY 2000 PRODUCTS AND MILESTONES:

FAA/industry data exchange

- Complete concept development phase for dynamic SUA information capabilities

Collaborative decisionmaking

- Conduct prototype development and evaluation for CRCT
- Complete concept development phase of the Dynamic Density analysis function

NAS flow analysis tools

- Conduct prototype development for System Impact Assessment (Miles in Trail and Routing)
- Complete concept development for Program Analysis/Selection Tool (PAST)
- Complete concept development for the performance assessment and Compliance Monitoring capabilities

FY 2000 PROGRAM REQUEST:

In FY 2000, the TFM R&D program will be in the final stages of providing the initial technical, functional, and procedural enhancements to the operational Traffic Flow Management system that form the basis of an FAA/industry collaborative decisionmaking environment. Concurrently, work will be maturing that will introduce significant additional data exchange, decision support, and near-real-time analysis capabilities that will make the collaborative capabilities envisioned in the Free Flight concept a reality.

A02a - Traffic Flow Management Product and Activities	Program Schedule FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY2004
021-110 Advanced Traffic Management System						
Completed Prototype Development (PD) Phase						
FAA/Industry Data Exchange						
Aircraft Situation Displayed to Industry	◆					
Data Exchanged for GDP Enhancements	◆					
Daily Download		◇				
Simplify Substitutions		◇				
Initial NAS Status Information (NASSI) data exchange (RVR data)		◇				
Enhance NASSI Data			◇			
Advance NASSI Data Exchange			◇			
Collaborative Decision Making (CDM)						
Flight Schedule Monitor (FSM)	◆					
Ration by Schedule (RBS)	◆					
Schedule Compression	◆					
Control By Time of Arrival	◆					
Collaborative Routing Coordination Tool (CRCT)			◇			
Interactive Flight Planning				◇		
Dynamic Density Monitor					◇	
NAS Flow Analysis Tools						
System Impact Assessment (Scheduling)	◆					
System Impact Assessment (Miles in Trail/Routing)		◇				
Program Analysis/Selection Tool (PAST)		◇				
Performance Assessment			◇			
Compliance Monitoring				◇		

Budget Authority ($ in Thousands)	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Request
Contracts	962	1,355	2,986	2,332	2,880
Personnel Costs	2,107	2,195	0	916	2,435
Other Costs	431	450	0	39	143
Total	**3,500**	**4,000**	**2,986**	**3,287**	**5,458**

A02b Runway Incursion Reduction — [*Program moved to 1999 Aviation System Capital Investment Plan (CIP) as S09 Runway Incursion Reduction Program (RIRP)*]

Runway Incursion Reduction

GOALS:

Intended Outcomes: Develop technological and nontechnological solutions that minimize the chance of injury, death and damage, or loss of property due to runway accidents/incidents within the civil aviation system. Reduce runway incursions by 15 percent from 1997 baseline.

Agency Outputs:

- Develop low-cost airport surface detection equipment.
- Develop secondary surveillance capabilities for the airport surface.
- Develop conflict-alerting and data fusion platform.
- Investigate alternative options such as visual aids (lights and signs), education, training, and advisory circulars.

Customer/Stakeholder Involvement: The Air Traffic Requirements office has been actively involved in developing requirements to meet objectives of reducing runway incursions. Additionally, the FAA Administrator's goal in her "Safer Skies—A Focused Agenda" is to reduce runway incursions by 15 percent in 1999, from the 1997 baseline of 318 incidents. Reducing runway incursions is second on the National Transportation Safety Board's (NTSB) "Most Wanted List" of safety improvements.

Accomplishments: The following R&D projects were accomplished in FY 1998:

- Completed final report of Raytheon x-band radar at Milwaukee (Phase II)
- Completed final report of self-organizing time division multiple access (STDMA) at Atlanta
- Completed final report of EL-AR Electronics, Ltd., frequency modulated continuous wave (FMCW)
- Awarded contract to AOPA Air Safety Foundation for general aviation (GA) pilots training and education video
- Completed acoustics evaluation/de-installation at Phoenix
- Completed joint FAA/NASA Runway Incursion/Low Visibility Surface Operations Demonstration at Atlanta
- Received Runway Incursion Reduction Program Mission Need Approval
- Completed evaluation of two industry commercial-off-the-shelf (COTS) low-cost airport surface detection sensors
- Received NAS change proposal approval for Dallas-Ft. Worth
- Completed final report of NASA Terminal Area Productivity (TAP) Demonstration at Atlanta
- Completed installation of Vehicle automatic dependent surveillance broadcast (ADS-B) system at Dallas-Ft. Worth

R&D Partnerships:

- Memorandum of Agreement (MOA) with NASA for Low-Visibility Landing and Surface Operations (LVLASO) demonstration in Dallas-Ft. Worth
- Research contracts on airport surface operations in reduced visibility
- Raytheon (x-band radar)
- Dassault (phased-array radar)
- Sensis (Vehicle ADS-B)
- Questech (safety algorithms)
- General Working Agreement with Volpe National Transportation Systems Center (VNTSC)
- Contract with AOPA Air Safety Foundation
- Technology transfer

Currently, runway incursion reduction technologies—including low-cost radar, secondary surveillance systems, conflict alerting systems, and other alternatives with various contractors—are being researched. After system evaluation is completed, specifications will be developed for soliciting competitive bids for production of successfully demonstrated systems. Periodic briefings to industry during the R,E&D phase will also be

conducted to inform industry of FAA's requirements for runway incursion reduction solutions.

MAJOR ACTIVITIES AND ANTICIPATED FY 1999 ACCOMPLISHMENTS:

Dallas-Ft. Worth

- ASDE-3, Vehicle ADS-B, Surveillance Fusion Platform (SFP) Integration
- Multilateration/ADS-B system (stand alone)

Low-cost surface detection equipment

- Complete test and evaluation and prepare final report for Dassault ASDE-X
- Complete test and evaluation and prepare final report for Raytheon ASDE-X
- Continue testing technology prototypes including low-cost radar, conflict alerting systems, and other potential runway incursion reduction alternatives

Air Traffic

- Runway Incursion Action Teams
- Program Implementation Plan (PIP)
- Airport modeling/data reduction/facility testing
- Human factors studies
- Tower Simulators

KEY FY 2000 PRODUCTS AND MILESTONES:

- Full System RIRP prototype demonstration at Dallas-Ft. Worth
- FAA/NASA RIRP/LVLASO demonstration at Dallas-Ft. Worth
- Air traffic activities including regional training, modeling/data reduction/facility testing, human factors initiatives, and industry conferences

FY 2000 PROGRAM REQUEST:

- In FY 2000, funding will provide for the Dallas-Ft. Worth Prototype Demonstration, incorporating real-time seamless surface surveillance with data fusion, conflict alerting, call sign identification, and information sharing with air traffic controllers, pilots, and vehicle operators.
- FAA/NASA Runway Incursion/Low-Visibility Surface Operations Demonstration at Dallas-Ft. Worth
- Implementation of activities consistent with the 1998 Airport Surface Operations Safety Action Plan, including Runway Incursion Action Team (RIAT) meetings
- Development of specification for low-cost surface detection equipment

Surface Automation Research and Development

GOALS:

Intended Outcomes: The FAA intends to improve the level of safety, increase airport capacity, and reduce costs and delays for aircraft operating on the airport surface by developing new automation, communications, and information distribution capabilities. These capabilities augment operational decisionmaking processes and improve situational awareness of surface operations under all visibility and weather conditions.

SMA will provide air traffic controllers, airline ramp managers, and airfield operators with unprecedented advisory and information sharing to help minimize congestion and reduce delays on the airport surface. Recipients of this information-sharing will be able to make informed decisions in managing airport surface resources. Specific SMA goals include:

- Facilitate an electronic exchange of flight critical information among airlines, air traffic control personnel, and airport operators
- Provide dynamic real-time data to help increase efficiency of ground movement operations
- Predict surface events that impact operational decisionmaking
- Help achieve at least 10 percent decrease in taxi-out delays

This coordination will improve safety by minimizing the risk of collisions and increasing the efficiency of aircraft movements on airport runways and taxiways. It will help meet system capacity needs by reducing constraints/limitations at the top level V delay/operationally impacted airports while improving the automated infrastructure to provide capacity-enhancing technologies and procedures. It will also create capabilities that ensure

safe separation while imposing minimum constraints on system users.

Low/zero-visibility tower environment R,E&D will develop augmentations to the air traffic tower environment that can provide an operationally useful, enhanced or synthetic view of the airport surface during periods of low- or zero-visibility. This will lead to improved safety and increased use of airport surface capacity under low or zero visibility conditions, and ensure that the airport surface capacity is adequate to manage the increased aircraft landing rates expected in the future.

Agency Outputs: The surface automation research and development program will produce new tower surface management functions and technologies, which will be validated in pre-production prototype systems in an operational tower/airfield environment. Included will be assessments of airport operational effectiveness, performance, and benefits to assist in the investment decisionmaking process. These activities will result in functional packages and specifications that can be transferred for implementation on the appropriate tower automation platform. This program will also result in new air traffic control, airline, and airport operating procedures for managing aircraft on the airport surface.

The low/zero visibility tower environment R,E&D program initiatives will develop prototype systems that provide synthetic views of the airport surface under all restricted visibility conditions. This will lead to the definition of operational requirements, procedures, emerging technologies, and system requirements for continuous operations under all visual conditions.

Customer/Stakeholder Involvement:

- The R,E&D program commits the FAA to increasing airfield safety and reducing runway incursions.
- The surface automation R&D involves the airlines and airport operators through an unprecedented sharing of dynamic, operationally critical information.
- The R,E&D program has involved the customers and stakeholders from concept exploration through development of a prototype system at Atlanta Hartsfield International Airport. air traffic controllers, airport authority, and aircraft operators have contributed to defining the functional performance of surface automation tools and have participated on the program design and management teams.

Accomplishments:

- Completed SMA concept evaluation and development
- Installed SMA prototype at Atlanta Hartsfield International Airport (2/96)
- Brought airport/ramp towers on-line (7/96)
- Completed Support Command/National Air Traffic Controllers Association (SUPCOM/NATCA) testing and initial evaluation (9/96)
- Began operational assessment (10/96)
- Completed operational assessment (05/97)
- Completed SMA benefit analysis (10/97).

R&D Partnerships: The R,E&D program is being conducted in close partnership with the NASA through the interagency ATM integrated product team (IPT), a joint research and technology development program managed cooperatively by the FAA and NASA. The NASA Ames Research Center is a key participant in the program's R,E&D activities.

Benefits to air traffic operators include an increase in terminal area situational awareness and reduced radio frequency congestion.

MAJOR ACTIVITIES AND ANTICIPATED FY 1999 ACCOMPLISHMENTS:

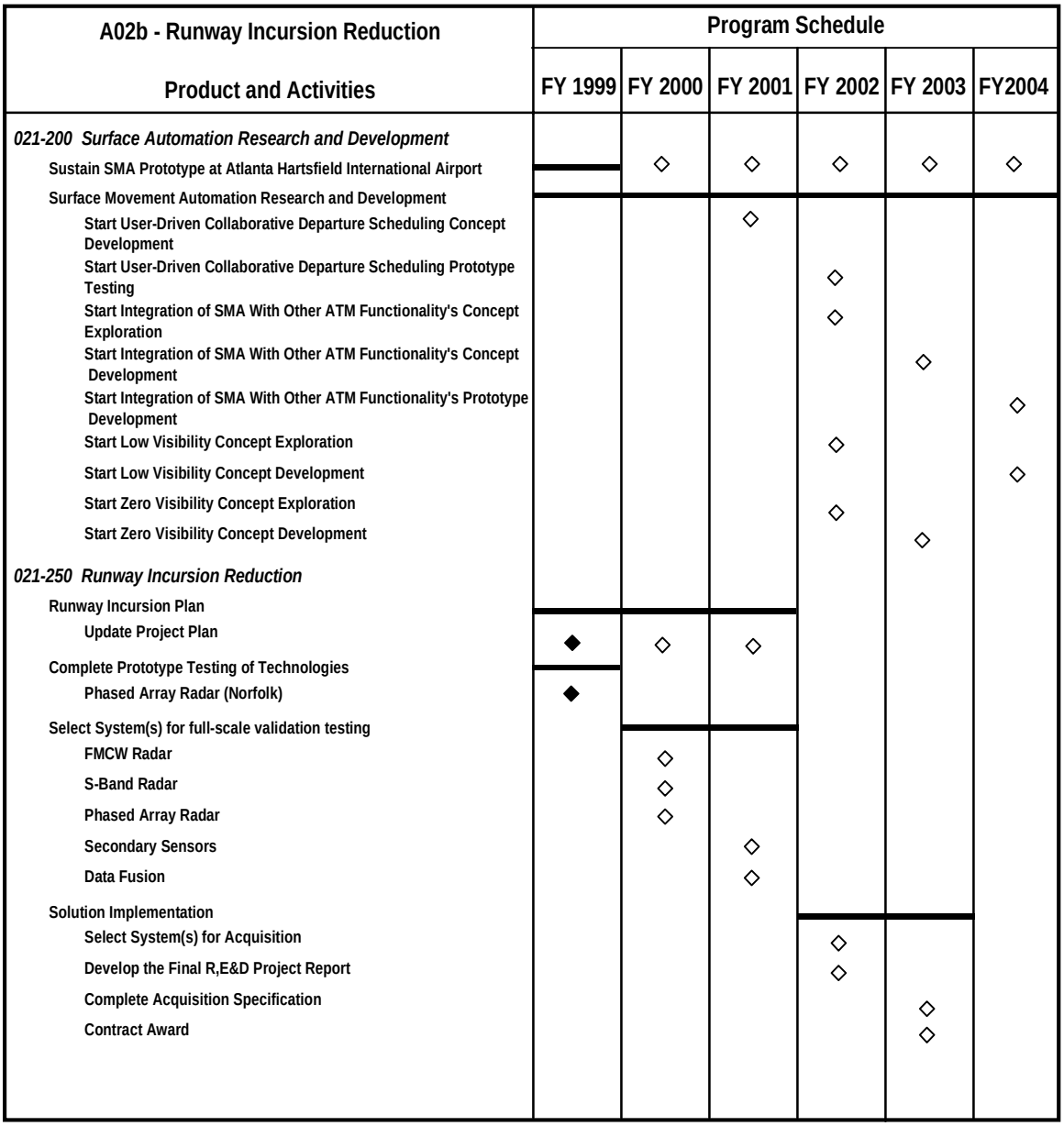
- Sustained operational SMA prototype at Atlanta Hartsfield International Airport

KEY FY 2000 PRODUCTS AND MILESTONES:

- Sustain SMA prototype at Atlanta Hartsfield International Airport

FY 2000 PROGRAM REQUEST:

- Sustain SMA prototype at Atlanta Hartsfield International Airport



Budget Authority ($ in Thousands)	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Request
Contracts	2,457	4,950	5,696	2,269	2,978
Personnel Costs	1,281	872	252	870	1,044
Other Costs	262	178	52	29	60
Total	**4,000**	**6,000**	**6,000**	**3,168**	**4.082**

A02c System Capacity, Planning and Improvements — [*Program moved to 1999 Aviation System Capital Investment Plan (CIP) as M08 Continued General Support – Aviation System Capacity Planning*]

GOALS:

Intended Outcomes: The FAA intends to develop an overall strategy to enhance capacity. This includes both terminal and en route airport and airspace assessment of procedures and capacity-related technologies. It also includes developing a performance measurement system for the air traffic system to measure FAA progress against customer expectations. This strategy allows programs and projects, coordinating across budgetary lines, to improve investment decisionmaking to achieve optimal strategic and operational results.

Initiatives are implemented in aviation system capacity planning to increase the number of aircraft operations per hour, reduce both en route and terminal airspace delays, reduce controller workload, and increase savings. As a result, the FAA, and the overall aviation community, will experience lower maintenance/operating costs. This program: (1) complies with the Congressional mandate to produce airport improvement plans; (2) responds to the aviation industry's high-priority initiatives for increased capacity; (3) responds to the Presidential Commission on Improved Airline Competitiveness recommendations; and (4) complies with the GPRA of 1993 and Executive order on infrastructure investment requirements.

Agency Outputs: To comply with GPRA, ATS has developed four areas of capacity-related outcomes: flexibility, predictability, access, and delay. These outcomes provide guidance and a framework to enable any ATS R,E&D program to successfully increase the value of services and, in parallel, reduce the cost of these services to the public. The capacity program strictly adheres to the guidelines of the following four areas:

Flexibility

The FAA estimates that each year operators experience a minimum of $558 million in inefficiencies in the terminal and en route airspace. The capacity program provides models and simulations that assess present shortfalls within the subject airspace. These models and simulations determine the delay, travel time, sector loading, and operating cost effects of all suggested redesign alternatives. Results include:

- The redesign of Salt Lake and Dallas-Ft. Worth terminal airspace
- New arrival routes to Los Angeles and Las Vegas International Airports
- Airspace suggestion changes to Minneapolis/St. Paul, based on construction of a new runway, at the request of the Minnesota State Legislature
- Annual savings to the aviation industry at airports and en route facilities estimated between $450–$500 million annually

Predictability

Because it can impose capacity restrictions at major airports, weather is the most dominant influence on air transportation. Although many airports are equipped with multiple runways (many converging), their resources become extremely restricted due to associated weather minima. The capacity program establishes criteria to develop and improve simultaneous converging instrument approaches and has achieved the following results:

- Reductions in the approach minima, ensuring an average capacity gain of 30 arrivals per hour
- Fundamental increases in the predictability of the system
- Use (anticipated) of GPS
- Combined savings (estimated) to the air carriers $40 million annually

Access

In the capacity program, the outcomes of predictability (the ability to land at a particular airport) and having access to that airport, are often considered the same thing. Work required to accomplish these outcomes, however, is different. Predictability establishes approaches to increase capacity under certain weather conditions. Access models simulate new technologies and procedures to ensure that these technologies are compatible for the airport in question. Examples include:

- Precision Runway Monitor—for closely spaced parallel runways with center lines separated by 3,000 feet (reduced from 4,300 feet)
- Reduced separation of 2.5 nmi on final approach (reduced from 3.0 nmi)
- Dependent staggered approaches to closely spaced parallel runways; stagger angle 1.5 nmi
- Offset Approach Course guidance for simultaneous operations at San Francisco, Newark, and St. Louis airports
- Converging approach standards at Chicago O'Hare International Airport

Delay

The major capacity program emphasis is to minimize the impact of airport and airspace delay on the overall NAS. One primary program focus is responding to near-term, airport-driven capacity issues. It is projected that by 2004, 29 of the top 50 airports will experience 20,000 hours or more of annual delay. This is cause for concern within the aviation industry. Delay reduction initiatives undertaken to date include:

- The capacity program has completed more than 50 airport enhancement projects.
- The program supports development of an overall capacity strategy that considers airport and technology conduct, measurement, and assessment; and electronic tools development and application to aid in forming that strategy.
- Airfield improvements such as new runways and runway extensions, improved approach procedures, and new facilities and equipment such as the precision runway monitor are being investigated.
- The improvements producing the greatest capacity increases, estimated delay reductions, and delay cost savings, are described and recommended for implementation in the final design plans.
- The top recommendations at any one airport are estimated to save the aviation industry $75–$100 million annually.
- Since 1994, based on recommendations, 18 new runways have been constructed at major airports.
- Efforts are underway to accommodate New Large Aircraft into the operational environment.

The FAA's airport and airspace design programs have the dual objectives of (1) addressing tactical improvements, which respond to industry requirement shifts, and (2) large-scale investment analysis and optimization planning. The process problem is identification at the local (regional) level with a high degree of coordination among affected facilities and user groups. Various proposed solutions to the problems are simulated, and the results are then compared to make intelligent investment decisions.

Example

On the Dallas-Ft. Worth Metroplex project, which involved substantial AIP, F&E, and operational investment, the effects on the system of several airspace structures, including a "do nothing" scenario, were compared. Given the industry's plan to expand operations at Dallas-Ft. Worth, the FAA concluded it was best to expand the airport. This meant designing new airspace supported by upgraded navigation and communications capabilities along with entirely new arrival and departure procedures. This approach enabled the community to construct a new runway and ground infrastructure. It also enabled the industry to schedule growth and capital investment.

This plan instilled confidence that there would be a return on investment since the revised system could support anticipated demand. The industry and local community, therefore, could commit this expanded service to the public. The cumulative 20-year (1997–2016) estimated aircraft operating cost savings based on the Dallas-Ft. Worth Metroplex, East Runway, and New West Runway in 2003 is $13 Billion.

Customer/Stakeholder Involvement: Although the FAA directs the entire capacity program, customers and stakeholders play active roles in its success. Airport authorities from all concerned airports, air carrier representatives, aviation interest groups, and FAA regional and local air traffic control personnel are an integral part of every airspace and airport capacity task force/project. Joint American/European airspace study through EUROCONTROL–Maastricht Center.

The capacity program annually publishes the Aviation Capacity Enhancement Plan to keep the aviation world informed of progress and advancements in the capacity arena. Both the national and international aviation community regularly request this document. Scholars, as well as students, in academia also request the document for their aviation studies.

As previously stated in "Goals," the overall capacity program parallels the Congressional mandates concerning airport improvement plans and agency performance and results.

Accomplishments: Airport and airspace recommendations and redesign studies have produced a conservatively estimated $1.2 billion in savings to the aviation industry. An accurate estimate is difficult because the improvements, either combined or treated individually, are a direct cause of the constant increase in traffic.

- Prototyped and tested the initial system performance measures
- Completed more than 50 major airport studies--some of which have been updated due to growth (Estimated annual savings $75–$100 million per airport)
- Completed three major terminal/en route airspace redesigns: (1) Salt Lake Terminal and air route traffic control center (ARTCC), (2) Dallas-Ft. Worth and Ft. Worth ARTCC, and (3) Northern California terminal radar approach control (TRACON)

The program's achievements reach beyond U.S. airspace. Inquiries about our modeling and design methods and requests for assistance have been received from countries in Asia and Europe (i.e., Schipol International Airport, Netherlands, and the new International airport in Seoul, South Korea).

R&D Partnerships:

- In accordance with the annex of the memorandum of understanding between the FAA and Eurocontrol, the capacity program has established a joint airspace technologies and initiatives group to modernize international aviation. The intended outcome is to meet compatibility requirements between the United States and the rest of the aviation world in such areas as Free Flight, the Global Positioning System, flight management system, precision runway monitor, and other emerging technologies.
- The FAA will partner with major air carriers and business aviation aircraft in developing financial management systems approaches.
- The FAA will partner with NASA in using performance measures developed by the capacity program for ATS in compliance with the Congressional mandate for GPRA. The FAA will participate in joint computer simulation modeling for TRACON systems including the CTAS and the Standard Terminal Automation Replacement System (STARS).
- NASA Short Haul Civil Tiltrotor simulation of proposed Simultaneous Non-Interfering (SNI) Approach procedure.

MAJOR ACTIVITIES AND ANTICIPATED FY 1999 ACCOMPLISHMENTS:

- Continuously conducted research to develop, refine, and/or enhance high-level outcome performance metrics; integrated these metrics into processes supporting GPRA requirements and investment decisionmaking
- Completed redesign of Salt Lake City terminal and ARTCC airspace in preparation for the 2002 Winter Olympics
- Initiated Offset Approach Course guidance for simultaneous operations at San Francisco, Newark, and St. Louis airports
- Develop new IFR approach and departure concepts and procedures for improving the safety and efficiency of operations at capacity constrained airports
- Identify the impact and develop proposed solutions to the planned introduction of New Large Aircraft in the NAS
- Initiated converging approach standards at Chicago O'Hare International Airport
- Initiated Airport Design Studies at John F. Kennedy and La Guardia airports
- Initiated ground analysis at Phoenix Sky Harbor International Airport; completed at Las Vegas and Salt Lake airports
- Initiated redesign of Phoenix Sky Harbor terminal airspace and Albuquerque and Seattle ARTCC's

- Initiated efforts to accommodate New Large Aircraft into the operational environment
- Completed Newark, La Guardia, Boston, Tampa, and San Diego Airport Design Studies
- Initiated Airspace review for relocation of the Honolulu Center Radar Approach Control (CERAP)
- Initiated Airport Design Study at Baltimore-Washington International Airport

KEY FY 2000 PRODUCTS AND MILESTONES:

- Continue developing new IFR approach and departure concepts and procedures
- Identify and develop proposed solutions to integrate New Large Aircraft into the NAS
- Complete airport design studies at JFK and Anchorage and ground analysis at Phoenix Sky Harbor International Airport
- Redesign Honolulu and Phoenix terminal airspace and Albuquerque and Seattle ARTCC's
- Continue analysis of new and/or additional performance measures for the national airspace system

FY 2000 PROGRAM REQUEST:

In FY 2000, the program will focus on capacity enhancement at all major airports as well as on terminal and en route airspace. Primary focus areas are: (1) airports where construction of suggested improvements can be completed within 2 to 3 years; and (2) air traffic radar facilities where airspace redesign reduces controller workload and provides the aviation industry with additional flexibility and predictability during flight.

In addition, the program will continue to fine tune air traffic system performance measures. These efforts will concentrate on reducing the cost of service delivery by targeting and coordinating investments across appropriations.

A02c - System Capacity, Planning and Improvements Product and Activities	Program Schedule					
	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY2004
024-110 Aviation System Capacity Planning						
Enhance/Design Plans & Consolidated Ops & Analysis Systems						
Aviation Capacity Enhancement Plans (Annual)	◆	◇	◇	◇	◇	◇
Regional/Airport Design Team Plans	◆	◇	◇			
Performance Measurement/Government Performance Results Act	◆	◇	◇	◇	◇	◇
Airspace/Airport Analysis						
Completed Airspace Redesign Las Vegas, Salt Lake Terminal & ARTCC	◆					
Redesign or Analysis of Phoenix, Seattle ARTCC & Albuquerque ARTCC	◆	◇	◇			
Integrated Measures into the Budget Process and GPRA			◇			
Performance Reports for Investment Decisions			◇	◇	◇	◇
Facilities Airspace in Preparation for 2002 Winter Olympics	◆					
Completion of Newark, Las Vegas, Boston, and San Diego Airport Design Studies	◆					
Analysis of New and/or Additional Performance for the National Airspace System			◇	◇	◇	◇
Ground Analysis of Phoenix Sky Harbor International Airport	◆	◇				
Anchorage Design Team Project	◆	◇				
Analysis of Low Level Routes Between Northern and Southern California				◇	◇	
Ground Analysis For Pittsburgh and Kansas City Airport				◇	◇	
San Francisco Ground Task Force				◇	◇	◇
Development of Simultaneous Offset Instrument Approach for San Francisco, St. Louis, and Newark Airports	◆	◇	◇	◇		
Converging Approach Standards at Chicago O'Hare Airport	◆	◇	◇			
Accommodate New Large Aircraft into the Operational Environment	◆	◇	◇	◇	◇	◇
023-120 Separation Standards						
Reduced Horizontal Separation Minimization						
Complete Annual Regional Traffic and Aircraft Performance Monitoring & Analysis	◆	◇	◇	◇	◇	◇

Budget Authority ($ in Thousands)	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Request
Contracts	3,602	3,676	1,354	228	6,064
Personnel Costs	4,480	4,377	2,196	2,408	2,891
Other Costs	918	897	450	364	268
Total	**9,000**	**8,950**	**4,000**	**3,000**	**9,223**

A02d Cockpit Technology— [*Program moved to 1999 Aviation System Capital Investment Plan (CIP) as M37 Cockpit Technology*]

GOALS:

Intended Outcomes: The FAA intends to improve system safety by upgrading a viable airborne collision avoidance capability to mitigate the risk of mid-air collisions.

The Traffic Alert and Collision Avoidance System (TCAS) is an avionics capability to warn pilots of proximate aircraft and to provide information and guidance for collision avoidance. TCAS I provides traffic advisory information indicating the range, bearing, and altitude of intruding aircraft. Pilots use this information to visually acquire intruders and maintain separation. TCAS II provides traffic advisory information as well as resolution advisories in the vertical plane. Resolution advisories indicate maneuvers (e.g., "climb") for collision avoidance.

Agency Outputs: The FAA provides the technical characteristics (technical standard orders) for TCAS avionics and certification guidance (advisory circulars) for installation and operation of the system. The R,E&D program develops the technical and operational information to support these products and is working with the TCAS user community to collect and analyze data to maintain and enhance TCAS.

Currently, the principal focus of the TCAS program is completion of the design and implementation of Change 7 to TCAS II. This change incorporates more than 300 detailed modifications to the surveillance and collision avoidance algorithms and displays in TCAS II avionics equipment. These changes have been developed based on 8 years of TCAS II operation in the United States and Europe and have been developed in partnership with industry and users. TCAS II Change 7 has also been selected by ICAO as the worldwide standard for airborne collision avoidance. Timely implementation of Change 7 is essential for the continued safe and effective employment of TCAS II.

The second annual report of TCAS activity will be provided to all interested organizations to review ongoing progress and update future activity. The FAA will develop and implement plans for future applications of TCAS (e.g., Free Flight) in close collaboration with industry and governments.

Customer/Stakeholder Involvement: The FAA has developed TCAS in collaboration with the domestic and international aviation communities. In particular, the R,E&D effort supports RTCA Special Committee (SC) 147 and the ICAO Secondary Improvements and Collision Avoidance System (SICAS) Panel in their efforts to finalize domestic and international standards for airborne collision avoidance systems. RTCA SC 147 provides the principal forum for collaboration among industry, aircraft operators (i.e., TCAS users), and FAA representatives in developing technical standards for avionics. It also provides the principal means for transferring TCAS technology to industry.

The FAA TCAS program responds to the requirements of Public Laws 100-223 and 101-236, which establish requirements and time frames for air carrier equipage with TCAS II. TCAS I also responds to CFR 135.180.

The TCAS program will directly support the RTCA Free Flight Action Plan, Future Air Navigation System (FANS) implementation, reduced aircraft spacing standards, oceanic operation, and in-trail climb.

ICAO has been closely monitoring and assisting in TCAS development for many years. Based on TCAS success in the United States, EUROCONTROL has mandated the use of TCAS in European airspace in the year 2000. Australia has a similar mandate in place for 2000. Several Pacific Rim countries (e.g., Japan, India) will also mandate use of TCAS. The FAA is supporting these activities.

Accomplishments: TCAS II has been installed on all commercial aircraft operating in U.S. airspace with more than 30 passenger seats. TCAS I or TCAS II is installed on all commercial aircraft with 10 to 30 passenger seats. The U.S. military has begun installation of TCAS II on all large transport category aircraft (e.g., C-130, C-147, KC-135, KC-10, etc.) The FAA is working with the services to ensure that their unique military requirements for TCAS are met. More than 15,000

aircraft around the world have TCAS systems on board; about 180 million hours of system operations have been accumulated. TCAS has been credited with averting near midair collisions in a significant number of documented encounters.

R&D Partnerships: The FAA is coordinating TCAS program activities with related international efforts through ICAO and EUROCONTROL. A principal consequence is that technical standards finalized by RTCA SC 147 have been incorporated into ICAO standards and recommended practices that will be used worldwide. ICAO member states, primarily the United Kingdom and Germany, have worked and are working with the FAA on a number of critical developments to ensure that TCAS operates properly in their airspace.

MAJOR ACTIVITIES AND ANTICIPATED FY 1999 ACCOMPLISHMENTS:

TCAS I

- Completed TCAS I transition program
- Continued data collection and analysis to support TCAS I implementation

TCAS II

- Began implementing Change 7 within the user community
- Initiated data collection and analysis to support Change 7 implementation
- Continued support to industry to resolve TCAS II implementation and user issues
- Issued first annual report on TCAS II Change 7 performance

KEY FY 2000 PRODUCTS AND MILESTONES:

TCAS I

- Continue support for TCAS I implementation and use by industry

TCAS II

- Continue support to industry and the international community to resolve TCAS II implementation and user issues; identify specific functional TCAS parameters and algorithms that require modification to permit safe and effective implementation of new ATC operational procedures, such as Free Flight
- Prepare second summary report on the operation and effectiveness of TCAS II Change 7

FY 2000 PROGRAM REQUEST:

In FY 1999, the user community began major implementation of Change 7; this effort will continue in FY 2000. While FAA does not fund this implementation activity, FAA resources are required to resolve issues associated with Change 7 installations.

Data analysis efforts supporting TCAS I and TCAS II will continue. These efforts use information provided by industry, users, pilots, air traffic controllers, and FAA facilities describing technical and operational difficulties experienced during system implementation. A team of TCAS program experts follows up on every event reported to identify both the source of the difficulty and a remedy to prevent its occurrence. This analysis and follow-up activity has been essential to the successful introduction of TCAS into operational service.

Working jointly with industry and the TCAS user community, the FAA will initiate an effort will to define the specific changes to TCAS, which will be necessitated because of future changes in ATC operations. This project element will be coordinated with ongoing Free Flight efforts and related work at NASA.

A02d - Cockpit Technology Product and Activities	Program Schedule					
	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY2004
022-110 Traffic Alert & Collision *Avoidance System (TCAS)*						
TCAS I						
Completed TCAS I Transition Program	◆					
Continued Data Collection and Analysis to Support the Implementation of TCAS I	◆					
Continued Support for Implementation and Use of TCAS I by Industry	◆					
TCAS II						
Began Implementation of Change 7 Within the User Community	◆					
Initiated Data Collection and Analysis to Support Change 7 Implementation	◆					
Continued Support to Industry to Resolve TCAS II Implementation and Use Issues	◆					
Completed Summary Reports on TCAS II Change 7	◆					
Continued Support for Implementation and Use of TCAS II by Industry		◇	◇			
Identify specific TCAS Changes needed to support new ATC procedures		◇				

Budget Authority ($ in Thousands)	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Request
Contracts	4,256	1,032	1,765	0	1,219
Personnel Costs	1,804	1,633	1,913	1,000	1,498
Other Costs	370	335	392	0	139
Total	**6,700**	**3,000**	**4,070**	**1,000**	**2,856**

A02e General Aviation and Vertical Flight Technology Program — [*Program moved to 1999 Aviation System Capital Investment Plan (CIP) as M35 General Aviation and Vertical Flight Technology*]

GOALS:

Intended Outcomes: The General Aviation and Vertical Flight (GA&VF) technology program supports GA demands through applied research and development, especially for communications, navigation, and surveillance (CNS) technologies. These technologies support cost-effective air traffic services, improve safety, and expand NAS capacity and efficiency, especially where CNS services are not currently available to GA users. GA&VF program products are integral to NAS modernization.

General aviation is one of the most diverse and productive elements of aviation. In addition to the traditional single- and multi-engine airplanes, GA users fly experimental aircraft, helicopters, and tiltrotors (known as "vertical flight aircraft"), business jets, and historic aircraft. The GA community includes lifesaving airborne emergency medical services (EMS) and law enforcement services, and is the first line of response in state and local disaster relief operations. The economic impacts of GA are global, but no other nation in the world produces more GA&VF aircraft and related goods and services than the United States. GA is a gross exporter of goods and services and provides the U.S. economy a positive balance of payments impact.

General aviation users currently rely on existing procedures and air traffic services, but many cannot take full advantage of them because of technological and economic limitations. Helicopters, for example, must operate heliport-to-heliport to support customers and the public more efficiently. For example, they need different instrument approaches that curve and support deceleration to land and depart from small landing areas.

The FAA GA&VF R,E&D program supports research and development across the full spectrum of GA operations. The program's research areas align with the most critical components for GA participation in the NAS-terminal operations: en route communications and navigation, landing facilities, airmen and controller training, and low-cost avionics.

Vertical flight terminal instrument procedures (TERPS) efforts support the terminal flight arena. Low-altitude CNS research provides critical data and evaluations for future low-altitude en route infrastructure to support Free Flight. TERPS capabilities facilitate implementation and use of advanced technology in the cockpit and at the controllers' workstation for GA needs. These efforts are interrelated and support mutual requirements without duplication or added costs.

Intended Outcomes: The GA&VF R,E&D program focuses on the outputs and products of the larger research efforts, as identified in the NAS Architecture planning process and major R&D programs such as GPS Satellite Navigation. The GA&VF R,E&D efforts are not duplicated in these and other FAA R,E&D programs. The GA program area is a collaborative and complementary effort, tailoring the successes and achievements of other, broader-scope efforts into affordable products and tangible benefits for GA. Outcomes of this program support the following strategic goals of the GPRA:

- *Improved level of safety:* ATS R,E&D mitigates the risk of low-altitude airborne collisions by adapting affordable GPS-based surveillance technology at GA airports, heliports, popular resorts and national parks, and in congested terminal areas. This is done by providing traffic information directly to the GA pilot via cockpit displays of traffic information (CDTI).
- *Improved flexibility:* The ATS R,E&D program goals ensure a collaborative and fully integrated air traffic control system. Free Flight technologies and procedures are ideally suited to allow GA users to operate at altitudes, speeds, and routes that provide more support to their missions and recreational uses. The GA&VF R,E&D program identifies, develops, and evaluates technology to satisfy user needs and support the overall goals to maintain a fully integrated air traffic control system focusing on GA use of Free Flight procedures.

- *Improved predictability:* With more access to weather services via data link and short-term weather information to GA users, ATS R,E&D allows more aircraft to operate safely in close proximity during periods of reduced visibility and adverse weather conditions.

- *Reduced delays:* This program researches and develops technology and procedures that enhance the utility of GA facilities. It complements the goals of the air traffic management program and traffic throughput automation systems. Affordable and effective non-radar navigation and communication systems (installed at the more than 17,000 GA airports) will attract more GA users to these facilities and away from the busier hub airports. Also, providing increased IFR capabilities at these airports will reduce GA users' demands at major hub airports during periods of bad weather and poor visibility.

- *Improved access:* This program is a key element in the ATS R,E&D strategic goal to make access to navigation and landing services nearly universal. GPS makes accurate navigation and landing signals available in the large volume of low-altitude airspace not currently covered by land-based landing signals. Investing in the development of GPS instrument approaches planned for use at major medical trauma centers and hospitals nationwide will save hundreds of lives each year.

- *Reduced costs:* This major ATS GA&VF R,E&D program goal contributes to overall goals of eventually phasing out the expensive ground-based infrastructure. The application of low altitude CNS equipment contributes to this cost savings.

Agency Outputs: Although the private sector designs and develops specific technologies to accomplish these outcomes, the ATS R,E&D GA program helps generate design criteria, publish advisory circulars and training documents, and provide for collaborative technology integration with the current and future NAS. This program area also provides technical and management expertise to establish highly successful partnerships.

Rotorcraft IFR procedures and infrastructure development

This research emphasizes the following efforts:

- The Vertical Flight Precision GPS TERPS project is the primary effort producing new precision instrument approaches at heliports and GA airports using GPS. This effort is the key R&D component supporting the overall GPS Satellite Navigation effort leading to full operating capability (FOC) for rotorcraft as part of WAAS. Because existing IFR instrument approach criteria are based on airplane performance characteristics, these existing IFR approaches do not support most of the missions demanded by IFR helicopters.

  This project develops criteria and design parameters that provide more effective and affordable instrument approaches to hospitals and corporate and urban business district heliports. Outputs include vertical flight TERPS criteria; certification procedures for potential supplemental-type certificates (which permit existing aircraft to add new technologies safely); IFR EMS procedures; and IFR EMS training guidelines and design standards such as minimum operational performance standards, minimum aviation system performance standards and technical standard orders. These standards, advisory circulars, and guidelines support planned implementation over the 5-year (1998–2002) schedule for up to 10 medical trauma centers, 150 commercial heliports, 5 DOD aviation facilities, and 3 vertiports (slightly larger heliports designed to accommodate the new civil tiltrotor aircraft).

  This program area supports joint DOD and manufacturers' research. The research evaluates cockpit displays design standards and symbology, air traffic procedures, and airspace requirements for new vertical flight aircraft (i.e., the BB-609 civilian tiltrotor, as well as the military V-22 Osprey tiltrotor).

- The low-altitude CNS infrastructure projects produce route system guidelines, cockpit display guidelines, noise abatement procedures, terminal and en route system integration plans for low-altitude CNS operations, and

cost-benefit analyses to improve NAS efficiency and safety.

Customer/Stakeholder Involvement: The GA program directly supports goals and programs delineated in Challenge 2000, the Aviation Safety Plan, the RTCA Free Flight Action Plan, and NAS architecture development. The program emphasizes GA&VF community's direct needs (helicopters and tiltrotors).

In setting a "zero accidents" goal, Challenge 2000 found that between 1986 and 1994, GA operations accounted for the greatest number of accidents in the NAS (44,102 of 48,164 accidents recorded by the NTSB were attributed to GA). Because flight crew problems accounted for 19,388 GA accidents, the GA program targets flight crew training as a key research element. Other important causal factors were environment (7,146) and facilities (4,867).

The Aviation Safety Plan calls for "implementation of a GPS-based ADS capability . . . that the FAA deems appropriate." The plan sets goals for training airmen and operational personnel in using new technology and for upgrading practical testing standards. The plan identifies goals for GPS-based category CAT I, II, and III landing capability. Work is underway to research rotorcraft GPSCAT I procedures. Specific stakeholders include:

- Helicopter Association International
- American Helicopter Society
- National Business Aircraft Association
- Experimental Aircraft Association
- General Aviation Manufacturers Association
- Small Aircraft Manufacturers Association
- National Association of State Aviation Officials
- Association of Aeronautical Medical Services
- National Emergency Medical Services Pilots Association
- Airborne Law Enforcement Association

Advanced General Aviation Transport Experiment

Accomplishments: Following are FY 1997 and FY 1998 accomplishments:

Air and ground infrastructure development

- Completed initial flight testing for CAT I GPS precision approach TERPS criteria
- Completed initial planning for the Alaska low altitude demonstration project
- Completed obstacle rich environment report (September 1998)
- Developed and published the advisory circular, *Integrating Rotorcraft Assets into Disaster Relief Planning*
- Coordinated development of the advisory circular *Vertiport Design Guide*

Civil tiltrotor technology analyses

- Initiated action to introduce tiltrotor technology into the NAS planning process

Aircraft avionics for single-pilot IFR

- Coordinated and implemented agreement with EAA to jointly explore advanced technology avionics for single-pilot GA aircraft
- Conducted installation and flight test of advanced technology for avionics by GA aircraft in experimental GlaStar aircraft

R&D Partnerships: Historically, the GA&VF R,E&D program has had a unique R&D partnership with industry. A partnership of 12 private sector companies and corporations, working together with GA&VF program teams, developed the initial GPS nonprecision approaches for rotorcraft. The successes of Operation Heli-STAR, an applied technology proof of concept demonstration conducted as part of the 1996 Summer Olympic Games, were due to the effective teamwork of over 230 individuals from over 30 public and private organizations.

This partnership has now evolved to an even higher and more efficient level of integration. Working with the various lines of businesses within FAA (AFS, ATS, ASC, ASY), the GA&VF program is now guided by top level policy and technical direction from the Administrator and Associates. Further, the GA&VF program is the product of very close planning and implementation by the two major CNS research and acquisition product teams, the Satellite Navigation Product Team (AND-730) and the GA&VF Product Team (AND-710), to maximize accomplishments and preclude duplication. Also, the William

J. Hughes Technical Center and the Rotorcraft Certification Directorate are now an integral part of the overall team.

MAJOR ACTIVITIES AND ANTICIPATED FY 1999 ACCOMPLISHMENTS:

- Publish CAT I GPS precision approach TERPS criteria for WAAS
- Continue GlaStar Advanced Avionics flight test and demonstration evaluations for single-pilot IFR operations
- Develop Civil Tiltrotor Infrastructure Development Plan
- Develop EMS IFR infrastructure development plan that will support GPS IFR operations at hospitals and trauma centers as part of 5-year program

KEY FY 2000 PRODUCTS AND MILESTONES:

- Establish joint FAA/DOD low-altitude routes system testbed at Quantico, Va
- Develop and publish design and training guidelines for installation and use of advanced avionics for single-pilot IFR based on GlaStar demonstration flight-testing
- Publish initial civil tiltrotor infrastructure planning requirements (terminal operations) for integrating CTR aircraft into urban and congested terminal areas

FY 2000 PROGRAM REQUEST:

- Continue FAA research to safely and effectively introduce tiltrotor technology into the NAS
- Continue research leading to establishing CAT II/III GPS precision approach TERPS criteria for vertical flight aircraft operations
- Continue research supporting use of advanced avionics (including GPS navigation and surveillance systems) for single-pilot IFR operations

A02e - General Aviation and Vertical Flight Technology Product and Activities	Program Schedule					
	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY2004
022-141 Low-Cost Avionics						
Single pilot IFR Advanced avionics for GA&VF						
Developed flight test plans for small airplane and helicopter advanced avionics applications	◆					
Conduct low altitude IFR corridor flight evaluations of WAAS based GPS navigation and non radar surveillance technology		◇				
Conduct EMS IFR flight evaluations using WAAS GPS		◇				
022-142 Rotorcraft Instrument Flight Rules (IFR) Procedures						
Air and Ground Infrastructure Development						
Completed Flight Testing for Category (CAT) I GPS TERPS Criteria	◆					
Completed Obstacle-Rich Environment (ORE) Report	◆					
Develop CAT II Rotorcraft TERPS Criteria		◇				
Complete CAT II & Continue CAT III GPS TERPS Research			◇			
Civil Tiltrotor Technology Analyses						
Develop Civil Tiltrotor Infrastructure Development Plan			◇			
Initiate FAA Research to Safely and Effectively Introduce Tiltrotor Technology into the NAS				◇		

Budget Authority ($ in Thousands)	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Request
Contracts	2,085	1,486	0	1,462	681
Personnel Costs	427	925	0	1,240	1,716
Other Costs	88	189	0	200	123
Total	**2,600**	**2,600**	**0**	**2,902**	**2,520**

A02f Safe Flight 21 — [*Program moved to 1999 Aviation System Capital Investment Plan (CIP) as M36 Alaska Capstone Initiative/Safe Flight 21 (FICS 21)] and S10 ADS-B Ohio Valley Prototype Project - Safe Flight 21*]

GOALS:

Intended Outcomes: Safe Flight 21 is a government/industry initiative designed to demonstrate and validate, in a real-world environment, the capabilities of advanced communications, navigation, surveillance, and air traffic procedures associated with Free Flight. The program will be a step in implementing any capabilities that prove to be beneficial. Specifically, Safe Flight 21:

- Enhances safety
- Increases system capacity and efficiency
- Maximizes user equipage costs and FAA operational costs
- Addresses pilot and controller human factors issues
- Develops and assesses new operational procedures and associated training
- Streamlines certification processes and procedures.
- Develops a cost-effective avionics and NAS infrastructure
- Defines a realistic NAS transition path supported by the user community

Agency Outputs: Safe Flight 21 is essential to the risk mitigation and evolution of the NAS. The program will address the risks and challenges of fielding the advanced communications, surveillance, and navigation systems, such as ADS-B, CDTI, Flight Information Services (FIS), and TIS.

Under the leadership of RTCA, user participants have committed to spending resources to accomplish the Safe Flight 21 objective:

> "To show that integrated CNS technological capabilities can provide functional enhancements that will produce operational benefits and sufficient cost/benefit to justify implementation. FAA policies and decisions should be based upon the ongoing results of this program."

This objective will be achieved through the following:

1. Evaluating the three ADS-B links (1090MHz, UAT, and VDL Mode 4)
2. Conducting operational evaluations of the nine operational enhancements identified by RTCA:
   - – FIS for SUA status, weather, windshear, notices to airmen (NOTAM), and pilot reports (PIREP)
   - – Cost-effective controlled flight into terrain (CFIT) avoidance through graphical position display
   - – Improved terminal operations in low-visibility conditions
   - – Enhanced see-and-avoid
   - – Enhanced operations for en route air-to-air communications
   - – Improved surface navigation
   - – Enhanced airport surface surveillance for controllers
   - – ADS-B for surveillance in non-radar airspace
   - – Establishing ADS-B-based separation standards

Customer/Stakeholder Involvement: Safe Flight 21 is the new name for the restructured Flight 2000 program that had many of the same projected outcomes. The change, made in August 1998, resulted from inputs from the RTCA Select Committee on Free Flight Implementation at the request of the FAA Administrator. The Safe Flight 21 program is a jointly developed program and is strongly endorsed by the RTCA Free Flight Steering Committee. The Safe Flight 21 steering committee includes RTCA Select Committee representatives from AOPA, ALPA, National Air Traffic Control Association (ATCA), Cargo Airline Association (CAA), and U.S. Airways.

Accomplishments:

- Established the Safe Flight 21 program office
- Obtained FY 1999 funding to support the CAA work and the Alaska Capstone program

- Began work to provide details for risk mitigation activities, site locations, number of aircraft required, cost, and schedule

R&D Partnerships: The Safe Flight 21 program is based on the principle that government and industry will share in the development of a global air transportation system as we move into the Free Flight era.

The FAA will partner the aviation industry in supporting Safe Flight 21. This will allow the FAA to build on ongoing industry initiatives. It will also allow industry and the FAA to fund avionics and ground systems. Safe Flight 21 will build on the Alaska and CAA activities by addressing:

- ADS-B technology issues
- Cockpit human factors issues
- Use of FIS to receive weather and other information
- An integrated cockpit display of terrain, traffic, and weather information

Work with the CAA will be addressed by a Cooperative Research and Development Agreement (CRDA).

Organizations representing controllers and commercial and general aviation pilots are included in Safe Flight 21 planning and in evaluation of the operational enhancements and data link alternatives.

MAJOR ACTIVITIES AND ANTICIPATED FY 1999 ACCOMPLISHMENTS:

During FY 1999, the FAA will accomplish the following tasks to implement the Safe Flight 21 program in the Ohio Valley, which will support the CAA ADS-B evaluation work and the Alaska Capstone program:

- Procure and install ADS-B ground stations
- Procure and install FIS and AWOS in Alaska
- Procure and install avionics in FAA and Alaska aircraft (CAA provides avionics in CAA aircraft)
- Initiate operational evaluation of the first five of nine operational enhancements
- Initiate procedures development
- Evaluate the three ADS-B links

KEY FY 2000 PRODUCTS AND MILESTONES:

Avionics and ground systems

- Complete the above procurement activities, as needed

Engineering and operational evaluation

- Complete the Safe Flight 21 program plan
- Continue operational evaluation for the nine operational enhancements
- Continue procedure development and certification tasks

FY 2000 PROGRAM REQUEST:

FY 2000 funding completes procurement of avionics and ground systems necessary for the operational evaluations. Funding also provides for the operational evaluation, procedures development, and certification tasks.

A02f - Safe Flight 21 (Capstone Initiative/Ohio Valley Product and Activities	Program Schedule					
	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY2004
025-150 Safe Flight 21 (Capstone Initiative/Ohio Valley)						
Operational Enhancements						
Provide Weather and Other Information to the Cockpit	◆	◇	◇			
Provide Affordable Means to Reduce Controlled Flight into Terrain	◆	◇	◇			
Improved Capability for Approaches in Low Visibility Conditions	◆	◇	◇			
Enhanced Capability to See and Avoid Adjacent Traffic	◆	◇	◇			
Enhanced Capability to Delegate Aircraft Separation Authority to the Pilot	◆	◇	◇			
Improved Capability for Pilots to Navigate Airport Taxiways	◆	◇	◇			
Enhanced Capability for Controllers to Manage Aircraft and Vehicular Traffic on Airport Surface	◆	◇	◇			
Provide Surveillance Coverage in Non-radar Airspace	◆	◇	◇			
Provide Improved Separation Standards	◆	◇	◇			
Data Link Evaluation						
Program Management and Support				◇		
Flight Information Services Available (including Graphical Weather)				◇		
ADS-B Surveillance and Separation Services Available				◇		
Micro-EARTS/ADS-B Modification Complete				◇		

Budget Authority ($ in Thousands)	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Request
Contracts	0	0	0	0	16,000
Personnel Costs	0	0	0	0	0
Other Costs	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**16,000**

A02g Operations Concept Validation — [*Program moved to 1999 Aviation System Capital Investment Plan (CIP) as M08 Continued General Support – Operations Concept Validation)*]

GOALS:

Intended Outcomes: Integrated guidance will be provided to the aviation community for the development and transition to a modernized NAS, including system specification, roles and responsibilities, and procedures, training, and certification requirements.

The RTCA Free Flight Steering Committee, the FAA's RE&D Advisory Committee, the White House Commission on Aviation Safety and Security, and numerous other members of the aviation community have called for development and validation of a Concept of Operations for Modernization. This concept is to be used as the driver and the integration guidance for the transition from the current rigid procedures and outdated failing infrastructure to a Free Flight environment. The RTCA Task Force 3 provided the modernized NAS capability descriptions sought by the user community. The validated operational concept describes how each part of the NAS, both ground and air, interacts to provide the capabilities while transitioning to a new infrastructure involving planners, pilots, service providers, and systems.

Agency Outputs: The agency provides:

- A well-defined and well-understood "validated" operational concept thoroughly described based on system modeling and simulation
- Validated, integrated, configuration managed requirements for the subsystems of the new target system to provide a coherent, comprehensive framework to guide the associated research and development activities (e.g., specific requirements for ADS-B capabilities, Surface Management capabilities, Advanced Concept Probe, etc.)
- Top-level designs for the major new ATM capabilities and subsystems associated with the operational concept (e.g., the ground-based and airborne information infrastructures required for modernization and the design of a capability to dynamically tailor an air traffic controller's airspace responsibility to more efficiently accommodate traffic demand)
- A system-level safety assessment of the operational concept and associated new capabilities
- A risk-mitigation plan to guide development activities for new capabilities
- A human factors validation plan that provides a comprehensive roadmap of activities to assure that new functionality will be operationally acceptable to flight crews and controllers.

Customer/Stakeholder Involvement: The RTCA Select Committee for Free Flight Implementation cooperates in operational concept development and validation. Its ATM Operational Concept Subcommittee participates to provide the user perspective and detail into both the initial narrative as well as each additional layer of detail. The participation ensures that the concept reflects user community requirements and is essential for validating the concept for a modern NAS based on a shared, integrated infrastructure.

Accomplishments: The vision for the modern NAS has been developed and published in the *Government/Industry Operational Concept for Free Flight* (RTCA, August 1997) and *A Concept of Operations for the NAS Airspace System in 2005* (Air Traffic Services, September 1997). These documents have provided guidance to the development of the NAS Architecture Version 4.0. Additional details appear in the appendices to this document.

Starting in FY 1999, activities to be initiated include validation of concepts and associated top-level designs, risk-mitigation planning, and coordination of a validation plan with the human factors activity.

R&D Partnerships: This work directly relates to the FAA/NASA Memorandum of Understanding (MOU) on ATM research and development. Work under this program is coordinated through the joint Integrated Product Team Plan to ensure NASA's efforts complement and are integrated into the NAS Operational Concept. NASA contributes to the development and validation of flight deck concepts and in the far-term ATM system development.

The concept development and concept validation effort is also coordinated with the European community via agreements with EUROCONTROL. This effort ensures that unique solutions/transitions are not developed in different quadrants of the globe, which would impose an undue burden on U.S. carriers, manufacturers, and other participants in the global airspace system.

MAJOR ACTIVITIES AND ANTICIPATED FY 1999 ACCOMPLISHMENTS:

Operational concept development

- Developed task assignment information and information performance requirements based on the operational needs and requirements concept document for 2005
- Performed engineering technical task analysis and developed related concept documents for the 2005 mid-term
- Developed scenario descriptions based on engineering technical task analysis concept document for the 2005 midterm

Concept validation

- Developed executable information flow tool
- Performed operational analysis, including fast-time simulation
- Conducted joint FAA/NASA/user concept validation activities, including human-in-the-loop simulations

KEY FY 2000 PRODUCTS AND MILESTONES:

Operational concept development

- Develop detailed concepts for individual service enhancement and domains to support the development of system level requirements for modernization
- Complete development of quantitative measures and goals for midterm concept capabilities
- Develop task assignments and information performance requirements for 2015 operational concept
- Develop scenarios based on engineering technical task analysis concept document for the 2015 concept

Concept validation

- Develop test-bed for modernization
- Perform operational analysis, including fast-time simulation
- Conduct joint FAA/NASA/user concept validation activities, including human-in-the-loop simulations

Concept system design

- Conduct analysis of en route sectorization strategies to support the midterm design for the Eastern Triangle

FY 2000 PROGRAM REQUEST:

The FY 2000 request expands the initial operational concept validation efforts to the point where detailed information and performance requirements will be established for several of the major modernization initiatives, including the information requirements for the Host software reengineering activities. Human factors research is expected to establish the type, update rate, and display requirements. The facilities for human-in–the-loop will be upgraded to provide a fully configurable test-bed for information performance and requirements analysis. This capability will be used to improve analysis of future controller team configurations to meet traffic growth and evaluate a horizontal versus vertical partitioning of NAS airspace.

Leveraging work is being conducted at NASA Langley for safety assessments, the methodology for safety and reliability assessment for the joint air-ground infrastructure, which will be used to evaluate reliability and safety performance of future concepts.

A02g - Operations Concept Validation Product and Activities	Program Schedule					
	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY2004
028-110 Operations Concept Validation						
Operational Concept Development						
Developed Operational Needs and Requirements Concept Documents for "2005"	◆					
Develop Roles and Responsibilities Based on the Operational Needs and Requirements Documents for "2005"	◆					
Perform Engineering Technical Task Analysis and Develop Related Concept Documents for "2005"	◆		◇			
Develop Scenario Descriptions Based on the Engineering Technical Task Analysis Documents for "2005"	◆					
Develop Operational Needs and Requirements Concept 2015		◇	◇			
Develop Roles and Responsibilities Based on the Operational Needs and Requirements Documents for "2015"				◇		
Perform Engineering Technical Task Analysis and Develop Related Concept Documents for "2015"				◇	◇	
Develop Scenario Descriptions Based on the Engineering "2015" Technical Task Analysis Documents for "2015"	◆		◇			
Concept Validation						
Develop Executable Information Flow Tool	◆	◇	◇	◇	◇	◇
Perform Operational Analysis, Including Simulation Conduct Information Flow Analysis		◇	◇	◇		
Perform Human-in-the-Loop Simulation		◇	◇	◇	◇	◇
Develop Test-bed for Modernization		◇	◇	◇		
Develop Distributed Simulation Standards & Database	◆					
Concept System Design						
Conduct Analysis for End-to-End Certification for Mixed Ground and Air Infrastructure	◆	◇				
Conduct Analysis of Advanced Airspace Sector Design and Dynamic Sectorization	◆		◇			
Conduct Analysis and Develop Service Reliability Methodology for NAS		◇		◇		

Budget Authority ($ in Thousands)	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Request
Contracts	0	0	0	3,412	2,531
Personnel Costs	0	0	0	3,099	3,307
Other Costs	0	0	0	307	271
Total	**0**	**0**	**0**	**6,818**	**6,109**

A02h Software Engineering R&D — [*Program moved to 1999 Aviation System Capital Investment Plan (CIP) as M28 Corporate Systems Architecture – Software Engineering*]

GOALS:

Intended Outcomes: The FAA intends to improve NAS and avionics safety and reduce NAS and avionics acquisition, development, and maintenance costs by developing and implementing improved software processes and procedures. These actions will directly benefit passengers as well as all elements of air transportation and greatly contribute to a safe, secure, and efficient NAS.

The FAA has been routinely criticized by the General Accounting Office (GAO) and the R,E&D Advisory Committee for its lack of software competency in acquiring and maintaining software-intensive systems. Deficiencies in this area have increased cost and decreased quality of new software-intensive systems. The agency has placed a priority on this area because most current and future NAS systems are software-intensive systems. For example, eight of the nine high drivers of change in the next 8 years, as identified by the Office of the Associate Administrator for Research and Acquisitions, involve adding or improving software-intensive systems.

The FAA Software Engineering Resource Center (SERC), which was established in June 1998, will be a focal point for research on FAA software-intensive systems. SERC leverages government, academic and industry resources by using interdisciplinary teams, which need not be collocated. SERC is an FAA-wide resource that will address strategic software technology problems that impact mission performance and enhancement of FAA in-house software/systems engineering competencies. The primary SERC facilities have been established at the William J. Hughes Technical Center and at FAA headquarters. Remote tie-ins with other facilities are also planned (e.g., at other research sites such as NASA and the EUROCONTROL Experimental Center).

Agency Outputs: The principal products of SERC efforts will include a series of standards, guidelines, models, and evolvable prototypes that demonstrate, validate, and verify the safety properties, performance, and other critical attributes of new technologies that are to be used within the NAS. SERC also will evaluate and validate improved software processes, methods, and engineering tools that enhance architecture, systems, and software engineering, testing, and certification functions over the life cycle of NAS systems. Finally, SERC will bring together recognized experts and FAA personnel to solve problems related to the certification of software, COTS/non-developmental item (NDI), and the next generation architecture. This will transfer skills to and increase the technical competency of the FAA workforce.

Following are specific focus and outcomes of SERC applied research work:

Software certification research

- Processes for certifying software aspects of safety-critical airborne and ground-based systems within the NAS**.** Current certification processes require a long leadtime and are costly. Resulting delays affect the rate at which aircraft can be equipped with modern, affordable avionics and are a significant contributor to the long leadtime required for NAS modernization. This research is exploring promising techniques for streamlining the certification process without affecting levels of safety.
- Processes for ensuring end-to-end safety and certification of integrated air and ground systems within the NAS**.** NAS air and ground segments are becoming more integrated through the introduction of new services such as data link. The current practice of separately certifying NAS airborne and ground components can no longer ensure safety of the integrated air-ground system. This research is investigating and will validate different approaches for performing end-to-end safety assessments and certification of the integrated air-ground systems.

This research will produce a series of guidelines and processes for improving certification of avionics and ground systems. Specific recommendations will also be provided to the appropriate RTCA committees that develop standards and guidelines for certification of avionics systems.

NAS architecture research

- Evaluation and prototyping of high-integrity, safety-critical architectures to find better and cheaper ways of ensuring that NAS hardware and software are safe, secure, and efficient in the face of challenges from bad code, security breaches, and the like. This may potentially eliminate a need for independent certification of software.
- Architecture definition and description. This research is investigating unified approaches to formal architecture definition and description for cost-effective evaluation and comparison of competing candidate architectures for acquisition.
- Analytical and simulation architecture models for the NAS. This research is investigating the effects of various constraints on NAS operational concepts and optimizing those constraints, including cost and performance, before committing resources to system implementation and deployment.

The specific architecture research outputs will be guidelines and standards for defining, representing, and designing high-integrity architectures for the NAS; and, executable and reusable architecture models and simulations that can be extended or tailored to support domain-specific engineering and product acquisitions for the NAS.

Research on applying COTS/NDI within the NAS ground systems and avionics

- COTS/NDI software assurance research**.** This research directly supports the Flight Controls and Digital Avionics Systems by investigating conditions under which a COTS software product can be certified to a given level of safety, as defined by current standards. It will help establish selection criteria and evaluation guidelines for ongoing work in Information Security Product Evaluation and a number of other related areas, such as NAS Infrastructure. The research also will identify and evaluate techniques for reducing the cost and time needed to ensure that COTS/NDI software, or systems containing COTS/NDI software, are safe and function as required.
- Evaluation and prototyping of systems and software engineering processes and methods for use in COTS-intensive systems. This research will identify and evaluate more effective practices for use in software requirements definition, software/systems analysis and design, and testing that are appropriate for safety-related systems using COTS/NDI software. It will include investigating different methodologies to quantify, characterize, and guard against the risk of accidentally activating unintended COTS functionality/responses for a given system and environment.
- Software estimation models for COTS-intensive systems. Research is seeking to identify/develop better ways of estimating and predicting the life cycle costs of COTS-intensive systems. This study will include consideration of the complex interactions of major cost and schedule drivers that relate to the evaluation, interfacing, integration, product refreshment, and maintenance of COTS.

This research will produce a set of evaluation criteria and guidelines for COTS software proposed for use in safety-related aviation systems. It will also establish the processes and technical methods required to evaluate COTS/NDI-based systems prior to contract awards and ensure that use of COTS/NDI software will not compromise aviation system safety.

Customer/Stakeholder Involvement: The goal of the streamlining software aspects of certification is to assess the cost and schedule drivers of the software aspects of certification for both avionics and ground systems, and to prototype solutions that show promise to reduce cost and schedules. This supports objectives of the Office of the Associate Administrator for Research and Acquisitions (ARA) and the Office of the Associate Administrator for Regulation and Certification (AVR).

Recommendation R-14 of the "Report of the Challenge 2000 Subcommittee of the FAA RE&D Advisory Committee for the Administrator" reads, in part:

> "The FAA should conduct an in-depth analysis of processes within the FAA which are affected by COTS/NDI technologies. . . . 5. Identify new methods to test and validate safety-critical systems that are not dependent on source code

> analysis. 6/7. Investigate ways to reduce cost and time to (re)establish high confidence in a system. . . 18. Promote software technology and process improvement techniques. . . ”

The COTS/NDI software assurance research work is directed toward answering the recommendations of this Subcommittee and also addresses concerns and recommendations contained in the *COTS/NDI in Safety-Critical System* report. This research also supports *Action Plan 5: Validation and Certification Methodology* of the FAA/EUROCONTROL R&D Committee agreements.

The *Subcommittee Report of the NAS ATM R&D Panel to R,E&D Advisory Committee* addresses the entire contents of its section 4.0 to Software Engineering Research and Development. It concludes with a number of critical recommendations concerning the need to initiate research in (1) certification of ground as well as air systems involving critical software; (2) systems/software complexity; (3) various software architectural issues such as reuse and reliability; and (4) software/computer security. This is all captured within several sections, beginning with the Major Recommendation 4.2.1.a #2, “The FAA should establish a Software Engineering Laboratory under the direction of the Chief Scientist for Software Engineering that performs as a center of excellence.” A major purpose of this research initiative is to address the concerns and identified weaknesses noted by the Subcommittee.

Accomplishments: N/A

R&D Partnerships: Partnership agreements are under discussion with EUROCONTROL, NASA, DOD, NIST, and others.

MAJOR ACTIVITIES AND ANTICIPATED FY 1999 ACCOMPLISHMENTS:

Establishment of the SERC was initiated in June 1998 using funds earmarked for software engineering operational planning. The center will be fully operational by the end of FY 1999. Several major research activities have already begun in the three key areas outlined above.

KEY FY 2000 PRODUCTS AND MILESTONES:

During FY 2000, the initial guidelines and prototypes for the three areas will be available for preliminary use and test. The SERC will act as a virtual and physical facility to coordinate development and testing of these software engineering research products. Links will be established with remote researchers and research sites.

FY 2000 PROGRAM REQUEST:

The software engineering research programs will initially make use of prior related activities conducted by the Office of Information Technology. The programs will subsequently use resources throughout the United States, particularly those of the SERC and aviation-related programs already underway at several universities. Support has been promised and is being negotiated with a number of FAA organizations.

A02h - Software Engineering R&D Product and Activities	Program Schedule					
	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY2004
028-130 Software Engineering R&D						
Software Engineering Resource Center (SERC)						
Establish/Maintain the infrastructure	◆					
Develop/Implement Operational Plans and Methodology	◆					
Establish/Maintain Working Relations with Other Centers	◆	◇	◇	◇	◇	
Establish/Maintain Working Relations with Contract Researchers	◆	◇	◇	◇	◇	
NAS Architecture Research						
Develop an Architectural Decision Tree	◆	◇	◇	◇	◇	
Prototype the Architectural Decision Tree			◇	◇	◇	
Develop Guidelines for a "Good" Definition		◇	◇	◇	◇	
Develop Guidelines for a "Good" Representation		◇	◇	◇	◇	
Develop Guidelines for Secure Software Systems				◇	◇	
Develop, Test, and Evaluate Analytical Models				◇	◇	
Develop, Test, and Evaluate NAS Simulations				◇	◇	
Research on Safe and Effective Application of COTS/NDI in the NAS						
Develop Standards and Guidelines for COTS/NDI Software/ System Assurance	◆			◇	◇	
Develop Standards and Guidelines for COTS/NDI Software/System Methods				◇	◇	
Develop Standards and Guidelines for COTS/NDI Software/System Cost Estimation	◆			◇	◇	
Software Certification Research						
Develop Standards and Guidelines for Certification of Safety	◆			◇	◇	
Develop Standards and Guidelines for End-to-End Test of Air/Ground Software Intensive Systems				◇	◇	

Budget Authority ($ in Thousands)	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Request
Contracts	0	0	0	462	689
Personnel Costs	0	0	0	474	1,001
Other Costs	0	0	0	64	84
Total	**0**	**0**	**0**	**1,000**	**1,774**

A03a Communications— [*Program moved to 1999 Aviation System Capital Investment Plan (CIP) as C20 Aeronautical Data Link (ADL)*]

GOALS:

Intended Outcomes: The FAA intends to increase safety, decrease delays, increase system flexibility and predictability, and increase user access to NAS data base sources by:

- Implementing decision support system services (DSSS) that integrate airborne flight management system capabilities with ground-based decision support automation
- Providing all NAS users a common view of weather and airspace traffic, thus allowing users to better anticipate and plan for flight deviations and/or delays through CDM process
- Increasing system flexibility by using data link services to derive, negotiate, and/or update flight plans both before and during flight

These improvements also reduce air traffic controller workload, increase situational awareness, and alleviate voice traffic congestion.

Providing data link services facilitates the transition from air traffic control to air traffic management and supports the evolution toward a Free Flight environment as envisioned in the RTCA Task Force 3 report and the Free Flight Action Plan. This also advances the concept of the self-reliant pilot described in the future architecture for automated flight service station support. Several government and industry initiatives have identified improved weather information in the cockpit as a key priority and mitigating strategy to reducing weather related accidents. After pilot error, weather is the number one cause/factor cited in aviation accidents. Over one-third of all fatal accidents in all sectors of aviation involve weather, and in general aviation more than 200 fatalities per year are due to weather.

Agency Outputs: The FAA provides cost-benefit analyses for ground processing and uplink of FIS/weather and DSSS.

Standards and guidance material for FIS/weather products and DSSS provide technical characteristics and approval guidelines for operational use and training. RTCA minimum aviation system performance standards (MASPS) and minimum operations performance standards (MOPS) provide guidance for data link avionics. FAA advisory circulars and the Aeronautical Information Manual provide certification guidance for installation and operational use/application. This program develops technical and operational information, including human factors criteria, to support these products.

Specifications for FIS/weather products and DSSS provide/identify requirements for FAA automation and industry implementation.

Customer/Stakeholder Involvement:

Free Flight: The integration of ATM DSSS with controller, pilot, and airline operations center (AOC) facilities systems via digital data link provides enhanced capabilities for trajectory prediction, in-flight planning, and rerouting. ATM DSSS alternatives include CTAS automated en route air traffic control technologies. Using these alternatives will lead to a reduction in the number of current procedural restrictions in the NAS. This is one of the primary goals of the Free Flight initiative, which also includes developing and implementing FIS/weather products in the cockpit.

RTCA: RTCA sponsors many special committees, including:

- SC-169, which formulates a systems-oriented approach to aeronautical data link (ADL) applications and coordinates standards development to integrate data ink functions for air traffic management
- SC-182, which develops standards for modular avionics concepts, which affect cockpit avionics used by ADL
- SC-162 (Open Systems Interconnections)
- SC-165 (Aeronautical Mobile Satellite Service)
- SC-172 (VHF Air-Ground Communication)
- SC-181 (Navigation Standards)
- SC-185 (Aeronautical Spectrum Planning)
- SC-186 (Automatic Dependent Surveillance-Broadcast)
- Task Force 3, Air Transport Association Flight Management System Task Force

ICAO: The International Civil Aviation Organization leads and participates in the following panels:

- The Automatic Dependent Surveillance Panel. which focuses on automated air-ground data exchange
- The Aeronautical Telecommunication Network Panel, which focuses on requirements for a globally interoperable digital data communications network
- The Aeronautical Mobile Communications Panel, which focuses on satellite-based safety services for data and voice, including standards development for high and very high frequency digital communications

Aviation Safety Plan: ADL-related initiatives include:

- Initiative 2.10.2, which deploys data link capability to disseminate alphanumeric and graphical FIS products, including weather, directly to the cockpit
- Initiative 4.2.6, which completes the definition of data link systems to support communications, navigation, and surveillance operations
- Initiative 4.2.7, which establishes two-way data link capability throughout domestic en route and terminal airspace.
- Initiative 4.3.4, which demonstrates/validates risk reduction benefits of weather and traffic products acquired by local surveillance systems delivered to aircraft, ATC facilities, air carriers, and any combination of these.

FANG: The Flight Management System (FMS)-ATM Next Generation (FANG) Team chaired by the ADL product team, focuses on developing DSSS. This team comprises government and industry representatives and is chartered to define an integrated flight management system/air traffic management/aeronautical operational control system.

The FAA participates in and sponsors the communications and surveillance operational implementation team. This is an Administrator-chartered organization established to coordinate the implementation of FAA modernization programs with the aviation industry.

The general aviation (GA) community also has participated in the FAA demonstration and operational suitability assessment of initial graphic and text data link products provided through the mode S-based Graphic Weather Service (GWS) at Dulles International Airport. The user community strongly advocates implementing dissemination of FIS/weather, especially graphics, to the cockpit as demonstrated through the Free Flight Action Plan (1996); the National Research Council report, Aviation Weather Services, A Call for Federal *Leadership and Action* (1995); the National Aviation Weather Program Plan (1992); and FAA order 7032.15 Air Traffic Weather Needs and Requirements. Most recently, in May 1998, the FAA issued an Airborne Flight Information Services Data Link Policy statement supporting a joint government/industry partnership in establishing FIS data link services. The policy statement was a result of a petition submitted by the General Aviation Coalition.

Accomplishments: The FANG Operational Concept has been published. It identifies a preliminary set of services, associated potential benefits, and required functional capabilities of an integrated flight management system/air traffic management/aeronautical operational control system.

The basic requirements and operational concepts for FIS/weather data link applications were jointly developed by industry and government, and published (DO-232) through the RTCA Special Committee 169, Working Group 3.

Terminal weather information for pilots (TWIP) is currently available at all Terminal Doppler Weather Radar locations through the ARINC ACARS vendor data link service.

Predeparture clearance (PDC) and digital-air traffic information service (D-ATIS) is currently available through the tower data link system (TDLS) at 57 TDLS locations. These services are also provided through the ARINC ACARS vendor data link service.

TIS is being deployed at all operational terminal Mode S locations. This service provides cockpit presentations of aircraft traffic to client aircraft based on terminal radar surveillance.

R&D Partnerships: The FAA is coordinating development of NAS improvements, including data

link applications with NASA. An interagency Integrated Product Team, formed between the FAA and NASA, develops future ATM systems. FAA and NASA DSSS-related efforts are coordinated through that mechanism. Also, the joint FAA/NASA AGATE project includes joint testing (ground and flight) with the AGATE partners. Finally, the NASA Aviation Weather Information (AWIN) program includes cockpit dissemination of weather information as a key strategy for mitigating aviation fatalities in a 7-year research program in response to the White House Safety Commission report.

MAJOR ACTIVITIES AND ANTICIPATED FY 1999 ACCOMPLISHMENTS:

- Completed Joint FAA/NASA Modeled Analysis of CTAS- and FMS-generated fuel-optimal trajectories
- Published FANG-required functional capabilities document
- Completed Three-Dimensional User-Preferred Trajectories Flight Trials Project
- Began Field Test portion of Joint FAA/NASA CTAS/FMS Data Exchange Field Test (Initial DSSS)
- Established required initial data link capabilities for En Route Aeronautical Telecommunications Network Decision Support Tool
- Established partnership(s) with industry to provide FIS data link services
- Established collaborative FIS data link testbed and test range facilities for developing sound technical data to support publication of standards and guidelines for operational implementation
- Published initial RTCA MOPS/MASPS and FAA advisory circulars and other regulatory materials to support FAA/industry FIS data link services

KEY FY 2000 PRODUCTS AND MILESTONES:

Funded:

- Conduct ground simulation and flight evaluations to analyze cockpit workload and pilot decision-aid impacts for new increment of FIS data link services (i.e., convective weather, AUTOMETS, in-flight icing, turbulence, SUA, and NOTAM's)
- Develop FIS standards and guidelines for the above convective weather and AUTOMET FIS data link services

FY 2000 PROGRAM REQUEST:

Aeronautical Data Link works collaboratively with FAA product teams, including en route, terminal, air traffic management, interfacility telecommunications, and weather to ensure the successful integration of data link services into the NAS.

Decision support system data link enhancement identification and development allows the benefits of advanced ATM automation tools to be fully realized.

Ground simulations and flight evaluations are conducted using the facilities and resources at the William J. Hughes Technical Center and other facilities, including those at the FAA Civil Aeromedical Institute (CAMI), MITRE Center for Advanced Aviation System Development (CAASD), and NASA. These simulations and evaluations identify data link product and system architecture specifications and operational guidance issues. Based on these specifications and operational guidance issues, implementation standards (MOPS, MASPS), operational guidance documents (advisory circulars), and system architecture strategies are drafted.

A03a - Communications Product and Activities	Program Schedule					
	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY2004
031-111 Aeronautical Data Link (ADL) Applications						
Decision Support System Services (DSSS)						
Begin Modeling/Simulation of proposed DSSS		◇				
Complete Cost/Benefit Analysis (CBA) for initial DSSS		◇				
Complete Comprehensive List of DSS Data Link Services		◇				
Complete AMS initial requirements document for DSSS			◇			
Complete CBA for DSSS			◇			
Develop FAA/Industry Consensus on DSSS Implementation				◇		
Implement initial DSSS					◇	
Integrate Advanced DSSS with Flight Management Systems (FMS)						◇
Flight Information Services (FIS)						
Established collaborative FIS data link test facilities	◆					
Established industry partnerships to provide initial FIS data link services	◆					
Developed standards & guidelines for initial FIS data link services	◆					
Conduct simulations/flight evaluations for follow-on FIS services		◇				
Develop standards & guidelines for follow-on FIS services		◇				
Conduct simulations/flight evaluations for advanced FIS services			◇			
Develop standards & guidelines for advanced FIS services			◇			
Develop operational specifications & standards/ guidelines for FIS Services based on Aviation Gridded Forecast System				◇		
Conduct simulations/flight evaluations for transition of FIS services for DSSS/Collaborative Decision Making (CDM) support					◇	
Develop standards/guidelines for FIS services supporting DSSS/CDM services						◇

Budget Authority ($ in Thousands)	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Request
Contracts	5,412	1,054	4,706	1,174	3,000
Personnel Costs	3,808	4,105	0	4,129	4,498
Other Costs	780	841	0	566	344
Total	**10,000**	**6,000**	**4,706**	**5,869**	**7,842**

A03b Navigation — [*Program moved to 1999 Aviation System Capital Investment Plan (CIP) as N12 – Augmentation for the Global Positioning System (WAAS/LAAS)*]

GOALS:

Intended Outcomes: The FAA intends to provide time efficiencies and cost savings through satellite-based navigation implementation. This technology allows direct point-to-point navigation, optimum routing, and other capacity improvements. These efficiencies and savings are realized by the airlines, the traveling public, and the FAA and include:

- Increased air traffic control efficiencies and NAS capacity through a restructured airway system to accommodate direct routings between airports as well as reduced separation standards
- Reduced fuel cost to airlines and reduced travel time to the public due to more economical air routes
- Reduced FAA operating costs due to decommissioning existing ground-based navigation equipment
- Simplified GPS augmentation infrastructure through wide area and local area interoperability to provide satellite navigation services at a reduced cost

Agency Outputs: The FAA uses the national satellite testbed (NSTB) as the foundation for all research and development associated with implementing satellite-based navigation technology. The NSTB is essential to the wide area and local area augmentation development strategy needed to implement GPS-augmented navigation technology. Findings from the NSTB help the FAA to develop required user equipment through avionics manufacturers, continue development of GPS user procedures, and gain international acceptance of a seamless global navigation satellite system.

The program is developing and implementing the capability to monitor and evaluate system performance of GPS and GPS-augmented systems, such as NSTB and WAAS, as they are implemented. During these evaluations, large quantities of complex, technical data will be collected, analyzed, archived, and made available to the FAA and other government agencies. Industry, academia, and international entities to further their research use the data, facilitate information exchange, and foster cooperation around the world to achieve a seamless global navigation system. The results of this "live" data collection and analysis will assist the FAA in defining and analyzing air traffic and airway facility requirements for satellite-based navigation technology, as well as connectivity and interoperability requirements for international augmentation systems being developed by other countries. The information obtained from these performance evaluations will also be instrumental in allowing the FAA to monitor the WAAS system contractor performance during interim contractor maintenance and logistics.

The FAA will approve GPS as a primary means of navigation through category I precision approaches by 2001 in all weather conditions by implementing WAAS. This will enable existing navigation equipment across the United States to be decommissioned.

The FAA will validate the capability to perform category II/III precision approaches through research and development efforts associated with LAAS. The FAA will provide a LAAS functional specification, architecture, and MOPS to industry for implementing local area systems across the United States. LAAS prototypes will be developed, and flight tests will be conducted to validate the specification and MOPS.

Customer/Stakeholder Involvement: The program's implementation strategy involves other government agencies, industry, and academia, as follows:

- The FAA establishes and participates on various teams addressing immediate needs for operational implementation issues. These include the Satellite Operational Implementation Team (SOIT), Satellite Procedures Implementation Team, the Air Traffic SOIT, and other teams and working groups at FAA regional offices.
- The FAA participates on the RTCA working groups and subcommittees.
- The FAA has completed 16 bilateral agreements with several countries and participates in ICAO panel sessions to further the accep-

tance of GPS augmentations as a seamless global navigation satellite system.

- The FAA supports the Positioning and Navigation Executive Committee, and the Joint Precision Approach and Landing System Program and interacts with the Department of Defense to establish and promote a national consensus on GPS management and operation.
- The FAA supports the Interagency GPS Executive Board (IGEB) regarding GPS modernization issues.

Accomplishments: During FY 1998, the NSTB continued to provide a MOPS compliant signal in space, allowing development of WAAS aircraft avionics, terminal en route procedures (TERPS) criteria, and user procedures. Research efforts included evaluating new algorithms, hardware, and communication topologies to improve the integrity and availability of the WAAS. Enhancements to the NSTB were made to improve its use as a performance assessment tool for the WAAS and to define the preplanned product improvements for WAAS. In addition, the NSTB conducted initial global navigation satellite system (GNSS) interoperability studies.

The FAA completed development of the LAAS functional specification and the MOPS. Development efforts for LAAS prototypes were initiated to validate and verify the specification and MOPS.

The FAA initiated the requirements definition and analysis of system performance characteristics for the satellite navigation center as the first step toward developing a monitoring network to evaluate GPS and WAAS system performance.

R&D Partnerships: The FAA has approximately 20 grants, interagency agreements, and contracts in place with industry, academia, and other government agencies to leverage their expertise and capabilities in satellite navigation R&D. Principal participants include Stanford University, Ohio University, the Naval Air Warfare Center Aircraft Division (NAWCAD), the Central Intelligence Agency (CIA), the Air Transport Association (ATA), and the Massachusetts Institute of Technology Lincoln Laboratories.

In addition, 16 cooperative bilateral agreements are in place, with additional agreements currently in work, to facilitate and promote the communication and information transfer for a seamless global navigation satellite system. The program also maintains a government industry partnership with the ATA for continued development of performance operating standards for GPS-based navigation with emphasis on local area applications.

MAJOR ACTIVITIES AND ANTICIPATED FY 1999 ACCOMPLISHMENTS:

- Performed data collection and analyses using the NSTB to further develop WAAS performance-assessment capabilities
- Continued to conduct ionosphere data collection and analyses to define WAAS final operational capabilities
- Initiated development of WAAS prototype to demonstrate international connectivity
- Continued development of WAAS performance-monitoring network
- Conducted ionospheric data collection and analyses
- Conducted WAAS/LAAS integration studies
- Initiated investigation studies for surface movement guidance, helicopter operations, and advanced LAAS augmentations
- Initiated installation and testing of LAAS prototypes to validate the functional specification
- Continued to coordinate with ICAO to produce SARP's to define LAAS in the international community

KEY FY 2000 PRODUCTS AND MILESTONES:

- Perform data collection and statistical analyses of initial WAAS performance capabilities--including developing WAAS antenna interference mitigation and rejection methods, a safety processor to meet FAA certification standards, and analyzing satellite alternatives for WAAS final operating capability
- Develop a prototype integrity monitor for the WAAS
- Conduct WAAS/LAAS integration studies

- Develop operations and maintenance connectivities
- Prototype international connectivity
- Develop WAAS performance monitoring network
- Establish research database and analysis capability
- Develop real-time simulation methodologies for WAAS components
- Conduct ionospheric data collection and analyses
- Continue research into signal quality monitoring, operations and maintenance, flight control monitoring, and automatic dependent surveillance with participation from Stanford and Ohio Universities
- Continue investigation studies analysis for surface movement guidance, helicopter operations, and advanced LAAS augmentations using pseudolites, instrument landing system glideslope, and low-earth-orbit satellites
- Continue to develop and mature the LAAS integrity algorithms
- Continue installing and testing LAAS prototype systems at several sites to ensure that the systems will validate the functional specification in particularly difficult sites

FY 2000 PROGRAM REQUEST:

In FY 2000, the program will continue to focus on developing and implementing GPS augmentations to further the transition to satellite-based navigation technology. Efforts focus on research and analysis of issues associated with accuracy, integrity, and availability to the users, with specific emphasis on interference to ensure service continuity. Efforts also focus on gaining continued acceptance and support by the international community for an integrated WAAS/LAAS architecture to achieve a seamless GNSS.

The FY 2000 request will focus primarily on the research and development efforts currently being performed by Stanford University, Ohio University, ATA, and MIT's Lincoln Laboratory. This will allow the FAA to continue to meet its objectives to transition to satellite-based navigation.

A03b - Navigation Product and Activities	Program Schedule					
	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY2004
032-110 Satellite Navigation Program						
Wide Area Advanced Research/NSTB						
Ionospheric Data Collection & Analyses	◆	◇	◇	◇	◇	◇
Worldwide Scintillation Monitoring & Analysis	◆	◇	◇	◇		
Develop Worldwide Iono Mode	◆	◇	◇			
Interference Mitigation Analysis	◆	◇	◇			
Develop Worldwide Service Volume Model	◆	◇	◇			
Clock Performance/Time Transfer Analysis	◆	◇				
International Connectivity & Interoperability	◆	◇	◇	◇	◇	
Integrate International Reference Sites	◆	◇	◇	◇	◇	
Conduct Flight Demonstrations	◆	◇	◇	◇	◇	
Data Collection, Distribution, Analysis	◆	◇	◇	◇	◇	
WAAS Performance Assessments	◆	◇	◇	◇	◇	
Minor Contractor Compliance	◆	◇	◇	◇	◇	
Support WAAS Algorithm Validation	◆	◇	◇	◇		
WAAS P3I Definition	◆	◇	◇	◇	◇	◇
Data Collection & Analysis	◆	◇	◇	◇	◇	◇
2nd/3rd Civil Frequency Addition	◆	◇	◇	◇	◇	◇
Local Area Concepts						
Initiate Installation/Test of LAAS Prototypes		◇	◇			
Begin Surface Movement, Helicopter & Advanced Research	◆	◇	◇			
Complete Validation of LAAS Specification/MOPS	◆		◇			
2nd/3rd Civil Frequency Integration						◇
WAAS/LAAS Inter-operability						
Conduct WAAS/LAAS Inter-operability studies	◆	◇	◇			
Develop Interface Control Requirements				◇		
Finalize Architecture Study				◇		
Conduct Prototype Tests				◇	◇	◇
NAS Integration Plan				◇	◇	

Budget Authority ($ in Thousands)	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Request
Contracts	10,334	10,772	10,426	10,718	5,665
Personnel Costs	2,213	1,849	2,466	1,844	1,757
Other Costs	453	379	505	433	131
Total	**13,000**	**13,000**	**13,397**	**12,995**	**7,553**

A03c Surveillance — [*Program moved to 1999 Aviation System Capital Investment Plan (CIP) as S10 – Automatic Dependent Surveillance-Broadcast (ADS-B) and ADS-B Ohio Valley Project – Safe Flight 21*]

GOALS:

Intended Outcomes: The FAA intends to improve system efficiency and safety by implementing a low-cost surveillance system that enables Free Flight capabilities, minimizes runway incursions, and provides coverage in existing nonradar areas.

ADS-B is a technique to derive aircraft position by an onboard GNSS receiver or other backup source of navigation data. Aircraft identity, altitude, and position are broadcast directly to ground receivers and to nearby aircraft. Transmitted ADS-B messages, received by nearby aircraft and information is displayed on an airborne CDTI used for situational awareness, conflict detection, and Free Flight capabilities. Accurate and timely updated reports from ADS-B minimize runway incursions, improve safety by increasing a pilot's awareness of nearby aircraft, and improve efficiency and airspace capacity by potentially reducing current separation standards. Its modular design and cooperative nature offer a low cost alternative for surveillance coverage in existing nonradar areas, and potentially in the long term, in some areas currently served by radars.

ADS-B as been identified by both the FAA and the aviation industry as an enabling technology for Free Flight.

Agency Outputs: Current efforts focus on developing standards for ADS-B avionics, ADS-B applications, CDTI, and transponders, and in validating the capabilities of ADS-B. These standardization efforts include minimum aviation system performance standards, minimum operational performance standards, technical standard orders, and design criteria. Outputs will include evaluation of operational procedures, procurement specifications for ground systems, deployment of system prototypes, and revised operational procedures.

Customer/Stakeholder Involvement: Air carrier and general aviation user communities have asked for FAA leadership in developing ADS-B technology. The FAA and the user community are actively involved in the standards development activity at RTCA SC 186. Some of the specific stakeholders include the Cargo Airline Association, Experimental Aircraft Association, Air Transport Association, Airline Pilots Association, Aircraft Owners and Pilots Association, United Airlines, Northwest Airlines, and the ICAO panels and European Work Group on ADS-B.

Accomplishments: Draft ADS-B avionics standards development has been initiated at RTCA. Additional engineering prototype and certification work, including development and test/validation, is required to complete these standards. A cooperative CRDA is being implemented with the CAA for an evaluation of selected operational enhancements and alternative radio frequency data links.

R&D Partnerships: The joint government/industry committees, RTCA SC-186 and SC-159, are tasked with achieving R&D consensus on system standards for ADS-B. Massachusetts Institute of Technology's Lincoln Laboratory and MITRE are also jointly involved in the technical development and integration of ADS-B technology into the NAS.

MAJOR ACTIVITIES AND ANTICIPATED FY 1999 ACCOMPLISHMENTS:

- Develop agency roadmap for ADS-B air-to-air, air-to-ground, and surface applications
- Complete development of ADS-B 1090 MHz MOPS with RTCA
- Develop initial draft of ADS-B/CDTI MOPS with RTCA
- Complete spectrum analysis of ADS-B 1090 MHz in high-density environment
- Procure, install and evaluate ADS-B prototype ground station

KEY FY 2000 PRODUCTS AND MILESTONES:

- Complete operational concepts development and alternative analysis, including cost benefit and cost-effectiveness studies
- Continue evaluation of ADS-B operational procedures, including field trials

- Publish draft ADS-B/CDTI standards
- Publish draft engineering specification for ADS-B ground station

FY 2000 PROGRAM REQUEST:

The FAA and RTCA continue to complete the ADS-B avionics standards for CDTI and I-MFD displays as well as standards for ADS-B related enhancements to Mode S transponders. Studies, analyses, and field tests will validate CDTI standards. Operational concept analysis describes proposed features and benefits obtained by implementing and deploying ADS-B. An analysis of ADS-B integration with existing radars and automation systems will be performed.

A03c - Surveillance Product and Activities	Program Schedule					
	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY2004
033-140 Automatic Surveillance-Broadcast (ADS-B)						
Plans, Standards, and Analysis						
Develop/Approval of 1090 MHz MOPS by RTCA	◆					
Develop ADS-B Roadmap	◆					
Support ADS-B Trials	◆					
Conduct ADS-B High Density Simulations	◆					
Complete Operational Concept Analysis for Air-to Air Applications	◆					
Perform/Complete CDTI-1 Field Trials and Analysis	◆					
Avionics Standards for CDTI	◆					
Conduct/Complete CDTI Operational Test & Evaluation (OT&E) for Visual Flight Rules		◇				
Update CDTI Standards		◇				
Validate Application Benefits for Air-to-Air			◇			
Conduct/Complete CDTI OT&E for General Aviation Instrument Flight Rules Applications			◇			
Update CDTI Standards			◇			
Develop Air-to Air and Surface Operations Concept		◇				
Ground Initiated Comm B (GICB) Analysis for Mode S Transponders			◇			
Analysis Report Describing Integration of ADS-B with Existing Radars and Automation Systems					◇	
Procure, Install and Demonstrate ADS-B Ground-Based Engineering Prototypes			◇			
Complete Demonstrations/Publish Ground-Based Systems Demonstration Report				◇		
Develop Integrated Requirements Document for Ground-Based Systems					◇	
Develop Specification for ADS-B Ground Systems					◇	
Develop Specifications for ADS-B Automation/Integration					◇	
Evaluate alternative implementation of ADS-B technologies for long-term applications					◇	
Investment Decision for ADS-B Ground Stations to support air-to- ground and surface ATC application Investment						◇

Budget Authority ($ in Thousands)	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Request
Contracts	0	0	0	3,506	2,600
Personnel Costs	0	0	0	701	896
Other Costs	0	0	0	83	48
Total	**0**	**0**	**0**	**4,290**	**3,544**

A04a Weather Program

GOALS:

Intended Outcomes: The FAA intends to provide the capability to generate weather observations, warnings, and forecasts that are more accurate and accessible than existing weather services. These upgrades enhance flight safety, increase system capacity, improve flight efficiency, reduce air traffic controller and pilot workload, improve flight planning, increase productivity, and enhance situational awareness.

In accordance with the Federal Aviation Act of 1958 as amended, the FAA is responsible, in cooperation with the Department of Commerce, to promote and develop meteorological science, and to foster support of research projects using private and governmental research facilities. These duties are further amplified by recommendations contained in an Aviation Weather Services report issued by the National Research Council (1995) and the final report of the Aviation Weather Subcommittee issued by the FAA's Research, Engineering, and Development Subcommittee (October 1995).

The weather program directly supports FAA Strategic Goal #1in the performance area of Safety: "Through research, identify methods that, when implemented would reduce the fatal accident rate, due to weather." The weather program also directly supports Strategic Goal #8 in the performance area of System Efficiency, "Demonstrate the capability of new systems to decrease the rate of delays due to weather."

The weather R,E&D program, in collaboration with NWS and National Science Foundation programs, produces weather algorithms (technology), more rapid forecasting and delivery of forecasts (delivery), and the development of aviation weather instructional material and training courses (education).

Agency Outputs: The weather program focuses on conducting applied research to solve operational problems leading to the development of new and improved algorithms. These models predict weather events that affect aviation as well as procedural and policy changes/updates. The algorithms, developed for implementation on appropriate NAS platforms (including the weather and radar processor, the integrated terminal weather system, and NWS systems) continue to be transferred to private weather service companies that support the NAS. This enables companies to develop specialized aviation weather products based on FAA research efforts. Algorithm development provides the following capabilities that:

- Accurately depict current and forecasted in-flight icing areas to enhance safety, airspace efficiency, and aircraft utilization
- Produce high-resolution and timely gridded information for icing, winds, temperature, and turbulence to improve aviation advisories and forecasts issued by the NWS
- Provide location, timing, and severity of convective weather hazards to improve flight safety and enhance capacity.

Customer/Stakeholder Involvement: The National Aviation Users' Forum has provided a process to develop a federal/industry consensus on user needs and priorities for aviation weather information. Forum participants include representatives from the Airline Pilots Association, United, American, and Delta Airlines, and other industry representatives. The Forum serves as a basis to set priorities for research and development as well as system acquisition. The FAA's weather priorities and plans are consistent with users' recommendations made at this forum, and the plans address industry recommendations.

The weather program analyzes aviation weather service users' needs and requirements found in the Aviation Safety Action Plan. It also addresses industry recommendations, as well as requirements contained in more than six other related documents and publications.

Accomplishments: Following are major weather program accomplishments:

- Completed rapid update cycle analysis and forecast capability providing more accurate and higher resolution upper winds, temperature, and precipitation data, resulting in reduced flight times and/or flight delays because the data on hazardous weather and jet streams are more accurate

- Issued a 'freezing precipitation aloft' forecast at the Kansas City aviation weather center--responding to a rulemaking proposal aimed at turboprops flying in weather conditions conducive to in-flight icing--increasing airspace efficiency, aircraft utilization, and safety, especially for commuter aircraft.
- Commenced flight test of humidity sensor on United Parcel Service (UPS) aircraft, as part of the water vapor sensing system (WVSS) program, leveraged with the National Oceanic and Atmospheric Administration (NOAA)--enabling more accurate in-flight icing and ceiling and visibility forecasts.
- Completed upgrades to next-generation weather radar (NEXRAD) algorithms, storm cell identification and tracking, hail detection, mesocyclone, and tornado detection (leveraged with NWS)--enabling better definition of location, timing, and severity of convective weather hazards, resulting in enhanced flight safety and capacity
- Completed storm growth and decay experiment on data collected in Memphis. This research will result in the accurate, short-term prediction of the beginning, growth, and decay of storm cells--enhancing safety and capacity by improving aircraft avoidance of hazardous weather, resulting in enhanced strategic and tactical flow management planning, and allowing more effective routing of traffic to and from airports and runways
- Operated weather support to deicing decisionmaking (WSDDM) testbeds at La Guardia and O'Hare airports in collaboration with the Port Authority of New York and several airlines providing ground deicing decisionmaking information to the airlines and cities--resulting in increased safety (takeoffs), savings in use of deicing fluids, and associated equipment and personnel costs, efficiencies in runway and off-airport plowing, and efficiencies in departures and arrivals
- Developed initial operating capability of the AGFS implemented at the NWS--providing an aviation-specific weather database for the aviation community
- Under the SOCRATES Project, fabricated and tested a two-beam system for Wake Vortex detection during a 2-week test period in May 1998 at John F. Kennedy Airport

R&D Partnerships: Program activities are closely coordinated and leveraged with industry, academia, and other government agencies. This is done directly through interagency agreements, university grants and MOA'S in conjunction with the National Science Foundation. Principal partners include the National Center for Atmospheric Research, NOAA's Forecast Systems Laboratory and National Severe Storms Laboratory, Massachusetts Institute of Technology's Lincoln Laboratory, NWS Aviation Weather Center and National Centers for Environmental Prediction, NASA Lewis, Office of Naval Research, and UPS, as well as several universities, airlines, port authorities, and cities. In addition, international agreements with the United Kingdom, France, and Canada further leverage FAA efforts.

Research results are transferred to the private sector via cooperative research and development agreements with GTE, Kavouras, WSI, Harris, and AccuWeather.

MAJOR ACTIVITIES AND ANTICIPATED FY 1999 ACCOMPLISHMENTS:

- Developed initial integrated in-flight icing algorithm
- Conducted field program to evaluate improved forecasts of in-flight icing
- Developed enhanced AGFS automated tools for forecasters
- Tested radar improvements to provide rapid updates of hazardous weather
- Integrated satellite data into 60-minute storm growth and decay forecast
- Completed technology transfer of WSDDM system to private industry for operational implementation
- Implemented preliminary turbulence forecasting algorithm at the Aviation Weather Center
- Fabricated and tested a two-team system at the FAA/Volpe Center Wake Vortex Site at JFK
- Processed, analyzed, and presented a final report on data obtained in the JFK test of the SOCRATES two-beam system

KEY FY 2000 PRODUCTS AND MILESTONES:

- Incorporate satellite data into an in-flight icing guidance product
- Implement interactive AGFS display-specific flight route forecasts
- Conduct airborne humidity sensor flight demonstration of utility
- Incorporate boundary layer data into 60-minute storm growth and decay forest
- Complete in-situ-based detection turbulence product evaluation
- Develop a 1- to 2-hour marine stratus burnoff forecast for San Francisco International Airport
- Implement wind data ingest and dissemination system at Juneau Airport

FY 2000 PROGRAM REQUEST:

- Develop new algorithms for improved forecasts of freezing drizzle aloft
- Continue to develop automated data analysis and assimilation techniques
- Transition weather research products to NWS, FAA, and industry automation and weather systems

The following activities are based on funding availability for SOCRATES in FY 2000:

- Design and fabricate and test and evaluate a SOCRATES eight-beam system; conduct local tests and prepare for evaluation testing
- Design, fabricate, and test a ground-based SOCRATES Particle Backscatter System and prepare for evaluation testing

A04a - Weather Program Product and Activities	Program Schedule					
	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY2004
041-110 Aviation Weather Analysis and Forecasting						
Develop Aviation Gridded Forecast System (AGFS)						
Developed Tools for Interactive Data Assimilation/Distribution	◆					
Implement Interactive Display Specific Flight Route Forecasts		◇	◇			
Implement Interactive Convective Sigmet/Airmet Ensemble Tools			◇	◇		
Imp/Demonstrate Interactive Forecast/Product Verification Tool					◇	◇
In-flight Icing						
Initial Development of IIFA	◆					
Incorporate Satellite Data into In-flight Icing Guidance Product		◇				
Imp. Yr.-Round Guidance Product & Severity/Type Forecasts			◇	◇		
Develop Terminal-Scale Icing Product & Field Program to Evaluate Radar/Satellite /Radiometer Detection Techniques					◇	◇
Winter Weather Research						
Develop Techniques to Detect/Forecast Precipitation Type and Rate, Incorporate Radar/Satellite Data				◇	◇	
Develop 6-Hour Forecast of Precip. Type/Rate						◇
Convective Weather						
Integrate Satellite Data into 60 Minute Forecast Algorithm	◆		◇			
Incorporate Boundary Layer Data, Transition to ITWS		◇				
Demo 90-Minute Forecast				◇		
Numerical Modeling 2 to 4 Hour Forecast					◇	◇
Turbulence Algorithm						
Implement Prelim. Turbulence Forecast Algorithm	◆	◇	◇			
Complete In-Situ Based Detection Product Evaluation		◇				
Improved Algorithm Using TDWR, Transition to ITWS			◇			
Incorporate Satellite Data into Turbulence Forecast					◇	◇
NEXRAD Algorithms						
Began Dual Polarization Research	◆					
Deliver Dual Polarization Algorithms to OSF				◇	◇	◇
Airborne Humidity Sensor						
Complete Sensor Evaluation/FAA/NOAA Decision on Utility		◇	◇			
Evaluate Combined Temp./Humidity Sensor				◇	◇	◇
Juneau Terrain-Induced Turbulence Project						
Develop Prototype System		◇				
Perform Test and Evaluation			◇			
Implement Operational System				◇		
Project SCORATES						
Completed Final Report of JFK Test Project Using 2-Beam Socrates System	◆					
Develop Eight-Beam SOCRATES System		◇				
Develop Ground-Based Particle Backscatter System		◇				
Complete Airborne System Applicability Demonstration			◇			

Budget Authority ($ in Thousands)	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Request
Contracts	5,978	11,683	14,500	17,836	15,100
Personnel Costs	427	1,093	664	817	629
Other Costs	88	224	136	31	36
Total	**6,493**	**13,000**	**15,300**	**18,684**	**15,765**