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 increase tomorrow's system safety, capacity and productivity. ATS continually seeks to improve the services it provides 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 the 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 delivered. The ATS R,E&D program is a vehicle for making long-term investments in improving services, procedures and infrastructure, as well as integrating new concepts and technology able to meet the increasing demands of safety, capacity, efficiency, and productivity. Human factors considerations are central to all outcomes of the program 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 Government Performance and Results Acts (GPRA). The program is also consistent with the goals delineated in the FAA Strategic Plan, Research and Acquisitions Performance Plan, and Regulation and Certification Performance Plan.

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

Improve Quality and Availability of Weather Information — Weather has a continual impact on both the safety of aircraft in flight and the efficiency of operations throughout the National Airspace System (NAS). Weather and weather decision making, factors in approximately 23% of all aviation accidents, annually cost the country an estimated $3 billion for accident damage and injuries, delays and unexpected operating costs. The ATS R,E&D program is striving to improve the accuracy, display, and timeliness of weather information—and also the ability of controllers and pilots to use that information to safely and efficiently. Aviation weather capabilities in the NAS must undergo major changes to improve decision making and reduce the number of weather-related accidents. Specifically, today's weather sensors must be converted to allow all NAS providers and users to receive the same weather information simultaneously.

The ATS R,E&D program is pursuing an aggressive schedule of developing and implementing a variety of technologies for improving the accuracy, timeliness, and usefulness of weather information in combination with extensive training for pilots and ATS personnel on the use of new weather systems.

Research is needed to measure how weather information enhances decision making and reduces fatalities/injuries caused by weather. ATS is currently collecting and analyzing data to demonstrate the capability of new weather technologies to decrease the rate of weather delays in the NAS.

Reduce Delays — The traditional measure of the efficiency of the ATM system is delay. Delay occurs in the aviation system when an activity does not happen within the planned, expected, or scheduled time. Delays to commercial aviation are estimated to cost the airlines over $3 billion per year. The inconvenience of delays directly affect passengers in terms of missed flight connections and business meetings, and loss of personal time. But not all delays are avoidable. Adverse weather, for example, can close a runway or whole airport, making it impossible to land at the scheduled time. ATS, therefore, differentiates between and tracks delays caused by ATC equipment and volume as well as by weather and factors over which is has less control. ATS recognizes that any delay is a disruption in the expected level of service and is committed to reducing all delays to the fullest extent possible.

Service improvements during the 2000-2002 timeframe will focus on Free Flight Phase 1 tools, new runways, and critical infrastructure replacement programs. Airspace and airport capacity will be enhanced to improve throughput and allow aircraft to operate with minimal delay in congested areas. ATS will reduce equipment-related delays by implementing AF's NAS Service Management Concept of Operations, and effectively conducting new risk management and risk mitigation processes.

Continuing to involve users in key decisions regarding national ground delay programs will reduce the impact of weather on flight schedules. While delays associated with weather are harder to influence, the ATS R,E&D program is continuing to support collaborative decision making and the implementation of automated detection and forecasting tools to mitigate the negative impact of these delays.

Improve System Predictability — System predictability allows users to plan and manage their resources efficiently. The majority of system users rely on schedules that define when aircraft takeoff and aircraft land. These schedules are central to the operations of most commercial flights, driving crew scheduling, ground service operations, and other operational components. Near-term decisions such as scheduling and planning flights—as well as longer-term decisions such as fleet sizes, airframe types and hubbing options—are all impacted by day-to-day variation in NAS performance. Because relatively small deviations from scheduled operations can cause drastic impacts, especially when ripple effects throughout the system are taken into account, scheduled operations are very dependent on system predictability.

The ATS R,E&D program is working toward increasing information flow to system users, a key ingredient to improved system predictability. Collaborative planning between ATS and all NAS users is a strategy being pursued during the 2000-2002 timeframe. As weather is a main contributor to the uncertainty in the ATM system, improvements are being undertaken in obtaining and disseminating weather products. These improvements will supply consistent information to pilots and controllers alike so that they can realize the same degree of situational awareness.

Improve System Flexibility — Measuring the flexibility of the ATM systems allows ATS to evaluate its own ability to permit users to adapt their operations to changing conditions. Users want to be able to optimize their operations based on their own objectives and constraints. These constraints can vary flight-by-flight and user-by-user.

ATC-preferred routes are important tools that help air traffic controllers to organize traffic flows around major airports and minimize conflict in congested airspace. These routes are generally not the most direct alternatives, and often differ significantly from the routes that pilots or flight planners would normally propose between two cities. Due to the constraints of ATC-preferred routes, users sometimes experience inflexibility during the flight planning process, especially when planning flights along heavily traveled corridors. Flexibility in flight planning offers users significant benefits. Once an aircraft is airborne, the very conditions for which a route and altitude were chosen may change. For example, winds may shift to make another route more desirable. The parameters that affect an optimal flight are very dynamic, and ATS options must be equally flexible.

For increased flexibility of flight operations in the NAS, the ATS R,E&D program will continue to evolve its services toward the free flight concept of operations and work with aviation users in the review and redesign of the national airspace.

Program Area Outputs

The developmental outputs of the ATS R,E&D program vary in composition from operational prototype equipment to operational concepts, modeling and simulation studies, emergent technology evaluations, and procedures, standards and guidance. Some specific examples of expected outputs for the ATS R,E&D program follow:

- Uplink of guidance information that will give aircraft and controllers the same situational awareness.
- 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 in 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 the following intended outcomes:

- Improve Quality and Availability of Weather Information
- Reduce Delays
- Improve System Flexibility
- Improve System Predictability

The ATS R,E&D program addresses these outcomes, and strives to make the most efficient and effective possible use of R,E&D resources, with the objective of adding value to benefit NAS users, operators, and the public.

Customer and Stakeholder Involvement

The ATS R,E&D program reaches and supports the interests of a broad spectrum of the aviation community, including those reflected in the Aviation Safety Plan, RTCA Free Flight Action Plan, and 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 their advice;
- The National Plan for Aviation Human Factors represents a cooperative effort between the FAA, NASA and DOD to establish a coherent national agenda for human factors research and development to improve the safety and efficiency of the NAS; and
- The National Aviation Weather Users' Forum provides a process to develop a federal/industry consensus on the needs and priorities for aviation weather information and serves as a basis for setting priorities for research and development. Forum attendance includes representatives 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
  - Other facets of industry

Accomplishments

The following represents a partial listing of recent past accomplishments of the ATS R,E&D program:

- Developed prototype methodology to evaluate the impact of technological and Concept of Operations change on controller selection requirements.

- Completed Weather Support to Deicing Decision Making (WSDDM) technology transfer to commercial vendor for operational implementation.
- Implemented in-situ turbulence algorithm on multiple airframes.
- Completed convective weather forecast algorithm commercial technology transition.
- Completed national implementation of next generation weather radar (NEXRAD) Tornado Detection algorithm.
- Completed Standard Terminal Automation Replacement System (STARS) Early Deployment Capability Human Factors evaluation.
- Conducted Data Link Evaluation Simulations and Studies.
- Commenced design of a sensor for parallel runway wake turbulence sensing.
- Integrated terminal area weather products with automatic updates for airborne aircraft through use of Flight Information Service (FIS) broadcasts.

R&D Partnerships

The ATS R,E&D program established, and continues to establish, partnerships with U. S. Government agencies, international organizations, academic institutions, the airline industry, industry and industry user groups, and non-profit organizations. A listing of some of the current partnerships is enumerated below:

- U.S. Government Agencies:
  - Department of Commerce
  - Department of Defense
  - National Aeronautics and Space Administration
  - National Science Foundation
  - National Weather Service

- International Organizations
  - British Civil Aviation Authority
  - EUROCONTROL
  - French DGAC
  - International Civil Aviation Organization
- Academic Institutions
  - Embry Riddle Aeronautical University
  - Massachusetts Institute of Technology
  - Pennsylvania State University
  - San Jose State University
  - University of Maryland
  - University of Oklahoma
  - University of Quebec at Montreal

- Non-Profit Organizations
  - Advance General Aviation Transport (AGATE) Consortium
  - RTCA

- Airline Industry
  - America West
  - American
  - Continental
  - Delta
  - Northwest
  - Southwest
  - Trans States
  - TWA
  - US Airways
  - United

- Industry and Industry User Groups
  - ALPA
  - ATA
  - Small Aircraft Manufacturers Association (SAMA)
  - AOPA
  - NBAA

Long-Range View

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

safety, capacity and productivity. Although the composition of the R,E&D program portfolio will change over time as some efforts come to fruition and transition to 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. The ATS R,E&D program is an ongoing effort that will have continuing funding expectations at or beyond the current level. A continued investment in the ATS R,E&D will ensure the FAA has an effective risk identification/mitigation strategy for the high-risk areas of the future NAS architecture.

F&E 1F01 Runway Incursion Reduction

GOALS:

Intended Outcomes: With the Runway Incursion Reduction program (RIRP), the FAA intends to develop technologies and other solutions that minimize the chance of injury, death and damage, or loss of property due to runway accidents/incidents within the civil aviation system. In addition, the program will improve safety and reduce the potential for accidents on the airport surface through increased pilot/controller situational awareness.

Agency Outputs:

- Develop low-cost airport surface detection equipment.
- Develop secondary surveillance capabilities for the airport surface.
- Develop a 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 has made Runway Incursion a priority within the Agency. 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 1999:

- Completed installation of Airport Target Identification System (ATIDS) at DFW.
- Completed installation of surveillance server at DFW.
- Completed initial ATIDS coverage testing at DFW.
- Continued informal evaluation of Airport Surface Detection Equipment Model X (ASDE-X) radars at Milwaukee, WI and Norfolk, VA.
- Completed initial testing of Loop technology system at Long Beach, CA.

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 Automatic Dependent Surveillance – Broadcast [ADS-B] and ATIDS).
- CACI (safety algorithms).
- General Working Agreement with Volpe National Transportation Systems Center (VNTSC).
- Contract with AOPA Air Safety Foundation.
- Technology transfer.

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

The FAA is currently developing a specification for the production of an ASDE-X system that will include a radar, multilateration system, and surveillance server.

MAJOR ACTIVITIES AND ANTICIPATED FY 2000 ACCOMPLISHMENTS:

Dallas-Ft. Worth

- ASDE-3, Vehicle ADS-B, Loops, Surveillance Fusion Platform (SFP) integration and testing.
- ASDE-X specification development.
- Full system RIRP prototype demonstration.

Low-cost surface detection equipment

- Complete Y2K upgrade for Dassault ASDE-X and continue evaluation.

- Complete processor and Y2K upgrade for Raytheon ASDE-X and continue evaluation.
- 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 2001 PRODUCTS AND MILESTONES:

- Full System RIRP prototype demonstration at Dallas-Ft. Worth.
- Extend RIRP system to Dallas-Ft. Worth (DFW) West Side.
- FAA/NASA RIRP/LVLASO demonstration at DFW.
- Loop technology full system evaluation at Long Beach, CA.
- Air traffic activities including regional training, modeling/data reduction/facility testing, human factors initiatives, and industry conferences.

FY 2001 PROGRAM REQUEST:

In FY 2001, funding will provide for:

- The DFW West Side extension.
- Incorporating real-time seamless surface surveillance with NASA cockpit technology.
- Vehicle ADS-B.
- Loop technology.
- Data fusion.
- Conflict alerting.
- Call sign identification.
- Information sharing with air traffic controllers, pilots, and vehicle operators.
- FAA/NASA Runway Incursion/Low-Visibility Surface Operations Demonstration at DFW.
- Implementation of activities consistent with the 1998 Airport Surface Operations Safety Action Plan, including Runway Incursion Action Team (RIAT) meetings.

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 will augment operational decision making processes and improve situational awareness of surface operations under all visibility and weather conditions.

The Surface Movement Advisor (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 decision making.
- Help achieve at least a 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 that will be validated in pre-production prototype systems in an operational tower/airfield environment. Assessments of airport operational effectiveness, performance, and benefits will be included to assist in the investment decision making 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 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 2000 ACCOMPLISHMENTS:

- Sustained operational SMA prototype at Atlanta Hartsfield International Airport.

KEY FY 2001 PRODUCTS AND MILESTONES:

- Sustain SMA prototype at Atlanta Hartsfield International Airport.

FY 2001 PROGRAM REQUEST:

Sustain SMA prototype at Atlanta Hartsfield International Airport.

Runway Incursion Reduction Product and Activities	FY 2001 Request ($000)	Program Schedule					
		FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY2005
021-250 Runway Incursion Reduction							
Runway Incursion Plan	$4,750						
Update Project Plan		◆	◇	◇	◇	◇	◇
Complete Prototype Testing of Radar Technologies		◆	◇	◇	◇	◇	◇
Phased Array Radar (Norfolk)		◆	◇	◇	◇	◇	◇
Prototyping Testing and Additional Technologies		◆	◇	◇	◇	◇	◇
Data Fusion/ATIDS/ADS-B/Loops (DFW)		◆	◇	◇	◇	◇	◇
Loop Technology (Long Beach)		◆	◇	◇	◇	◇	◇
FAA/NASA Evaluation (DFW)		◆	◇	◇	◇	◇	◇
Secondary Sensors		◆	◇	◇	◇	◇	◇
Select Systems for Full-Scale Validation Testing		◆	◇	◇	◇	◇	◇
Continuous Research on Additional Technologies		◆	◇	◇	◇	◇	◇
Runway Incursion Non-Technical Solutions	$3,200						
Develop Procedures		◆	◇	◇	◇	◇	◇
Develop Educational Process		◆	◇	◇	◇	◇	◇
Develop Training Guidelines		◆	◇	◇	◇	◇	◇
Total Budget Authority	**$7,950**	**	**$7,950**	**$5,700**	**$5,700**	**$5,700**	**$5,700**

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

Budget Authority ($ in Thousands)	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Request
Contracts	4,950	5,696	2,269		7,950
Personnel Costs	872	252	899	**	***
Other Costs	178	52	0		***
Total	**6,000**	**6,000**	**3,168**		**7,950**

** By Congressional direction, budget line item 1F01 was reduced in FY 2000. The allocation of that reduction is currently under review.

*** In the Facilities and Equipment appropriations, personnel and other costs are budgeted in Activity 5, not the program budget line item.

F&E 1F01 System Capacity, Planning and Improvements

GOALS:

Intended Outcomes: The FAA intends to develop an overall strategy to enhance capacity. This includes both terminal and enroute 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 coordinates across budgetary lines allowing programs and projects to improve investment decision making and 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 enroute 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 Government Performance and Results Act (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 enroute 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 Las Vegas terminal and enroute arrival procedures.
- New departure routes from Los Angeles International Airport.
- Airspace suggested changes to Phoenix departure procedures.
- New dual arrival procedures into San Francisco.
- Annual savings to the aviation industry at airports and enroute facilities estimated at a minimum of $450 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 the Global Positioning System (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 using 1.5 nmi diagonal separation.
- Offset Approach Course guidance for simultaneous operations at San Francisco, Newark, St. Louis, Cleveland, Seattle and other candidate airports.
- Converging approach standards at Chicago O'Hare, Dulles, and Dallas-Ft. Worth International Airports.

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. By 2008, 21 of the top 29 large hub airports are projected to exceed an average of five minutes of delay per operation. 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 1995, based on recommendations, 20 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 addressing tactical improvements, in response to industry requirement shifts, and facilitating large-scale investment analysis and optimization planning. Securing active cooperation at the local (regional) level, and the high degree of coordination needed among affected facilities and user groups, pose process problems.

Various solutions to these problems have been proposed and simulated. The results have then been compared to make intelligent investment decisions. A detailed example follows:

> Problem: On the Dallas-Ft. Worth Metroplex project, which involved substantial Airports Improvement Program (AIP), F&E, and operational investment, the effects on the system of several airspace structures, including a "do nothing" scenario, were compared.
>
> Solution: 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.
>
> Result: This approach enabled the community to construct a new runway and ground infrastructure. It also enabled the industry to schedule growth and capital investment.
>
> Comment: 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.

The capacity program annually publishes the Aviation Capacity Enhancement Plan to keep the aviation world informed of progress and advancements in the capacity arena. Members of the international aviation community regularly request this document. Requestors in this country include Congress; scholars and students, who use it for their aviation studies; and aviation groups, who use it to develop congressional budget justifications.

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. The program has recently accomplished the following:

- Prototyped and tested 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 four major terminal/enroute airspace redesigns: (1) Las Vegas approach procedures; (2) Los Angeles terminal procedure and ZLA Sectors; (3) Phoenix departure procedures; and (4) Dual arrival procedures into San Francisco.
- Completed aircraft ground movement analysis studies at Las Vegas and Salt Lake City International Airports.
- Completed Palles Verdes airspace environmental initiative.

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 (e.g., Frankfurt am Main International Airport, Germany, 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, GPS, the flight management system, the 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 Center Tracon Automation System (CTAS) and the Standard Terminal Automation Replacement System (STARS).
- NASA Short Haul Civil Tiltrotor simulation of proposed Simultaneous Non-Interfering (SNI) Approach procedure.
- The FAA will partner with aircraft manufacturers Boeing and Airbus, avionics manufacturers, Municipal Airport Authorities, Airports Council International – North America, Air Transport Association, and the Airlines Pilots Association for proposed New Large Aircraft (NLA).
- Wide Area Augmentation System/Local Area Augmentation System (WAAS/LAAS) for Minimum Vectoring Altitude (MVA) and Automatic Dependent Surveillance – Broadcast

(ADS-B) for closely spaced parallel runway analysis for Airports Council International – North America (ACI-NA).

MAJOR ACTIVITIES AND ANTICIPATED FY 2000 ACCOMPLISHMENTS:

- Continuously conducted research to develop, refine, and/or enhance high-level outcome performance metrics that were then integrated into processes supporting GPRA requirements and investment decisionmaking.
- Initiated Offset Approach Course guidance for simultaneous operations at San Francisco.
- Developed new Instrument Flight Rules (IFR) approach and departure concepts and procedures for improving the safety and efficiency of operations at capacity constrained airports.
- Identified 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, La Guardia, and Portland airports.
- Completed ground analysis at Phoenix Sky Harbor International Airport.
- Initiated redesign of the Phoenix Sky Harbor terminal airspace and the Oakland, Los Angeles, and Albuquerque ARTCCs.
- Initiated efforts to accommodate New Large Aircraft into the operational environment.
- Completed Newark and Tampa Airport Design Studies.
- Continued Airspace review for relocation of the Honolulu Center Radar Approach Control (CERAP).
- Participated in airport design study at Dulles International Airport and Baltimore- Washington International Airport.
- Developed procedural alternatives for increased capacity in Anchorage area.
- Completed experiment on civil tilt rotor operations into Newark.
- Explored 250 knot departure route restriction at Houston.
- Initiated and completed the Aviation Capacity Enhancement (ACE) Plan.
- Initiated NAS integration studies at 11 major airports.

KEY FY 2001 PRODUCTS AND MILESTONES:

- Continue to develop new IFR approach and departure concepts and procedures.
- Initiate offset approach course for simultaneous operations at St. Louis and Newark.
- Continue to develop proposed solutions to integrate New Large Aircraft into the NAS.
- Complete airport design study at JFK, terminal area airspace study at Anchorage, and ground analysis at Phoenix Sky Harbor International Airport.
- Complete redesign of Honolulu CERAP and Phoenix-Tucson tower enroute control procedures within Albuquerque and adjacent ARTCCs.
- Continue analysis of new and/or additional performance measures for the national airspace system.
- Initiate and complete the ACE Plan.
- Initiate airspace analysis for Seattle and NCT/SCT.

FY 2001 PROGRAM REQUEST:

In FY 2001, the program will focus on capacity enhancement at all major airports as well as on terminal and enroute airspace. Primary focus areas are: (1) airports where construction of suggested improvements can be completed within two to three 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.

System Capacity, Planning and Improvements	FY 2001 Request ($000)	Program Schedule					
		FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY2005
Aviation System Capacity Planning							
Enhance/Design Plans & Consolidated Ops & Analysis Systems	$1,500						
Aviation Capacity Enhancement Plans (Annual)		◆	◇	◇	◇	◇	◇
Regional/Airport Design Team Plans		◆	◇	◇	◇	◇	◇
Performance Measurement/Government Performance Results Act (GPRA)		◆	◇	◇	◇	◇	◇
Airspace/Airport Analysis	$3,800						
Completed Airspace Redesign of Las Vegas, Salt Lake Terminal and ARTCC, Las Vegas Approach Procedures, Los Angeles Terminal Procedures and 2 Los Angeles Sectors, and San Francisco Arrival Procedures		◆					
Redesign or Analysis of Phoenix, Seattle ARTCC and Albuquerque ARTCC		◆	◇	◇			
Integrate Measures into the Budget Process and GPRA				◇			
Performance Reports for Investment Decisions				◇	◇	◇	◇
Completed Newark, Tampa, and San Diego Airport Design Studies		◆					
Analyze New and/or Additional Performance Metrics for the National Airspace System			◇	◇	◇	◇	◇
Ground Analysis of Phoenix Sky Harbor International Airport		◆	◇				
Completed Anchorage Design Team Project		◆					
Analyze Low Level Routes Between Northern and Southern California					◇	◇	
Perform Ground Analysis For Pittsburgh and Kansas City Airports					◇	◇	
San Francisco Ground Task Force					◇	◇	◇
Develop Simultaneous Offset Instrument Approaches for San Francisco, St. Louis, Newark, Cleveland, and Seattle Airports		◆	◇	◇	◇		
Develop Converging Approach Standards at Chicago O'Hare and Dallas-Fort Worth Airports		◆	◇	◇	◇		
Accommodate New Large Aircraft into the Operational Environment		◆	◇	◇	◇		
Developed New Departure Routes from Los Angeles International Airport		◆					
Develop Design Studies at John F. Kennedy, La Guardia, and Portland Airports		◆	◇	◇			
Redesign Honolulu CERAP and Phoenix-Tucson Tower En Route Control Procedures			◇				
Developed Airport Design Studies at Dulles and Baltimore-Washington International Airports		◆					
EWR Tilt Rotor		◆					
Houston 250 Knot		◆					
Total Budget Authority	$5,300	**	$5,300	$5,300	$5,600	$5,900	$6,200

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

Budget Authority ($ in Thousands)	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Request
Contracts	2,392		228		5,300
Personnel Costs	3,419		1,627	**	***
Other Costs	0		0		***
Total	5,811		1,855		5,300

** By Congressional direction, budget line item 1F01 was reduced in FY 2000. The allocation of that reduction is currently under review.

*** In the Facilities and Equipment appropriations, personnel and other costs are budgeted in Activity 5, not the program budget line item.

F&E 1F01 — General Aviation and Vertical Flight Technology Program

GOALS:

Intended Outcomes: The General Aviation and Vertical Flight (GA&VF) technology program supports GA demands for Communications, Navigation, and Surveillance (CNS) technologies through applied research and development. 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.

The FAA GA&VF technology 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: enroute communications and navigation, landing facilities, airmen and controller training, and low-cost avionics.

Vertical flight Terminal Instrument Procedures (TERPS) efforts support the terminal and enroute flight environment. Low-altitude CNS research provides critical data and evaluations for future low-altitude enroute 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.

Agency Outputs: The GA & VF technology 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.

The project creates the following types of products and engages in the following activities related to Rotorcraft IFR Procedures and Infrastructure:

Terminal Airspace

Criteria and design parameters for instrument approaches to hospital, corporate, and business district heliports. This development effort supports TERPS criteria, aircraft and avionics certification standards, Instrument Flight Rules (IFR) Emergency Medical Service (EMS) procedures and training guidance, as well as Minimum Aviation System Performance Standards (MASPS), Minimum Operational Performance Standards (MOPS), and Technical Standard Orders (TSO).

Rotorcraft Air routes

Procedures and test systems designed in an operational environment to work with Global Positioning System (GPS) navigation, surveillance and terrain avoidance technology developed by other projects. Resulting experience and information helps to integrate newer, safer, and more efficient rotorcraft routings into the NAS, including the Gulf of Mexico, and can be useful to other GA systems operating at low altitudes.

Avionics and Cockpit Technology

Avionics, equipment, procedures, and related testing to enable the safe efficient integration of GA aircraft into the NAS. These efforts have become particularly important with the introduction of GPS navigation/landing and surveillance systems, Free Flight and other advanced concepts.

Low Altitude CNS Infrastructure

Route system guidelines, cockpit display guidelines, noise abatement procedures, and terminal and enroute system integration plans for low altitude CNS operations.

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 the GA&VF community's direct needs related to helicopters and tiltrotors. 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.

R&D Partnerships: Historically, the GA&VF technology program has maintained a unique R&D collaboration with industry. Partnerships existing or planned for the near future include:

- Experimental Aircraft Association in advanced technology avionics — for single pilot GA aircraft.
- Helicopter manufacturers and user organizations — to focus development of IFR procedures (including approaches) as well as systems and equipment to meet user identified and validated operational needs.

MAJOR ACTIVITIES AND ANTICIPATED FY 2000 ACCOMPLISHMENTS:

- Completed flight test evaluation report in support of helicopter instrument approaches as a function of differential GPS technology equipage. The report will facilitate the development of special differential GPS helicopter precision approaches. (3/00)
- Developed a Strategic plan and operations concept for vertical flight operations using advanced technology. (4/00)
- Developed an operations concept plan to provide enhanced weather data and Flight Information Services to helicopter operations in the Gulf of Mexico as part of the next generation CNS technology (6/00).
- Developed GPS based route criteria for low altitude air route system. (9/00)

KEY FY 2001 PRODUCTS AND MILESTONES:

- Revise airplane and rotorcraft VFR procedures and standards to incorporate new technology (e.g. moving map, terrain data, and cockpit weather information, ADS-B). (7/01)
- Establish standards for FIS data link services for offshore vertical flight operations in the Gulf of Mexico (8/01).
- Develop procedures and demonstration for simultaneous non-interfering operations for emergency response operations and law enforcement. (9/01).

FY 2001 PROGRAM REQUEST:

- Development of improved VFR procedures and standards to take advantage of new technology capabilities.
- Continue research leading to establishing improved low speed GPS precision approach TERPS criteria for vertical flight aircraft operations.
- Develop procedures and standards for vertical flight simultaneous non-interfering VFR and IFR operations in terminal areas.
- Continue research supporting use of advanced avionics (including GPS navigation, dependent surveillance, and cockpit display of traffic and weather information).

General Aviation and Vertical Flight Technology Program Product and Activities	FY 2001 Request ($000)	Program Schedule					
		FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY2005
General Aviation and Vertical Flight							
Developed Augmented Fixed Wing Visual Flight Rules (VFR) Procedures and Technology Applications/Standards (ADS-B, Moving Map, Terrain, Weather)	$160		◇				
Developed Pilot Procedures and Instrumentation for Low Speed Operations	$210		◇				
Developed Augmented Rotorcraft VFR Operational Procedures for Simultaneous Non-Interfering (SNI) VFR Operations	$350						
Law Enforcement Emergency Response			◇				
Standardized Terminal Area Route Criteria			◇				
Technology Applications/Standards			◇				
FAR Part 135 ADS-B Locating Applications	$70		◇				
Business Management	$150		◇				
Salt Lake City Olympics Support	$2,000		◇				
Total Budget Authority	$2,940	**	$2,940	$1,000	$1,200	$1,400	$1,500

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

Budget Authority ($ in Thousands)	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Request
Contracts	1,486	0	1,462		2,940
Personnel Costs	925	0	1,440	**	***
Other Costs	189	0	0		***
Total	2,600	0	2,902		2,940

** By Congressional direction, budget line item 1F01 was reduced in FY 2000. The allocation of that reduction is currently under review.

*** In the Facilities and Equipment appropriations, personnel and other costs are budgeted in Activity 5, not the program budget line item.

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 advanced communications, surveillance, and navigation systems, such as Automatic Dependent Surveillance - Broadcast (ADS-B), Cockpit Display of Traffic Information (CDTI), Flight Information Services (FIS), and the Traffic Information Service – Broadcast (TIS-B).

Under FAA leadership in coordination with RTCA, user participants have committed to spending resources to accomplish the Safe Flight 21 objective:

> "To show that integrated Communication Navigation and Surveillance (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:

- Evaluating the three ADS-B links (1090MHz, UAT, and VDL Mode 4)
- Conducting operational evaluations of the following nine operational enhancements identified by RTCA:
  - FIS for Special Use Airspace (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 enroute 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: The Safe Flight 21 resulted from inputs that the FAA Administrator requested from the RTCA Select Committee on Free Flight Implementation. The Safe Flight 21 program is a jointly developed program that is strongly endorsed by the RTCA Free Flight Steering Committee. The Safe Flight 21 steering committee includes RTCA Select Committee representatives from the FAA, the Aircraft Owners and Pilots Association (AOPA), the Airline Pilots Association (ALPA), the National Air Traffic Control Association (ATCA), the Cargo Airline Association (CAA), the MITRE Corporation, and U.S. Airways.

Accomplishments:

- Established the Safe Flight 21 program office.
- Obtained approval for FY 1999-2000 funding to support the CAA work and the Alaska Capstone program.

- Provided details for risk mitigation activities, site locations, number of aircraft required, cost, and schedule.
- Completed evaluation of ADS-B enhanced visual approaches using ADS-B only.
- Completed evaluation of enhanced visual acquisition for see and avoid using ADS-B only.

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 is being 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 2000 ACCOMPLISHMENTS:

The FAA anticipates to accomplish the following FY 2000 tasks toward implementing Safe Flight 21 program in the Ohio Valley in preparation for CAA ADS-B evaluation work and the Alaska Capstone program:

- Procured and installed ADS-B ground stations in Ohio River Valley and in the YK delta region in Alaska.
- Procured and installed FIS and the Automated Weather Observation System (AWOS) in Alaska.
- Procured and installed avionics in FAA and Alaska aircraft (CAA provides avionics in CAA aircraft).
- Procured and installed ADS-B surface surveillance equipment.
- Procured and installed terminal automation equipment for ADS-B/radar fusion evaluation.
- Continued operational evaluation of the nine operational enhancements.
- Initiated procedures development.
- Evaluated the three ADS-B links and submitted link status report.
- Required avionics manufacturers to submit applications for selected ADS-B air-to-air applications.
- Completed evaluations of:
- Enhanced visual approaches
- Final approach spacing
- Runway and final approach occupancy awareness
- Presentation of ADS-B targets to controllers
- ADS-B enhancement of terminal surveillance
- Presentation of today's FIS-B products in the cockpit
- Low-cost terrain situational awareness
- Separation of aircraft in non-radar airspace using ADS-B

KEY FY 2001 PRODUCTS AND MILESTONES:

Avionics and ground systems

- Complete initiated procurement activities, as needed. (Focus on end-to-end evaluations.)

Engineering and operational evaluation

- Continue the Safe Flight 21 program plan.
- Continue operational evaluation for the nine operational enhancements.
- Continue enhanced visual approaches using ADS-B and TIS-B.
- Continue final approach spacing using ADS-B and TIS-B.
- Continue enhanced see and avoid using ADS-B and TIS-B.

- Continue runway and final occupancy awareness using ADS-B and TIS-B.
- Continue ADS-B surface surveillance at airports without ASDE.
- Extend FIS-B products to the cockpit.
- Increase access to terrain-constrained low altitude airspace.
- Continue procedure development and certification tasks.
- Make globally harmonized ADS-B link decision.

FY 2001 PROGRAM REQUEST:

FY 2001 funding completes procurement of avionics and ground systems necessary for the operational evaluations. Funding also provides for operational evaluation, procedures development, and certification tasks.F&D 1F01 — Operations Concept Validation

GOALS:

The RTCA Free Flight Steering Committee, the FAA's R,E&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.

Safe Flight 21 (Capstone Initiative/Ohio Valley) Product and Activities	FY 2001 Request ($000)	Program Schedule					
		FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY2005
Safe Flight 21 (Capstone Initiative/Ohio Valley)							
Operational Enhancements	$23,500						
Provide Weather and Other Information to the Cockpit		◆	◇	◇			
Provide Affordable Means to Reduce Controlled Flight Into Terrain (CFIT)		◆	◇	◇			
Improve Capability for Approaches in Low Visibility Conditions		◆	◇	◇			
Enhance Capability to See and Avoid Adjacent Traffic		◆	◇	◇			
Enhance Capability to Delegate Aircraft Separation Authority to the Pilot			◇	◇	◇	◇	◇
Improve Capability of Pilots to Navigate Airport Taxiways		◆	◇	◇	◇		
Enhance 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	$1,500						
Program Management and Support		◆	◇		◇		◇
Flight Information Services Available (including Graphical Weather		◆	◇				◇
ADS-B Surveillance and Separation Services Available		◆		◇	◇	◇	◇
Micro-EARTS/ADS-B Modification Complete		◆		◇			
Total Budget Authority	**$25,000**	**$16,000**	**$25,000**	**$25,000**	**$20,000**	**$15,000**	**$15,000**

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

Budget Authority ($ in Thousands)	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Request
Contracts				16,000	25,000
Personnel Costs			****		***
Other Costs					***
Total				**16,000**	**25,000**

*** In the Facilities and Equipment appropriations, personnel and other costs are budgeted in Activity 5, not the program budget line item.

**** The FY99 Facilities and Equipment appropriation allocated $11M for the Alaska Capstone project and $5 for the Ohio Valley project. In FY 2000 Safe Flight 21 was Funded as F&E Budget Activity 1.

F&D 1F01 — Operations Concept Validation

GOALS:

Agency Outputs: The agency provides:

- A well-defined and well-understood "validated" operational concept 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 associated research and development activities (e.g., specific requirements for Automatic Dependent Surveillance Broadcast (ADS-B) capabilities, Surface Management capabilities, Advanced Concept Probe).
- 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 ensure 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. The FAA has conducted a detailed survey of the major stakeholders to obtain their ranking of future concept sub-elements to support modernization. This level of stakeholder participation — essential for validating the concept for a modern NAS based on a shared, integrated infrastructure — ensures that the concept fully reflects user community requirements.

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 initiated included validation of concepts and associated top-level designs, risk-mitigation planning, and coordination of a validation plan with the human factors activity. These activities include:

Operational concept development

- Developed a detailed framework for individual service enhancement and domains to support the development of system level requirements for modernization.
- Developed a NAS performance model for evaluating the impact of proposed concepts on operational performance.
- Conducted an analysis of current separation procedures as the first step in developing a concept for separation normalization to leverage increased technical performance of NAS systems to meet increasing demand capacity imbalances.

Concept validation

- Conducted a comparison of U.S. Eastern Triangle operations to European core airspace.
- Developed the capability for fast-time analysis of new concepts such as multi-sector planning and dynamic resectorization.

Concept system design

- Conducted an analysis of the effects of dynamic boundaries on operational and controller performance as a step in the development of dynamic sectorization to support increased route flexibility in the face of increasing demand.

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 2000 ACCOMPLISHMENTS:

Operational concept development

- Developed detailed concepts for individual service enhancement and domains to support the development of system level requirements for modernization (in particular, to support development of a concept of use for integrated Decision Support Tools for the 03 - 05 timeframe).
- Completed development of quantitative measures and goals for midterm concept capabilities.
- Developed task assignments and information performance requirements for changes to separation assurance based on new roles and technology.

Concept validation

- Developed test-bed for modernization.
- Performed operational analysis, including fast- time simulation.
- Conducted joint FAA/NASA/user concept validation activities, including human-in-the-loop simulations.

Concept system design

- Conducted analysis of enroute sectorization strategies to support the midterm design for the Eastern Triangle.

KEY FY 2001 PRODUCTS AND MILESTONES:

Operational concept development

- Develop detailed concepts for Flight Intent.
- Develop detailed concepts for Information Management of airspace resources to facilitate improved flight planning and impact assessment.
- Develop concept of use for integrated surveillance navigation capabilities for 04-06 timeframe.

Concept validation

- Develop test-bed for modernization.
- Perform airspace assessment of gridded airspace uniform ultra-highs sectors, ultra-high centers.
- Conduct joint FAA/NASA/user concept validation activities, including human-in-the-loop simulations.
- Complete development of information flow model to translate concepts into interface requirements.

Concept system design

- Conduct close loop modeling of changes in Airspace/Airports and user demand.

FY 2001 PROGRAM REQUEST:

The FY 2001 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 integrated decision support tools and 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 that will be used to evaluate reliability and safety performance of future concepts.

Also leveraging work is being performed by: (1) Eurocontrol on the European EATMS Concept

and the associated ATM 2000+ strategy, and (2) the FAA in support of the International Civil Aviation Organization (ICAO) Air Traffic Management Concept Panel.

Operations Concept Validation Product and Activities	FY 2001 Request ($000)	Program Schedule					
		FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY2005
Operations Concept Validation							
Operational Concept Development	$500						
Develop Detailed Concepts for Flight Intent		◆	◇				
Develop Detailed Concepts for Information Management of Airspace Resources to Facilitate Improved Flight Planning and Impact Assessment		◆	◇				◇
Develop Concept of Use for Integrated Surveillance Navigation Capabilities for 04 - 06 Timeframe		◆	◇		◇	◇	◇
Concept Validation	$400						
Develop Testbed for Modernization		◆	◇	◇	◇	◇	◇
Perform Airspace Assessment of Gridded Airspace Uniform Ultra-High Sectors, Ultra-High Centers		◆	◇	◇	◇	◇	◇
Conduct Joint FAA/NASA/User Concept Validation Activities, Including Human-in-the-Loop Simulations		◆	◇	◇	◇	◇	◇
Complete Development of Information Flow Model to Translate Concepts into Interface Requirements		◆	◇	◇	◇	◇	◇
Aviation Support Laboratory (Aircraft)	$510						
Conduct Closed-Loop Modeling of Changes in Airspace/ Airports and User Demand		◆	◇		◇	◇	◇
Aviation Support Laboratory (Aircraft)	$2910						
Total Budget Authority	$4,320	**	$4,320	$1,500	$2,600	$2,700	$2,700

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

Budget Authority ($ in Thousands)	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Request
Contracts	0	0	3,412		4,320
Personnel Costs	0	0	3,406	**	***
Other Costs	0	0	0		***
Total	0	0	6,818		4,320

** By Congressional direction, budget line item 1F01 was reduced in FY 2000. The allocation of that reduction is currently under review.

*** In the Facilities and Equipment appropriations, personnel and other costs are budgeted in Activity 5, not the program budget line item.

F&E 1F01 Software Engineering R&D

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 Software Engineering Resource Center (SERC), established in June 1998, is a focal point for research on FAA software-intensive systems. SERC is an FAA-wide resource that will address strategic software technology problems impacting the 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. They will demonstrate, validate, and verify the safety properties, performance, and other critical attributes of anticipated new NAS technologies. SERC also will evaluate and validate improved software processes, methods, and engineering tools that enhance architecture and systems, as well as engineering, testing, and certification functions for the life cycle of NAS systems software. Finally, SERC will bring together recognized experts and FAA personnel to solve problems related to the Commercial Off-The-Shelf/Nondevelopmental Item (COTS/NDI), and the next generation architecture. These activities 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 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. Air and ground segments are becoming more integrated within the NAS through new services such as data link. The current practice of separately certifying NAS airborne and ground components can no longer be relied upon as the sole means to 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. The emphasis is to find better and cheaper ways to ensure that NAS hardware and software are safe, secure, and efficient in the face of challenges from bad code, security breaches, and the like.
- 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 operational effects of optimized constraints, including cost and performance, before committing resources to NAS systems 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 that allow COTS software products to be certified to a given currently-defined level of safety. 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 streamlining the software aspects of certification is to assess cost and schedule drivers for certifying both avionics and ground systems software, and to prototype solutions that may 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 R,E&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) soft-

ware/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:

Software certification research

Initiated a Streamlining Software Aspects of Certification (SSAC) program to focus on identifying cost/schedule/quality issues in the certification of ground-based systems software components.

NAS architecture research

Funded studies to develop a business case for consolidating projects requiring computing resources in order to reduce acquisition, operations and maintenance costs. ("Enterprise view" as opposed to "stovepipe/project specific" approach).

Developed a proposal to leverage investments in Enroute Sustainment projects to include requirements supporting the NAS 4.0 Communications infrastructure. (Cost and People resource savings).

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

Completed development of a Constructive COTS Cost Estimation model (COCOTS) and collected data on 18 projects to begin validation and tuning effort.

NAS Implementation/Supportability Research

Completed NAS adaptation process improvement (API) study. This resulted in initiation of Summary of Mission Analysis Findings for the National Airspace System Resources (NASR) System.

R&D Partnerships:

- Constructive COTS Cost Model – USC, SMI
- COTS Guidelines - SEI
- Adaptation Process Improvement – Boston University
- Evolutionary Spiral Process - SPC
- NAS Architecture - Massachusetts Institute of Technology

Partnership agreements are under discussion with EUROCONTROL, NASA, DOD, NIST, and others.

MAJOR ACTIVITIES AND ANTICIPATED FY 2000 ACCOMPLISHMENTS:

Software certification research

Continued to maintain Communication, Navigation, and Surveillance/Air Traffic Management (CNS/ATM) Guidelines to ensure consistency with RTCA-SC-190, CNS/ATM subgroup.

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

- Established a Constructive COTS Cost Estimation model – Pilot model on 2 FAA projects. This small FAA organizational entity will provide SW cost estimating services as a corporate asset to all of FAA.
- Developed guidelines for test & evaluation of COTS-intensive systems.
- Supported development of COTS life cycle mgmt plans and life-cycle issues, including the Standard Terminal Automation Replacement System (STARS) program and the Display System Replacement (DSR) program.
- Conducted studies and developed prototype applications to improve efficiency of accomplishing NAS Adaptation Services.

NAS architecture research

Funded research studies to develop business cases for consolidation of projects requiring computing resources to reduce acquisition, operations and maintenance costs. (Enterprise view vs. stovepipe/project specific)

KEY FY 2001 PRODUCTS AND MILESTONES:

During FY 2001, the COCOTS model, initial guidelines and prototypes will be available for preliminary use and test. The API Electronic Access to Aeronautical information prototype products will be made available for field use and feedback. 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 2001 PROGRAM REQUEST:

The software engineering research programs will build upon prior related activities conducted by the SERC and will continue to leverage resources throughout the United States, particularly those of aviation-related programs already underway at several universities. Specific work will be focused on advanced software architecture and technology applications for specific NAS Programs, and on continued end-to-end assurance of safety critical software systems.

Software Engineering R&D Product and Activities	FY 2001 Request ($000)	Program Schedule					
		FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY2005
Software Engineering							
Constructive Commercial Off-the-Shelf (COTS) Cost Estimation Model Development and Pilot Use	$270	◆	◇	◇			
COTS/Non-Destructive Inspection (NDI) Application Research	$50		◇	◇	◇		
NAS Adaptation Services Process Improvement and Prototyping	$300	◆	◇	◇	◇		
NAS Architecture Research	$120	◆	◇	◇	◇	◇	◇
Software Certification Research	$200	◆	◇	◇	◇	◇	
Total Budget Authority	$940	**	$940	$1,000	$1,000	$1,000	$1,100

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

Budget Authority ($ in Thousands)	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Request
Contracts	0	0	462		940
Personnel Costs	0	0	538	**	***
Other Costs	0	0	0		***
Total	0	0	1,000		940

** By Congressional direction, budget line item 1F01 was reduced in FY 2000. The allocation of that reduction is currently under review.

*** In the Facilities and Equipment appropriations, personnel and other costs are budgeted in Activity 5, not the program budget line item.

F&E 1F01 — Communications

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 using aeronautical data link.
- Integrating existing and planned decision support tools with Controller Pilot Data Link Communications (CPDLC) capabilities.
- Enabling increases in system flexibility by using data link services to derive, negotiate, and/or update flight plans both before and during flight.

These improvements also reduce/redistribute 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.

From its onset, implementation of CPDLC will free-up time controllers had previously spent communicating with aircraft by shifting this task to other members of the controller team. The controllers will then be better able to manage their airspace through use of decision-support tools. The next step is to integrate these tools with the CPDLC capability, thus maximizing the efficiency of both systems.

DSSS will later use existing but not-yet-applied data link applications, in addition to CPDLC, to integrate flight deck automation with ground-based systems and expand on the capabilities just described. Other promising applications still must be developed in conjunction with processes the International Civil Aviation Organization (ICAO) requires for the creation of standards.

Agency Outputs: The FAA provides cost-benefit analyses for DSSS, integrating ground tools and flight deck automation with data link capabilities. Standards and guidance material for DSSS provide technical characteristics and approval guidelines for operational use and training. RTCA standards provide service descriptions, implementation planning, and operational guidance for data link systems. 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.

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 Center Tracon Automation System (CTAS) automated enroute air traffic control technologies. Use of these alternatives will reduce the number of current procedural restrictions in the NAS, one of the primary goals of the Free Flight initiative. The development and implementation of FIS/weather products in the cockpit are additional Free Flight goals.

RTCA: Special Committee 194, ATM Data Link Implementation, is responsible for developing consensus implementation plans, principles of operation, operational service description and human factors guidance for data link systems. The Free Flight Steering Committee has recognized this committee as the “keepers” of industry consensus data link plans.

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

- The Automatic Dependent Surveillance Panel—focuses on automated air- ground data exchange.
- The Aeronautical Telecommunication Network Panel—focuses on requirements for a globally interoperable digital data communications network.
- The Aeronautical Mobile Communications Panel—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 4.2.6—completes the definition of data link systems to support communications, navigation, and surveillance operations.
- Initiative 4.2.7—establishes two-way data link capability throughout domestic enroute and terminal airspace.

Accomplishments: The FMS/ATM Next Generation (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. RTCA SC-194 has integrated the efforts of FAA, NASA, and industry to detail the implementation requirements for FMS-ATM-AOC services enabled by addressed data link.

Terminal Weather Information for Pilots (TWIP) is currently available at all Terminal Doppler Weather Radar locations through the ARINC Airborne Collision Avoidance Radar System (ACARS) vendor data link service.

Predeparture Clearance (PDC) and Digital-Automated Terminal 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.

MAJOR ACTIVITIES AND ANTICIPATED FY 2000 ACCOMPLISHMENTS:

- Completed Joint FAA/NASA En Route Data Exchange flight test, validating the downlink of aircraft state and intent parameters to decision support tools.
- Established required initial data link capabilities for En Route Aeronautical Telecommunications Network Decision Support Tool.

KEY FY 2001 PRODUCTS AND MILESTONES:

- Establish the RTCA DO-Integration, *Implementation Requirements for FMS-ATM-AOC Integrated Services using addressed data link.*
- Perform the operational viability, technical feasibility, and benefits analyses for individual integrated services.

FY 2001 PROGRAM REQUEST:

Aeronautical Data Link works collaboratively with FAA product teams, including enroute, 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 MITRE Center for Advanced Aviation System Development (CAASD), and NASA. These tests identify data link product and system architecture specifications and operational guidance issues to be addressed in the drafting of implementation standards (e.g., MOPS, MASPS), operational guidance documents (advisory circulars), and system architecture strategies.

Communications Product and Activities	FY 2001 Request ($000)	Program Schedule					
		FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY2005
Aeronautical Data Link (ADL) Applications							
Design Support System Services (DSSS)	$2,620						
Begin Validation Efforts for DSSS		◆	◇	◇	◇		
Develop FAA/Industry Consensus for DSSS							
Simulation/Modeling of Proposed DSSS							
Flight Trials/Experiments							
Initial Benefits Analyses							
Initial Acquisition Management System (AMS) Documentation for DSSS							
Develop Procedures/Identify Standards Requirements	$200						
Cost/Benefit Analysis (CBA) for Identified DSSS			◇	◇	◇	◇	◇
Initial DSSS						◇	◇
Total Budget Authority	$2,820	**	$2,820	$3,000	$3,600	$3,200	$2,900

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

Budget Authority ($ in Thousands)	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Request
Contracts	1,054	4,706	1,174	**	2,820
Personnel Costs	4,105	0	4,695		***
Other Costs	841	0	0		***
Total	6,000	4,706	5,869		2,820

** By Congressional direction, budget line item 1F01 was reduced in FY 2000. The allocation of that reduction is currently under review.

*** In the Facilities and Equipment appropriations, personnel and other costs are budgeted in Activity 5, not the program budget line item.

F&E 1F01 — Navigation

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—realized by the airlines, the traveling public, and the FAA—include:

- Increased air traffic control efficiencies and NAS capacity through an airway system that is restructured to accommodate direct routings between airports as well as reduced separation standards.
- Reduced fuel cost to airlines and reduced travel time to the public through use of more economical air routes.
- Reduced FAA operating costs through the decommissioning of existing ground-based navigation equipment.
- Simplified Global Positioning System (GPS) augmentation infrastructure through introduction of wide area and local area interoperability that provides satellite navigation services at a reduced cost.

Agency Outputs:

The FAA uses the National Satellite Test Bed (NSTB) as the foundation for all current research and development activities associated with implementing the Wide Area Augmentation System (WAAS). The NSTB is essential to the development and implementation of GPS and its WAAS augmentations. Findings from the NSTB help the FAA develop required user equipment through avionics manufacturers, continue development of GPS user procedures, and gain international acceptance of a seamless Global Navigation Satellite System (GNSS).

Using the NSTB as a prototype system, the program is developing and implementing the capability to monitor and evaluate system performance of the basic GPS service (as well as WAAS) during implementation activities. During these evaluations, large quantities of complex, technical data will be collected, analyzed, and archived. The data will be made available to the FAA and other Government Agencies—as well as to industry, academia, and international entities—to facilitate information exchange, foster cooperation around the world, and achieve a seamless global air navigation system.

The results of this “live” data collection and analysis will assist the FAA in: (1) analyzing and defining the satellite-based navigation technology requirements of air traffic and airway facilities; and (2) determining connectivity and interoperability requirements for international augmentation systems being developed by other countries. The information obtained from these performance evaluations will also allow the FAA to monitor the WAAS system contractor performance during interim contractor maintenance and logistics.

When the Phase I WAAS becomes operational in the Fall 2000, the FAA plans to approve the use of GPS as a primary means of navigation for enroute through non-precision approaches and supplemental use for Category I precision approaches. This initial WAAS capability will increase the numbers of airfields with a precision approach capability, and eventually enable the decommissioning of some existing ground-based navigation equipment throughout the U.S.

The Local Area Augmentation System (LAAS) Test Prototype (LTP) system is being used to test and validate the expected performance of the LAAS systems. The LAAS is intended to complement the WAAS, and the systems function together to supply users of the NAS with seamless satellite based navigation for all phases of flight. The LAAS will be used to meet Category I Precision Approach requirements at those locations where WAAS is unable to meet those requirements. LAAS will also be used to meet the more stringent Category II/III requirements at selected locations throughout the U.S. LAAS will yield the extremely high accuracy, availability, and integrity necessary for Category II/III precision approaches. It is fully expected that the end-state configuration will pinpoint an aircraft’s position to within one meter or less.

The FAA has developed and provided a functional Category I LAAS specification, architec-

ture, and Minimum Operational Performance Standards (MOPS) to industry for implementing local area systems across the United States. The FAA will validate the capability to perform Category II/III precision approaches through continued research and development efforts associated with the LAAS Program. An LTP has been developed, and is being used to conduct nationwide flight tests in cooperation with several end-state users of LAAS technology including United Parcel Service (UPS) and Federal Express (FedEx).

Customer/Stakeholder Involvement:

The program's implementation strategy involves other Government Agencies, industry, and academia.

The FAA has established and continues to actively participate on various teams addressing immediate needs for operational implementation issues. These include the Satellite Operational Implementation Team (SOIT), Satellite Procedures Implementation Team, Air Traffic SOIT (AT-SOIT), and many other Teams and working groups.

The FAA has also founded the Technical Interoperability Working Group (IWG) in which the developers of all worldwide satellite based augmentation systems (SBAS) (U.S. WAAS, the European Geostationary Navigation Overlay Service [EGNOS], Japan MSAS, and Canadian WAAS) meet on a quarterly basis to identify and address all of the potential technical barriers to seamless travel between any of these systems. These meetings began in 1997 and are expected to continue until approximately 2001-02.

The FAA works cooperatively with the Positioning and Navigation Executive Committee, the Joint Precision Approach and Landing System Program, and the Department of Defense to establish and promote a national consensus on GPS management and operation. The FAA also provides active support to the Interagency GPS Executive Board (IGEB) regarding overall GPS modernization issues.

Accomplishments:

On September 2, 1999 the FAA Joint Resource Council (JRC) meeting was held to decide the future direction of satellite navigation programs. This forum also considered information from the recently performed and congressionally mandated Investment Analysis. The JRC reaffirmed the FAA's commitment to satellite-based navigation; approved the WAAS Acquisition Program Baseline (APB); approved additional satellite leasing preparatory activities; and kept the current 1998 baseline in effect for LAAS. The LAAS accelerated baseline will be considered as a part of the FAA's Affordability Analysis.

This year, the development of WAAS continued to achieve many significant program milestones. One key milestone set was a series of WAAS signal-in-space (SIS) software builds.

Build 1 (Stability Build) required continuous operation for 72 hours and was completed two weeks early in April 1999. Build 2 (Full Functionality Build) added the fast, long-term, and ionospheric corrections and demonstrated 70+ hours of continuous operation in June 1999. Build 3 (Performance Build) required a fully functional and usable signal in space with integrity that would be operational continuously for eight days. This Build was successfully completed four days early in August 1999. The final and 4th software configuration item (corrections and verification) completed Formal Qualification Testing (FQT) in September 1999.

The resulting WAAS signal-in-space provides accuracies well within the range required by the WAAS specification.

Several flight trials took place in FY 1999 using the NSTB, WAAS signal in space, and the LTP. In October 1998, a series of WAAS test flights at Iceland's Keflavik Airport was conducted using signals from both the NSTB and a European satellite test bed. These flight trials assessed many of the interoperability issues that currently exist between the WAAS and EGNOS.

In December 1998, the FAA conducted WAAS test flights in Santiago, Chile to support the commitment by the Chilean Director General of Civil Aviation to the implementation of WAAS in Chile, as well as the eventual progression of WAAS throughout the entire Caribbean and South American Region (CAR/SAM).

To further support this expansion of WAAS to the CAR/SAM region, the FAA has secured letters of intent from Mexico and Panama for participation

in the operational U.S. WAAS. Additionally, both countries signed bilateral agreements for the installation of NSTB reference stations to be used to prepare for the installation of operational WAAS reference stations in the near future. Related uses of the reference stations include pre-operational support, technology familiarization, flight tests, certification activities, procedure development, and siting analyses. These agreements will significantly cut the FAA's expenses by reducing the agency's need to field WAAS reference stations along the southern U.S. border.

In May 1999, the FAA, with support from the Civil Aviation Authority of Singapore, installed an NSTB reference station and master station at Singapore Changi Airport and performed flight tests to demonstrate the potential benefits of the WAAS within the Asia Pacific region.

In July 1999, the FAA assisted the International Civil Aviation Organization (ICAO) with plans and strategies for the development of a WASS/LASS-based GNSS test bed capability for the CAR/SAM region. The resulting South American Test Bed (SATB) will pave the way for an operational system in the region that is completely compatible with the U.S. systems. This future capability based on U.S. technology will also provide cost-sharing opportunities on GEO satellite services, significantly reducing projected FAA leasing expenses for end-state WAAS GEOs.

In September 1999, the FAA conducted a series of flight trials using the Raytheon WAAS Test Signal. This was the first demonstration flight for any audience (domestic or international) that used the current Raytheon WAAS Test Signal.

The successful completion of all of these flight tests and other activities helped to: (1) demonstrate U.S. technological leadership in satellite navigation; (2) ensure the seamless transfer from one regional satellite-based navigation system to another; (3) promote the adoption satellite-navigation in regions where improved navigation capability will increase the safety of flight for U.S. citizens traveling abroad. It will provide the groundwork necessary to achieve the International Civil Aviation Organization's vision of a future, worldwide, seamless, navigation capability.

Research and development activities to use LAAS to achieve Category I and Category III precision approaches progressed substantially through the use of the LAAS Test Prototype (LTP). Tests using the LTP were completed with excellent results at various locations around the nation.

In August 1999, the FAA in conjunction with UPS and the Air Transport Association (ATA) conducted approximately 40 precision approaches using a wide-body aircraft and the LTP. These tests had very positive results for the use of LAAS and its pseudolite technology on wide-body aircraft. All previous tests were conducted on narrow-body aircraft.

In October 1999, the FAA in conjunction with FedEx and ATA conducted further wide body flight testing at Memphis International Airport. The purpose of these tests was to verify the reception of the airport pseudolite (APL) signal by a wide body aircraft (MD-10) and the ability to accurately range from that signal. A total of 45 precision LAAS approaches were conducted to all six runway ends. Results of the test indicated the typical horizontal navigation system error (NSE) estimate was less than one meter, and the vertical NSE was less than two meters. These results are well within LAAS requirements. These successful flight tests demonstrated the potential of this new technology and the significant contribution LAAS will make to the advancement of satellite-based aviation.

The LAAS Integrity Monitoring Test Bed (IMT) is another tool currently being utilized to validate LAAS requirements and performance. The final version will be deployed at San Francisco International Airport for ground data collection.

Furthermore, LAAS Category I development is proceeding forward. Government Industry Partnerships (GIP) reflecting this effort were signed with Honeywell and Raytheon in April 1999. The LAAS Category I Specification was finalized and approved in September 1999. The Category I MOPS is expected to be approved by February 2000. Category II/III research and development efforts are continuing. LAAS development is ongoing with an initial public use expected for mid-2002 for Category I and late 2005 for Category III.

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), and the Central Intelligence Agency (CIA).

In addition, 15 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.

MAJOR ACTIVITIES AND ANTICIPATED FY 2000 ACCOMPLISHMENTS:

- Performed data collection and analyses using the NSTB to further develop WAAS performance-assessment capabilities.
- Performed 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.
- Continued to conduct ionosphere data collection and analysis to define WAAS final operational capabilities.
- Continued research into signal quality monitoring, operations and maintenance, flight control monitoring, and automatic dependent surveillance with participation from Stanford and Ohio Universities.
- Continued investigation studies and analysis for surface movement guidance, helicopter operations, and advanced LAAS augmentations using pseudolites.
- Continued to develop and mature the LAAS integrity algorithms.
- Continued installing and testing LAAS prototype systems at several sites to ensure that the systems will validate the functional specification in particularly difficult sites.
- Continued to demonstrate and test international connectivity as a transition to a seamless global navigation system.
- Initiated investigation studies for surface movement guidance, helicopter operations, and advanced LAAS augmentations.
- Continued to coordinate with ICAO to produce SARPS to define LAAS in the international community.
- Continued interference analysis to identify and mitigate potential threats.
- Continuation/Completion of LAAS Category I Specification Validation efforts.

KEY FY 2001 PRODUCTS AND MILESTONES:

- Define optimum SatNav architecture for Alaska.
- Investigate satellite anomalies.
- Develop WAAS performance monitoring and assessment capabilities.
- Define assumptions and parameters for worldwide Service Volume Model (SVM).
- Define and test SBAS interoperability scenarios.
- Support development of WAAS ionospheric algorithm to be incorporated beyond initial operational capability.
- Validate LAAS Category I Integrity.
- Develop LAAS Category II/III Algorithm.
- Implement and test LAAS Category II/III.
- Develop and validate LAAS Category III Specification.
- Validate LAAS Category II/III Integrity Monitoring/SARPS.
- Develop Improved Signal Quality Monitoring Techniques for CAT III LAAS.
- Investigate Ephemeris Monitoring requirements for CAT III LAAS.
- Develop Airport Pseudolite Integration Techniques.

FY 2001 PROGRAM REQUEST:

In FY 2001, the program will continue to focus on developing and implementing GPS augmentations to further the transition to satellite-based navigation technology. Efforts will focus on research and analysis of issues associated with accuracy, integrity, and availability to the users, with specific emphasis on the ionosphere and interference to ensure service continuity of service. Current research efforts will focus on better utilization of present and future global navigation satellite systems, analysis of LAAS VHF data broadcast characteristics and LAAS category I/II/III evaluations at various locations across the country.

The FY 2001 request of $6,900,000 will focus primarily on the research and development efforts currently being performed by Stanford University, Ohio University and JPL. This will allow the FAA to continue to meet its objectives to transition to satellite-based navigation.

Navigation Product and Activities	FY 2001 Request ($000)	Program Schedule					
		FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY2005
Navigation							
Wide Area Augmentation System (WAAS)	$2,900						
Perform Data Collection and Analyses Using the National Satellite Test Bed (NSTB) to Further Develop WAAS		◆	◇	◇	◇	◇	◇
Continue to Conduct Ionosphere Data Collection and Analysis to Define WAAS Final Operational Capabilities and Support the Development of Enhanced WAAS Ionospheric Algorithm		◆	◇	◇	◇	◇	◇
Define Optimum Architecture for Alaska		◆	◇	◇	◇	◇	◇
Investigate Satellite Anomalies							
Continue Interference Analysis to Identify and Mitigate Potential Threats		◆	◇	◇	◇	◇	◇
Develop WAAS Performance Monitoring and Assessment Capabilities		◆	◇	◇	◇	◇	◇
Define Assumptions and Parameters for Worldwide Service Volume Model							
Perform Interoperability Analyses to Support Seamless Global Navigation Satellite System (GNSS)							
Local Area Augmentation System (LAAS)	$4,000						
Validate LAAS Category I (CAT I) Integrity		◆	◇	◇	◇	◇	◇
Develop LAAS CAT II/III Algorithm		◆	◇	◇	◇		
CAT II/III Implementation and Testing		◆		◇	◇	◇	◇
Develop Improved Signal Quality Monitoring Techniques for CAT III LAAS		◆		◇	◇	◇	
Develop Improved Integrity Algorithms for CAT III LAAS		◆				◇	◇
Investigate Ephemeris Monitoring Requirements for CAT III LAAS							
Develop Airport Pseudolite Integration Techniques							
Total Budget Authority	**$6,900**	**	**$6,900**	**$5,700**	**$5,700**	**$5,700**	**$5,700**

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

Budget Authority ($ in Thousands)	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Request
Contracts	10,772	10,426	10,718		6,900
Personnel Costs	1,849	2,466	2,277	**	***
Other Costs	379	505	0		***
Total	**13,000**	**13,397**	**12,995**		**6,900**

** By Congressional direction, budget line item 1F01 was reduced in FY 2000. The allocation of that reduction is currently under review.

*** In the Facilities and Equipment appropriations, personnel and other costs are budgeted in Activity 5, not the program budget line item.

F&E 1F01— Surveillance

GOALS:

Intended Outcomes: The FAA plans to improve system efficiency and safety by implementing a low-cost surveillance system that enables Free Flight capabilities and enhances safety and efficiency. This program evaluates specific applications of Automatic Dependent Surveillance - Broadcast (ADS-B) and develops domestic and international ADS-B standards to facilitate global system interoperability.

The system uses an onboard Global Navigation Satellite System (GNSS) receiver or other backup source of navigation data to derive the identity, altitude, and position of an ADS-B-equipped aircraft in the vicinity of the airport. These data are broadcast directly to ground receivers as well as to nearby aircraft. An ADS-B message displayed on a neighboring aircraft's airborne Cockpit Display of Traffic Information (CDTI) facilitates the flight crew's situational awareness, conflict detection, and Free Flight capabilities.

The ADS-B technology's modular design and cooperative nature offer a low cost alternative to the surveillance coverage in existing nonradar areas, and potentially, in some areas currently served by radars. Through accurate and timely updates directly to pilots, the system offers the potential to reduce current separation standards while still improving overall safety, efficiency, and airspace capacity.

Agency Outputs: Current efforts focus on validating the capabilities of ADS-B and also on developing standards for the system's avionics, its applications, CDTI and transponders. Standardization efforts include RTCA minimum aviation system performance standards, minimum operational performance standards, technical standard orders, and design criteria. International standards such as the International Civil Aviation Organization's (ICAO) Standards and recommended Practices (SARPS) will also be developed. Outputs will include evaluation of operational procedures outside the scope of Safe Flight 21, 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's panels and European Work Group on ADS-B.

Accomplishments: Draft ADS-B avionics standards development has been initiated at RTCA. Additional engineering prototype, flight tests, and certification work, including development and test/validation, is required to complete these standards. A cooperative Research and Development Agreement (CRDA) is being planned with United Airlines or an evaluation of selected operational enhancements.

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

MAJOR ACTIVITIES AND ANTICIPATED FY 2000 ACCOMPLISHMENTS:

- Completed development of ADS-B 1090 MHz MOPS with RTCA (version 1).
- Developed initial draft of ADS-B/CDTI Minimum Operational Performance Standards (MOPS) with RTCA (version 1).
- Completed spectrum analysis of ADS-B 1090MHz.
- Completed report on flight test of ADS-B 1090MHz at LAX.
- Conducted flight test of ADS-B 1090MHz at Frankfurt Germany and EUROCONTROL sites.
- Conducted pilot and controller simulation of paired approach procedure.

KEY FY 2001 PRODUCTS AND MILESTONES:

- Provide update to RTCA ADS-B 1090 MHz MOPS and ICAO SARPS on extended squitters.
- Continue evaluation of ADS-B/CDTI operational procedures.
- Complete version 1 of draft RTCA ADS-B MOPS on Airborne Surveillance and Separation Assurance Processing.
- Publish draft ADS-B/CDTI standards (version 2).
- Complete operational safety assessment of ADS-B.

FY 2001 PROGRAM REQUEST:

The FAA and RTCA will continue to update RTCA 1090MHz MOPS and complete version 2 of the ADS-B avionics standards for CDTI. Version 1 of the draft RTCA MOPS on Airborne Surveillance and Separation Assurance Processing will be completed. Updates will be provided to ICAO SARPS on extended squitter. Studies, analyses, and field tests will validate paired approach procedures.

Surveillance Product and Activities	FY 2001 Request ($000)	Program Schedule					
		FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY2005
Automatic Dependent Surveillance-Broadcast (ADS-B)							
Plans, Standards, and Analysis							
Minimum Operational Performance Standards (MOPS) and Standards and Recommended Practices (SARPs)	$432						
Update RTCA UAT MOPS		◆	◇	◇	◇		
Provide Initial RTCA UAT MOPS		◆	◇	◇	◇		
Provide Technical Support to RTCA MOPS on Traffic Information System - Broadcast							
Update RTCA MOPS on Surface Guidance and Control							
Update ICAO SARPs and Documents on Extended Squitters							
Performa Simulation evaluation of ADS-B Procedures and Algorithms	$1900						
Final Approach Spacing			◇	◇			
Surface Situation Awareness			◇	◇			
Runway and Final Approach Occupancy Awareness			◇	◇			
Analyze Architecture of Multi-Link ADS-B Ground Station	$300	◆	◇	◇			
Total Budget Authority	$2,632	**	$2,632	$2,800	$500		

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

Budget Authority ($ in Thousands)	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Request
Contracts	0	0	3,506		2,632
Personnel Costs	0	0	784	**	***
Other Costs	0	0	0		***
Total	0	0	4,290		2,632

** By Congressional direction, budget line item 1F01 was reduced in FY 2000. The allocation of that reduction is currently under review.

*** In the Facilities and Equipment appropriations, personnel and other costs are budgeted in Activity 5, not the program budget line item.

F&E 1F01 — Airspace Management Laboratory

GOALS:

Intended Outcomes: The Air Traffic Airspace Management Program Office (ATA) is fundamentally responsible to ensure that the national airspace is designed effectively and efficiently. The AT Airspace Laboratory reports to the ATA with continuing tasking to:

- Identify issues and perform analyses, with appropriate environmental evaluations, to support ATA in its airspace design activities. This responsibility includes the development of airspace designs to resolve current as well as future problems through use of currently available and emerging technologies and procedures.
- Support the current and future automation of ATA and other FAA operations. The Laboratory will continue to build automated systems to support such initiatives as overflight "fee for service" assessments and obstacle evaluation.
- Serve as the agency's repository and redistribution center for air traffic data. The Laboratory currently provides ETMS data to various FAA activities, including the Consolidated Operations and Delay Analysis System and the Daily Measurement of Air Traffic Service. The laboratory will expand its sources and distribution of data as needed.

The vision for the AT Airspace Laboratory is that the laboratory will provide data and analysis of the highest caliber and in the most timely manner to meet the needs of AT, as well as other FAA organizations and stakeholders.

Agency Outputs: The AT Analysis Laboratory was initially developed as a proof-of-concept prototype that would be used to identify issues and perform analyses in airspace design activities and environmental evaluations. Existing outputs include:

- Quantitative and qualitative analysis of current NAS performance.
- Integration of local and regional airspace design concepts into a system-wide national level scope.
- Environmental evaluations of alternative airspace configurations.
- Examination of new technology or procedures with respect to potential for performance improvements.
- Acquisition, storage, distribution, and information extraction of air traffic operational data.
- Development of systems to support various FAA and non-FAA lines of business, such as:
  - Obstruction evaluation
  - Overflight fee for service assessments
  - Foreign Overflight Notification System (for DOD)
  - The Consolidated Operations and Delay Analysis System (CODAS)
  - The Daily Measurement of Air Traffic Service (DMATS)

While airspace changes have been analyzed and implemented for decades at the local level, a systematic, comprehensive national analysis has not been performed and no overall national design has been implemented. Significant changes in avionics and air traffic control technology, coupled with continuing changes in the type, amount, and distribution of traffic, have created a need to study and redesign the nation's airspace for current and future use. It is particularly likely that airspace redesign will be required to complement FAA's implementation of global positioning navigation systems, Free Flight Phase I sequencing tools, and dynamic sectorization.

Customer/Stakeholder Involvement: Successful demonstration of the AT Analysis Laboratory capability has shown benefits across multiple lines of business. In addition to the Airspace Management Program Office (ATA), the Office of System Architecture and Investment Analysis (ASD), the Office of System Capacity (ASC), Air Traffic Planning and Procedures (ATP), and Air Traffic System Management (ATM), the Lab has supported the missions of the Cost Accounting Team, the Office of Financial Services, the Office of Aviation Policy, and the Y2K Contingency Planning Work group. The capability exists in demonstration and prototype and an opportunity

is in place to develop this capability into a full mission analysis and support laboratory.

The Laboratory also has provided on-going support for numerous projects of the FAA Eastern Region (AEA) involving field analyst staffing, analytical work, daily access to operational data, and continuing technical support for database query programming.

The AT Laboratory has been identified as the element responsible for supporting airspace design dependencies for FAA F&E programs with broad government and industrial involvement, including:

- Local-Area Augmentation Systems (LAAS) — all category approaches.
- Low Altitude Direct Routing using Wide-Area Augmentation Systems (WAAS).
- Runway Incursion Program.
- WAAS Precision Approaches.
- Automatic Dependent Surveillance (ADS) studies.
- Single and Multi-center metering.
- Final Approach Spacing Tool (FAST) implementation studies.
- New Host Consolidation/Dynamic Resectorization studies.

Accomplishments:

Airspace issue identification.

- Tracked critical parameters for proactive identification of issues
- Visualized/analyzed past and current traffic patterns
- Analyzed system performance

Airspace design and environmental evaluation.

- Developed alternative airspace designs for examination
- Analyzed changes to airspace design on flow, capacity, delay, workload, and other metrics as required
- Developed data necessary to evaluate noise and consider pollution impacts to complement airspace design analysis

R&D Partnerships: Organizations that will use or support the laboratory include the Office of System Architecture and Investment Analysis (ASD), the Office of System Capacity (ASC), Air Traffic Planning and Procedures (ATP), and Air Traffic System Management (ATM).

MAJOR ACTIVITIES AND ANTICIPATED FY 2000 ACCOMPLISHMENTS:

- Developed national listing of aircraft diversions
- Developed New York and Washington metro area arrival and departure fix reports
- Provided analytical support with two operational studies:
  - Comparison of sector densities from four Aircraft Management Program (AMP) based systems—OAMP, HAME, STT, and PCOAT
  - Review of the Staffing to Traffic (STT) data (Input Data, Air Traffic Activity Measures, and Output Reports. (See CNAC reports CRM 95-22 and CRM 94-128.)
- Performed analytical work/studies on behalf of Eastern Region
- Provided SDAT support with sector analysis studies
- Developed concept papers on a range of topics, including:
  - Concept for a Field-Level Traffic Management Unit Operational Test, Evaluation and Development Capability
  - En-route Sector Spacing Tool
  - Smart Log and Lessons Learned

KEY FY 2001 PRODUCTS AND MILESTONES:

- Perform quantitative and qualitative analysis of current NAS performance
- Integrate local and regional airspace design concepts into a system-wide national level scope
- Conduct environmental evaluations of alternative airspace configurations
- Examine new technologies or procedures with respect to potential for performance improvements

- Acquire, store, distribute, and extract information from air traffic operational data
- Develop systems to support various FAA and non-FAA lines of business

FY 2001 PROGRAM REQUEST:

Airspace Management Lab Product and Activities	FY 2001 Request ($000)	Program Schedule					
		FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY2005
Develop Systems to Support FAA and non-FAA lines of business	$2,400	◆	◇	◇	◇	◇	◇
Data Collection, Analysis and Reporting of Current NAS performance	$1,600	◆	◇	◇	◇	◇	◇
Total Budget Authority	$4,000	$3,000	$4,000	$4,000	$5,000	$5,000	$5,000

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

Budget Authority ($ in Thousands)	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Request
Contracts	0	0	0		4,000
Personnel Costs	0	0	0	**	***
Other Costs	0	0	0		***
Total	0	0	0		4,000

** By Congressional direction, budget line item 1F01 was reduced in FY 2000. The allocation of that reduction is currently under review.

F&E 1F01 — ATC/ATM Decision Support Tools

GOALS:

Intended Outcomes: Through this program, the FAA intends to increase the capacity of the National Airspace System in all weather conditions, without negatively impacting safety. Specifically, this research supports the FAA System Efficiency Mission Goal regarding the reduction of system delays and contributes to the achievement of the first three outcomes of the ATS Performance Plan:

- Outcome 1 - Increase System Safety—by aiding in the sequencing and spacing of aircraft, reduces the risk of operational errors and deviations.
- Outcome 2 - Decrease System Delays—decision support tools resulting from this research will allow more flights to land and takeoff at our nations airports during peak usage periods.
- Outcome 3 - Increase System Flexibility—the tools will allow more effective flight planning resulting in more direct routing of flights.

Some of the decision support tools developed by prior research are being implemented on a limited basis in selected FAA facilities and participating airline operational centers (AOC). Examples include: the Final Approach Spacing Tool (FAST), the User Request Evaluation Tool (URET), the Traffic Management Advisor (TMA), and the Surface Movement Advisor (SMA). Benefits from the use of these tools are expected to contribute to the FAA Strategic Plan System Efficiency Goal of reducing the rate of volume delays by 20 percent and should aid the FAA in attaining its Strategic Plan Safety Goal of an 80-percent reduction in the US aviation fatal accident rate.

The requested research program will support the development of the next generation of decision support tools and the information exchange networks that the NAS Architecture 4.0 anticipates to enter full-scale development by 2008. Successful development and implementation of these next generation tools are projected to yield an additional 10 to 20 percent reduction of NAS volume delays (Strategic Plan System Efficiency Goal) and contribute substantially to the goal of an 80-percent reduction in the accident rate (Strategic Plan Safety Goal).

Agency Outputs: As envisioned by the NAS Architecture, this research will lead to designs for: decision support tools for use by air traffic controllers in the enroute, terminal, and surface environments; decision support tools for use by FAA ATM operations and the airline AOCs in the strategic and tactical management of the flow of air traffic; and decision support tools for use by the flight crews as participants in the NAS.

Some of the major projected concept demonstration outputs of this research follow:

- The TMA Multi-Center Tool.
- Dynamic Density Monitor, Compliance Monitor, and System Impact Assessment tools.
- Integrated surface surveillance and movement planning systems, low visibility surface guidance and movement monitoring systems.
- Integrated enroute, terminal and surface decision support tools and their combined impact on the gate-to-gate performance of the NAS.
- Enhanced Center TRACON Automation System (CTAS) and URET tools that provide controllers and managers with sequencing, spacing, and separating alternatives (e.g. Active FAST, Conflict Resolution Advisory and others) with enhanced linkages to weather systems.
- Dynamic Wake Vortex Spacing Tool.
- Integrating aircraft FMS with ground side decision support tools.

The research also is expected to result in: the specification of requirements for linking decision support tools to the NAS Wide Information Network; and the high fidelity modeling and simulation of decision support tool performance when coupled with the aircraft flight management systems (FMS).

R&D Partnerships:

NASA is a full partner in this research with its ongoing Terminal Area Productivity, Advanced Air Transportation Technologies, and Advanced General Aviation Technologies Experiment projects. The Center for Advanced Aviation System Development (CAASD) has

been conducting decision support tools research for the FAA over the past several decades and will continue to work on this research agenda. NASA and FAA/CAASD research efforts are coordinated through the Interagency ATM Integrated Product Team (IAIPT).

The separately funded research proposed herein is both in concert with the planning of the IAIPT and necessary if NASA and FAA/CAASD research efforts are to be integrated into products that the FAA's capital investment program and the aviation industry can fully implement. Contract funding is required to establish the environment for the NASA and CAASD concept exploration and demonstration work. This includes tool adaptation for the demonstration phase, controller and ATM evaluation of the concept demonstration tools, high fidelity simulations of concept alternatives, experimentation with tool integration, interface testing to ensure non-interference with center and/or TRACON operations, and performance validation.

EUROCONTROL is also pursuing research in the development of ATM decision support tools. This requested research project (and associated contract support funding) is additionally in support of joint FAA/EUROCONTROL agreements in the development of decision support tools for ATM/ATC.

MAJOR ACTIVITIES AND ANTICIPATED FY 2000 ACCOMPLISHMENTS:

- Evaluated NASA's Direct-To Decision Support Tool.
- Explored TMA Multi-Center Tool application to Northeast Corridor.
- Planned for Conflict Resolution Tool demonstration at the William J. Hughes Technical Center (WJHTC).
- Participated in FAA/EUROCONTROL Conflict Detection/Resolution Technical Interchange Meeting.
- Developed and received approval for TMA Multi-Center Research Management Plan.
- Developed and received approval for the Enroute Conflict Resolution Research Management Plan.
- Developed Research Management Plan for Surface Management Tools.

KEY FY 2001 PRODUCTS AND MILESTONES:

- Complete the scenario build for the TMA Multi-Center Tool.
- Complete the concept exploration for the Surface Decision Support tools.
- Complete the modeling of alternatives for the integration of Enroute, Terminal and Surface tools.

FY 2001 PROGRAM REQUEST:

In the immediate future, the volume of air traffic movement is projected to grow by more than 3 percent per year. To service this growth, the nation must increase the size of its aviation infrastructure, develop methods to employ its existing infrastructure more effectively or turn to some combination of these strategies. Putting existing infrastructure to better use is the most cost efficient strategy for the nation and is the focus of this research. Unless the proposed research tasks are funded, the decision support tools concept exploration work by NASA and FAA/CAASD will not result in products that can be cost effectively integrated into the FAA's NAS modernization program.

The Airport Technology FY 2001 research program is a collaborative effort among many government organizations, universities, and industry associations. The program funding requested provides the contract support necessary for an integrated, effective research program that delivers the standards and guidelines for maintaining and enhancing airport infrastructure.

ATC/ATM Decision Support Tools Product and Activities	FY 2001 Request ($000)	Program Schedule					
		FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY2005
ATC/ATM Decision Support Tools							
Traffic Management Advisor (TMA) Multi-Center - Complete Scenario Build	$338	◆	◇				
TMA Multi-Center - Demonstration	$127	◆	◇				
Complete Surface Decision Support Tools Concept Exploration	$212						
Complete Development of Demonstration System		◆	◇	◇	◇	◇	◇
Demonstration and Evaluation		◆	◇	◇	◇	◇	◇
Integrate En Route, Terminal and Surface Tools	$169						
Complete Modeling of Alternatives		◆	◇	◇	◇		
Complete Simulation of Selection Alternative		◆		◇	◇	◇	◇
Complete Demonstration Design		◆		◇	◇	◇	
Complete Demonstration - Complete Analysis		◆	◇		◇	◇	◇
Demonstrate FMS/CTAS/URET Integration Concept		◆		◇			◇
Total Budget Authority	**$846**	**	**$846**	**$900**	**$1,000**	**$1,000**	**$1,000**

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

Budget Authority ($ in Thousands)	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Request
Contracts	0	0	0	0	846
Personnel Costs	0	0	0	0	***
Other Costs	0	0	0	0	***
Total	**0**	**0**	**0**	**0**	**846**

*** In the Facilities and Equipment appropriations, personnel and other costs are budgeted in Activity 5, not the program budget line item.

F&E 1F01 — Separation Standards

GOALS:

Intended Outcomes: The Separation Standards Program works to reduce separation standard values within international airspace to make the following benefits available to providers and users of oceanic air traffic control systems:

- Increased system efficiency—evidenced through reduced aircraft fuel-burn and transit times.
- Increased theoretical system capacity—evidenced through an increase in the number of routes and flight levels that controllers can safely support within the same volume of airspace.
- Increased international standardization of separation criteria and resultant enhanced system safety.

Agency Outputs: The FAA's "Strategic Plan for Oceanic Enhancements and Separation Reductions" describes a systematic process for revising international separation values and establishes priorities for such changes. To document and evaluate each separation change, the FAA produces a series of supporting products:

- Operational assessments of the value the change brings to Air Traffic Control (ATC) system providers and users.
- Benefit-cost analysis regarding the change.
- Safety assessment of the system before and after application of the separation change.
- Publication of FAA regulatory material required by the change.
- Completion of any new rulemaking required by the change.
- Development of ATC procedures required by the change.
- Development of any new or changed International Civil Aviation Organization (ICAO) guidance material, annexes, or regional supplementary procedures required to standardize and make the reduced separation value safe for international operations.
- Establishment and maintenance of any long-term safety oversight functions required for the implementation and continued safe use of the reduced separation value.

Customer/Stakeholder Involvement: The Separation Standards Program establishes appropriate ICAO- government-industry forums to draw all parties concerned with a change in separation standards into a common process. The cooperating entities may include: state Civil Aviation Authorities (CAA), ICAO regional and Headquarters elements, ATS providers, ATC system users, industry trade organizations, and unions representing controllers and pilots.

Participants in specific change processes include:

- *Pacific separation standards*. Changes proceed with the coordination and endorsement of the (North Pacific) Oceanic Work Group, Informal (North) Pacific ATC Coordinating Group, and Informal South Pacific ATS Coordinating Group, as well as the ICAO Pacific Reduced Vertical Separation Minimum (RVSM) Task Force.
- *North Atlantic separation standards*. Changes are carried out through the ICAO regional planning group, the North Atlantic Systems Planning Group.
- *West Atlantic Route System Separation Standards (WATRS).* Proposed improvements involve participation of the New York Oceanic Capacity Enhancement Task Force.

The program also provides FAA representation on ICAO's Review of the General Concept of Separation Panel (RGCSP)—the focal point for development of the technical justification for new separation minima as well as the forum for assessing application of recommended ICAO separation practices on a global and regional basis.

Accomplishments: The Separation Standards Program has been the vehicle for the FAA to bring about major reductions in separation standard values affecting international airspace. In the past three years, the program has been responsible for several significant changes:

- *North Atlantic RVSM, or 1000-ft. vertical separation standard above flight level (FL) 290 (March, 1997).* Introduction of this change marked the culmination of a 15-year

effort by the FAA and other State CAAs to reduce the high-altitude separation standard. Several studies had predicted that the RVSM would be the single most cost-beneficial separation change possible for oceanic airspace; actual experience has proven that the studies were accurate forecasters of RVSM benefits. Within the first 12 months after RVSM implementation, each of the 10 operators accounting for a combined 60 percent of annual North Atlantic operations had recovered the sunk costs associated with bringing its aircraft into compliance with RVSM requirements.

- *North Pacific 50-nm lateral separation standard based on operator compliance with required navigation performance (RNP)-10 requirements (April, 1998 and December, 1998).* This linkage between a separation standard and an RNP value marked the first use of the ICAO-endorsed concept in any portion of worldwide airspace. The change led to measurable improvements in both ATC operations and aircraft fuel-burn and transit time.
- *North Atlantic Implementation Management Group Cost Effectiveness (NICE) Program (October, 1999).* This comprehensive fast-time-simulation-based assessment of the benefits associated with North Atlantic separation changes proposed through the year 2010 resulted in significant changes. Plans were modified for ATS system infrastructure expenditures and users were held to different schedules and equipage requirements in order to participate in the project within the airspace. The FAA's NICE Program contributions were the result of a combined effort by federal staff members and grant-sponsored university researchers.
- *Pacific RVSM leadership (June, 1997 to present).* Based on FAA encouragement, contributions and previous experience in the North Atlantic, the ICAO Asia and Pacific Region planning group established the Pacific RVSM Task Force to facilitate implementation of the RVSM in February, 2000. The FAA chairs or co-chairs all Task Force working groups and has provided the technical consultation concerning RVSM implementation to States in the Region. The ICAO planning group has agreed that the FAA Technical Center will provide the safety oversight function associated with RVSM implementation and has endorsed establishment of the Asia/Pacific Approvals Registry and Monitoring Organization (APARMO) to carry out this function.

R&D Partnerships: The Separation Standards Program provides FAA representation to ICAO's RGCSP, the principal global forum for moving ahead with the development of new separation minima. The FAA and other CAAs typically cooperate in such work, with each state-participant freely sharing research results within the Panel. In addition, the Separation Standards Program maintains close research ties with academia through sponsorship of grants and cooperative work with Rutgers University in the development of large fast-time simulation models of oceanic airspace. The program also has a direct link with international separation research activities in which the FAA's GPS Monitoring System supports EUROCONTROL's RVSM safety oversight activities. In turn, that international body provides access to the products of its RVSM research.

MAJOR ACTIVITIES AND ANTICIPATED FY 2000 ACCOMPLISHMENTS:

- Emphasis in FY 2000 will be in four major areas:
- Pacific RVSM: with intended simultaneous implementation in all Pacific flight information regions on February 24, 2000.
- Implementation of 50-nm lateral separation standard in the Central East Pacific track system on February 24, 2000.
- Preparations for November 2001 implementation of RVSM in the West Atlantic Route System.
- Establishment of a comprehensive plan to introduce RVSM and horizontal–plane separation reductions in the Gulf of Mexico and the ICAO Caribbean/South American Region.

KEY FY 2001 PRODUCTS AND MILESTONES:

- Finalize the planning and establishment of infrastructure necessary to support November

2001 West Atlantic Route System RVSM implementation.

- Provide limited introduction of a 50-nm longitudinal separation in the Pacific—based on controller-pilot data link communication.
- Complete work within RGCSP to formalize requirements for 30-nm lateral and 30-nm longitudinal separation standards.
- Implement the plan formulated in FY 2000 to reduce separation minima in Gulf of Mexico and ICAO Caribbean/South American Region.
- Continue the safety oversight function in Pacific and North Atlantic.
- Initiate further NICE work to quantify North Atlantic communication requirements associated with reduced separation minima.

FY 2001 PROGRAM REQUEST:

The FY 2001 program request provides for:

- Completion of real-time simulation, procedure development and safety oversight activities necessary to permit November 2001 introduction of RVSM into the West Atlantic Route System.
- Completion of work necessary to finalize requirements for reducing horizontal-plane separation minima to 30-nm—with such requirements anticipated as satisfied by automatic dependent surveillance.
- Expansion of safety oversight assistance beyond the Pacific and North Atlantic— including augmentation of the GPS Monitoring System to support Gulf of Mexico, Caribbean/ South American and possible NAS RVSM implementation
- Completion of NICE Program North Atlantic studies and publication of revised plan for introduction of separation reductions.

Separation Standards Product and Activities	FY 2001 Request ($000)	Program Schedule					
		FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY2005
Separation Standards							
West Atlantic Route System Reduced Vertical Separation Minima (RVSM)	2,200						
Conduct Safety Oversight		◆	◇	◇	◇	◇	◇
Develop Procedures		◆	◇				
Implement		◆		◇	◇	◇	◇
Complete North Atlantic Implementation Management Group Cost Effectiveness (NICE)		◆	◇				
30/30 Nautical Mile Requirements		◆	◇	◇	◇		
Gulf of Mexico (GOMEX) and Caribbean Separation Changes		◆	◇	◇	◇	◇	
Total Budget Authority	2,200	**	$2,200	$2,200	$2,400	$2,500	$2,500

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

Budget Authority ($ in Thousands)	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Request
Contracts	1,284	0	0		2,200
Personnel Costs	1,855	0	1,145	**	
Other Costs	0	0			
Total	3,139	0	1,145		2,200

** By Congressional direction, budget line item 1F01 was reduced in FY 2000. The allocation of that reduction is currently under review.

A04 — 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 will 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, for promoting and developing meteorological science, and for fostering support of research projects through the use of 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 Advisory Committee (October 1995).

The weather program directly supports FAA Strategic Goal #1 in the performance area of Safety: "Through research, identify methods that, when implemented would reduce the fatal accident rate, due to weather."

This weather R,E&D program, in collaboration with National Weather Service (NWS) programs, produces weather algorithms (technology), more rapid forecasting and delivery of forecasts (delivery), and supports the development of aviation weather instructional material (education).

Agency Outputs: The weather program focuses on conducting applied research to solve operational problems through the development of new and improved algorithms. These algorithms, are being developed for implementation on appropriate NAS platforms (including the weather and radar processor, and the integrated terminal weather system) and on NWS systems continue to be transferred to private weather service companies in support of the NAS. This transfer enables companies to derive specialized aviation weather products from FAA research efforts. Algorithm development provides capabilities including:

- Depiction of current and forecasted in-flight icing areas to enhance safety, airspace efficiency, and aircraft utilization.
- Interactive data assimilation, editing and forecast tools to improve aviation advisories and forecasts issued by the NWS.
- Location, timing, and severity of convective weather hazards to improve flight safety and enhance capacity.
- Depiction of current and forecasted precipitation type and rate to enhance safety and efficiency in the terminal area
- Short-term forecasts and prediction of ceiling and visibility in the terminal area for enhanced capacity
- In situ and remote detection and forecast of enroute turbulence including clear air

In addition, through Project SOCRATES, the weather program is developing and deploying sensors to provide a tactical safety net for aeronautical weather-dependent hazards with an initial focus on wake turbulence hazards for closely spaced, parallel runway operations.

Customer/Stakeholder Involvement: The National Aviation Users' Forum has provided a process to develop a federal/industry consensus on their needs and priorities for aviation weather information. Participants in the Forum include representatives from the Airline Pilots Association, United, American, and Delta Airlines, and other industry representatives. This 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 responsive to 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 and requirements found in six or more related documents and publications.

Accomplishments: The following represent major accomplishments of the weather program:

- Rapid update cycle analyses and forecast capabilities providing more accu-

rate and higher resolution upper winds, temperature, and precipitation data. Use of more accurate data on hazardous weather and jet streams has reduced flight times and/or flight delays.

- Issued the first-ever forecast of freezing precipitation aloft at the aviation weather center in Kansas City in response to FAA proposed rulemaking for turboprops flying into conditions conducive to in-flight icing. These forecasts have increased 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 NOAA. The availability of detailed water vapor data in real time will be utilized to make 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, and mesocyclone and tornado detection (leveraged with NWS). These upgrades have enabled better definition of location, timing, and severity of convective weather hazards resulting in enhanced flight safety and capacity.
- Completed storm growth and decay field tests in Dallas and Orlando. This research will result in the accurate short-term prediction of the initiation, growth, and decay of storm cells. It will enhance safety and capacity by improving aircraft avoidance of hazardous weather, resulting in enhanced strategic and tactical flow management planning, allowing more effective routing of traffic to/from airports and runways.
- Transferred Weather Support to Deicing Decision Making (WSDDM) system technology to a commercial weather provider to provide ground deicing decision making information to airlines and cities. WSDDM System information has resulted in increased safety (takeoffs) cost savings in use of deicing fluids/associated equipment/ personnel, and efficiencies in runway and off-airport plowing/departures/arrivals.
- Implemented initial operating capability of the Aviation Gridded Forecast System (AGFS) at the NWS, providing an aviation specific weather database for the aviation community and user access to this data via the Aviation Digital Data Service (ADDS).
- Fabricated and tested a two beam, laser based, acoustic system for wake turbulence detection at JFK Airport under Project SOCRATES.
- Initiated installation of a wake turbulence and wind monitoring system at San Francisco International 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 Memorandums of Agreement (MOAs). Principal partners include the National Center for Atmospheric Research, NOAA's Forecast Systems Laboratory, Environmental Technology Laboratory and National Severe Storms Laboratory, Massachusetts Institute of Technology Lincoln Laboratory, NWS's Aviation Weather Center and Environmental Modeling Center, Center for Wind, Ice, and Fog Research at the Mount Washington Observatory, NASA Dryden, Langley and Glenn, Office of Naval Research, U.S. Army Cold Regions Research and Engineering Laboratory, and UPS, as well as several universities, airlines, port authorities, and cities.

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

Project SOCRATES provides direct wake turbulence measurement and support for FAA Air Traffic and Flight Safety capacity and safety initiatives. Wake turbulence activities are also closely coordinated with NASA and international research efforts.

MAJOR ACTIVITIES AND ANTICIPATED FY 2000 ACCOMPLISHMENTS:

- Developed initial integrated icing forecast algorithm.

- Commenced inclusion of turbulence in situ data into forecast models.
- Generated AGFS custom graphics of weather along user-specified flight routes.
- Tested radar improvements to provide rapid updates of hazardous weather.
- Conducted field test of storm growth and decay prediction technology.
- Developed 1-2 hour snow forecast.
- Conducted Juneau project field program with research aircraft.
- Implemented preliminary turbulence forecasting algorithm at the Aviation Weather Center.
- Obtained data in the SOCRATES proof-of-concept and analyzed follow on tests at JFK to define system improvements.
- Completed initial installation of a wake turbulence and wind monitoring system at San Francisco International Airport.

KEY FY 2001 PRODUCTS AND MILESTONES:

- Incorporate satellite data into in-flight icing guidance product.
- Implement AIRMET/SIGMET tools
- 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.
- Implement a 1-2 hour marine stratus burn off forecast for San Francisco International Airport.
- Implement phase I wind data ingest and dissemation system at Juneau Airport.
- Commence Phase I development of Oceanic Convective Nowcasting manual products.
- Develop west coast haze algorithm.
- Deploy enhanced wake turbulence monitoring system at San Francisco, under Project SOCRATES, to support parallel runway operations under reduced visibility conditions.
- Demonstrate eight-beam SOCRATES laser acoustic sensor.

FY 2001 PROGRAM REQUEST:

- Develop new algorithms for improved forecasts of freezing drizzle aloft, and west coast haze.
- Continue to develop automated data analysis and assimilation techniques.
- Transition weather research products to NWS, the FAA, and industry automation and weather systems.
- Develop oceanic convective nowcasting products.
- Commence national ceiling and visibility program.
- Design, fabricate, and test a SOCRATES eight beam laser acoustic system.
- Incorporate SOCRATES technology into San Francisco wake turbulence monitoring system.
- Provide wake turbulence support for developing terminal procedures for closely spaced, parallel runway operations at major airports.

A04a - Weather Program Product and Activities	FY 2001 Request ($000)	Program Schedule					
		FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY2005
041-110 Aviation Weather Analysis and Forecasting							
Develop Aviation Gridded Forecast System (AGFS)	$2,700						
Generated Custom Graphics of Weather Along User-Specified Flight Routes		◆					
Implement AIRMET/SIGMET Tools			◇				
Implement Interactive Convective SIGMET/AIRMET Ensemble Tools				◇	◇		
In-Flight Icing	$2,146						
Initial Development of Integrated Icing Forecast Algorithm		◆					
Incorporate Satellite Data into In-Flight Icing Guidance Product			◇				
Improve Year-Round Guidance Product and Severity/Type Forecasts				◇	◇		
Winter Weather Research	$617						
Develop Techniques to Detect/Forecast Precipitation Type and Rate, Incorporate Radar/Satellite Data				◇	◇	◇	
Storm Growth and Decay	$3,350						
Conducted Field Test of Storm Growth and Decay Prediction Techniques		◆					
Incorporate Boundary Layer Data, Transition to ITWS			◇				
Demonstrate 90-Minute Forecast				◇	◇		
Turbulence Algorithm	$2,400						
Inclusion of Turbulence Data into Models		◆	◇				
Complete In-Situation Based Detection Product Evaluation			◇	◇			
NEXRAD Algorithms	$1,375						
Tested Improvements for Rapid Updates of Hazardous Weather		◆					
Deliver Dual Polarization Algorithms to OSF					◇	◇	◇
Airborne Humidity Sensor	$300						
Complete Sensor Evaluation/FAA/NOAA Decision on Utility			◇	◇			
Juneau Terrain-Induced Turbulence Project	$3,100						
Implement Phase 1 System			◇				
Implement Operational System					◇		
Ceiling and Visibility	$2,710						
Implement Marine Stratus Burn-Off Forecast at San Francisco International Airport (SFO)			◇				
Model Development and Enhancement	$2,600						
Commence Development of Weather Research & Forecasting Model			◇				
Oceanic Convective Nowcasting	$1,000						
Commence Phase 1 Development of Products			◇				
National Ceiling and Visibility Program	$1,500						
Develop West Coast Haze Algorithm			◇				
Project SOCRATES	$3,200						
Completed Evaluation of 2-Beam SOCRATES System		◆					
Complete Evaluation of SFO Operational Configuration			◇				
Personnel and Other Costs	$791						
Total Budget Authority	**$27,789**	**$19,300**	**$27,789**	**$28,052**	**$28,491**	**$29,115**	**$29,942**

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

Budget Authority ($ in Thousands)	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Request
Contracts	11,683	14,500	17,836	18,635	26,998
Personnel Costs	1,093	664	817	629	705
Other Costs	224	136	36	36	86
Total	**13,000**	**15,300**	**18,684**	**19,300**	**27,789**

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