1993 Federal Aviation Administration Plan for Research, Engineering and Development

U.S. Department
of Transportation

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U.S. Department
of Transportation

**Federal Aviation
Administration**

Office of the Administrator

800 Independence Ave., S.W.
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The last few years have clearly demonstrated the rapid changes and growing challenges that the aviation industry and the Federal Aviation Administration (FAA) must face. To meet these challenges, the FAA cannot proceed with a "business as usual" attitude. We must develop innovative, cost-effective solutions to problems in the National Airspace System (NAS) that meet the aviation industry's needs in a timely manner. Also, we must take a total system approach when developing new systems so that we do not create a new problem in our attempt to solve an existing one.

The 1993 FAA Plan for Research, Engineering and Development (R,E&D) describes the FAA's efforts to develop technologies that address both current and projected NAS issues so that our Nation can maintain a competitive, robust aviation infrastructure. Continuing with the R,E&D Plan's evolution as a living document, this year the FAA introduced a revised R,E&D review process. This new process ensures that projects selected for funding address the agency's top requirements-driven priorities. More importantly, the new process strengthens the R,E&D Plan's system engineering approach so that new systems developed for future field implementation will have a smooth transition phase and function as an integrated whole within the NAS.

It is important to remember that this plan is not meant to function in a vacuum or as a rigid, inflexible blueprint for the FAA to follow. Just as new systems must be integrated to achieve a total systems approach, the R,E&D Plan must be integrated with other FAA plans to create a system development and implementation pipeline. The Capital Investment Plan and Airport Improvement Program are examples of other plans the FAA uses to implement the new systems, materials, or procedures that satisfactorily complete their development phase in the R,E&D Plan. Also, the R,E&D Plan must be as dynamic as the aviation industry so that the FAA can respond in a timely manner to new requirements from its "customers" in every segment of the aviation community.

We at the FAA are committed to ensuring a successful R,E&D program by fostering a closer partnership with our NAS users and operators while exploiting innovative technologies. In this context, the R,E&D efforts described in this plan contribute to maintaining the United States global aviation leadership.

David R. Hinson
Administrator

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1.0 OVERVIEW

1.1 Introduction To The Research, Engineering and Development (R,E&D) Program

The Federal Aviation Administration (FAA) manages and operates the National Airspace System (NAS), a significant national resource. However, the demands on this system are continuously growing, and changing technologies provide the opportunity to dramatically improve system effectiveness and efficiency. To this end, the FAA's R,E&D Program is an investment in the future that will sustain the United States preeminence in aviation throughout the world. Without this investment, the United States leadership would erode. Thus, the importance of aviation to the Nation mandates a comprehensive research, engineering, and development program to ensure both the safety of public air transportation and the fulfillment of national priorities and policy goals.

The contributions of aviation to the Nation's economy cannot be overstated. Aviation and related industries contribute over $600 billion to the United States economy (5.5 percent gross domestic product (GDP)), encompassing over 8 million jobs. Aviation is critical to business travel, tourism, and travel services (a $47.5 billion industry), as well as aircraft components ($24.7 billion), cargo and mail transport, and industrial national and international competitiveness.

Aerospace is by far the largest exporting industry for the United States, with a 1990 industry trade surplus of $27 billion. The United States is currently the recognized world leader in aerospace, aviation, and air traffic control. However, this leadership role cannot be sustained without continued research into new and evolving technologies.

Today, 23 of the country's largest airports are plagued by more than 20,000 hours of delay per year, which is projected to grow to 40 major airports by 2000. Nationally, air traffic delays cost the economy an estimated $6 billion in passenger delays and $3 billion in airline operating costs in 1990. At current trends, these costs will increase 50 percent within 10 years.

Aviation and related industries are also challenged by energy and environmental factors. Currently, 45 percent of air carrier aircraft operating costs are for fuel, a large portion of which is from imported oil. While reducing fuel usage is a priority in terms of energy conservation, it is also an increasingly critical environmental issue, based on recent findings relating to nitrogen oxide emissions at high altitudes. Given the projected increases in aviation activity and stringent environmental standards being proposed in Europe and elsewhere, noise and engine emissions reductions are essential to the national aviation industry's viability as well as being fundamental to fulfilling our environmental responsibilities.

The FAA must accommodate the increasing demand on limited airport and airspace capacity, deal with crucial airport security issues, and cope with the unforeseen problems of an aging aircraft fleet. These requirements pose unprecedented challenges, which can only be met through a major investment in R,E&D.

In recognizing these challenges, the Aviation Safety Research Act of 1988 requires the FAA to prepare a national aviation research plan describing R,E&D "...to ensure the continued capacity, safety, and efficiency of aviation in the United States, considering emerging technologies and forecasted needs of civil aeronautics, and provide the highest degree of safety in air travel."

1.2 National Priorities: Quality Results; Quality Delivery

The FAA R,E&D Plan is focused on an ambitious, but attainable, program that spans eight thrust areas and impacts the five key national priorities: (1) Economic Health and Productivity; (2) Technological Leadership and Competitiveness; (3) Aviation Safety and Security; (4) Fostering Intermodalism; and (5) Environmental Protection. A discussion of these national priorities and how they relate to this Plan follows:

Strengthening Transportation's Role in Supporting the Economy

There is little doubt of aviation's significance to the United States economy. With no additional major airports planned in the near term, the FAA must expand the current system's capacity while maintaining its safety and reducing its inefficiencies.

More automated air traffic control systems, higher capacity and more reliable communications, improved surveillance, enhanced detection and weather information dissemination, more flexible navigation and landing systems, and improved human/machine interfaces will provide NAS improvements (e.g., reduced delays and increased system capacity), while keeping pace with technology, and help maintain economic growth.

Research, necessary to accommodate and integrate new technological developments, will also help create markets for industry. With the increase in international competition, Government and industry must continue to expand and modernize our aviation transportation system rapidly, or the United States will likely suffer economic consequences in terms of future risk to jobs and business leadership.

Advancing U.S. Transportation Technology and Expertise

A primary R,E&D Program goal is to introduce technology advancements into the NAS without impeding aviation services or market mechanisms. Such technology advancements include new types of aircraft, avionics, and flight modes. Research is basic to long–term economic competitiveness since it supports developing enabling technologies at precompetitive stages of the R,E&D process. Only by maintaining the flexibility to integrate new technologies can we ensure that the United States will retain its technological leadership.

Aerospace is key to American technological leadership. Most Government and independent organizations compiling "critical technologies" lists have included technologies essential to the aviation industry, such as propulsion technology, advanced materials, simulation, and automated guidance and control. Examples of FAA research activities to accommodate such advances include satellite navigation and communication systems for traffic over oceans or remote areas; more flexible approach control and landing systems; flight profile optimization techniques; and air traffic models and evaluation tools.

Supporting the Safety of our Transportation System

The overall goal in this area is to reduce the probability and mitigate the results of accidents and terrorism. Research relating to engine and aircraft design will improve airworthiness and crashworthiness, plus eliminate engine and propulsion system failures, aircraft fires, and aging

aircraft safety concerns. Human factors and aeromedical research projects have been established to assess injury/fatality patterns and to develop measures that reduce the severity of these patterns. Developing the safest, most efficient aircraft systems also will benefit industry by increasing global sales for U.S. products.

Terrorism remains a threat, and attacks on aircraft or airports have always been a means to attract attention. During the Persian Gulf War, scheduled passenger miles on U.S. carriers decreased by over 16 percent internationally and by over 5 percent on domestic flights. To maintain public confidence in the NAS, new security technologies are being developed to ensure the highest criminal activity detection and prevention levels, while minimizing the disruption to air traffic services. Key initiatives include weapons and explosives detection measures, which are critical given the increased use of lightweight, nonmetallic materials in such devices; aircraft hardening techniques to minimize the impact of criminal activity; and airport design measures to minimize the risk and disruption to passengers, aircraft, and aviation services.

Fostering Intermodalism

Through research areas such as the FAA's Technology Transfer, Joint University, and Small Business Innovation Research programs, information and data gained through the R,E&D effort can be shared with government agencies and industries involved in other transportation modes. While FAA–sponsored R,E&D programs do not necessarily have direct applications for other modal transportation needs, the technologies developed for specific FAA requirements may have spin–off benefits. For example, airport pavement design theories and data gathered in the research process may benefit future highway construction. A major element in the FAA's pavement research is reducing life cycle costs by extending pavement life through a more comprehensive design theory and improved construction materials.

FAA R,E&D work in navigation and communication satellites can also have benefits for the automotive, rail, and shipping transportation modes. FAA satellite navigation research will adapt global positioning system (GPS) technology for many uses; however, aircraft precision landing is the most stringent application. Other transportation modes with less stringent requirements may be encouraged to use GPS with confidence or to adapt the FAA's technology for their own needs. FAA communications research in areas such as data link will dovetail with the navigation effort for potential shipping, truck, and rail industry tracking applications.

Strengthening the Linkage Between Transportation and Environmental Policy

The importance of aviation to the national economy and the projected increases in air travel provide the stimulus to reduce aviation's environmental impact. Key R,E&D areas include reducing engine emissions and aircraft noise. More efficient routes, traffic management, and fuel efficient engines all contribute to reducing emissions into the environment. Improved computer tools to systematically assess environmental effects will lead to better decisions on mitigating the impacts of agency actions.

Research is required to identify new engine designs that reduce emissions and thus counteract the potential impact future standards will have on U.S. manufacturers. The aviation community recommends developing engine/airframe technology that is 4 to 6 decibels quieter than Stage 3 aircraft. Both domestic and international requirements dictate R,E&D for establishing stricter standards that will allow the United States to manufacture engines with reduced emissions and noise while maintaining its world leadership

in a competitive market. In addition, developing more cost-effective environmental certification procedures will enhance the aviation industry's economic wellbeing.

Table 1 provides a synopsis of R,E&D programs contained in this plan, their benefits to users, and the national priorities to which they relate:

Table 1. Impact of R,E&D Programs on National Priorities

Program Area	Feature	User Benefits	Principal National Priorities
Air Traffic Management System	Ability to handle increased traffic	Reduce operating costs	Strengthening Transportation's Role in Supporting the Economy
		Reduce flight delays	
		Accommodate requested routes	
Oceanic Air Traffic Automation	Ability to handle increased traffic	Reduce operating costs	Strengthening Transportation's Role in Supporting the Economy
		Reduce flight delays	
		Accommodate requested routes	
Terminal ATC Automation	Ability to improve aircraft arrival capacities	Reduce operating costs	Strengthening Transportation's Role in Supporting the Economy
		Reduce flight delays	
Airport Surface Traffic Automation	Ability to prevent runway accidents/incidents	Improve safety on airport surface	Supporting the Safety of Our Transportation System and Strengthening Transportation's Role in Supporting the Economy
Aviation System Capacity Planning	Ability to provide short-term capacity improvements	Reduce impact of projected traffic bottlenecks	Strengthening Transportation's Role in Supporting the Economy
Traffic Alert and Collision Avoidance System	Ability to reduce chance for midair collision	Improve safety in air	Supporting the Safety of Our Transportation System and Advancing U.S. Transportation Technology & Expertise
National Simulation Capability	Ability to validate ideas	Reduce development risk	Advancing U.S. Transportation Technology & Expertise and Strengthening Transportation's Role in Supporting the Economy
	Ability to engage in applied research	Improve human factors	
Aeronautical Data Link	Ability to use data link capability fully	Reduce miscommunication between pilot and controller	Supporting the Safety of Our Transportation System and Strengthening Transportation's Role in Supporting the Economy
		Reduce congestion in communication links	
Airway Facilities Future Technology	Ability to define advance technology for future operations and management	Reduce operation costs	Supporting the Safety of Our Transportation System and Advancing U.S. Transportation Technology & Expertise
		Increase technology injection and improve NAS integrity	

Table 1. Impact of R,E&D Programs on National Priorities

Program Area	Feature	User Benefits	Principal National Priorities
Satellite Navigation	Ability to use satellites in aircraft navigation	Reduce operating costs Reduce delays	Strengthening Transportation's Role in Supporting the Economy, Advancing U.S. Transportation Technology & Expertise, and Fostering Intermodalism
Terminal Area Surveillance System	Ability to define next generation sensors	Increase terminal area capacity	Supporting the Safety of Our Transportation System
Weather Detection/ Dissemination	Ability to reduce impact of weather	Reduce delays due to weather	Strengthening Transportation's Role in Supporting the Economy and Supporting the Safety of Our Transportation System
Airport Technology	Ability to improve airport planning and design	Reduce airport and airline operating costs Reduce airport surface accidents	Strengthening Transportation's Role in Supporting the Economy, Supporting the Safety of Our Transportation System, and Fostering Intermodalism
Aircraft Systems Fire Safety	Ability to improve fire detection/suppression	Reduce fire-related injuries and deaths	Supporting the Safety of Our Transportation System and Fostering Intermodalism
Aircraft Crashworthiness	Ability to increase passenger protection from an accident	Reduce crash-related injuries and deaths	Advancing U.S. Transportation Technology & Expertise and Supporting the Safety of Our Transportation System
Propulsion and Fuel Systems	Ability to increase the safety, reliability, and durability of engine installations and fuel systems	Enhance airworthiness Reduce accidents	Advancing U.S. Transportation Technology & Expertise and Supporting the Safety of Our Transportation System
Flight Safety/ Atmospheric Hazards Research	Ability to improve methods for dealing with ice, lightning, and other hazards	Reduce accidents Develop criteria for aircraft design	Advancing U.S. Transportation Technology & Expertise and Supporting the Safety of Our Transportation System
Aging Aircraft	Ability to detect, control, and prevent aircraft structural weaknesses	Reduce accidents Develop criteria for aircraft design	Supporting the Safety of Our Transportation System and Strengthening Transportation's Role in Supporting the Economy
Aircraft Catastrophic Research	Ability to prevent catastrophic aircraft failures	Reduce crash-related injuries and deaths Reduce hull losses	Supporting the Safety of Our Transportation System and Advancing U.S. Transportation Technology & Expertise
Threat Detection	Ability to improve weapons and explosives detection	Eliminate civil aviation as a terrorist target Increase public confidence	Supporting the Safety of Our Transportation System and Advancing U.S. Transportation Technology & Expertise

Table 1. Impact of R,E&D Programs on National Priorities

Program Area	Feature	User Benefits	Principal National Priorities
National Airspace System Security	Ability to evaluate security improvement ideas	Reduce security threats	Supporting the Safety of Our Transportation System
Aircraft Hardening	Ability to reduce damage from explosives	Reduce explosive-related injuries and deaths	Supporting the Safety of Our Transportation System and Advancing U.S. Transportation Technology & Expertise
		Reduce hull losses	
Human Factors	Ability to reduce human errors or inefficiencies	Reduce human-caused accidents, incidents, and inefficiencies	Supporting the Safety of Our Transportation System and Strengthening Transportation's Role in Supporting the Economy
Environment and Energy	Ability to reduce noise and air pollution	Improve air quality	Strengthening the Linkage Between Transportation and the Environmental Policy, and Advancing U.S. Transportation Technology & Expertise
		Reduce aviation noise impacts	
Innovative/Cooperative Research	Ability to develop new ideas jointly	Stimulate market productivity	Advancing U.S. Transportation Technology & Expertise and Strengthening Transportation's Role in Supporting the Economy
		Increase technology injection	

1.3 Goals

The NAS goals listed in both the Capital Investment Plan (CIP) and the R,E&D Plan were derived from the R,E&D goals listed in previous R,E&D Plan editions. The FAA is in the process of reviewing and refining these goals to ensure that they are measurable and attainable. For this reason, the NAS and R,E&D goals listed in the charts below are an interim step in the goal development process. When this review is complete, these interim goals will be modified. The charts below depict the NAS goals and R,E&D–specific goals.

NAS Goals Supported by the R,E&D Plan

- Reduce the civil aviation fatality rate from all causes by 10 percent by 2000

  For 1990, 1991, and 1992 the respective fatality rates were 14.5, 16.4, and 15.9 fatalities per million departures.

- Reduce the number of accidents attributable to weather by 20 percent by 2000

  For 1990 and 1991 the respective accident and incident rates attributable to weather were 15.9 and 15.2 per million departures.

- Reduce runway incursions by 80 percent by 2005

  For 1990, 1991, and 1992 the respective runway incursion rates showed a decrease from 25.3 to 21.3 to 20.3 incursions per million departures from airports with FAA towers.

- Ensure that system capacity will meet demand

- Reduce weather–related delays by 15 percent by 2005

  For 1990, 1991, and 1992 the respective delay rates for all the delays of 15 minutes or more were 6,647, 5,006, and 4,784 delays per million departures. These delays are caused by a combination of factors, including capacity reduction due to weather.

- Accommodate a projected doubling of oceanic air traffic demand by 2010

  Total oceanic traffic volume in 1990, 1991, and 1992 amounted to 840,000, 853,000, and 862,000 respectively. With a projected growth rate of five percent per year, oceanic traffic is one of the fastest growing areas in air transportation demand.

- Provide more user–preferred routes and altitudes to minimize aircraft operating costs

  The current air traffic system in the oceanic regions consists of a number of fixed tracks and step–climb procedures. Oceanic flights in the Pacific currently use a flexible track procedure, which allows aircraft to fly wind–favored tracks, determined by United States planners on a daily basis. Depending on oceanic traffic volume and congestion, current oceanic procedures allow aircraft step–climbs to reach a more favorable altitude.

R,E&D–Specific Goals

- Reduce the costs of pavement expenditure by at least 10 percent by 2010

  Currently over $2 billion is spent each year in pavement design, rehabilitation, construction, repairs, and maintenance.

- Develop advanced aircraft fire safety and crashworthiness technologies by 2005

  During the 15–year period from 1975–1990, there have been over 1,200 fatalities in impact-survivable accidents. Forty percent of these fatalities were attributed to fire.

- Develop advanced technologies that increase assurance of aging and in–service aircraft structural integrity and minimize the potential for aircraft catastrophic failure by 2001

  From 1981-1992, there were 16 accidents and incidents resulting from catastrophic or structural failures involving contemporary and aged aircraft.

- Reduce accidents and incident rates attributable to controller, flightcrew, and maintenance crew human error

  For 1990 and 1991 the respective accident rates attributable to human factors decreased from 60.2 to 58.3 per million departures.

- Provide satellite-based non-precision approach capability at 95 percent of airports currently having approved approaches by 1996

  In 1993 the FAA approved the GPS overlay program for 5,000 non–precision approaches at 45 percent of airports (approximately 2,500 of the 5,545 public use airports). Having satisfied the original goal for non-precision approaches, this goal has been updated to include GPS for precision approaches.

- Anticipate new threats and develop and implement new security philosophies technologies, and systems that operate effectively with minimal interference to passengers and carriers

1.4 R,E&D Initiatives and Accomplishments

The table below is a mapping of goals to R,E&D initiatives and accomplishments. The R,E&D initiatives column outlines broad program areas undertaken by the FAA in support of the corresponding goal. The accomplishments column depicts some of the recent strides made towards achieving the corresponding goal.

NAS Goals Supported by the R,E&D Plan

Goal	R,E&D Initiatives	Accomplishments
Reduce the civil aviation fatality rate from all causes by 10 percent by 2000	• Two complementary focuses – reduce accident rate – increase survivability of accidents • Specific programs address – safer aircraft flight operations – improved delivery of weather information to pilots and controllers – advanced collision avoidance technology – improved human factors – elimination of catastrophic failures	• Developed the Traffic Alert and Collision Avoidance System (TCAS) which will be installed on all airlines operating in the United States • Validated innovative, deicing protection technologies and certification techniques
Reduce the number of accidents attributable to weather by 20 percent by 2000	• Basic and applied weather research to – improve forecasts – provide real–time warning – develop airborne sensors – develop an airborne windshear evaluation and certification system	• Established multiagency program to provide real–time weather information to pilots and controllers • Demonstrated improved thunderstorm forecasting capability • Completed ground testing of airborne humidity sensor • Completed flight experiments of windshear detection system
Reduce runway incursions by 80 percent by 2005	• The airport surface traffic automation program includes – surveillance sensor integration – aural and visual controller warnings – electronically controlled airfield lights	• Completed testing of airport movement area safety system (AMASS) at San Francisco International airport • Successfully demonstrated automatically controlled runway status light system at Boston's Logan International Airport • Developed standards for stop bar system for controlling aircraft movement in low visibilities

NAS Goals Supported by the R,E&D Plan

Goal	R,E&D Initiatives	Accomplishments
Ensure that system capacity will meet demand	• Broad R,E&D thrusts include – automated flow management – ATC automation systems and controller aids – improved information and digital communication systems – improved airport pavements – vertical flight in short–haul transportation system	• Began implementation of automated demand resolution functions • Completed instrument approach procedures for triple parallel runways at 5000 feet apart • Predeparture clearance procedures now operational at 31 rts • Demonstrated digital . ated terminal information system (ATIS) at three airports • Began field development of automated Center–TRACON automation system (CTAS) • Completed design of pavement testing machines
Reduce weather–related delays by 15 percent by 2005	• Capacity improvements under instrument meteorological conditions (IMC) – automated flow management – improved information and communication systems • Basic and applied weather research to – improve forecasts – provide real–time warning – develop airborne sensors	• Began implementation of automated demand resolution functions • Converging runway display aid (CRDA) field implementation at St. Louis • Developing programs to provide real–time weather information to pilots and controllers • Completed ground testing of airborne humidity sensor

NAS Goals Supported by the R,E&D Plan

Goal	R,E&D Initiatives	Accomplishments
Accommodate a projected doubling of oceanic air traffic demand by 2010 and Provide more user–preferred routes and altitudes to minimize aircraft operating costs	• Develop satellite–based, direct, two–way (voice & data) communication capability • Develop in–flight rerouting capability to optimize routes • Reduce oceanic separation standards while enhancing safety • Develop automatic transmission of aircraft position to ATC via data link • Develop digital communication system • Develop oceanic track display system • Develop oceanic aircraft conflict resolution capability	• Completed avionics certification standards for supplemental global positioning system use over the ocean • Delivered testbed for digital voice communications • Provided regulatory and implementation materials in support of 1000 feet vertical aircraft separation standard in the North Atlantic • Developed prototype two–way data communications systems for ATC clearances • Developed traffic management display system • Developed flexible track generation and traffic advisory capabilities in the Central Pacific

R,E&D-Specific Goals

Goal	R,E&D Initiatives	Accomplishments
Reduce the cost of pavement expenditure by at least 10 percent by 2010	• The pavement initiatives include: – pavement design and evaluation – pavement materials and construction – pavement maintenance and repairs	• Developed a comprehensive long and short term pavement research plan • Completed instrumentation installation at the new Denver airport for pavement evaluation • Completed development of layered elastic theory for pavement design • Completed design specification for national pavement test machine
Develop advanced aircraft fire safety and crashworthiness technologies by 2005	• Aircraft safety and crashworthiness initiatives include: – ultra fire resistant aircraft cabin – improved aircraft structures/materials – improved occupant protection/ evacuation	• Completed fire suppression and containment tests, including a new technology water spray system • Completed fuselage fire-hardening tests • Developed mechanical property test methods for composite aircraft structures
Develop advanced technologies that increase assurance of aging and in–service aircraft structural integrity and minimize the potential for aircraft catastrophic failure by 2001	• Aircraft structural technology research addressing: – aging aircraft structural design, improved maintenance and inspection and performance analysis – catastrophic failure prevention relating to aircraft airframes and all aircraft systems	• Developed criteria for estimating residual strength of aging aircraft structural components • Developed aging aircraft training material for inspectors and advisory information for industry • Developed prototype systems for non-destructive inspections • Developed risk analysis assessments for in-service aircraft.
Reduce accident and incident rates attributable to controller, flight crew, and maintenance crew human error	• Specific human factors technologies addressing – aircraft flight deck – air traffic control (ATC) – aircraft maintenance – airway facilities – flight deck/ATC integration	• Completed prototype flight deck information management system • Advisory circular on controlled in–place crew rest • Developed prototype intelligent tutoring systems for maintenance specialists

R,E&D-Specific Goals

Goal	R,E&D Initiatives	Accomplishments
Provide satellite-based non-precision approach capability at 95 percent of airports currently having approved approaches by 1996.	• Global Navigation Satellite System (GNSS) research program –national and international	• Completed avionics certification standards • Approved procedures for 5,000 certified global positioning system non–precision approaches at 2,500 U.S. airports
Anticipate new threats and implement new security philosophies, technologies, and systems that operate effectively with minimal interference to passengers and carriers	• Several interrelated thrust areas include advances in: – explosives detection – weapons detection – airport security – security systems integration – aircraft hardening • Cooperative efforts with other U.S. agencies as well as several international working agreements	• Conducted vulnerability assessment of FAA facilities • Developed prototype weapons and explosive detection technology • Deployed dual–sensor nuclear and X–ray technology systems for explosive detection at international gateway airports • Demonstrated feasibility of explosive resistant luggage container

1.5 Planning For The Future Aviation System

The 21st century aviation system will have less noise, fewer fatal accidents, fewer acts of terrorism, and reduced passenger delays. The future system will be planned to accommodate a broad user spectrum that includes single engine general aviation aircraft, business aircraft, helicopters, commercial aircraft, and military aircraft of all types. It will also be able to accommodate new generation designs such as tiltrotor vehicles, supersonic, and possibly even hypersonic aircraft.

The aviation system will be international in scope. The changes that are taking place around the world and the rapid increases in the demand for aviation services worldwide, all underscore that we cannot operate independently. The future system will be designed by sharing key technologies with other aviation authorities.

System development will be evolutionary. While it is tempting to design on a "clean sheet of paper" and to propose radical changes, the reality is that changes will evolve systematically.

The Secretary of Transportation's comprehensive policy vividly describes the Nation's transportation infrastructure needs. The FAA's Strategic Plan, based on the NTP, provides the long–term goals and objectives that the agency is working toward. The R,E&D Program will be used to determine which systems and technologies should be pursued to accomplish these goals and objectives. As R,E&D programs near completion, they may begin a transition stage to the Capital Investment Plan. The CIP provides the framework for investing in the facilities and equipment needed to improve the NAS.

The FAA has documented a description of the future Air Traffic Management (ATM) system. The description and technical basis for this vision appear in the Administrator's "A Vision of the Future, the ATC System Beyond the NAS Plan" and the FAA's "Concepts and Description of the Future Air Traffic Management System for the United States." The latter is contained as an appendix to the FAA Strategic Plan.

The vision has broad support from the R,E&D Advisory Committee, users, industry, and the international community through the International Civil Aviation Organization. However, to bring the vision to operational reality in a reasonable time requires a substantive and aggressive R,E&D Program. Among the vision's elements are:

- Satellite communication technology for air/ground communications over oceans and sparsely populated areas.

- Satellite navigation systems for aviation (and all transportation) over oceans, in less developed parts of the world, and in providing high quality approach guidance to any runway end anywhere in the world.

- Air traffic control (ATC) digital communications, or data link, to increase safety by reducing misunderstood communications, and, most importantly, in connecting aircraft systems with ATC automation systems.

- Airborne collision avoidance systems, in themselves a major safety tool, that are available to create, in the cockpit, a valuable picture of the traffic situation around the aircraft. Working with the ATC system, such capabilities will lay the basis for a system having greater capacity and enhanced safety.

- Flight management systems, increasingly available in modern transport aircraft, that can facilitate major improvements in working with ATC to create optimal flight profiles.

- Air traffic management and control automation technology that will create major improvements in strategic flow management

across the country, providing users more direct routes. Automation in terminal airspace will significantly increase capacities while reducing controller workload.

- Better air traffic surveillance systems. Mode S Secondary Surveillance Radar, satellite and terrestrially–based Automatic Dependent Surveillance, new surface surveillance tools, and fast–scan radar will revolutionize the ability to track an aircraft's position.

- Better ways to acquire and use weather and environmental data are on the horizon. Major strides have been made in windshear detection, gathering winds aloft data, and severe storm forecasts. Reducing the impact of wake vortices, a detriment to airport capacity, is possible.

- Airway Facilities Operation Control Center to improve operational integrity of all fielded systems.

Additionally, the FAA is pursuing a vision to enhance safety and security for aircraft occupants. Elements include:

- Materials that further protect the fuselage and cabin interior from burnthrough.

- Water spray systems for fire protection inside the cabin.

- In–flight smoke venting systems to discharge smoke and noxious fumes prior to landing.

- Expanding technologies to detect explosives carried by passengers, in baggage, or in cargo.

- Aircraft hardening techniques to better contain explosive forces.

- Improved nondestructive inspection techniques to identify fuselage cracks and corrosion.

- Aircraft design materials and construction techniques to enhance long term airworthiness, improve crashworthiness, and prevent catastrophic failure from all sources.

1.6 R,E&D Plan Components

This year's R,E&D Plan describes the FAA's program for achieving the future system vision. It provides the underpinnings of a comprehensive program designed to carry us from the present to the next generation National Airspace System. The Plan contains details to meet the challenges from a dynamic aviation system posed by growing demand, limited capacity, a changing work force, threats to security, and emerging key technologies adaptable to aviation.

To help the reader understand the FAA's integrated R,E&D efforts, the Plan groups this comprehensive program into eight research areas:

- Capacity and Air Traffic Management Technology (Chapter 2).

- Communications, Navigation, and Surveillance (Chapter 3).

- Weather (Chapter 4).

- Airport Technology (Chapter 5).

- Aircraft Safety Technology (Chapter 6).

- System Security Technology (Chapter 7).

- Human Factors and Aviation Medicine (Chapter 8).
- Environment and Energy (Chapter 9).1/

1.7 The Imperative

In the final analysis, the FAA must pursue an effective R,E&D Program because the country cannot afford anything less. Transportation, commerce, national defense, and the national welfare demand increased system capacity and security with no reduction in safety levels. These goals can only be achieved and maintained by aggressively pursuing new and better ways to do things. The Plan is a "snapshot" of a continuous process that cannot follow a fully predictable path, but that does have clear vision of where it is headed.

The projects in this Plan are those needed to bring the FAA's vision of the future system to reality in the context of a continuing top-level system engineering process. The Plan has enjoyed contributions from across the spectrum of scientific, operational, and user communities.

These contributions from both inside and outside Government are solicited and greatly appreciated.

1/ The research areas are comprised of one or more projects that are described in the subsequent chapters of this R,E&D Plan. Each project is identified by a six-digit number. This number ties the project to a research area and correlates it with the FAA budget.

2.0 CAPACITY AND AIR TRAFFIC MANAGEMENT TECHNOLOGY

ATC SYSTEM CAPACITY AND AUTOMATION TECHNOLOGY

A major FAA Research, Engineering and Development (R,E&D) aim is to safely increase air traffic control (ATC) system capacity. Automating the ATC information gathering process is already advanced, but requires major improvement and augmentation in the supporting technologies. The need to help controllers/system managers cope successfully and efficiently with increasing numbers of more demanding and capable aircraft requires introducing automation aids for conducting the ATC process itself. While in the past it was possible to spread the work among a variety of separable functions (oceanic, en route, terminal, tower/airport, etc.), efficient operations now demand carefully integrating and managing aircraft flows throughout the operating regime without artificial "walls."

Increasingly, the air traffic management (ATM) process and its supporting elements must be considered a single system. In the following material, the term "air traffic control" refers to the tactical safety separation service that prevents collisions between aircraft and between aircraft and obstructions. "Traffic flow management" refers to the process that allocates traffic flows to scarce capacity resources. "Air traffic management" is the composite process ensuring safe, efficient, and expeditious aircraft movement. Air traffic control and traffic flow management are components of the air traffic management process.

Further ATM system development must be evolutionary. There is often the temptation to design on a "clean sheet of paper" to take full advantage of new capabilities that new technology offers. The reality is that transition and integration are the most difficult institutional problems facing system designers. However, while change in the system will be evolutionary, the design for the future is intended to provide a well–understood, manageable, cost–effective improvement sequence. These improvements will keep pace with user needs for safety, capacity, efficiency, and environmental demands.

PROCEDURES AND SEPARATION STANDARDS

The ATM system is fundamentally based on a system of rules and procedures scrupulously applied to achieve a safe system in which all participants understand their responsibilities.

Emerging technologies and aircraft capabilities will require changes to the rules and operational procedures, because the new capabilities permit far more cooperative arrangements between the controller and the pilot than before. These evolving capabilities include: flight management systems, data link, more capable ground computer data processing/display systems, inertial reference, and navigation systems.

Because separation standards have an important influence over the future system's capacity and functioning, it will be necessary to develop comprehensive, reliable models for determining separation standards based on new technologies and procedures.

An important additional initiative will be to improve the procedures development process so that users contemplating an investment in new technology can have reliable guidance on a new capability's benefits before they make the investment.

En route airspace capacity will be substantially improved by reducing the vertical separation standard above 29,000 feet from 2,000 feet to 1,000 feet through increased altimetry accuracies and procedures.

IMPROVING THE INFORMATION AVAILABLE FOR ATM

ATM quality depends on the dynamic air traffic management plan's efficacy and its ability to adapt rapidly to changing circumstances. The future ATM system can be no better than the information available to it.

The R,E&D challenge is to develop and implement better sensors, better information sources, and the communications links that permit the information to be used efficiently by people and computers.

Best airspace and airport use requires an efficient airspace structure that permits dynamic planning in the aircraft and in the ATM system. The airspace structure must dynamically adapt to changing circumstances, accommodate the aircraft user's capabilities and desires, and utilize data available in the aircraft.

INFORMATION ON THE DYNAMIC CHANGE IN AIRPORT CAPACITY

The traffic flow management process, whether central or local, depends heavily on current actual and short–term predicted airport capacities. These capacities in turn depend on environmental factors as well as airport circumstances – runway and facility availability, runway configuration strategy, special noise considerations, wake separation requirements, taxiway/holding area availability, and other factors. The future system will have the best possible data on actual and short–term projected airport capacities.

INFORMATION ON AIRCRAFT POSITION AND MANEUVER INTENTION

The ATM process depends on the position information quality available to the ATM system and the flightcrews.

In the future system, the basic source of accurate aircraft position data will be the altitude–reporting Mode S secondary surveillance radar (SSR) transponder. Other position data sources, such as relaying aircraft–derived navigation position using GNSS, the Global Navigation Satellite System,[1/] may come into use and should be acceptable if their accuracy, availability, and integrity are proven adequate. However, SSR Mode S surveillance will be the standard for high traffic terminal area operations.

Accurate airport surface surveillance, navigation, guidance, and control information will increasingly be required to support automating the ATM process at the busiest airports. There are several sources for this service, including airport surface detection radar augmented by positive identification using the Mode S system in a multilateration mode or transmitting aircraft GNSS position data. Other new technologies are also appearing, and the need for rapid data

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1/ GNSS is a generic term that comprises the United States Global Positioning System (GPS) and the Commonwealth of Independent States Global Orbiting Navigation Satellite System (GLONASS).

communications is apparent. A system study and system decisions about the proper roles for various system elements – electronic, visual aids, signage, etc., are important near–term challenges.

AIR TRAFFIC MANAGEMENT AUTOMATION

The core of the benefits of the future system to the users will be derived from ATM system automation.

The approach for the future is to seek the correct balance between strategic planning, tactical execution, and modifying the plan as near as possible to the scene by rapidly exchanging information from all available sources.

While the present system can and does adapt to changing circumstances (aircraft mix changes, runway configuration changes, severe weather problems), the system depends heavily on a route structure designed for the specific geographic area. Rapid changes are possible but are difficult and require a high skill level because present computers are limited in capacity and flexibility. Controllers must, out of necessity, limit dynamic changes because the number of alternatives are virtually limitless and the number of variables which a highly skilled and experienced controller can handle safely, are strictly limited. Developing new tools to help controllers handle more variables, and thus make the system more flexible, will be a major system change.

A part of this increasing flexibility involves rapid communication and data exchange between aircraft and the ground ATC system.

THE AIR TRAFFIC CONTROL AND SEPARATION PROCESS

In the future the computer/data processing/display system, with "expert system" help, will give controllers the capability to supervise the situation. Because the aircraft systems will be in automatic communication with the ATC system, they can provide instant information on the cockpit crew's desires and capabilities. The ATC system can then utilize these capabilities to plan the terminal traffic flow in an optimum fashion for both the individual aircraft and the system. After the planning and decisionmaking are done, the controller can then automatically execute the plan.

New ground ATC automation systems and controller aids can provide enormous benefits to aircraft operators and the National Airspace System by fully utilizing the navigation and flight management capabilities that modern aircraft offer. In order for the controller to fully comprehend the traffic situation today, it is necessary to limit the alternatives available to aircraft in terms of acceptable routes and profiles. Yet, an increasing number of aircraft have highly capable flight management systems that can offer and execute optimum flight profiles and routings. However, these optimum profiles and routings cannot be accommodated by the current restricted–capability ATC system, which results in fuel, time, and airspace inefficiencies.

Terminal and en route automation functions will be integrated using automation to provide a system in which traffic flows smoothly into and out of terminal areas. Military airspace requirements and utilization will be fully coordinated with the civil system to ensure that airspace not in use by the Department of Defense is available to accommodate civil traffic demand.

Aircraft not equipped with flight management computers capable of communicating with ATM automation will communicate with the ground–based system via data link and voice channels. Ground–based automation aids will be available for use in developing flight–plan amendments and control instructions with these operators.

TRAFFIC FLOW MANAGEMENT AND CONTROL

The traffic flow management objective is to fully utilize system capacity resources and ensure that unacceptable traffic congestion levels do not occur by efficiently managing traffic without unnecessary flow restrictions.

The vital ingredient to successful traffic flow management is tightly integrating the central traffic flow management process, where it applies, with local traffic flow management systems and terminal automation. Because of implementation timing differences, not all the system elements will appear at the same time, but the system design must ensure that the elements mesh properly.

As aids to traffic flow management in the future system, real–time automation tools are required to assimilate the mass of information and to offer flow strategies that take full advantage of changing terminal area and airport conditions. Because aircraft themselves have sophisticated flight management systems that can adapt to changing situations and will be in automatic communication with the ground, they will be valuable partners in the traffic flow management decisionmaking process.

OCEANIC OPERATIONS

International air traffic is growing at a rate far exceeding the growth in domestic activity. This area provides a full breadth of opportunity to benefit from new technologies and will experience significant improvements through the next decade. The overall goal will be to make oceanic operations as flexible as reasonably possible in accommodating user–preferred trajectories.

Future oceanic operations will extensively use automatic dependent surveillance (ADS), satellite–based voice and data link communications, GNSS, cockpit traffic display, aviation weather system improvements, and automation to integrate ATM systems with flight management computer operations via data link. These new capabilities will permit flexible routing for system users and dynamic modifications to aircraft routes. This includes reducing oceanic separation standards to levels close to domestic operations and responding to changes in weather or traffic conditions.

ACHIEVING INTERNATIONAL HARMONIZATION OF AIR TRAFFIC MANAGEMENT DEVELOPMENTS

The future system adopted in the United States clearly must be compatible with developments worldwide. It must be possible to equip international aircraft with a single avionics set that is usable everywhere. It is not acceptable to require one avionics set within the United States and a different set overseas, each performing essentially the same functions. Moreover, if international operators improve their onboard capabilities to exploit service improvements implemented in one country, the return on their investment will be enhanced if the same improvements are implemented in other countries. In oceanic areas, some service improvements cannot be implemented meaningfully by only one country; that is, in only one flight information region. Reduction in separation standards, for example, must be implemented in all contiguous regions through which aircraft will travel.

A RANGE OF SUPPORTING RESEARCH AND DEVELOPMENT NEEDS

The above future ATM system capability description will be made a reality through the connected and integrated research and development projects described in this chapter. The specific projects and discussions of their relationship to the future system (i.e., the justifications for the work) are described, and they are keyed to the preceding discussion.

Improvements in system capacity and introducing automation require activities in a number of support areas and are keyed to specific projects in the following sections. The primary support areas are: communications, surveillance, weather, collision avoidance/traffic alert and collision avoidance system (TCAS), airport capacity technology, and modeling tools for integration, planning, and capacity analyses.

DEVELOPMENT CHALLENGES

The FAA R,E&D efforts needed to achieve increased ATM system capacity and to introduce automation technology represent a major effort with many important challenges to the FAA's and the Nation's R,E&D community. Among the many challenges, the following may stand out in importance:

- To develop a system architecture and create a system design that recognizes and accommodates the full ATM system demands as an integrated whole.
- To establish the appropriate balance between the basic ATC separation processes and the overlying flow management/control system.
- To establish the best ways for controllers/system managers to interact with and effectively use automation systems to safely and efficiently handle more variables.
- To achieve the correct balance between strategic planning, tactical execution, and modifying the ATM as near as possible to the scene. This will be accomplished by rapid information exchange from all available sources and by using alternative plans created by rule-based computers.
- To establish the best tactical responsibility balance between participating flightcrews with increasingly capable aircraft systems and the centralized ATM system.
- To achieve basic increases in airport capacity and en route/transition sector capacity.
- To create a digital communications system architecture that permits implementing a variety of data link services (space, terrestrial, airport surface, administrative) without requiring multiple data links or excessive overhead communication burdens.
- To create a new level of safety and operational efficiency by developing a full–time airport surface traffic management system.
- To create an ATM system for oceanic areas and remote land areas that emulates U.S. domestic airspace standards by using new surveillance, navigation, and communications technologies.
- To use environmental information from participating aircraft in operating the ATM system.

2.1 Capacity and ATM Technology Project Descriptions

021–110 Advanced Traffic Management System (ATMS)

Purpose: This project will develop automated techniques to enhance and better use system capacity resources and eliminate unnecessary flow restrictions. The result will reduce operating costs and flight delays through a more efficient and effective national flow management process.

Approach: The ATMS project is the research extension for the operational Enhanced Traffic Management System (ETMS) Program. The project captures the classic problem solving approach to enhance the national flow management process. This approach has identified six discrete and evolutionary automation enhancements, including a need to enhance airspace usage coordination between military and civil agencies. The six automated elements are: (1) displaying the traffic situation (aircraft situation display (ASD)), (2) alerting flow managers to projected congestion conditions (monitor alert function (MA)), (3) generating alternative flow management strategies (automated demand resolution (ADR)), (4) integrating military airspace planning into the civil flow management process (dynamic special use airspace) (DSUA)), (5) evaluating the operational impact of those alternative strategies (strategy evaluation (SE)), and (6) automatically selecting and implementing the "best" strategy (automatic execution function (AEX)).

The migration of functions from research to operational applications is facilitated through a computer complex shared by the ATMS and ETMS programs. This complex, located at the Department of Transportation's Volpe National Transportation Systems Center (VNTSC), is comprised of five groups/strings of distributed processors. The ATMS flow functions are initially researched on the developmental D–string; more mature functions migrate to the E–string for operational evaluations, and finally, flow functions identified as operational requirements transition to the ETMS Program Office where they migrate to the operational A-, B-, and C-strings.

Related Projects: 021–140 Oceanic Air Traffic Automation, 021–180 Terminal ATC Automation (TATCA), 021–190 Airport Surface Traffic Automation (ASTA), and 025–120 Operational Traffic Flow Planning. Capital Investment Plan projects: 21–06 Traffic Management System (TMS), 21–13 Automated En Route Air Traffic Control (AERA), 61–22 ATC Applications of Automatic Dependent Surveillance (ADS), 61–23 Oceanic Automation System (OAS), and 62–20 Terminal ATC Automation (TATCA).

Products: The following products build upon the completed Aircraft Situation Display and Monitor Alert functions:

- Automated Demand Resolution Function
- Strategy Evaluation Function
- Automated Execution Function
- Dynamic Special Use Airspace Function

FY 1992–1993 Accomplishments:

- Commenced initial evaluation of ADR–1 re–route function and ADR–2 multiple airport scheduler function on the E–string.
- Completed transition strategies analysis of open computer system architectures that allow hardware/software compatibility.

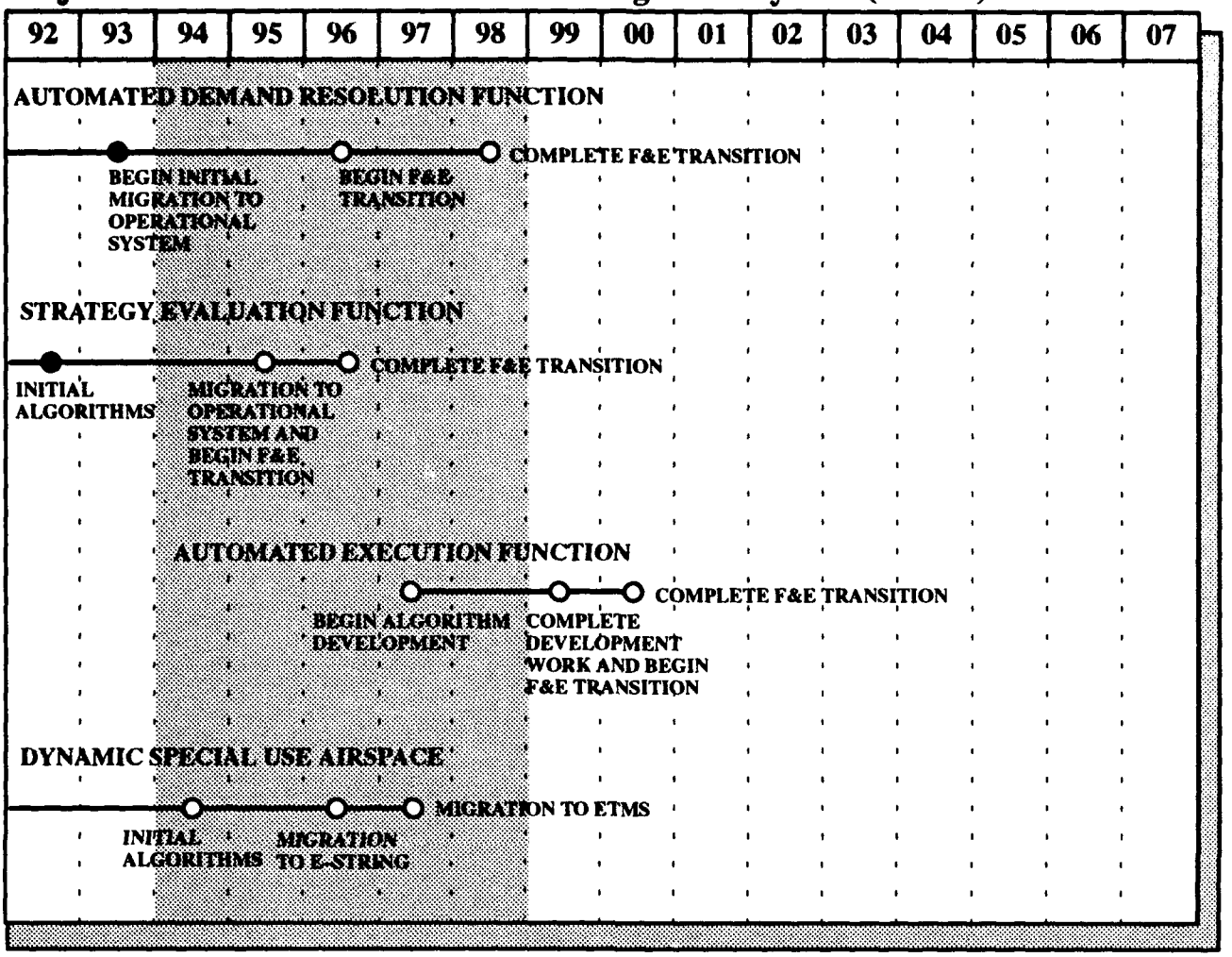
Planned Activities:

Beginning in FY 1994, the remaining ADR functions that incorporate en route congestion, airport dynamics, weather conditions and military airspace usage will be developed through FY 1996. F&E transition will begin in FY 1996 and be completed in FY 1998. The ADR function will provide incremental enhancements to generate real–time, system level, alternative national flow management strategies that reflect demand, weather, and special use airspace conditions.

Dynamic special use airspace automation algorithm development will begin in FY 1994 with migration to the E–string beginning in FY 1996. The DSUA function will automate and coordinate military special use airspace with the FAA flow management system. The dynamic special use airspace function will be evaluated and refined for planned transition to the ETMS in FY 1997.

In FY 1994, the SE function development will be complete and migrated to the operational system in FY 1995. Facilities and equipment (F&E) transition will begin in FY 1995 with projected completion in FY 1996. The SE function will provide the capability to compute real–time operational impact analysis on alternative national flow management strategies. The AEX function development will complete the domestic flow management automation system. This function will generate and distribute facility and/or aircraft specific flow management instructions that implement a selected national flow strategy. The AEX algorithmic development will begin in FY 1997 and be completed in FY 1998. AEX F&E transition will begin in FY 1999 and be completed in FY 2000.

Project 021–110: Advanced Traffic Management System (ATMS)



021–140 Oceanic Air Traffic Automation

Purpose: The current oceanic system is very different from the rest of the domestic National Airspace System (NAS) and has some inherent limitations. The oceanic environment has no radar coverage and navigation is handled using only aircraft on–board systems. Air traffic operations are performed manually or with limited automation, and air/ground communications are through a third party via high frequency (HF) radio that are subject to a variety of atmospheric as well as human error. Consequently, there is a requirement for large separation standards that limit user–preferred route flexibility and efficiency. Without improvements, oceanic airspace will be unable to support continued air traffic growth.

This project is aimed directly at enhancing capabilities to increase oceanic air traffic capacity and efficiency without degradation to safety.

Approach: Research efforts will focus on requirements analysis; National/International standards and procedures; traffic management and

control automation; and comprehensive, full–system simulation testing capabilities.

The Oceanic Automation project combines three oceanic R,E&D projects (ADS, Dynamic Ocean Track System (DOTS), Oceanic Automation) to achieve a total systems engineering approach.

Standards/Requirements

The FAA must adhere to International Civil Aviation Organization (ICAO) standards for the airspace delegated to the United States. The Oceanic Project Office will participate on international committees to coordinate agreement for global standards and requirements.

Studies and Analysis

The studies program will identify new air traffic control procedures and automation necessary to increase the airspace users' operating efficiency. The R,E&D Oceanic Program Office completed a Technical Management Plan to focus and prioritize the requirements for Oceanic R,E&D Studies. The studies are categorized into three major areas: Airspace Utilization, System Development, and Advanced Functions.

Traffic Management

The traffic management effort will provide oceanic traffic managers with automation designed to improve fuel and time efficiencies for oceanic airspace users. Development efforts include the DOTS functions of generating flexible tracks to take advantage of favorable weather conditions and providing traffic managers with a traffic display system. Another effort will include a track advisory function that electronically provides airlines with anticipated traffic conditions. Also capabilities will be developed for transferring traffic management information between international ATC facilities. These oceanic traffic management functions will ultimately be integrated with the domestic traffic management system (TMS).

When fully developed, the traffic management system will provide airspace structuring that will reduce controller workload and safely increase system capacity to help cope with the ever increasing demand for transoceanic travel.

Traffic Control

Air traffic control is based on three core elements: communications, navigation, and surveillance. This subproject concentrates on the communications and surveillance core areas. Project efforts are focused on developing ground–based systems utilizing ADS technology and satellite communication links. Specifically, development efforts will upgrade oceanic display and planning system (ODAPS) technology with new displays and controller input–output devices. Added capabilities will include electronic ATC clearance delivery to aircraft, enhanced conflict detection and resolution, and electronic flight strip displays.

Testing

Standards, requirements, and procedures will be tested to validate system performance and capabilities prior to a production decision. Interfaces will be tested to ensure new automation can be integrated into the overall Oceanic Automation System (OAS).

An initial testing capability exists at the Oceanic Development Facility. This capability will be enhanced to conduct the full–range testing needed to complete this project. The facility will provide the capability to conduct end–to–end testing utilizing real satellites, real ground/earth stations, and aircraft cockpits to identify total system performance and highlight areas needing improvements.

Engineering trials will be conducted with other civil aviation authorities to validate global compatibility of new automation systems.

Related Projects: 021–110 Air Traffic Management System, 031–110 Aeronautical Data Link Communications and Applications, 031–120 Satellite Communications, and 032–110 Satellite Navigation. Capital Investment Plan projects: 21–05 Oceanic Display and Planning System (ODAPS) and 21–12 Advanced Automation System (AAS).

Products:

- Telecommunications Processor for flight data input/output (FDIO) hardware replacement and software emulation
- Ground/Ground Data Communications capability
- Oceanic Controller Situation Display
- Oceanic traffic planning and management functionality into domestic TMS
- Automated data interchange/transfer to and from foreign Civil Aeronautics Administrations (CAA)
- Oceanic airspace coordination functions
- Two–way communications between aircrews and oceanic controllers
- Enhanced conflict detection/resolution capability
- Next generation flight data processor
- Dynamic aircraft route planning study (DARPS) in South Pacific
- Track Advisory capability for Oakland and New York Oceanic Centers

FY 1992–1993 Accomplishments:

- Completed track generation capabilities for use by Oceanic controllers.
- Developed Telecommunications Processor.
- Completed development requirements for Ground/Ground Data Communications.
- Conducted South Pacific engineering trials (PET) for Oceanic Track generation.
- Completed studies for Oceanic Operational Impact, Integrated Strategic Planning System, and Exploratory DOTS Weather Data Base.
- Completed development of the ICAO Regional Development Plans.

Planned Activities:

Standards/Requirements

In FY 1994, efforts will continue toward coordinating industry standards in the areas of avionics characteristics and minimum operational performance standards. These same standards will also be coordinated on an international basis.

In FY 1995 and beyond, coordination work will continue both nationally and internationally to ensure that standards and procedures are in place to use the advanced technology being developed for Oceanic Automation.

In FY 1995, engineering trials in the Atlantic and Pacific will be completed. These trials will be used for developing requirements and standards for ADS functions, dynamic re–routing, track generation and other oceanic automation features.

Studies and Analysis

In FY 1994, a study will be completed for achieving improved Oceanic separation standards and a track advisory assessment will be completed at Oakland. These studies will provide a Separation Improvement Program Plan and analysis which will be the focal point for supporting a U.S.-led

initiative for reduced oceanic separation standards with the international community.

In FY 1995, an ODAPS central processor replacement study and an Oceanic electronic flight data display computer human interface study will be completed. These studies will be used in FY 1996 with a study on ADS reporting rates to support transitioning ODAPS to an advanced oceanic automation system.

In FY 1996 through FY 1997, studies will be completed for advanced functions such as ADS/radar data integration and automatic 4–dimensional clearance generation.

Traffic Management

In FY 1994, development work will continue on a flight plan processing system and track advisory/airspace coordination system. This project will begin developing a prototype South Pacific strategic planning system which will connect international service providers in the South Pacific with DOTS at the Oakland Center to share traffic management information. This will be used as a basis for the "International Inter–Facility Planning" follow–on work. In FY 1995, the flight plan processing system will be completed.

In FY 1995 through FY 1998, this project will expand the South Pacific strategic planning system concept to incorporate foreign traffic management systems. The goal is to integrate U.S. traffic management systems with foreign systems to create an international traffic management/planning system. Development will be completed in FY 1997.

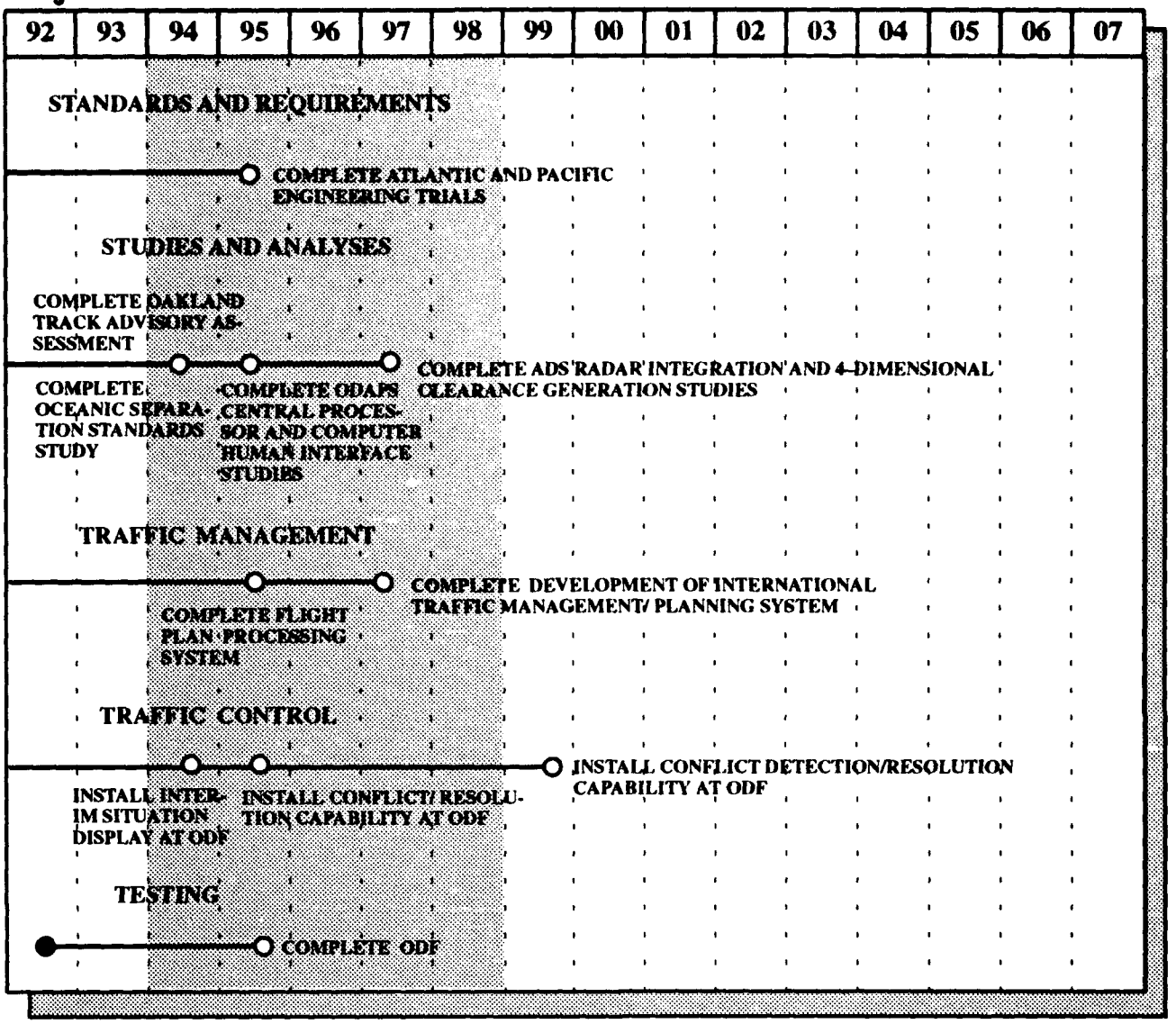
Traffic Control

In FY 1994, the Ground/Ground Data Communications function will facilitate data communications between controllers and service providers, thus laying the ground work for full 2–way data link communications between pilots and controllers. The interim situation display will be completed and installed at the Oceanic Development Facility (ODF). Additionally, development work will begin on electronic flight strips and a conflict detection/resolution capability. These systems are planned for delivery to the ODF in FY 1995. In FY 1995, evolutionary development will continue on display enhancements for integration into the interim situation display hardware. In FY 1996, a final software version will be completed that provides controllers with aircraft separation recommendations. Additionally, development will begin on a new flight data processor with ODF installation planned for FY 1999.

Testing

In FY 1995, the Oceanic Development Facility will be completed when the cockpit interface to the end–to–end simulation capability is installed. The ODF will be the primary test facility for all oceanic developmental and implementation testing.

Project 021–140: Oceanic Air Traffic Automation



021–160 ATC Automation Bridge

Purpose: Current plans require that existing Air Route Traffic Control Center (ARTCC) and Terminal Radar Approach Control (TRACON) automation equipment remain in service until replaced by AAS in the late 1990's. This project will develop technical designs and implementation strategies for interim systems to replace existing equipment, if necessary, to ensure adequate automation capability until the AAS is implemented. The equipment under consideration for replacement is the automated radar terminal system (ARTS) IIIA and the en route computer display channel equipment, which links en route Host automation with the controller's plan view display.

Approach: The ATC Automation Bridge project is divided into three phases.

Phase 1 will determine alternative interim system design approaches, evaluate the alternatives, then select a design approach.

Phase 2 will provide detailed alternative approach designs. Risk areas will be identified, and risk mitigation efforts will be planned to define the risks in those areas.

Phase 3 will provide risk mitigation and technical feasibility demonstrations. Procurement planning will be completed to support any subsequent implementation.

Related Projects: Capital Investment Plan project: 21–12 Advanced Automation System (AAS) and 56–29 On–site Simulation–based Training Systems.

Products:

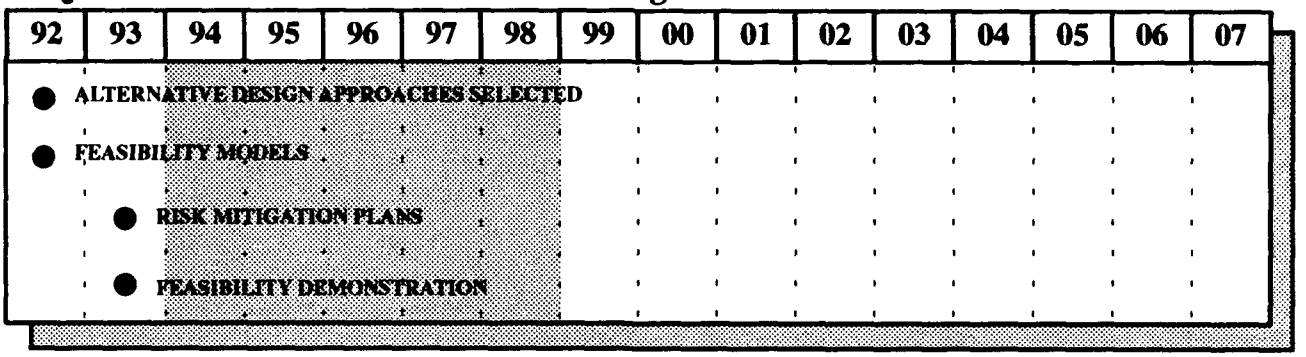
- Alternative terminal and en route system replacement strategies and interim system designs
- Technical feasibility studies and risk mitigation demonstrations
- Equipment specifications and procurement plans for implementation

FY 1992–1993 Accomplishments:

- Awarded contracts to begin ATC Automation Bridge effort.
- Alternative design approaches determined, evaluated, and selected.
- Began detailed design efforts on alternative approaches selected for further investigation.

Planned Activities: This project is completed in FY 1993.

Project 021–160: ATC Automation Bridge



021–180 Terminal ATC Automation (TATCA)

Purpose: This project will develop air traffic automation aids to assist both controllers and traffic managers in optimizing traffic flow in Terminal airspace. This project will also

facilitate expeditious implementation of these aids at selected ARTCCs and/or TRACONs.

Approach: The TATCA program consists of three projects: the Converging Runway Display Aid (CRDA), the Controller Automated Spacing Aid (CASA), and the Center/TRACON Automation System (CTAS). Terminal operations analyses show that a leading cause of delays is losing capacity during instrument meteorological conditions (IMC). For example, many airports use multiple runways to land aircraft during visual meteorological conditions (VMC), but are restricted to a single arrival runway during IMC. CRDA is proving to be an effective automation tool for maintaining throughput capacity during IMC. In particular, CRDA allows two converging runway arrival streams to be maintained in IMC. Through software changes in existing ARTS processors, CRDA uses the "ghosting" technique to provide geometric spacing aids on existing displays for sequencing and spacing aircraft. The CRDA project transitioned to an F&E phase in FY 1992 and provides the basis for developing "ghosting" applications under CASA. CASA will explore using the "ghosting" technique to merge traffic streams to a fix. The "ghosting" technique enhances a controller's ability to precisely space merging aircraft and thereby improve airspace utilization.

The CTAS project is currently undergoing laboratory development and field development/evaluation. CTAS uses auxiliary workstation processors interfaced to existing ATC processors to project future aircraft locations, develop a coordinated arrival traffic plan, and provide ATC advisories to help controllers meet the plan. The four CTAS products are the traffic management advisor (TMA), the final approach spacing tool (FAST), the descent advisor (DA), and the expedite departure path (EDP). The TMA provides ARTCC and TRACON controllers with automation aids for sequencing and spacing aircraft in a coordinated plan as far as 200 nautical miles from the airport. FAST provides optional advisories for TRACON controllers to sequence and space aircraft on final approach. The DA will provide Center sector controllers with top–of–descent points, speed, altitude, and heading advisories that will help them meet the TMA generated traffic plan. EDP provides controllers with optional advisories to integrate peripheral airport traffic with the main airport traffic flow. Longer–term TATCA activities focus on fully developed terminal automation techniques integrated with other ATC and cockpit automation capabilities.

To minimize technical risk and provide early products, the program places priority upon delivering a developmental system to the field at the earliest possible date. Prototyping in developmental laboratories is used to develop the automation logic and its associated human–system interfaces. Prototypes are then taken to ATC facilities for field development in an operational environment. Limited deployment of an operational system will be made at selected sites prior to a decision for national implementation. In parallel with field evaluation, developmental prototype software is being restructured, hardened, and documented under MIL–STD–2167A in preparation for operational testing. At the conclusion of this effort, all software and hardware intended for operational use will be tested at the Federal Aviation Administration Technical Center (FAATC) prior to limited deployment. CTAS products are being designed to interface with existing equipment, and later, with the Advanced Automation System.

Related Projects: 021–110 Advanced Traffic Management System (ATMS) and 021–190 Airport Surface Traffic Automation (ASTA). Capital Investment Plan projects: 21–06 Traffic Management System (TMS), 21–12 Advanced Automation System (AAS), 21–13 Automated En Route Air Traffic Control (AERA), 41–21 En Route Software Development, 62–20 Terminal ATC Automation (TATCA), 62–21 Airport Surface Traffic Automation (ASTA), 62–24 National Implementation of the Imaging Aid For Dependent Converging Runway Approaches, and 63–21 Integrated Terminal Weather System.

Products:

- TMA, FAST, DA, and EDP hardware/software limited deployment
- CTAS interface specifications to the Advanced Automation System (AAS)

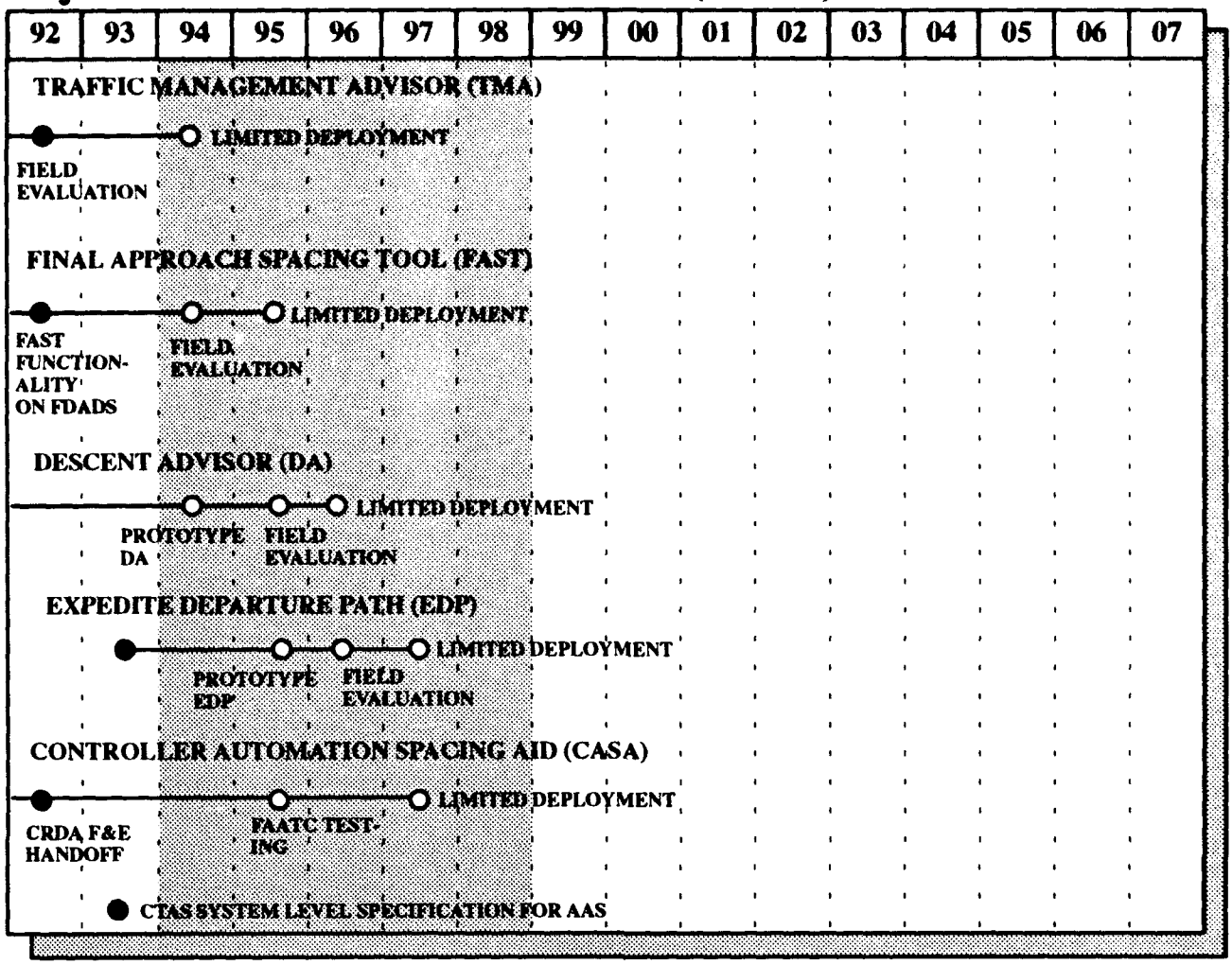
FY 1992–1993 Accomplishments:

- Implemented CRDA at St. Louis.
- Completed CRDA national implementation effort.
- Completed TMA and FAST laboratory evaluations and demonstrations.
- Completed software and hardware interfaces to the ARTS IIIA for FAST.
- Developed FAST prototype.
- Completed TMA field evaluation.
- Demonstrated FAST function on the full digital arts display (FDAD) at the FAATC as a precursor to field testing.
- Developed CTAS system specification and modified AAS system-level specification.

Planned Activities: In FY 1994, CASA functionality prototyping and simulation with active controller participation will continue. The Controller Automation Spacing Aid project will continue research into possible extensions of the automation technique utilized in the CRDA to applications in both terminal and en route environments. New applications will be identified and tested in a laboratory environment; successful products will undergo testing at the Technical Center prior to deployment.

Development activities will continue on the TMA, FAST, DA, and EDP components of CTAS. TMA will be ready for limited deployment in FY 1994. FAST field evaluation will be completed in FY 1994 in preparation for limited deployment in FY 1995. A prototype DA will be fielded in FY 1994 with evaluations completed in FY 1995, in preparation for limited deployment in FY 1996. A prototype EDP will be fielded in FY 1995, with evaluations completed in FY 1996 and limited deployment in FY 1997. CASA testing at the FAATC will be completed in FY 1995, with limited deployment completed in FY 1997.

Project 021–180: Terminal ATC Automation (TATCA)



021–190 Airport Surface Traffic Automation (ASTA)

Purpose: This project will develop an enhanced surface safety system, utilizing ground sensor primary radar airport surface detection equipment (ASDE–3), automated radar terminal system (ARTS), differential corrected global positioning system (DGPS), and airport movement area safety system (AMASS) to help prevent runway incursions. ASTA will provide controllers with automatically generated alerts and cautions in all–weather conditions, as well as data tags to identify all aircraft and special vehicles on the airport movement area. Future enhancements will include a traffic planner and cockpit display of surface traffic information (CDTI).

Approach: To prevent runway incursions, automatic backup systems must be developed and implemented to guard against human failures. The ASTA program examines the roles and responsibilities of controllers, pilots, and ground vehicle operators operating on the airport. The ASTA program comprises five elements: a runway status light system, a surveillance data link, aural

and visual warnings, data tags, and a traffic planner. ASTA is a streamlined program starting with technical and operational specification development and evolving into one preproduction prototype unit and 40–60 production level systems. A critical part of the overall ASTA project is to share information with the Terminal Air Traffic Control Automation project to create an interrelated runway incursion prevention system.

Runway status light system (RSLS) will automatically control lights developed by the ASTA project to show pilots if the runway is occupied. ASTA will further enhance this demonstration system by providing new surveillance data and interface software to enable the RSLS to function with ASDE–3 sensors, AMASS, and ARTS. As part of the upgrade, commercial–off–the–shelf (COTS) runway incursion system software will be demonstrated as a possible alternative.

For the surveillance data link, ASTA will combine surveillance information from ASDE–3 radars, DGPS, and other potential ground movement sensors. All airports slated to receive ASDE–3/AMASS equipment under the F&E program will also receive ASTA. At those airports not equipped with ASDE–3/AMASS, ASTA will use other potential ground movement sensors, such as DGPS surveillance data link, for detecting aircraft and vehicles.

ASTA will utilize this combined surveillance data with the appropriate safety logic to provide controllers with prioritized aural and visual warnings and cautions on ARTS equipment. ASTA will utilize elevation information to prevent helicopter/vertical flight operations from causing unnecessary automatic safety alerts. Additionally, the ASTA project is laying the groundwork for future tower control computer complex (TCCC) interface requirements.

Data tag generation is a key ASTA functionality. Currently, there is no requirement for AMASS to display data tags. ASTA will assist controllers by displaying target locations with alpha–numeric data tags. Furthermore, ASTA will provide positive target identification for special vehicles such as fire, rescue, snow plows, etc.

Other ASTA add–on capabilities will include developing enhancements such as a traffic planner and Cockpit Display of Traffic Information for surface operations. All enhancements will stem from an approved ASTA operational concepts document.

Related Projects: 021–110 Advanced Traffic Management System (ATMS), 021–220 Multiple Runway Procedures Development, 021–180 Terminal ATC Automation (TATCA), 031–110 Aeronautical Data Link Communications and Applications, and 051–130 Airport Safety Technology. Capital Investment Plan projects: 21–13 Automated En Route Air Traffic Control Automation (AERA), 24–12 Mode S, 24–14 Airport Surface Detection Equipment (ASDE–3) Radar, 62–20 Terminal ATC Automation (TATCA), 62–21 Airport Surface Traffic Automation (ASTA), and 62–23 Airport Movement Area Safety System (AMASS).

Products:

- Concept development and demonstration
- Communications architecture
- Automatic runway entrance status light system
- Aircraft and vehicle identification tags on the ASDE–3/AMASS display
- Aircraft and special vehicle movement conformance monitoring and alerting system
- Dynamic surface traffic management planning process for arrivals, departures, and taxiing aircraft

- Automatic coordination of surface traffic management automation with other ATC automation systems
- Preproduction prototype and testbed
- System specifications to produce 40–60 ASTA systems

FY 1992–1993 Accomplishments:

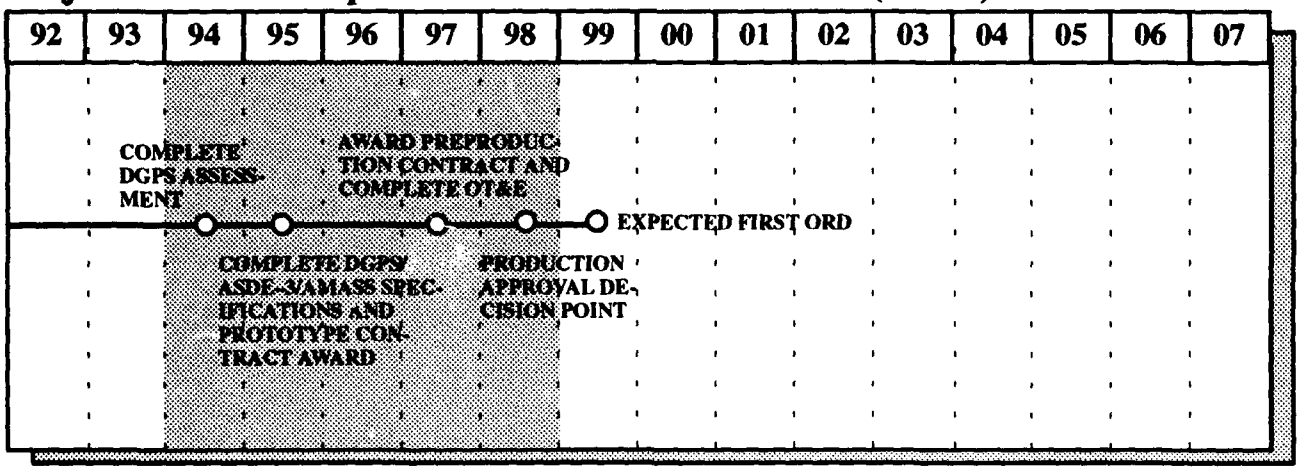
- Awarded broad agency announcement (BAA) contracts demonstrating alternative technologies to prevent runway incursions.
- Established AMASS #3 at Boston Logan Airport to provide ASTA differential global positioning system (GPS) testbed.
- Successfully demonstrated runway status light system to industry at Boston Logan Airport.

Planned Activities: In FY 1994, technical performance assessments will be completed at Boston Logan Airport. These assessments focus on the surveillance data link, and associated ground processing functions, to transmit differential GPS aircraft position/velocity/heading data. ASTA will integrate this data with ASDE–3/AMASS inputs.

In FY 1995, a detailed system specification for incorporating differential GPS data with ASDE–3/AMASS and aircraft/vehicle data tags will be completed. This specification will be used to award a contract for developing an ASTA prototype by FY 1996.

In FY 1996, an RFP for developing a preproduction unit and 40–60 production units will be released. Contract award and Operational Test and Evaluation (OT&E) are scheduled for FY 1997. An ASTA production approval decision point is scheduled for FY 1998, with first operational readiness date (ORD) scheduled for FY 1999.

Project 021–190: Airport Surface Traffic Automation (ASTA)



021–210 Tower Integrated Display System (TIDS)

Purpose: This project will resolve tower space constraints and make available much needed space for future enhancements. TIDS will consolidate the displays and instrumentation for airport environmental data and control equipment used in towers.

Approach: The TIDS project will be accomplished in two phases. In Phase 1, a market survey will be conducted to determine the availability of systems capable of meeting air traffic requirements with a minimal developmental effort. The results of the market survey will be used to determine an initial set of TIDS requirements and an appropriate acquisition strategy in order to field a TIDS in the near term. These requirements will be developed through a team effort within the FAA. Documentation for transition to a Facilities and Equipment program will be developed, including the program documents and production specifications to support implementation of the initial TIDS.

In parallel with Phase 1 activities, Phase 2 will be initiated to assess and integrate TIDS enhancements packages to meet the full range of air traffic's TIDS requirements. These enhancements could be implemented on a periodic basis.

Related Projects: 021–190 Airport Surface Traffic Automation (ASTA). Capital Investment Plan projects: 23–09 Automated Weather Observing System (AWOS), 24–08 Runway Visual Range (RVR), 43–12 Upgrade Low–Level Windshear Alert System (LLWAS) to Expanded Network Configuration, and 43–13 Digital Altimeter Setting Indicator (DASI) Replacement.

Products:

Phase I

- Initial TIDS requirements
- Prototype TIDS

Phase II

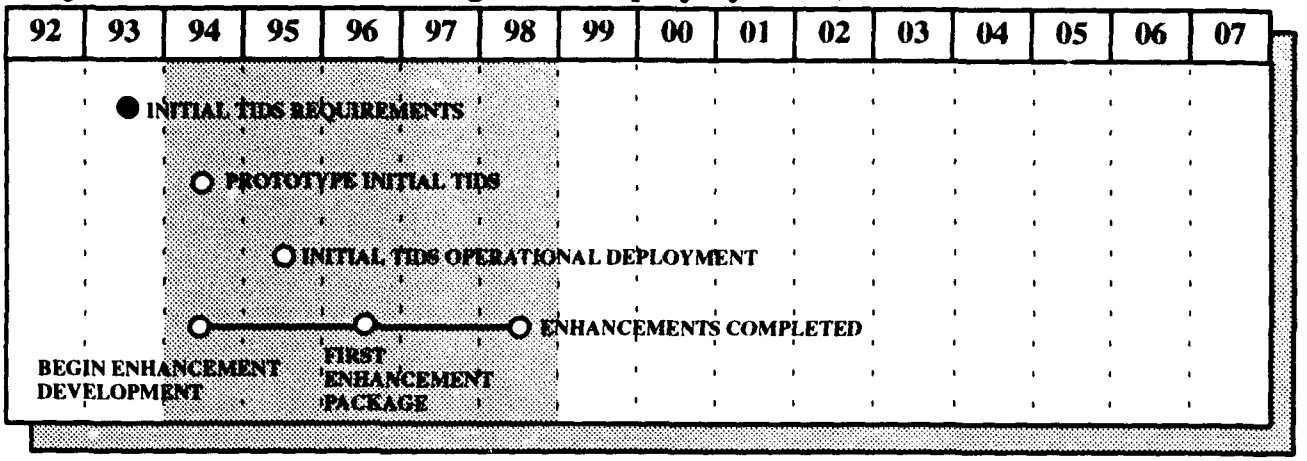
- TIDS enhancement requirements
- TIDS enhancement prototype

FY 1992–1993 Accomplishments:

- Completed market survey.
- Completed report defining potential TIDS architectures.
- Completed initial TIDS requirements.
- Completed and released TIDS request for proposal (RFP).

Planned Activities: In FY 1994, a contract will be awarded for an initial TIDS capability with options for enhancements. Documentation for a transition to a Facilities and Equipment program will be developed. An initial TIDS prototype is planned for FY 1994 with Integrated Operational Test and Evaluation activities to follow leading to a potential initial TIDS deployment in FY 1995. TIDS enhancement activities are planned to begin in FY 1994, leading to a potential first enhancement package in FY 1996. Further enhancement packages will be investigated through FY 1998.

Project 021–210: Tower Integrated Display System (TIDS)



021–220 Multiple Runway Procedures Development

Purpose: This project will develop ATC procedures to reduce airport delays by more fully utilizing multiple–runway capacity during instrument meteorological conditions. This project will investigate using precision runway monitor (PRM) technology, including electronically scanned antenna systems with higher update rates, in conjunction with advanced techniques for reducing parallel runway spacing standards to less than 3,400 feet. Air traffic procedures and flight standards criteria for simultaneous triple and quadruple instrument flight rule (IFR) parallel approaches will also be developed and validated. Requirements and techniques for improved surveillance and navigation capabilities will be developed to support these procedures. Additionally, this project will develop a terminal airspace visualization and design tool to assist the airspace planner in rapid terminal airspace reconfiguration to accommodate multiple arrivals and departures.

Approach: The FAA has completed demonstrations of electronically scanned and "back-to-back" antenna PRM technologies resulting in acceptance of simultaneous independent approaches to parallel runways spaced as closely as 3,400 feet. The PRM Program Office is currently upgrading the Raleigh-Durham PRM system to commissionable status and procuring additional PRM systems for five airports that satisfy the 3,400 feet spacing standard. Additionally, real-time simulations have shown the value of a final monitor aid (FMA), based on high–resolution color displays with controller alert aid and surveillance inputs from ASR–9 or Mode S, for monitoring parallel runway operations. This project will conduct additional simulations and analyses to develop national standards and ATC procedures for parallel runways using PRM and FMA technologies. Further research efforts on reducing runway spacing standards will focus on allowing approaches to parallel runways with less than 3,400 feet separation. The results of these studies for dual parallel runways will provide the basis for developing the spacing standards for closely spaced triple and quadruple parallel runways. This project will provide data and recommendations to the Air Traffic Service for formulating standards and procedures.

Along with developing the new procedures for parallel runway operations, the terminal airspace structure must be improved to facilitate traffic flow from the terminal area boundaries to final approach. This program will develop a prototype computer–based system to assist airspace designers in rapid terminal airspace design and

reconfiguration. This graphics–oriented workstation system will capture the rules and procedures of ATC airspace design and analyze the alternative design's efficiency.

Related Projects: 021–180 Terminal ATC Automation (TATCA), 025–130 Air Traffic Models and Evaluation Tools, and 033–110 Terminal Area Surveillance System (TASS). Capital Investment Plan projects: 62–20 Terminal ATC Automation (TATCA) and 64–27 Precision Runway Monitor.

Products:

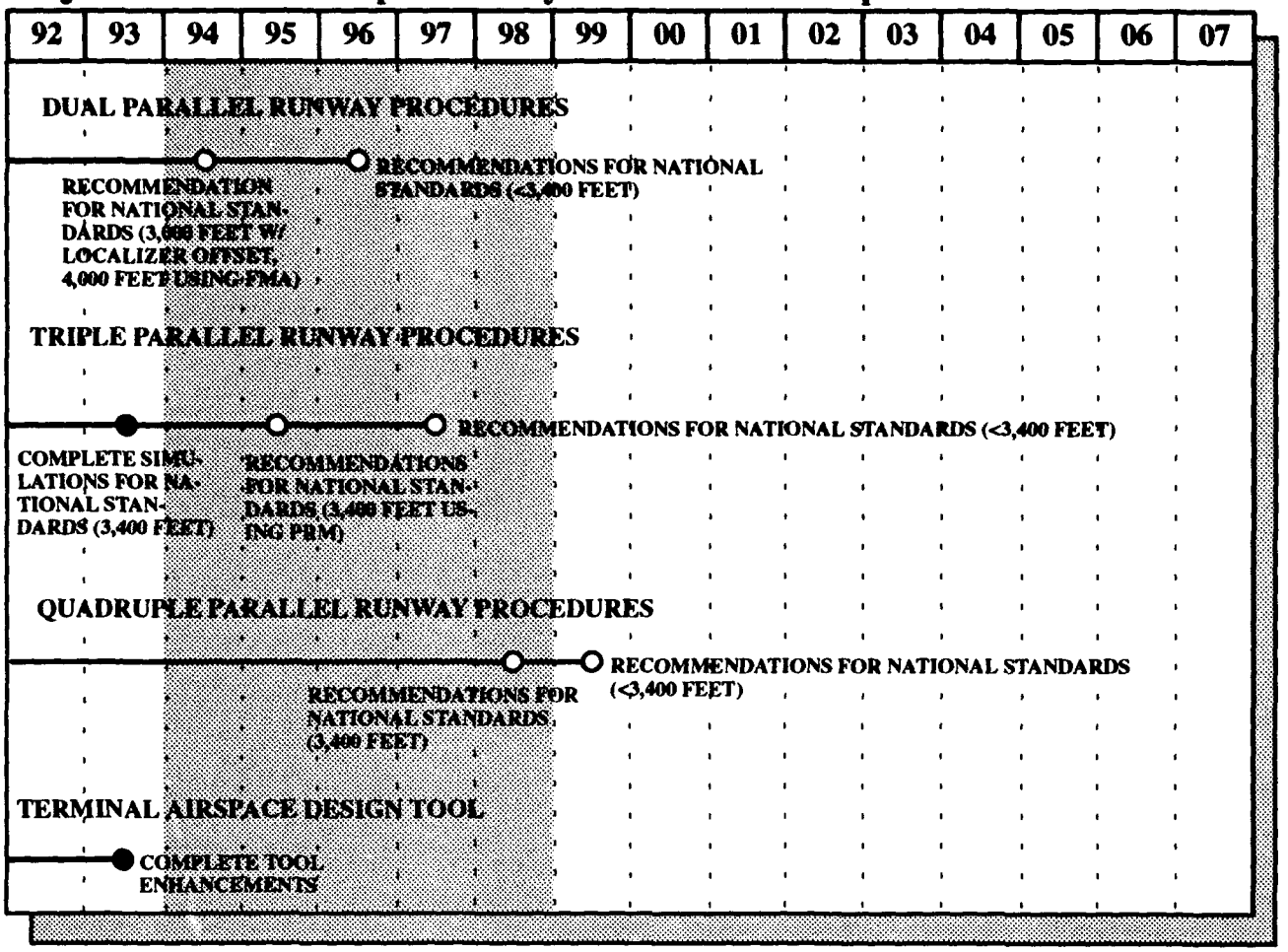
- Supply data and recommendations to develop approach standards for closely spaced dual, triple, and quadruple runways
- ATC simulation evaluations of IFR procedures for triple and quadruple parallel runways using existing and improved runway monitoring systems
- Technical reports on simulation results and risk analyses
- Prototype graphics–oriented computer tool for displaying airspace structures and for evaluating airspace design performance

FY 1992–1993 Accomplishments:

- Completed realtime ATC simulations with controller and pilot participation for:
  - Triple approaches to parallel runways spaced at 3,400 feet for PRM systems with 2.4 second update rate.
  - Approaches to dual parallel runways spaced at 3,000 feet for PRM with 1 second update rate and 1 degree localizer offset.
  - Dual and triple approaches to parallel runways spaced at 4,300 feet for ASR–9 radar with high–resolution color display and controller alert.
- Issued FAA Order 7110.65 authorizing independent simultaneous approaches to parallel runways spaced between 3,400 and 4,300 feet when PRM is used.
- Recommended standards for triple parallel runways using existing monitoring equipment.
- Completed terminal airspace visualization and design tool enhancement.
- Provided data and recommendations to develop national standards for IFR approaches to triple parallel runways with 3,400 feet separation.

Planned Activities: In FY 1994, research will continue on the combined use of electronically–scanned (E–scanned) PRM technology and advanced techniques for possible further reduction of runway separation standard to less than 3,400 feet. In FY 1994, recommendations for national standards will be developed for IFR approaches to dual and triple parallel runways with approximately 4,000 feet spacing using the FMA system with airport surveillance radar (ASR)–9 radar or Mode S secondary surveillance radar. Recommendations for national standards for dual parallel runways with 3,000 feet spacing using the PRM and offset localizer will be developed in FY 1994. Recommendations will be developed for approaches to triple and quadruple parallel runways with 3,400 feet separation using PRM in FY 1995 and FY 1998 respectively. Dual, triple, and quadruple standards for runways with less than 3,400 feet spacing will be accomplished in FY 1996, FY 1997, and FY 1999, based on PRM and advanced navigation/landing systems. Advanced techniques include the potential use of state–of–the–art autopilots, microwave landing system, global positioning system, and collision avoidance logic in controller displays.

Project 021–220: Multiple Runway Procedures Development



021–230 Wake–Vortex Separation Standards Reduction

Purpose: Wake vortices, particularly those generated by large transport aircraft, can present significant hazards to following aircraft in single runway operations. Parallel runway operations may also be severely affected by vortices which can propagate great distances while in ground effect. This project will focus on safely reducing separation standards leading to increased capacity in the terminal area. These gains will be accomplished by understanding wake vortex strength, duration, and transport characteristics, particularly as the vortices experience ground effect in the terminal environment. Potential methods for minimizing the wake vortex effect to enhance airspace use, decrease delays, and increase airport capacity in instrument meteorological conditions will be examined.

Approach: Current air traffic operations will be assessed to determine actual traffic spacing being used under visual flight rule (VFR) conditions. Vortex strength, decay, and transport characteristics, as well as the metrological conditions that effect these characteristics, will be examined at selected, high traffic airports. Data from tower fly–by tests and other previously collected data

will be combined with new data to provide a basis for reviewing existing separation standards and recommending modifications. Flight test simulations will be designed and conducted to determine if reducing the separation standards currently being used under IFR conditions is feasible. Issues such as closely spaced parallel and converging runways, departure delays, and potential departure sequencing will also be explored through simulation.

Existing aircraft weight classifications will be reviewed, and a determination will be made as to whether the weight classifications and corresponding separations can be modified to improve single runway operations.

Related Projects: 021–180 Terminal ATC Automation (TATCA) and 024–110 Aviation System Capacity Planning. Capital Investment Plan projects: 62–20 Terminal ATC Automation (TATCA) and 63–21 Integrated Terminal Weather System (ITWS).

Products:

- Feasibility report on reducing separation standards in the terminal area
- Recommendations on aircraft weight classifications
- Provide separation algorithms to TATCA based on leading/following aircraft types

FY 1992–1993 Accomplishments:

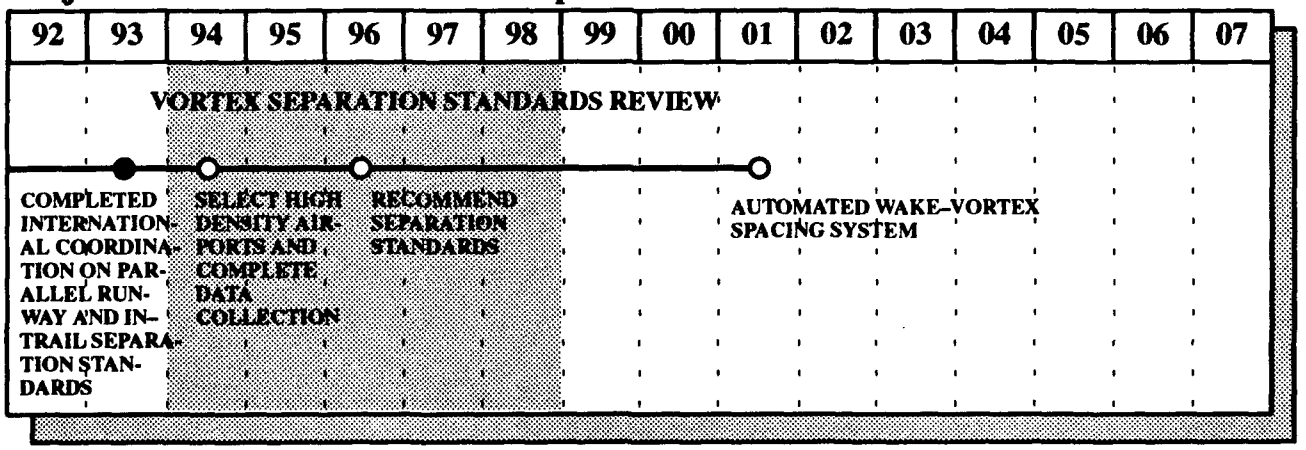
- Completed processing and analyzing Dallas–Fort Worth vortex transport and delay data.
- Completed international coordination on parallel runway and in–trail separation standards.
- Completed analysis on data collected for sensor technology and vortex separation standards/options.

Planned Activities:

In FY 1994, data collection will be completed on aircraft landing at high traffic density airports with a variety of aircraft types. The airport selection will be completed in FY 1994 based on capacity analyses conducted in FY 1993. In FY 1994, flight tests will be conducted to collect field data on closely spaced parallel runways. This data will be analyzed in FY 1995 to develop new parallel runway separation criteria for FAA approval in FY 1996.

In FY 1995, development work will begin on an automated wake vortex spacing system to be completed in FY 2001.

Project 021–230: Wake–Vortex Separation Standards Reduction



022–110 Traffic Alert and Collision Avoidance System (TCAS)

Purpose: This project will develop, demonstrate, and assist in implementing an independent airborne collision avoidance capability to increase the safety and capacity of the National Airspace System. Safety will be increased by reducing the potential for midair collisions. Capacity will be increased by using the improved cockpit display capability provided by TCAS to aid capacity enhancements such as simultaneous approaches to parallel runways and pilot-maintained intrail spacing. The aviation community will be provided with the standards and certification guidance materials required for implementing the system. TCAS will reduce midair collision risks.

Approach: There are three TCAS versions: I, II, and III, each with successively increasing capability. TCAS I is under evaluation through a Limited Implementation Program (LIP). TCAS II development has been completed and operational implementation has started. TCAS III development is continuing with the intention of conducting a LIP in FY 1998.

TCAS I

TCAS I generates traffic advisories to assist pilots in locating potential midair collision threats. The FAA has established a cost–shared contract with an avionics manufacturer to furnish TCAS I avionics for a LIP evaluation on several types of in–service commuter aircraft. This effort will provide operational and performance data on commercial TCAS I equipment in actual service.

TCAS II

TCAS II equipment, which includes a Mode S transponder, is intended for installation in transport category and high performance general aviation aircraft. TCAS II equipment will not only provide traffic advisories, but will also compute vertical–plane resolution advisories to indicate the direction the aircraft should maneuver to avoid collisions. To ensure that maneuvers from two TCAS–equipped aircraft do not conflict, resolution advisories are coordinated between aircraft using the integral Mode S transponder.

Through an LIP, an operational TCAS II evaluation has been carried out on a number of inservice airline aircraft. Currently, TCAS II operational installation and use has begun. Federal Aviation Regulations require that all airplanes with more than 30 passenger seats operating in U.S. airspace be equipped with TCAS II by December 30, 1993.

TCAS III

TCAS III equipment, intended for installation in transport category aircraft, is designed to generate traffic advisories and resolution advisories in both the horizontal and vertical planes. Maneuvers will be coordinated between similarly equipped aircraft.

The FAA is supporting minimum operational performance standards (MOPS) development for TCAS III by a Radio Technical Commission for Aeronautics (RTCA) special committee.

In response to congressional direction, the FAA has developed a plan to complete the remaining development and test efforts and evaluate the TCAS III system on airline aircraft in an LIP. Completing the development program and the LIP for TCAS III will enable the aviation community to implement the most advanced airborne collision avoidance system as a user option.

Related Projects: 024–110 Aviation System Capacity Planning. Capital Investment Plan project: 24–12 Mode S.

Products:

TCAS I

- LIP — Reports on the TCAS I avionics evaluation to provide industry with guidance for TCAS I certification and operation

TCAS II

- LIP — Reports on TCAS II installation, certification, and operation on air carrier aircraft during routine operations
- TCAS II transition program report documenting TCAS II implementation program results and any required modifications
- TCAS II requirements document for TCAS II certification in transport category aircraft
- ICAO standards and recommended practices (SARPs) that provide a basis for international certification and operational approval

TCAS III

- RTCA MOPS that define required performance under standard operating conditions
- System safety study assessing the overall safety characteristics associated with using the TCAS III collision avoidance system
- LIP — Report on TCAS III installation, certification, and operation in air carrier aircraft

FY 1992–1993 Accomplishments:

- Completed SARPs for international TCAS II certification.
- Issued a TCAS III airborne antenna report.
- Completed first phase of TCAS II transition program.
- Certified first TCAS I equipment, began flight demonstration portion of TCAS I LIP.
- Issued software modifications for TCAS II.

Planned Activities:

TCAS I

All 10 to 30 seat turbine–powered commuter aircraft must be equipped with TCAS I by February 9, 1995, in accordance with Federal Aviation Regulations. In FY 1994, the TCAS I LIP will be completed, and the FAA will begin a multi–year TCAS I transition program to assist aircraft operators with implementation of TCAS I in the National Airspace System. Periodic transition program reports will provide guidance in the installation, crew training, and operation of the system.

TCAS II

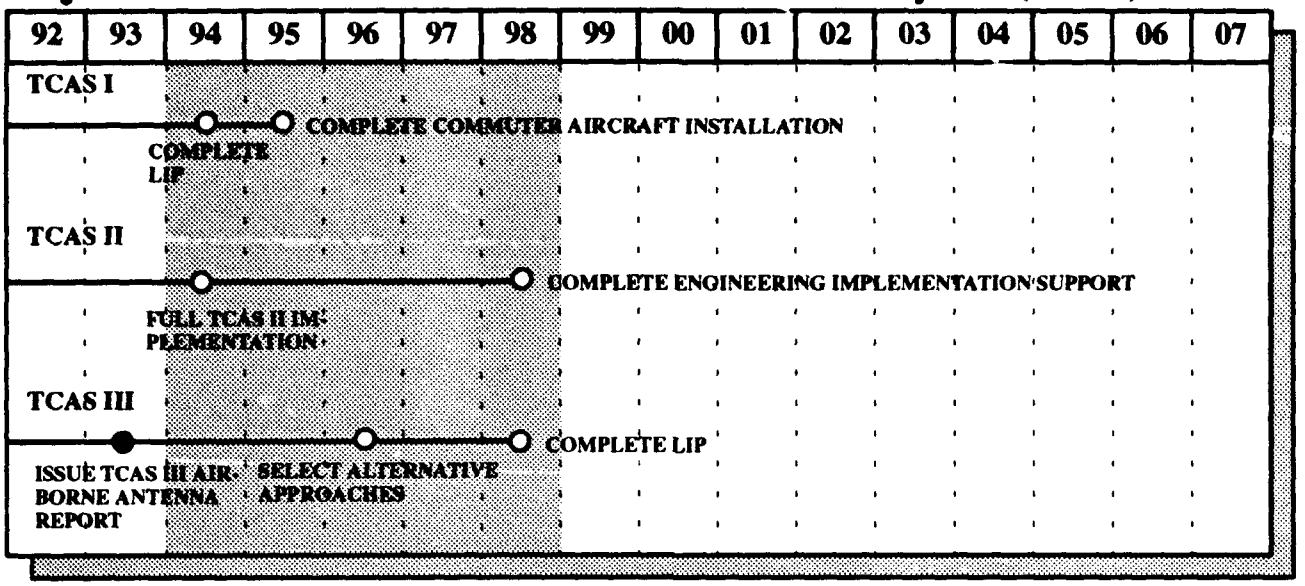
All commercial turbine–powered aircraft with more than 30 passenger seats must be equipped with TCAS II by December 30, 1993, in accordance with Federal Aviation Regulations. In FY 1994, the FAA will continue to work with the aviation community to resolve technical and operational issues associated with TCAS II implementation. Engineering support, such as developing logic modifications to reduce unnecessary alert rates, will continue through FY 1998.

TCAS III

The TCAS III airborne antenna report suggests that current, state-of-the-art TCAS antennas will not support the horizontal resolution advisories for TCAS III. Alternate approaches will be evaluated during FY 1994 and the most promising approaches will be selected in FY 1996 for flight testing during FY 1996–1997. An LIP will be conducted in FY 1998 to determine the

certification and operational requirements for TCAS III. At the conclusion of the LIP, TCAS III will be available for airline implementation.

Project 022–110: Traffic Alert and Collision Avoidance System (TCAS)



022–140 Vertical Flight Program

Purpose: This project will help improve the safety and efficiency of vertical flight (VF) operations and increase NAS capacity through research, engineering, and development into air traffic rules and operational procedures; heliport/vertiport design and planning; and aircraft/aircrew certification training. The term vertical flight, in additional to conventional rotorcraft (helicopters), includes advanced technology designs for aircraft that have the ability to hover and take off and land vertically, such as the tiltrotor, tiltwing, fan–in–wing, and vectored–thrust aircraft. These aircraft are also referred to as "powered–lift" aircraft. The Rotorcraft Master Plan (RMP) envisions using advanced VF technologies, such as the tiltrotor, to provide scheduled short–haul passenger and cargo service for up to 10 percent of the projected domestic air travel. Significant reductions in the estimated $5 billion national annual aviation delay cost could be realized by such aircraft.

To meet the goals of the RMP, research will be conducted in the following areas: (1) air and ground infrastructures to permit VF operations under visual and instrument flight conditions en route and in the terminal area; (2) VF operations safety; (3) VF operations noise reduction; (4) VF training and certification procedures; and (5) Integration of civil tiltrotor (CTR) and other maturing advanced technologies into VF operations.

Approach: To accomplish this expanded use of vertical flight, the FAA is responsible for developing the appropriate infrastructure and regulations in parallel with industry's actions and commitment to develop and operate market–responsive aircraft. The VF program will focus on

the following technical subprogram areas: air infrastructure, ground infrastructure, and human/machine. R,E&D efforts will consist primarily of studies and analyses, simulations, model development, and flight testing. The work will be performed by NASA, MITRE, the Volpe National Transportation Systems Center, university grants, the FAA Technical Center, and support contractors.

Air Infrastructure

For advanced VF operations to achieve their potential and be competitive, vertical flight aircraft must be as operationally safe and reliable as commuter-sized turboprop airplanes. In the NAS, vertical flight aircraft must operate in all-weather conditions.

This subprogram will provide R,E&D to enable reliable, all-weather operations for VF passenger and cargo aircraft. The research results will include developing both visual and instrument terminal approach and departure procedures, steeper IFR approach angles, improvements in low altitude navigation and air traffic control services, VF air route design, and noise abatement procedures.

Research will focus on the ability to operate at heliports and vertiports in terminal airspace without interfering with fixed-wing traffic flow. Much of the initial work relating to emerging technologies, such as tiltrotor, will be done through simulation, to be validated with actual flight test data as the aircraft become available.

Ground Infrastructure

Any current or future VF transportation system success will largely depend on the ability to land near demand centers. This means operating in obstacle-rich environments and landing in or near city centers.

The ground infrastructure subprogram will provide R,E&D into heliport and vertiport design and planning issues, including the terminal area facilities and ground-based support systems that will be needed to implement safe, all-weather, 24-hour flight operations. Developing obstacle avoidance capabilities is a critical design-related effort. Research will include applying lessons learned from detailed accident and rotorcraft operations analyses. Simulation will be used extensively to collect data, analyze scenarios, and provide training to facilitate safe operations.

Human/Machine

With the necessity for increased simulation use, this subprogram will develop the criteria and guidance for VF simulators used for crew member training/evaluation. Training procedures will be established to reduce the human element causal factor in VF accidents.

Human/machine research will: (1) develop minimum performance criteria for visual scenes and motion-base simulators; (2) evaluate state-of-the-art flight performance for cockpit design technology; and (3) develop crew and aircraft performance standards for display and control integration requirements. Research will also be conducted to develop certification standards for both conventional and advanced technology VF aircraft.

Related Projects: 021-140 Oceanic Air Traffic Automation, 024-110 Aviation System Capacity Planning, 025-110 National Simulation Capability (NSC), 031-120 Satellite Communications Program, and 032-110 Satellite Navigation Program. Capital Investment Plan projects: 24-07 Microwave Landing System (MLS) and 61-22 ATC Applications of Automatic Dependent Surveillance (ADS).

Products:

- Terminal area approach procedure requirements
- ATC route standards, procedures, and models

- Vertiport/heliport design standards
- Improved VF noise planning model
- VF noise abatement procedures
- Rotorcraft simulator standards
- VF aircrew training and certification requirements

FY 1992–1993 Accomplishments:

- Updated and published heliport design advisory circular.
- Published helicopter and heliport landing site accident risk exposures and profiles.
- Published technical report detailing magnetic resonance imaging (MRI) effects on EMS helicopter instruments/personnel.
- Completed night vision goggle testing for EMS safety evaluation/recommendations.
- Completed impact analysis of civil tiltrotor on northeast corridor delay.
- Published VF noise R,E&D Plan.
- Published VF Terminal Area Procedure Development Plan (VERTAPS).

Planned Activities: In FY 1995, a civil tiltrotor air carrier profitability report will be published as well as advanced technology VF performance and demonstration guidelines. In FY 1996, national–level guidelines for joint industry/local government advanced technology VF demonstration program will be published.

Air Infrastructure

Extensive VF noise data collection will be conducted in FY 1994. In FY 1995, night vision enhancement device technology applications will be identified. The following activities will be completed in FY 1997: low noise conversion corridor criteria for tiltrotors will be developed; terminal area procedures for steep angle approach and departure will be published; night vision enhancement devices operations and training advisory circular materials will be delivered; and, VF noise abatement corridor standards will be published.

In FY 1998, VF terminal, en route, and corridor route standards will be published as well as ATC systems integration guidelines for VF. In addition, minimum IFR and VFR airspace requirements for both conventional and advanced VF will be published. Also in FY 1998, VF noise abatement and control advisory circular materials will be delivered. A VF demonstration programs advisory circular will be delivered in FY 1999.

Ground Infrastructure

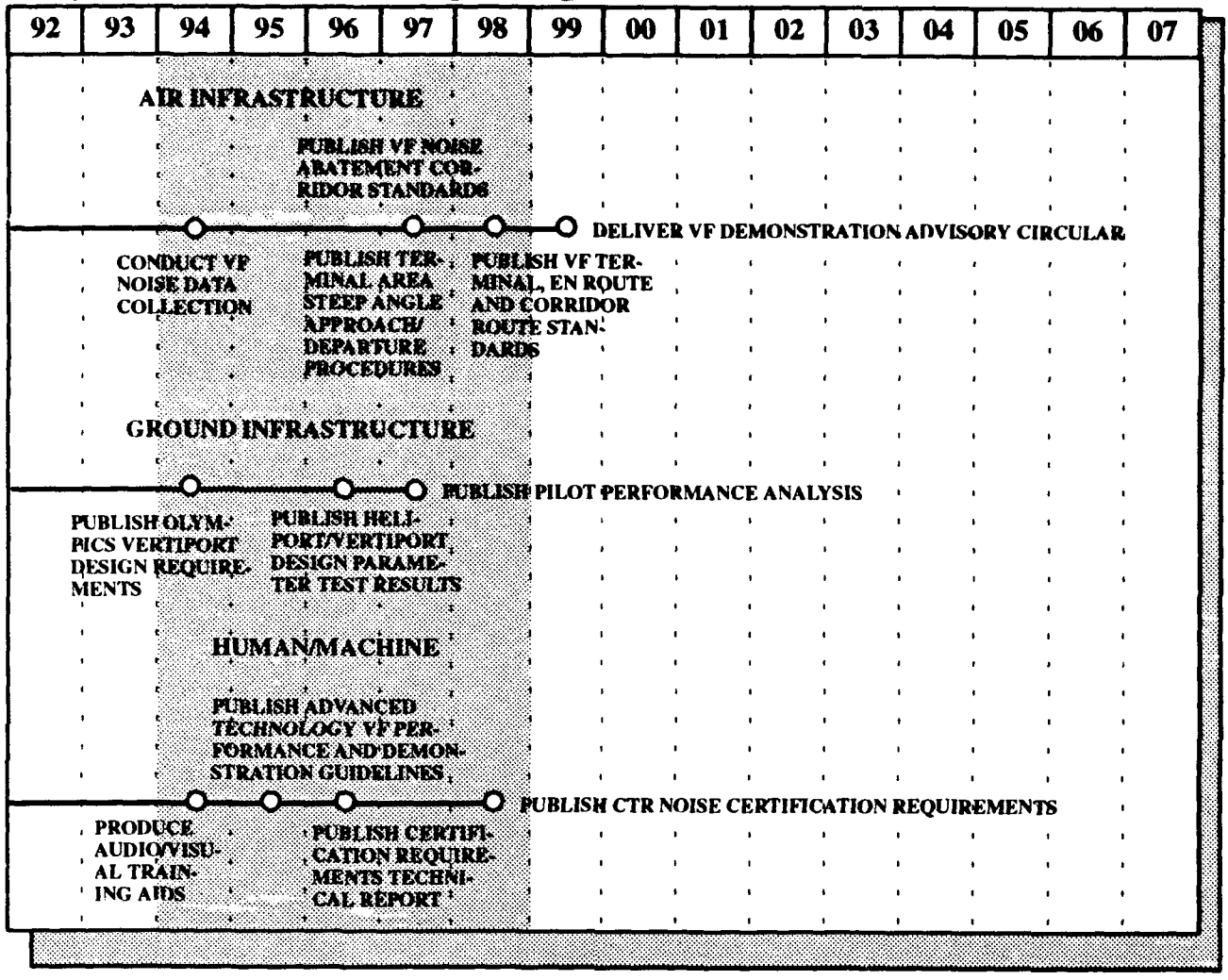
In FY 1994, vertiport design requirements for the 1996 Olympics will be published. Community handbooks and computer planning aids to assist civic planners on rotorcraft noise issues will be published in FY 1995. In FY 1996, test results and analyses of heliport and vertiport design parameters, including minimum required VFR airspace for curved approaches and departures, minimum parking and maneuvering areas, marking and lighting, and rotorwash protection requirements, will be published. A simulation–based analysis of pilot performance in an obstacle–rich environment will be published. Results of this study will be used to evaluate necessary heliport and vertiport design criteria.

Human/Machine

In FY 1994, audio visual training aids and workbooks to assist in training expert decision making techniques will be produced. A technical report supporting VF aircraft display certification requirements will be published in FY 1996. In

FY 1998, CTR noise certification requirements will be published.

Project 022–140: Vertical Flight Program



022–150 Flight Operations and Air Traffic Management Integration

Purpose: A cornerstone of the future air traffic management system will be the direct information interchange between flight management system (FMS) computers and ground–based ATM computers via data link. This project will develop the capability to integrate flight management computer operations with ground–based air traffic management automation. Integrating FMS and ATM operations via data link is expected to increase airspace capacity and ensure more efficient flight operations along more flexible, conflict–free route trajectories.

Approach: This project will establish the operational requirements for flight operations

procedures and standards that will fully utilize existing FMS capabilities to enhance system capacity and flight efficiency in oceanic, en route, and terminal airspace in the near term. This analysis, which supports flight standards for FMS–guided curved approaches to selected airports and FMS–guided departures, will lead to standards for nationwide FMS–guided terminal operations.

This project will develop a standard set of operational requirements for advanced FMS capabilities to support the next generation (1996) FMSs with work accomplished through a cooperative effort between the FAA and industry. This effort will integrate existing and planned capabilities of the ATM system and the FMS/aircraft flight deck.

A key to successful ATM/FMS integration is developing automated communications between aircraft FMS and ground ATM computers. This will be accomplished by developing a set of flight operations and air traffic management integration (FTMI)–specific data link operational requirements. These will be included as part of an FAA/industry set of data link operational requirements that support air traffic and flight information services.

Related to operational requirements work is developing and validating FTMI operational concepts. Simulation experiments coupled with aviation community–supported flight trials will be used to evaluate FTMI scenarios and validate associated procedures.

In addition to enhanced ATM/FMS integration, this project will explore the benefits of including airline operation control (AOC), the third component to the air transportation system, with ATM/FMS. A high speed information exchange network between AOC and ground ATM could provide fuel savings, more efficient airspace utilization, and reduced delays.

Related Projects: 021–110 Advanced Traffic Management System (ATMS), 021–140 Oceanic Air Traffic Automation, 021–180 Terminal ATC Automation (TATCA), 031–110 Aeronautical Data Link Communications and Applications, and 084–110 Flight Deck/ATC System Integration. Capital Investment Plan projects: 21–06 Traffic Management System (TMS), 21–13 Automated En Route Air Traffic Control (AERA), 61–22 ATC Applications of Automatic Dependent Surveillance (ADS), 62–20 Terminal ATC Automation (TATCA), and 63–05 Aeronautical Data Link Communications and Applications.

Products:

- Flight operations procedures and standards for FMS–guided curved approaches to selected airports
- Flight operations procedures and standards for FMS–guided departures to selected airports
- Flight operations procedures and standards for FMS–guided terminal operations nationwide
- ATM/industry operational requirements document for the next generation FMS
- Flight operations procedures and standards for FMS–guided oceanic operations
- Flight operations procedures and standards for FMS–guided en route operations

FY 1992–1993 Accomplishments:

- Developed scenarios and associated systems requirements for integrated FMS and ATM operations.

- Provided analytical support to Flight Standards for developing an advisory circular on FMS–guided operations.

- Provided FTMI–specific data link operational requirements to support RTCA Task Force 2 in building an FAA/industry consensus on data link.

- Developed AOC model for use in FTMI simulations.

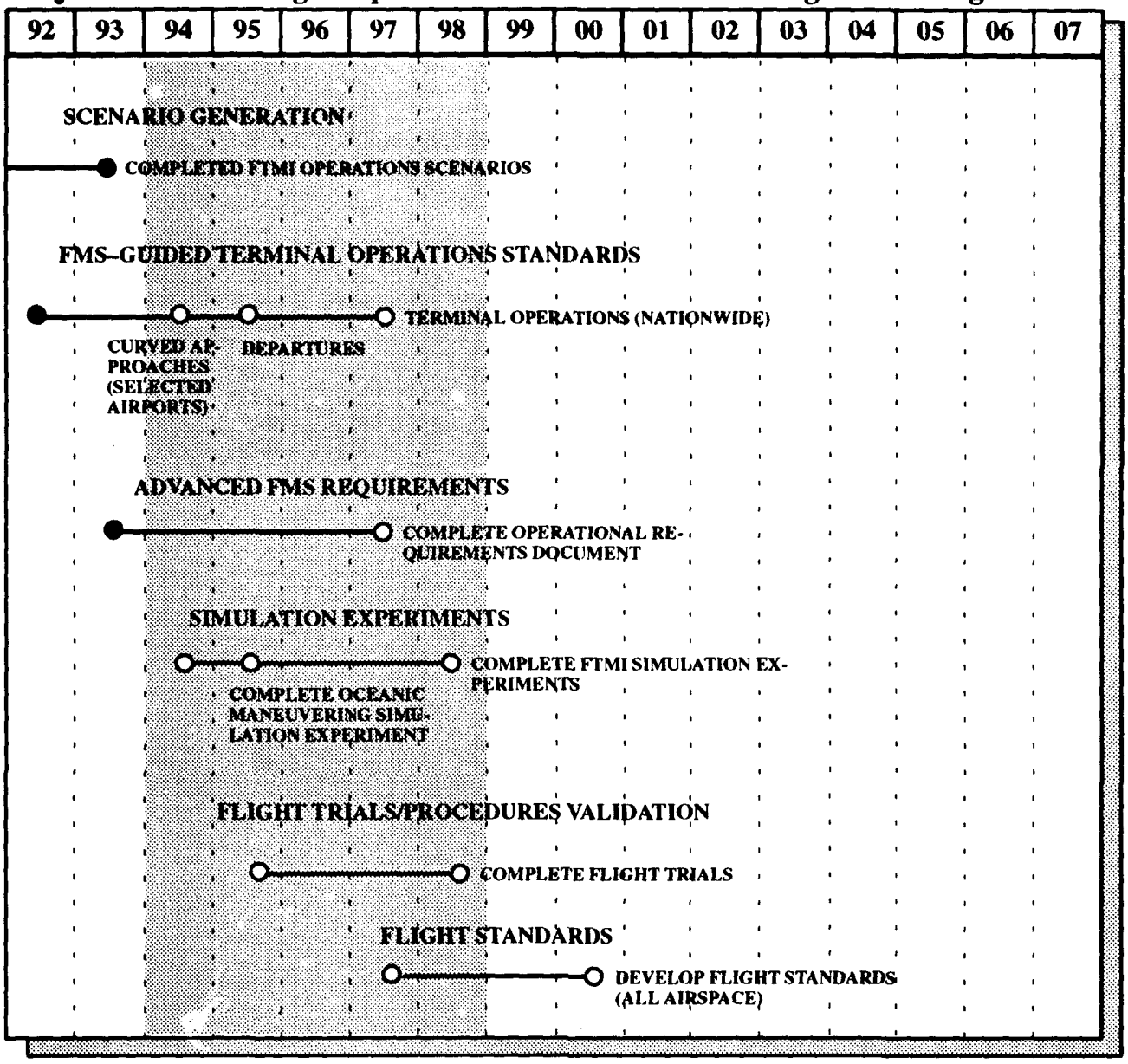
Planned Activities:

Analyses will be completed to support flight standards for developing FMS–guided curved approaches to selected airports in FY 1994 and FMS–guided departures in FY 1995, leading to nationwide FMS–guided terminal operations standards in FY 1997.

A simulation experiment involving route maneuvering in oceanic airspace will commence in FY 1994 and be completed in FY 1995. This experiment will demonstrate FMS capabilities to improve oceanic airspace utilization and flight efficiency. In FY 1995 – FY 1998, further simulation experiments involving FTMI scenarios will be conducted. In parallel to this activity, flight trials will be conducted with industry to validate procedures generated as a result of these simulations. Analysis of simulation experiments and flight trials will yield flight standards by FY 2000.

An activity will be initiated in FY 1994 to develop an operational requirements document by FY 1997 for advanced FMS capabilities to ensure full integration of flight management and ATM operations.

Project 022–150: Flight Operations and Air Traffic Management Integration



023–120 Separation Standards

Purpose: This project will provide quantitative guidance for domestic and international efforts to establish minimum vertical and horizontal separation standards. Increasing system capacity is directly related to separation standards. As new technology is introduced, separation standards will be reduced, resulting in increased system capacity and efficiency.

Approach: Tests will be conducted to provide quantitative guidance for determining domestic and oceanic separation minima permissible as

new technologies are introduced. This effort will establish separation minima based on improved navigation, ADS, other new technologies, and ATC improvements.

This project will analyze separation standards in the North Atlantic, Central East Pacific, North Pacific, and West Atlantic route systems. It will examine the impact of various system improvements on horizontal and vertical separation. Time–based navigation capabilities and associated ATC procedures will be analyzed to determine if time–based separation standards are feasible.

Related Projects: 021–140 Oceanic Air Traffic Automation, 031–110 Aeronautical Data Link Communications and Applications, 031–120 Satellite Communications Program, 032–110 Satellite Navigation Program, and 032–120 Navigation Systems Development. Capital Investment Plan projects: 61–22 ATC Applications of Automatic Dependent Surveillance (ADS), 61–23 Oceanic Automation System (OAS), 63–05 Aeronautical Data Link Communications and Applications, and 64–05 Global Navigation Satellite System (GNSS).

Products:

- Reports on reduced horizontal oceanic separation feasibility
- Report on domestic and international general guidance material for establishing separation standard minima
- Data packages for coordinating international horizontal oceanic separation standards
- Reduced domestic vertical separation data analyses, operational tests, and evaluations
- Recommendations for rulemaking on reduced vertical separation standards

FY 1992–1993 Accomplishments:

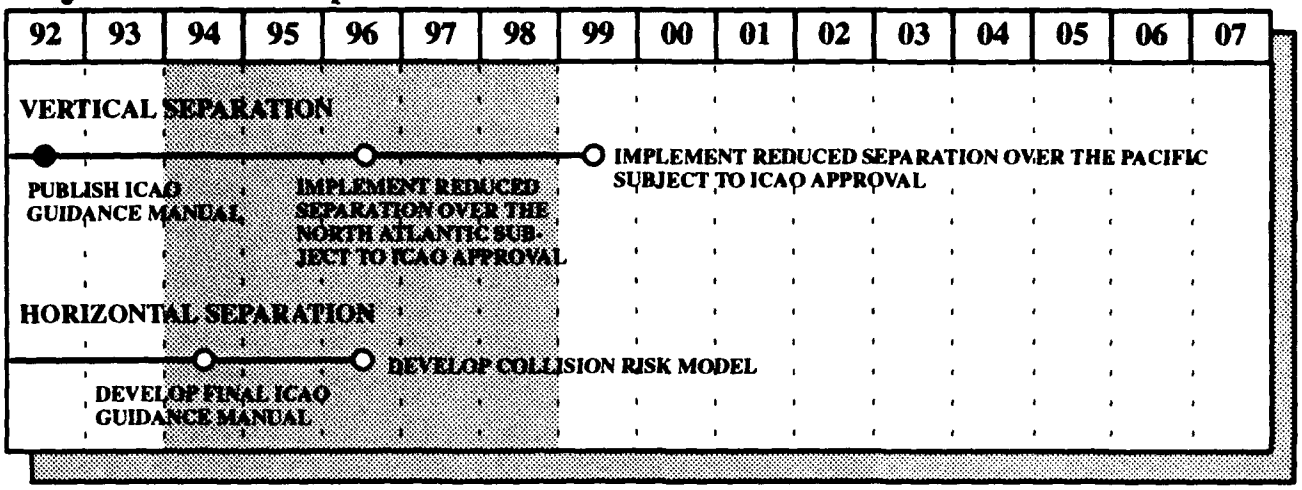
- U.S. report submitted to ICAO concluding that reduced vertical separation above FL 290 is technically feasible.
- Analysis submitted to FAA Air Traffic Service on reduced longitudinal and horizontal separation standards for the West Atlantic route system.
- Material submitted to ICAO on minimum navigation performance standards for airspace without radar monitoring.
- Completed ICAO guidance material for reducing vertical separation between FL 290 and FL 410 to 1,000 feet.

Planned Activities: The North Atlantic Systems Planning Group will continue planning for vertical separation reduction over the North Atlantic. The FAA's goal is to implement these standards by FY 1996, subject to ICAO approval. Planning will continue for vertical separation standards reduction in Pacific airspace with possible implementation by FY 1999, subject to ICAO approval.

In conjunction with ICAO, a general separation standards guidance manual for domestic and international airspace will be developed. The plan is to develop a guidance manual in FY 1994 for ICAO adoption in FY 1995–1996. This manual will consider such items as improved navigation accuracy based on satellite capability, ADS, TCAS, improved ATC automation, and improved air–ground communications.

A new or modified collision risk model is being developed to provide quantitative guidance for establishing separation standards where ADS is used. This effort is expected to be completed during FY 1996.

Project 023–120: Separation Standards



024–110 Aviation System Capacity Planning

Purpose: This project will provide system capacity planning and identify/develop near– and long–term capacity improvements.

Approach: Airport capacity design teams, currently on–site at 12 airports, are comprised of airport operators, airlines, other users, and FAA representatives. Each team starts with a current airport and adjacent airspace environment simulation using actual operating data to establish a baseline. The team then develops a list of potential improvements to increase capacity and, using a variety of simulation and queuing models, tests their effect in the specific airport environment. Among the improvements investigated are airfield improvements, such as new runways and runway extensions; improved approach procedures; and new facilities and equipment, such as the microwave landing system. Those improvements found to produce the greatest capacity increases, together with the estimated delay reductions and cost savings, are described and recommended for implementation in the final design team plans.

Design teams also address airspace structure and develop new designs and traffic flow modifications to accommodate more aircraft. Airspace redesign begins with simulating the air traffic control center airway environment using operational data to establish the baseline. The airspace design team then develops alternatives such as more direct routings; segregating jet, turboprop, and piston engine traffic; and relocating corner-post navigational aids to allow for more arrival and departure routes. These alternatives are simulated to determine their effect on delay, travel time, sector loading, and aircraft operating cost. The most successful alternatives are incorporated into a plan to redesign the airspace for increased capacity.

The Aviation Capacity Enhancement (ACE) action team program, on the other hand, works to develop achievable near–term solutions for chronic delay airports by focusing on resources under FAA control. This program is limited to initiatives that will produce results within 2 years.

Related Projects: 021–230 Wake Vortex Separation Standards Reduction, 022–110 Traffic Alert and Collision Avoidance System (TCAS), 022–140 Vertical Flight Program, 025–130 Air Traffic Models and Evaluation Tools, and 091–110 Environment and Energy.

Products:

- Aviation System Capacity Plan
- Airport Capacity Design Team Plans
- Airspace Analysis Technical Plans
- Aviation Capacity Enhancement Action Plans
- Near- and long-term capacity enhancement report
- Aviation System Capacity Enhancement video

FY 1992–1993 Accomplishments:

- Produced 1993 Aviation System Capacity Plan.
- Completed Airport Capacity Design Team Plans for Albuquerque, Boston, Cleveland, Dallas–Fort Worth, Ft. Lauderdale, Houston, Indianapolis, Minneapolis–St. Paul, Port Columbus, Las Vegas, and eastern Virginia (Richmond, Norfolk, and Newport News).
- Completed Airspace Analysis Technical Plans for Atlanta and Miami ARTCCs and joined both data bases to the Washington/ New York/Jacksonville data base.
- Completed analysis of the terminal airspace at Houston International and Philadelphia International airports.
- Completed ACE Action Team Plans for Los Angeles, Newark, and Philadelphia airports.
- Completed and disseminated an Aviation System Capacity Enhancement video.
- Developed and distributed internationally a new capacity initiatives report.

Planned Activities: Airport Capacity design teams will be initiated in FY 1994 at Detroit, Tulsa, Milwaukee, West Palm Beach and Southern California (Burbank, Ontario, and Santa Anna). These teams will develop Airport Capacity Plans for each airport by FY 1995.

Airspace analyses at Albuquerque, Boston, and Memphis ARTCCs will be initiated in FY 1994, and their data bases will complement those for the Atlanta, New York, and Washington ARTCCs. These analyses will lead to plans to redesign airspace usage at these locations during FY 1995.

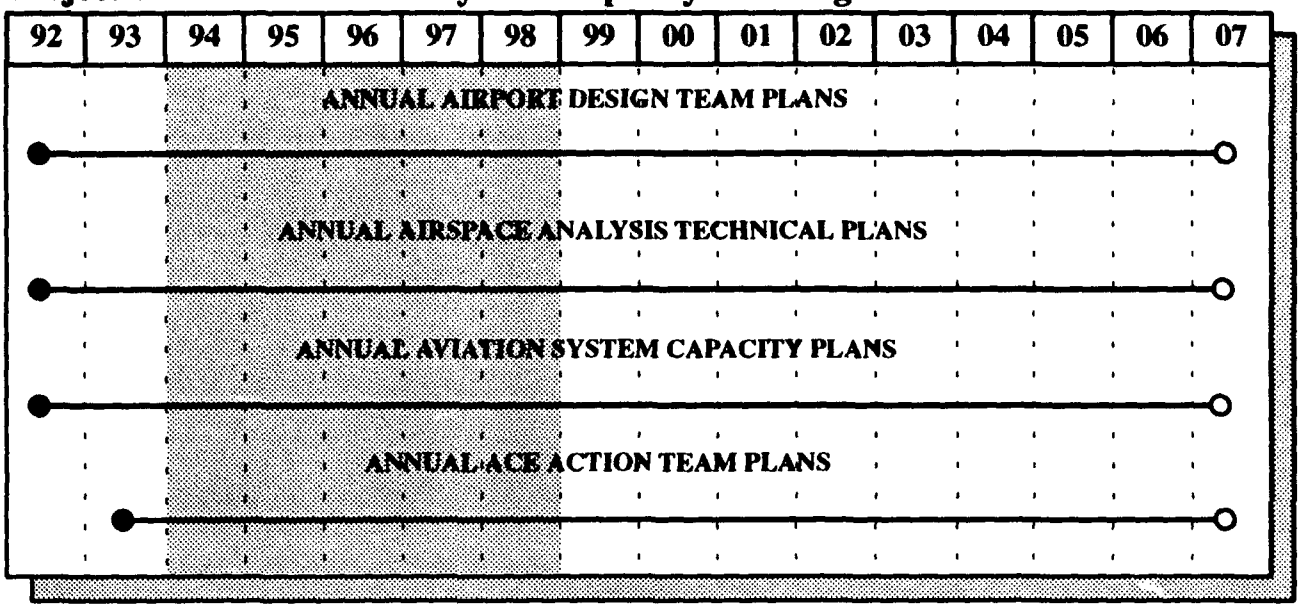
Also in FY 1994, improved independent converging approach procedures and standards will be analyzed and developed by a technical working group. These standards will allow improved flexibility of operations at major airports which will result in capacity increases without any derogation of safety.

From FY 1995 to 1998 simulations and flight demonstrations will be conducted to determine if TCAS can be expanded for separation assistance. The FAA Strategic Plan goals are improved system efficiency, a reduction in controller workload, and enhanced safety.

In FY 1994, ACE action team program work will continue. These teams will investigate near–term solutions to problems at the top 24 airports experiencing chronic delay. As technology evolves, the ACE action teams will continually analyze delay problems and develop new, near–term solutions.

The Aviation System Capacity Plan will continue to be produced annually.

Project 024–110: Aviation System Capacity Planning



025–110 National Simulation Capability (NSC)

Purpose: The NSC will aid and support the R,E&D and systems engineering missions of the FAA by horizontally integrating the various R,E&D program elements across the NAS environment. The capability to horizontally integrate future ATC subsystems during the conceptual stage of a project permits early requirements validation, problem identification, developing solutions to those problems, and demonstrating system capabilities. It permits early injection of human factors and system user inputs in the concept formulation process. The net result is a reduced risk in developing products for the National Airspace System, faster infusion of new technology, early acceptance of new NAS concepts by system users, and greater efficiency in performing the R,E&D and systems engineering missions.

Approach: The NSC will be a unique capability in that it will not exist in any one place but will be achieved by linking together, on a distributed interactive network, existing simulation capabilities. That capability will allow the FAA to horizontally integrate components of future ATC systems and assess their suitability and capability before production investment decisions are made. Horizontal integration will bring together diverse system components such as terminal automation, en route automation, oceanic control, aircraft flight management systems, and mixes of aircraft types and performance in a flexible, interchangeable, and dynamic simulation environment. The NSC will permit the evaluation of new operational concepts, human interfaces, and failure modes in a realistic, real–time interactive ATC environment capable of simulating new or modified systems at forecast traffic levels. Simulation capabilities will be expanded through the interface with various remote research centers that possess nationally unique facilities and expertise.

Related Projects: All major operational subsystems.

Products:

- NSC Operating Plan
- NSC documentation including: configuration management plan, software development plan, coding standards, experimental protocol standards, external program interface requirements, and experimentation plans and reports
- Operational Integration Laboratory (I–Lab)
- Operational NSC

FY 1992–1993 Accomplishments:

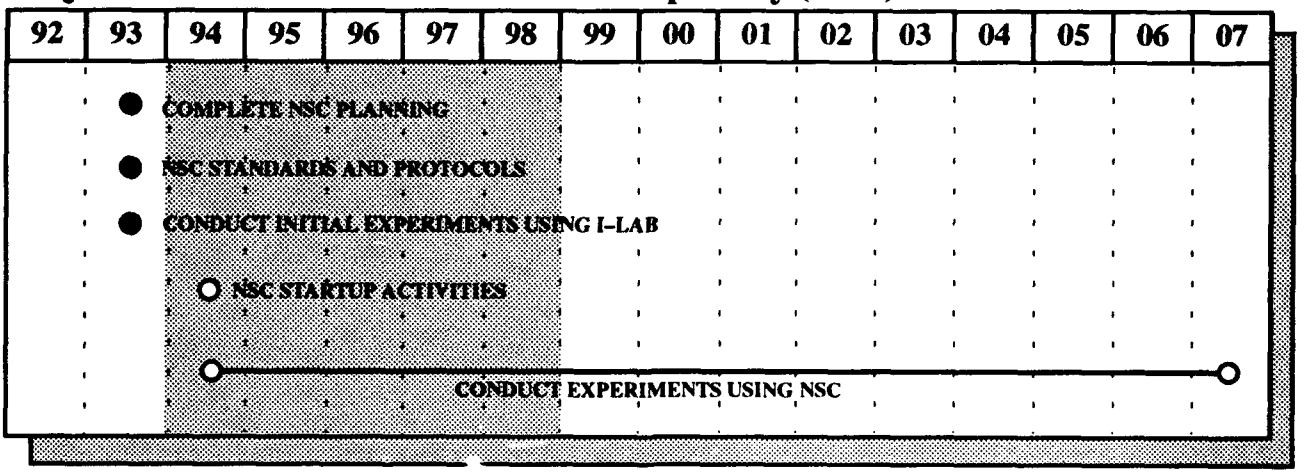
- Completed NSC Requirements.
- Completed the NSC Technical Plan and Program Master Plan.
- Developed NSC Architecture Description.
- Integrated AERA/TMA (TATCA)/TMS into I–Lab.
- Completed initial Integration and Interaction Laboratory (I–Lab) experiments and initiated experiments at the FAA Technical Center.
- Completed initial NSC standards and protocols.

Planned Activities:

In FY 1994, standards and protocols will be implemented to facilitate linking nodes on the NSC laboratory network and transferring models/simulations between laboratories. NSC will continue to support developing expanded experimentation capability at both the I–Lab and the FAA Technical Center that will be responsive to FAA sponsor organization requirements. New experiments will be conducted that take full advantage of the additional NSC functionality.

As more issues are identified, experiments will be developed and conducted in the NSC during the out years.

Project 025–110: National Simulation Capability (NSC)



025–120 Operational Traffic Flow Planning

Purpose: The OTFP project produces near–term improvements in national–level traffic flow management (TFM) conducted at the FAA's Air Traffic Control Systems Command Center (ATCSCC) which will: improve airspace use by providing optimal traffic flows; minimize delay, fuel consumption, and service disruption to increase aircraft operators' efficiency; and balance demand and capacity to reduce controller workload.

The OTFP project involves operational concept exploration, rapid–prototyping, and proof–of–concept evaluation using advanced operations research (OR) techniques and computer modeling. The OTFP System consists of a coordinated set of computer–based decision support tools to assist the TFM specialists of the ATCSCC.

Approach: The FAA's Operations Research Service (AOR) and the ATCSCC have identified four crucial requirements that, when met, will equip the TFM specialist with a decision support system to dramatically increase the overall efficiency of NAS operations. Meeting these requirements is the objective of the OTFP Project. The four ATCSCC requirements are:

Availability of Critical TFM Information

The amount of data generated during NAS operations is enormous and includes filed flight plans, aircraft position data from radar, and weather to mention a few. The OTFP Program is developing ways to transform these data into information regarding past, present, and projected NAS conditions. The OTFP System will present this information to the TFM specialist in an intuitive manner using graphics and data visualization extensively to improve the rapid comprehension of large amounts of data.

TFM Strategy Evaluation

The ATCSCC must resolve demand/capacity imbalances in the NAS. Currently, the TFM specialist relies solely on expertise to derive a traffic flow management strategy. The OTFP System will evaluate the proposed strategy before implementation, allowing the specialist the opportunity to review the predicted NAS effects. If necessary, the specialist can alter the strategy or propose alternative ones.

TFM Strategy Generation

The OTFP System generates optimal strategies for current or anticipated NAS conditions. OTFP supplies the TFM specialist with one or more highly efficient strategies to consider. This process is analogous to having a computer analyze numerous possible moves for a chess game in advance. Performed in real–time, this capability provided by OTFP significantly improves the final choice of strategies.

TFM Decision Support Tool Testbed

There are many ways to use computers to characterize the current NAS condition, generate effective plans, and predict the impact of alternative strategies. The ATCSCC needs quick, economical means to experiment with various automated traffic flow planning techniques and computer–based OR methods. The OTFP System provides a testbed for decision support tools that minimizes the costs and time required for such efforts. OTFP eliminates duplicate efforts in both data access and graphical user interfaces that operations research projects typically need.

Related Projects: 021–110 Advanced Traffic Management System (ATMS), 021–180 Terminal Air Traffic Control Automation (TATCA),

and 025–130 Air Traffic Models and Evaluation Tools. Capital Investment Plan projects: 21–06 Traffic Management System (TMS), 61–23 Oceanic Automation System (OAS), and 62–20 Terminal ATC Automation (TATCA).

Products: The OTFP project will develop the following coordinated set of computer models and decision support tools tailored to meet the four critical ATCSCC requirements.

Availability of Critical TFM Information

- Daily decision analysis system (DDAS) for automation tools to quickly analyze airline schedule change impacts
- ATCSCC analyses to evaluate ATCSCC traffic management operations
- Ground Delay Program Substitution Visualizer to demonstrate the TFM effects of airline substitution practices

TFM Strategy Evaluation

- Daily flow simulation model (FLOWSIM) for fast–time national pacer airport traffic flow simulation
- NAS simulation (NASSIM) for detailed NAS–wide traffic prediction and simulation

TFM Strategy Generation

- High altitude route system (HARS) for optimized, fuel efficient jet routes
- Planned arrival and departure system (PADS) for developing optimal departure and arrival scheduling plans
- Knowledge–based flow planning (SMARTFLO) for quick response flow advisories using expert systems
- Optimized flow planning (OPTIFLOW) for dynamic national traffic flow optimization

TFM Decision Support Tool Testbed

- Conterminous United States data model (CONDAT) to provide a common data source for all OTFP simulation and optimization efforts
- OTFP System to integrate functions of the individual project initiatives

FY 1992–1993 Accomplishments:

- Delivered, demonstrated, and operationally evaluated HARS to assist ATCSCC with the National Route Program and Severe Weather Management Program.
- Developed DDAS to accurately predict resource usage through filed flight plans and the Official Airline Guide.
- Delivered and demonstrated the Ground Delay Program Substitution visualizer to show TFM effects of airline substitution practices.
- Developed fast–time national pacer airport traffic flow simulation model to evaluate TFM plans.
- Developed SMARTFLO for fast advisory response.
- Completed research on OPTIFLOW techniques for deriving optimal TFM strategies by computer while considering changing conditions.

Planned Activities: In FY 1994, HARS planning capabilities will be expanded to include enhanced communications software for interactive planning between FAA and airline planners.

Continuing field prototype development will provide follow–on enhancements to enable full track generation and traffic optimization for high altitude traffic anywhere within the United States. It will also develop the integration necessary to provide interoperability with national and oceanic traffic management systems. In FY 1995, ADS and data link system interfaces will be developed to provide real–time communications between ATCSCC and the full range of airspace users. This will complete HARS development, and the resulting technologies will migrate into OPTIFLOW.

In FY 1994, development will continue on the testbed prototype for the PADS Planning Model with demonstration and evaluation completed later in the year. The PADS functional prototype, scheduled for ATCSCC testing in FY 1995, will provide a real–time ability to develop airport departure and arrival scheduling plans that optimize daily traffic flows for long–range flights between major city–pairs. The PADS field prototype development and demonstration is planned for FY 1995–1996. PADS field prototype delivery in FY 1996 will enable ATCSCC and traffic management unit (TMUs) to interactively plan with commercial aviation dispatchers to develop optimized high altitude flight sequencing in conjunction with the HARS and OAS traffic models.

Operations research for the OPTIFLOW model will continue in FY 1994 and be completed in FY 1995. The OPTIFLOW initial prototype testbed demonstration and ATCSCC evaluation will begin in FY 1995. OPTIFLOW field prototype development will follow in FY 1996 with field prototype demonstration and evaluation planned for late FY 1996 and early FY 1997. OPTIFLOW field prototype delivery is planned for FY 1997.

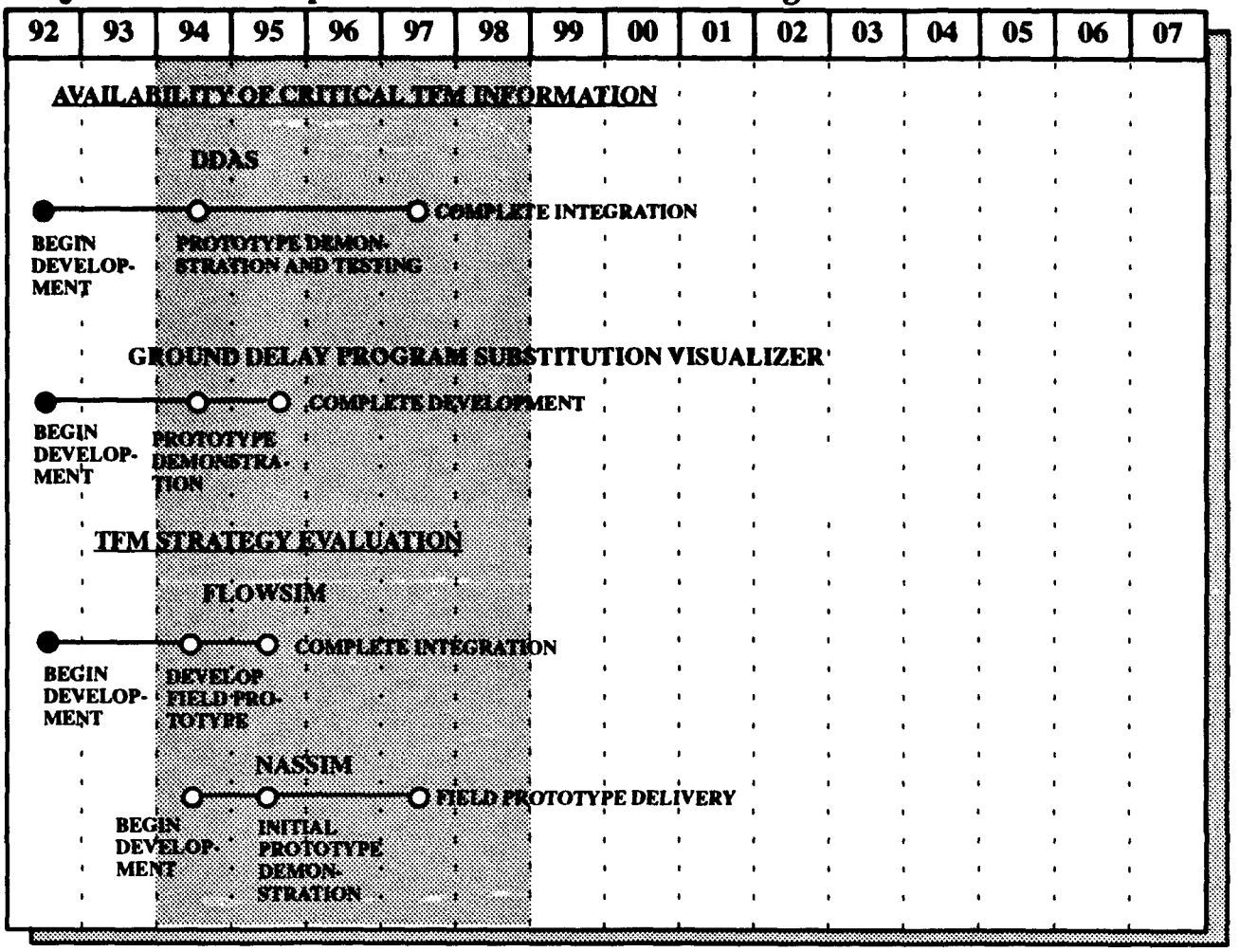
In FY 1994, a FLOWSIM field prototype will be developed. Integration with other tools will begin in FY 1994 and be completed in FY 1995. Work on the CONDAT data model will continue with initial prototype demonstration and testing scheduled for FY 1994. Follow–on CONDAT development and integration will continue through FY 1997. Operations research to develop NASSIM, for predicting and simulating detailed daily traffic and flow strategies, will continue in FY 1994. NASSIM will utilize and integrate many technologies and tools developed in preceding projects such as HARS, PADS, FLOWSIM and OPTIFLOW. NASSIM initial prototype testbed development is scheduled to begin in FY 1994 with initial prototype demonstration and evaluation planned for FY 1995. NASSIM field prototype development is planned for FY 1995–1996, with field prototype demonstration and evaluation scheduled to begin in FY 1997. NASSIM field prototype delivery to ATCSCC and TMUs is planned for late FY 1997.

In FY 1994, a SMARTFLO field prototype will be completed, demonstrated, and tested. SMARTFLO delivery to the ATCSCC is scheduled for FY 1995.

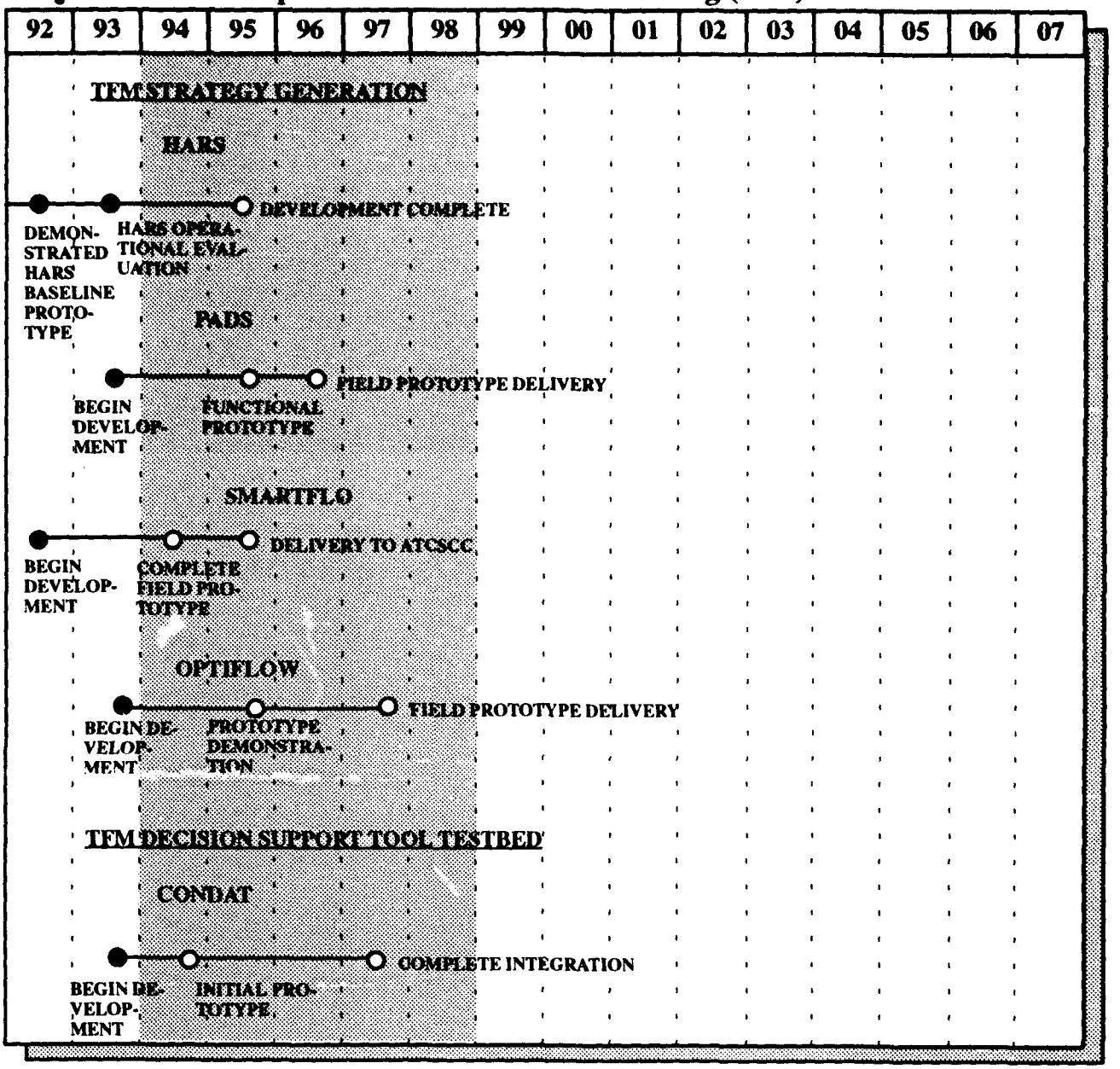
In FY 1994 DDAS will begin testbed prototype development of tools for dynamic, digital data exchange of scheduling information between the ATCSCC and airlines scheduling facilities. Prototype demonstration and testing is scheduled in FY 1995. DDAS integration with other OTFP projects will follow in FY 1995–1997.

In FY 1994, a Ground Delay Program Substitution Visualizer prototype will be demonstrated. Development will be completed in FY 1995. ATCSCC analysis and integration will continue for ATCSCC operations during the Operational Traffic Flow Planning project development and fielding stages from FY 1994 to FY 1997.

Project 025–120: Operational Traffic Flow Planning



Project 025–120: Operational Traffic Flow Planning (con.)



025–130 Air Traffic Models and Evaluation Tools

Purpose: This project will produce modeling and analytic tools to support operational improvements, airspace and airport design, environmental analysis, investment decisionmaking, and ATC system design analysis. The products from this project will provide ATC with the ability to rapidly plan, evaluate, and update operational changes to accommodate the more dynamic airport/airspace environment. This project's models will respond to the dynamic

changes resulting from satellite navigation and increased ATC and cockpit automation. The program will emphasize improvements to existing models and new model developments that produce the highest payoff. Modeling products will be improved to make them simpler, faster, more effective, and more widely used and accepted.

Approach: Development will focus on integrated airport and airspace modeling. Previously developed models, such as National Airspace System performance analysis capability (NASPAC) and SIMMOD, will be made easier, faster, and more flexible to use. New model variants will enable clients to make fast approximations to complex situations. SIMMOD, an FAA trademark software program, is used by the FAA, industry, and foreign governments to design airport layouts and airspace routings.

The sector design analysis tool (SDAT) aids in redesigning en route airspace to increase capacity and balance the controller workload. SDAT derivatives are the terminal airspace sector design analysis tool (T–SDAT) and the national airspace sector design analysis tool (N–SDAT) that provide new capabilities for evaluating terminal and multi–center en route airspace design. Additionally, a critical sector detector (CSD) will be developed to determine when airspace sectors will reach critical traffic density levels based on controller workload limits.

Related Projects: 021–220 Multiple Runway Procedures Development, 024–110 Aviation System Capacity Planning, 025–110 National Simulation Capability (NSC), and 025–120 Operational Traffic Flow Planning.

Products:

- Enhanced SIMMOD airport and airspace simulation model
- SIMMOD capability installed in ARTCCs, TRACONs, and FAA regional offices
- Production NASPAC U.S. airspace simulation model
- SDAT, T–SDAT, and N–SDAT
- Critical Sector Detector

FY 1992–1993 Accomplishments:

- Released 3–D, graphics–oriented SIMMOD workstation version.
- Implemented SDAT at all ARTCCs.
- Conducted SIMMOD operational demonstration at the Southeast Region, Atlanta ARTCC, and Dallas–Fort Worth TRACON.
- Delivered NASPAC Release 3.

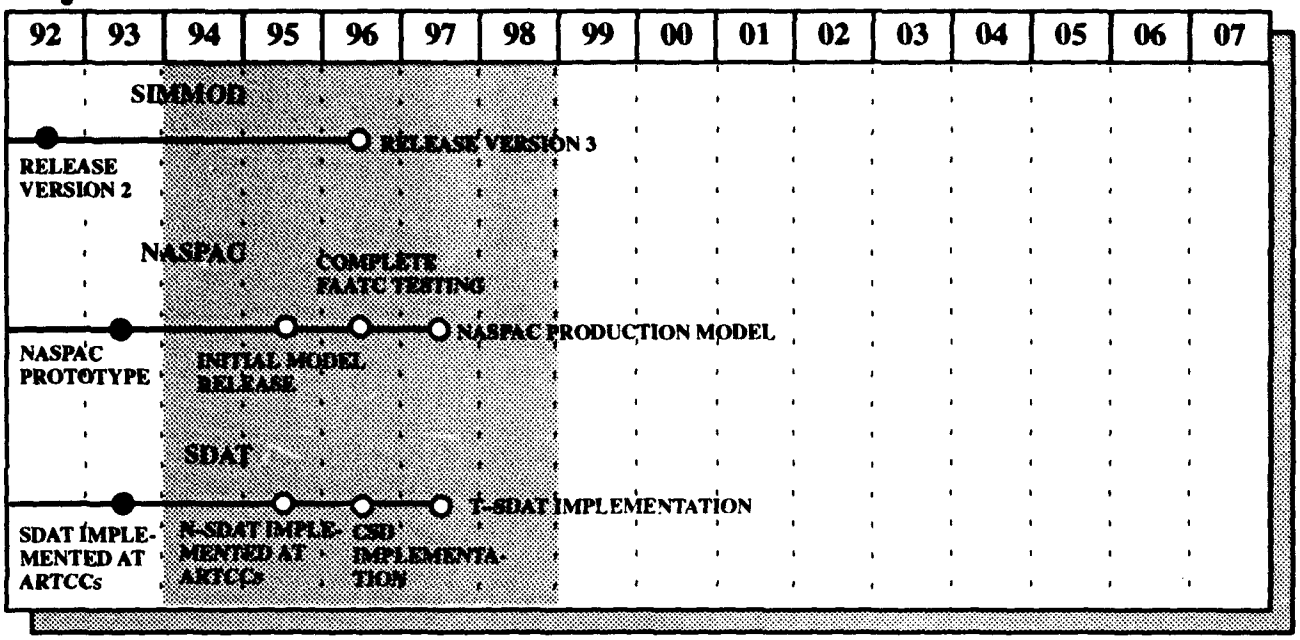
Planned Activities: In FY 1994, new SIMMOD logic enhancements will increase simulated traffic dynamic control and account for en route system dislocations. SIMMOD capabilities will be established in FAA regions and en route centers. Additional regions and centers will be added in FY 1995. In FY 1996, a new SIMMOD version will be released to accommodate future airspace requirements for user–preferred direct routing.

In FY 1994, work will continue on SDAT derivatives. N–SDAT will be completed in FY 1994 with implementation expected in FY 1995. In FY 1994, work will continue on CSD development with completion/implementation in FY 1996. T–SDAT testing will be conducted in FY 1995, with completion/implementation in FY 1997.

In FY 1994, work will continue on NASPAC to develop a user–friendly workstation production version. The current NASPAC version is a prototype developed by MITRE Corporation that considers various performance measures for determining NAS–wide impacts from proposed system improvements. The production model

will permit analysts to conduct studies more easily and quickly and will provide more sensitivity to proposed changes in the overall airspace system design. In FY 1995, an initial NASPAC production model version will be released. NASPAC testing will be conducted at the FAA Technical Center through FY 1996, with implementation expected in FY 1997.

Project 025–130: Air Traffic Models and Evaluation Tools



026–110 Airway Facilities System Technology Concepts and Methodologies

Purpose: The traditional airway facilities (AF) service role is changing dramatically. These changes are driven by new technology, a changing work force, and increasing levels of automated airway facilities systems management. This project will assess future changes and develop appropriate policies to help guide the FAA to meet future AF operational needs.

Approach: An investigation and review of current Airway Facilities directives, guidelines, data bases, and other supporting documents addressing the current and future concepts and methodologies will be conducted. The data gathered during this effort will be cataloged into categories which address the specific areas of systems management and resource allocation and utilization. Additional information from similar activities conducted in other Government and private organizations will be added to this archive of information. Using data collected, simulation models that represent future AF operational concepts/methodologies will be developed. These models will be used to evaluate strategies for both the work force and future technologies applications, plus develop operational concepts/methodologies for addressing the requirements that future airway facilities technology will impose.

This project provides two important functions: the first is to develop the overall strategic plan for the Airway Facilities R,E&D program; and the

second is to serve as the basis for integrating the most promising concepts and methodologies for the future. Once the most promising concepts and methodologies are identified from the models, rapid prototyping capabilities will be used to evaluate proposed operational standards for people and equipment. Proposed standards will then be tested in appropriate facilities to simulate an operational environment.

Related Projects: 025–110 National Simulation Capability (NSC), 031–130 NAS Telecommunications for the 21st Century, 032–110 Satellite Navigation Program, and 083–110 Airway Facilities Human Factors.

Products:

- Airway Facilities Research Program Plan
- Integrated concept/methodology tools
- Airway Facilities standards for people and equipment
- Operational concepts, methodologies, and data to support prototype equipment
- Transition strategy for integrating future operations control centers (OCC) into the NAS

FY 1992–1993 Accomplishments:

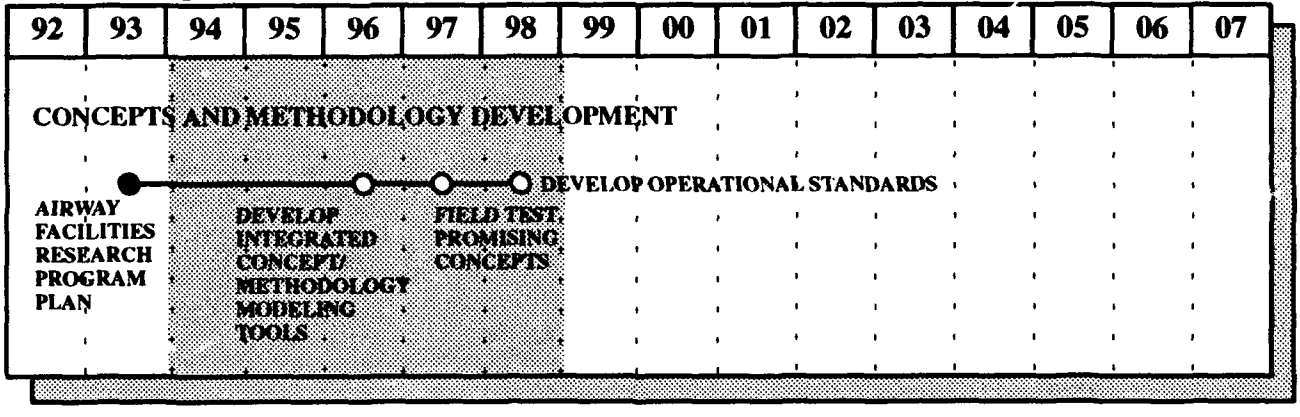
- Developed AF R,E&D program plan.

Planned Activities: In FY 1995, integrated modeling tools will be developed to simulate future system responsibilities/functions in the NAS. These models will be used in FY 1996 to develop Airway Facilities strategies, concepts, and methodologies for modernization and/or replacement within the NAS.

In FY 1996, modeling tools will be used to: (1) develop strategies for system modernization/ replacements based on the most cost–effective system management concept; and (2) measure performance for application of procedures and technologies used in system management.

In FY 1996, promising concepts and methodologies will be evaluated. These evaluations will be followed in FY 1997 with field testing at selected locations for final validation. Airway Facilities operational standards will then be developed in FY 1998.

Project 026–110: Airway Facilities System Technology Concepts and Methodologies



026–120 Airway Facilities Diagnostic Tools and Future Technology

Purpose: Emerging technology has always served as a driver in how AF has managed its organization, facilities, and personnel. While this has proven to be effective when replacing a single system or part of a single system, it may prove ineffective due to the magnitude of the Capital Investment Plan (CIP) modernization plan. The transition to the new AF environment cannot occur in a vacuum; research must investigate interdependencies for total system integration. This project will explore emerging technology applications in the total AF environment.

Approach: This project will concentrate on two major research areas: developing testbeds for operational alternative scenarios and building both intelligent tutoring systems and expert diagnostic, predictive, and resolution tools. The testbeds will be used to investigate various scenarios associated with new technologies, such as remote maintenance monitoring and control functions, Operations Control Center, and potential satellite and data link interfaces. The scenarios will be used to analyze technology alternatives, develop proof-of-concept prototypes, and select an optimum approach for maintaining the NAS using parameters like reliability and life-cycle costs. Results from the testbed analyses will be utilized by Project 026–110 for developing system technology concepts and methodologies.

The scenario analyses will also provide direction on developing intelligent tutoring systems and expert diagnostic, predictive, and resolution tools. Appropriate areas will be identified for intelligent tutoring systems (ITS) development. The ITS will provide interactive tools for the AF work force to increase worker productivity, provide a job aid knowledge base, increase worker efficiency, and reduce training costs. The ITS will be fully integrated with expert diagnostic, predictive, and resolution tools that will serve as troubleshooting job aids for the AF system specialist. The expert diagnostic, predictive, and resolution tool is a comprehensive interactive computer program to help isolate and solve equipment problem areas.

Related Projects: 026–110 Airway Facilities System Technology Concepts and Methodologies, 032–110 Satellite Navigation Program, and 083–110 Airway Facilities Human Factors. Capital Investment Plan projects: 26–01 Remote Maintenance Monitoring System (RMMS) and 26–04 Maintenance Control Center (MCC).

Products:

- Scenario testbed for interaction with GPS/GNSS technology, national, and local operations control centers
- Expert diagnostic, predictive, and resolution tools
- Intelligent tutoring system
- Information support to develop policies, procedures, and standards

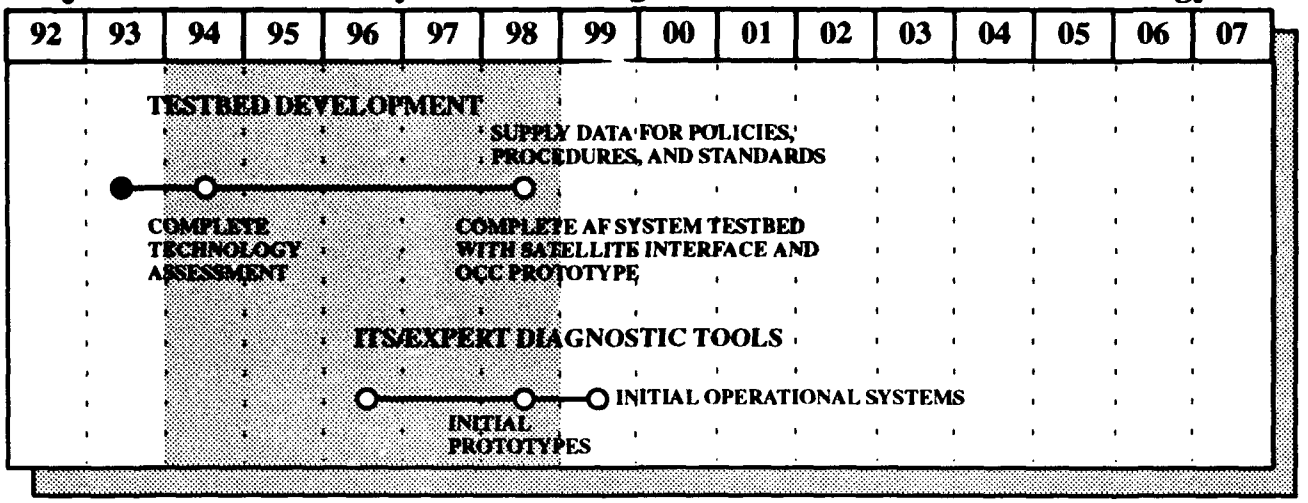
FY 1992–1993 Accomplishments: None. This is a new project.

Planned Activities: In FY 1994, a technology assessment will be completed to determine how future technologies could be used in Airway Facilities operations. As a result of this research, test bed assessment reviews will begin in FY 1994, leading to an AF system testbed (OCC–based) with an Airway Facilities satellite interface in FY 1998. The analyses will be completed and data will be available for project 026–110 in FY 1997 and FY 1998, respectively, for developing policies, procedures, and standards.

In FY 1996, development will begin on the ITS and expert diagnostic solution tools. This work is predicated upon the test bed analyses results.

System prototypes will be completed in FY 1998 with operational systems available by FY 1999. Additional ITS/expert tool development needs will be identified in future years, based on future NAS technology.

Project 026–120: Airway Facilities Diagnostic Tools and Future Technology



026–130 Airway Facilities Functional Models and Evaluation Tools

Purpose: As new technology systems become operational, the current AF organizational structure and functions may not be consistent with achieving full system capabilities. Management will need to assess AF organizational configuration in response to such issues as the size and location of sectors, centralized maintenance versus decentralized maintenance, and AF cross functionality with other organizations. This project will identify future organizational structure and functions by developing alternative models and evaluation tools.

Approach: This project will produce analytical models to support AF operational improvements, including organizational efficiency. The first task will be to examine current AF organizational aspects from a systems viewpoint to determine the baseline and explore the interdependencies/ cross functionalities with external organizations. Subsequent efforts will develop various models dealing with AF sector size and location, centralized versus decentralized maintenance, and control facilities.

These models will provide the ability to examine alternative organizational structures. A key element in this project is developing an evaluation tool that measures the correlation between organizational structures, functions, and the future AF mission. This tool will test the alternative organizational structures developed from the analytical models. Once the new organizational structure is implemented, the analytical tool will be used to continually evaluate its validity. This project is highly integrated with, and dependent upon, Projects 026–110 System Technology Concepts and Methodologies and 026–120 Diagnostic Tools and Future Technology.

Related Projects: 026–110 Airway Facilities System Technology Concepts and Methodologies, 026–120 Airway Facilities Diagnostic Tools and Future Technology, and 083–110 Airway Facilities Human Factors.

Products:

- Establish existing organizational structure baseline
- Alternative organizational structures and scenarios
- Models for future organizational structure
- Analytical tool for evaluating organizational structure versus AF mission

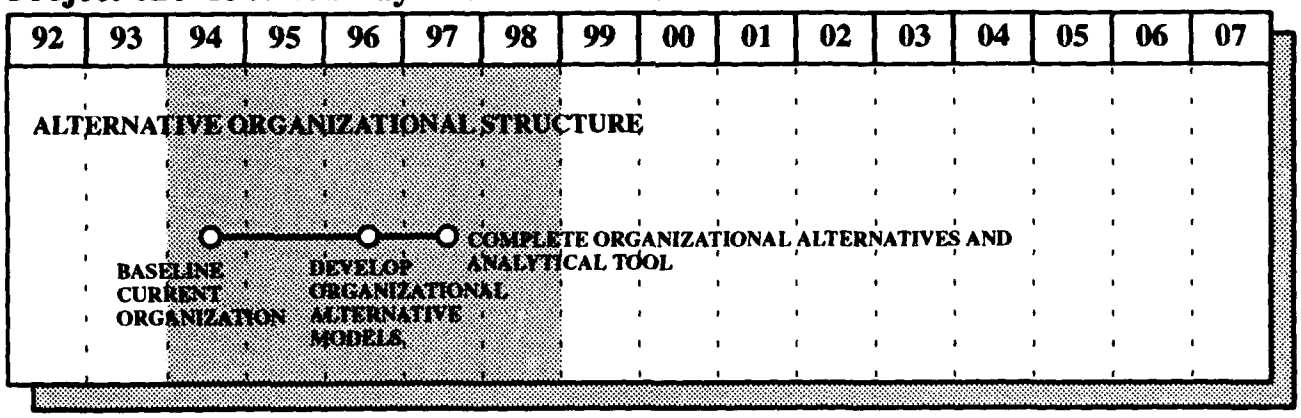
FY 1992–1993 Accomplishments: None. This is a new project.

Planned Activities: In FY 1994, an initial background study will be conducted to determine the areas that need improvement or adjustment to achieve the most effective future organizational structure and function. This will serve as the current organizational baseline for future improvements. An analysis will be conducted in FY 1995 to determine cross functionality with organizations external to Airway Facilities.

In FY 1995, prototype models will be developed for identifying organizational alternatives. These models will be tested through FY 1996, and alternative organizational structures will be available in FY 1997.

In FY 1996, development work will begin on the organizational structure analytical tool, with completion in FY 1997. This tool will be used to evaluate organizational alternatives and periodically validate the future organizational structure.

Project 026–130: Airway Facilities Functional Models and Evaluation Tools



3.0 COMMUNICATIONS, NAVIGATION, AND SURVEILLANCE

The air traffic management (ATM) system's ability to support safe and efficient future flight operations is critically dependent upon a high–performance, reliable, cost–effective communications, navigation, and surveillance (C/N/S) infrastructure. Because these systems require avionics development and certification, the FAA takes an active role in assessing and defining system requirements, strengths, and characteristics for appropriate integration into the ATM system.

The sensor and computer technology to provide the desired C/N/S infrastructure is an extension of successful commercial and military developments during the 1980's. One key technology is a high capacity air mobile communication system that permits automation in the cockpit to communicate with the automation products being developed in ground computers discussed in Chapter 2. The International Civil Aviation Organization (ICAO) has recognized the need to develop international standards for this capability and has directed the Secondary Surveillance Radar Improvements and Collision Avoidance Systems Panel to include this standardization activity in its work program.

Another key technology is applying satellites to ATM. The satellite's role in future C/N/S systems has been highlighted by the Future Air Navigation System (FANS) committee established by ICAO in 1983. The FAA has adopted the FANS recommendation as a basis for its C/N/S research program. This technology offers a number of opportunities to improve C/N/S coverage, accuracy, and reliability. Aircraft users are anticipating sufficient benefits and are aggressively planning to incorporate this technology in future airframe deliveries by developing appropriate interface standards. It is essential that the FAA proactively pursue this technology so that validated standards and certification criteria are available in a responsible time frame. The Research, Engineering and Development (R,E&D) challenge is to provide this C/N/S infrastructure by the mid-1990's for inclusion in the next generation aircraft.

Enhancements in C/N/S achieved through these R,E&D projects provide the basis for dramatic improvements in system performance including improved safety, reduced delay, increased capacity, and greater efficiency. These three functional areas represent key ATM infrastructure elements. For this reason, many of the quantitative benefits from this area will be realized by implementing projects in the capacity and ATM technology thrust area. For example, the Aeronautical Data Link project, the Satellite Communications project, and the Satellite Navigation project provide the technology necessary to achieve the benefits associated with reducing oceanic separation standards in the Oceanic Air Traffic Control (ATC) Automation program. Similarly, the benefits associated with terminal and en route automation rely on data link capabilities that will be achieved through the Mode S Data Link Enhancement project.

Several projects in this thrust area are focused on replacing, at the appropriate time, existing systems with systems that have enhanced capabilities. The future benefits assessment for these projects will only focus on the enhancements' value.

The Department of Defense's (DOD) Global Positioning System (GPS) deployment has been justified by national security requirements. The DOD has stated that GPS will be available, at no direct cost, for civilian applications for the next 10 years. Some projects in this thrust area are designed to use the GPS system, supplemented by the Global Orbiting Navigation Satellite System (GLONASS) or Long–Range Navigation (Loran)–C, as the primary means for air navigation. The benefit from these projects will be the ability to forgo using the present very high frequency omnidirectional range (VOR)/distance measuring equipment (DME) network rather

than replace the present electronic equipment. Furthermore, the ability to use differential GPS to provide near Category (CAT)–I landing capabilities could make this service available at virtually all airports.

COMMUNICATIONS

The primary R,E&D goals in communications (which support the goals listed in chapter 1) are:

- To reduce or eliminate voice frequency congestion and the occasional miscommunication inherent in today's voice communications. Both of these problems place a major constraint on controller and pilot productivity and adversely impact ATC safety.

- To provide a seamless communications network that allows ground and airborne computers to exchange information efficiently and reliably under controller/pilot management to obtain new services from ATC.

Recognizing that individual air/ground digital communications systems already exist, an overall communications network architecture is needed to permit defining and implementing user interfaces independent of the specific air/ground data link systems employed. The system must be seamless so that when aircraft move across sector and communication coverage boundaries within and outside the United States, communications remain uninterrupted and the associated controller/pilot workload is reduced. The architecture to achieve this seamless performance must be validated and coordinated with international organizations to achieve global standards. This job is a huge undertaking. Standards must be developed for the protocols, encoding, security, routers, and network management functions. Independent technical experts acknowledge that this activity is at the technology forefront in network communications. Users, airframe manufacturers, avionics manufacturers, service providers, Government, and aviation consultants have recognized the importance of this work, and they are pursuing a joint industry/Government research project to develop an initial capability.

Other needed communications research and development involves developing standards for satellite communications and data link applications to transmit information identified by user groups. This information includes weather data, automatic terminal information system (ATIS), pre–departure clearances (PDC), automatic voice channel assignments, position reports, winds aloft, and airspace restrictions.

NAVIGATION

The major R,E&D goals in navigation are to extend GPS to precision approaches and surface navigation and integrate it with the instrument landing system (ILS), the microwave landing system (MLS), and the overall ATM system. This activity recognizes that GPS satellites are in use by DOD, receivers were successfully used during Operation Desert Storm, and users are already experimenting with this technology for civil aviation.

Another GPS technology application is its use in improving situational awareness in the cockpit, thereby eliminating one of the causal factors involved in runway incursions.

The FAA needs an aggressive research program to understand the capabilities and limitations imposed by satellite technology and determine the correct role for it in the ATM system. It is widely acknowledged that MLS is required at

international gateway airports requiring CAT II and III service. However, GPS may provide a CAT I capability, and possibly a CAT II/III capability, that would be sufficient at many airports. The challenge is to expedite development work so that nonprecision approach capability can be established at virtually all airports. Concurrent research will determine the degree to which GPS can approach CAT I landing minima for users requiring this capability. Research is also being conducted to support the MLS/GPS CAT II/III tradeoff decision.

SURVEILLANCE

The R,E&D goals in surveillance activities are to continue developing radar sensors that increase safety, provide operational benefits, and reduce costs. Although air traffic accidents may occur during any flight phase, the highest percentage occur during take–off and landing. The need for improved surveillance has been emphasized by recent runway incursions resulting in loss of life. It is mandatory that the next generation surveillance sensors, properly coupled with automation functions, provide the increased safety required by both passengers and the FAA.

Currently, there are many airports without surveillance radars, and the Airport Surface Detection Equipment-3 radar being procured by the FAA will not be available at all airports due to cost considerations. It is important, therefore, to develop affordable sensors to support airport capacity initiatives and provide a reliable surveillance source for terminal operations and automation developments.

The effort to define and develop next generation surveillance capability must include both contemporary radar technology to improve aircraft detection and integrating new surveillance capabilities with the ATM system. This integration is required to exploit the possible range of benefits available in future surveillance. For example, terminal sensor systems will use emerging technology in microwave transmitter module fabrication, weather detection and processing technology, and flexible agile beam antenna technology. This will lead to modular, cost-effective primary and secondary radar systems with application for flexible, high capacity data links, improved surveillance accuracy, improved runway monitoring, improved windshear detection and dissemination, and improved wake–vortex tracking. Requirements for a new terminal area surveillance radar have been identified. Initial investigations indicate that it would be costly to implement all identified capabilities. The development activity will focus on adapting commercial technology to develop a radar meeting validated requirements in a cost–effective manner.

SUMMARY

To maintain and improve safety, it is imperative that the FAA develop an aggressive and coordinated research program to exploit technological capabilities integrated into a safe and efficient ATM system that will satisfy future needs. The emerging C/N/S systems must be integrated with the automation and weather programs to achieve the safe and efficient ATM system that is required.

3.1 Communications, Navigation, and Surveillance Project Descriptions

031–110 Aeronautical Data Link Communications and Applications

Purpose: This project will develop and validate domestic and international data communications standards and data link services associated with the Aeronautical Telecommunications Network (ATN) as well as special purpose air/ground data link capabilities. The ATN will be used for both air/ground and ground/ground data communications, for National Airspace System (NAS), and international aeronautical communications. This project will also provide the technical framework for all NAS systems that plan to implement data link services/applications.

Approach:

Communications

Communications protocols for aviation use will be developed, validated, and standardized both nationally and internationally. Domestic standards are being developed with the Radio Technical Commission for Aeronautics (RTCA) and international standards with ICAO. ATN standards are currently being validated with industry participation.

A critical effort for this project is investigating extended use of the Mode S Squitter for delivering GPS–based aircraft position reports. This automatic dependent surveillance (ADS) concept, if validated, will provide an enabling technology that supports Airport Surface Traffic Automation (ASTA) in developing an airport surface surveillance system. Additionally, this technology will serve as a basis for future cockpit traffic information systems.

Applications

Data link services in oceanic, en route, terminal, and tower environments are defined in coordination with the air traffic and aviation user communities. These services will be developed and evaluated by a team that includes air traffic controllers, pilots, and other system users as appropriate. Demonstrations will then be conducted with both ground and airborne system users to validate the overall operational system effectiveness.

The operational and procedural benefits of data link applications will be verified using full–fidelity airborne and ground simulation facilities. The tower ATC services will be evaluated at selected airports in a fully operational environment with participating air carriers. Routine and hazardous weather applications will be demonstrated and evaluated in various simulation and airborne testbed facilities. Weather and aeronautical services such as traffic advisories, digital automatic terminal information service (ATIS), and ADS–Mode S Squitter applications will be validated using this approach.

Related Projects: 021–140 Oceanic Air Traffic Automation, 021–160 ATC Automation Bridge, 021–180 Terminal ATC Automation (TATCA), 021–190 Airport Surface Traffic Automation (ASTA), 022–150 Flight Operations and Air Traffic Management Integration, 025–110 National Simulation Capability, 031–120 Satellite Communications Program, 031–130 NAS Telecommunications for the 21st Century, 041–110 Aviation Weather Analysis and Forecasting, 041–120 Airborne Meteorological Sensors, 042–110 Integrated Airborne Windshear Research, and 084–110 Flightdeck/ATC System

Integration. Capital Investment Plan Projects: 21–12 Advanced Automation System (AAS), 21–13 Automated En Route Air Traffic Control (AERA), 24–12 Mode S, 62–20 Terminal Air Traffic Control Automation (TATCA), 62–21 Airport Surface Traffic Automation (ASTA), 63–05 Aeronautical Data Link Communications and Applications, 63–21 Integrated Terminal Weather System (ITWS), and 63–22 Aviation Weather Products Generator (AWPG).

Products:

- U.S. and international ATN data communications and applications standards
- Specifications for production automation and communication systems that utilize/support data link
- Prototype systems to support operational data link service evaluations
- Demonstration testbeds for developing advanced weather, flight information, and ATC services
- Testbed for ATN development, evaluation, and validation

FY 1992–1993 Accomplishments:

- Performed evaluations of initial terminal and en route ATC data link services.
- Developed guidelines for ATN in the domestic and international environments for RTCA and ICAO publications.
- Completed Digital ATIS operational evaluation at Pittsburgh and Baltimore–Washington International (BWI) airports.
- Developed testbed with multiple prototype ATN routers.
- Conducted ADS–Mode S Squitter proof–of–concept demonstration.

Planned Activities:

In FY 1994, operational procedures development will continue for ATC air/ground data link applications in en route, terminal, and tower environments. First operations for the initial terminal ATC data link services are planned for the FY 1996–1997 time frame, followed by en route services in FY 1997–1998.

In FY 1994, ICAO will publish version 2 of the ATN manual. ICAO standards and recommended practices (SARPs) for Mode Select (Mode–S) data link and ATN will be published in FY 1997 for the initial ATN. R,E&D activities will continue through FY 1999 to support developing and validating standards that extend the ATN for international operations and management. ATN research, jointly sponsored by FAA and industry, will validate the ATN protocols and standards. This will be accomplished through a cooperative flight test program starting in FY 1994. This test program will be completed in FY 1996 to support initial ATN validation and provide ATN operating experience.

Computer–generated voice and digital ATIS development will be completed by FY 1994.

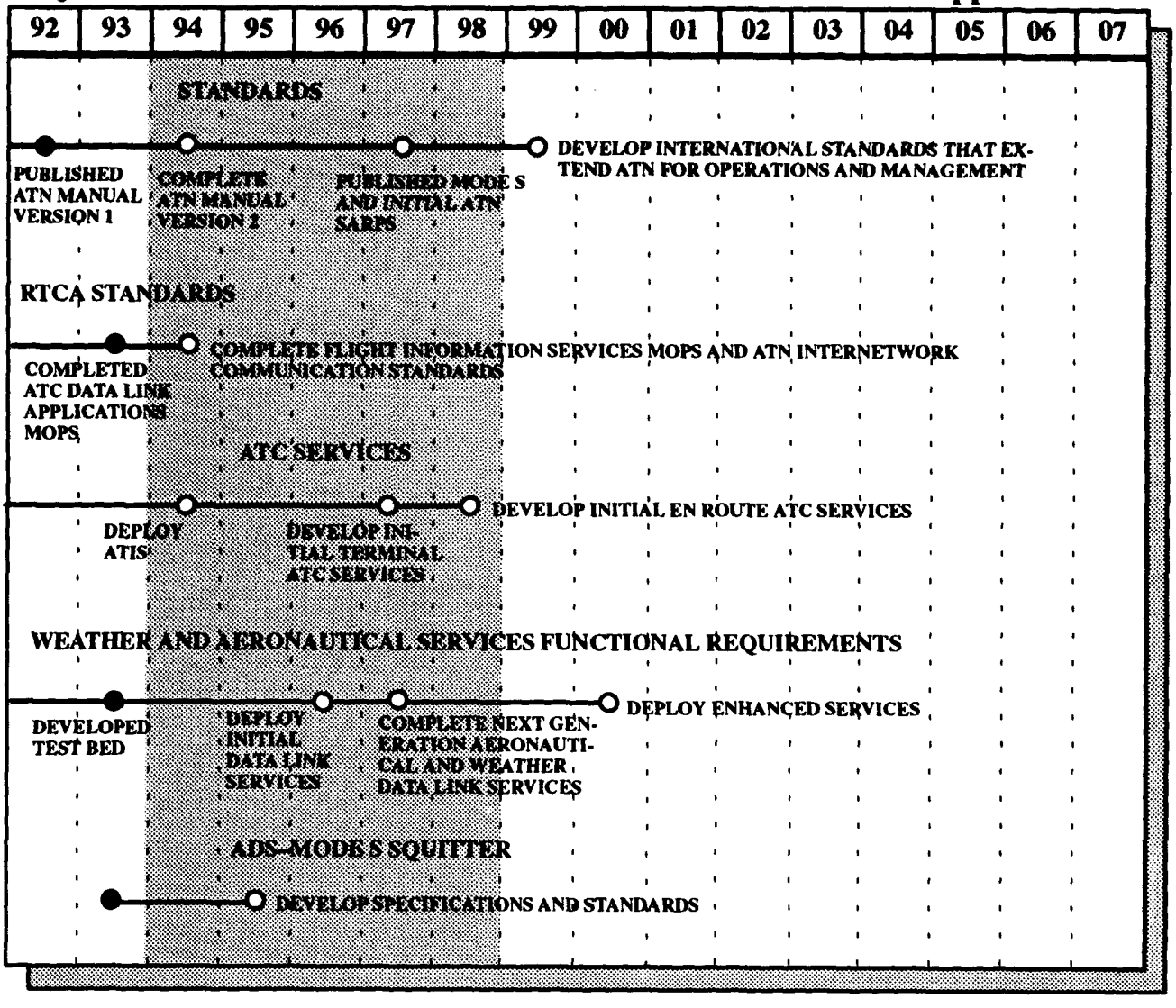
In FY 1996, initial weather and aeronautical data link functions will be deployed. In FY 1997, functional specifications will be completed for the next generation aeronautical and weather data link services, with implementation targeted for FY 2000. This research will provide graphical and route–oriented weather information to airborne users.

In FY 1994, RTCA flight information services minimum operational performance standards (MOPS) will be completed. These MOPS will define the initial aeronautical and weather

application requirements. Additionally, ATN internetwork communication standards will be completed in FY 1994.

In FY 1994, development efforts will continue on surface/air surveillance applications that use ADS techniques based on GPS aircraft position information. These applications will employ the Mode S Squitter for delivering this data to airport surface and terminal surveillance systems. Demonstrations are planned in FY 1994–1995 with system specifications and standards completed in FY 1995.

Project 031–110: Aeronautical Data Link Communications and Applications



031–120 Satellite Communications Program

Purpose: This project will develop the standards and perform required testing to support mobile satellite communication (SATCOM) operational use for civil aviation starting with oceanic, offshore, and remote regions. This capability will be extended to enhance NAS communications and surveillance functions.

Approach: This project is separated into four distinct initiatives:

Developing Satellite Communications Data Capabilities for Oceanic and Remote Regions

The FAA will support draft ICAO SARPs and guidelines development for frequency coordination. Additionally, support will be provided to RTCA Special Committee 165 to develop MOPS and ensure that the MOPS are consistent with the SARPs.

SARPs validation will be performed using simulation, analysis, testing, and demonstration. A test plan to validate SARPs and MOPS will be completed. A ground test facility will be developed to conduct system end–to–end and radio frequency (RF) tests to validate standards not currently validated by manufacturers' data. In addition, flight tests will be performed to evaluate state–of–the–art equipment and system enhancements. Aeronautical mobile satellite service (AMSS) testing will be conducted with industry– and FAA–developed equipment. Simulation will be used to evaluate the planned architecture performance and limitation under various communication traffic conditions.

Developing Satellite Communications Voice Capabilities for Oceanic and Remote Regions

This initiative is necessary to provide satellite voice capability between the cockpit and the Air Route Traffic Control Center (ARTCC) in oceanic flight information regions. In conjunction with RTCA, a guidance document will be produced describing the full range of technical requirements to provide satellite voice capability. In coordination with the oceanic project office, an architecture will be developed that will enable controllers to send and receive direct satellite voice communications. This effort includes developing appropriate interfaces for FAA equipment. Flight trials will be conducted with major airlines to demonstrate/evaluate satellite voice capabilities.

Implementing Satellite Communications Services in Oceanic and Remote Regions

This initiative addresses support for the Communications/Surveillance Operational Implementation Team (C/SOIT). This support includes technical expertise, analyses, and technical data. The team is responsible for developing operational regulations and procedures that implement satellite communications. The benefits derived from SATCOM require a combined effort among ATN, ADS, ARTCC automation, and SATCOM. The C/SOIT ensures the joint implementation of these efforts. Technical data will be collected from bilateral and multilateral engineering trials. This effort will integrate real–time end–to–end communications and communication emulation capabilities into the Oceanic Development Facility.

Developing Satellite Communications Services for Selected Domestic Applications

The currently defined oceanic AMSS system may have applications in domestic areas. For example, offshore or mountainous regions where very high frequency (VHF) does not penetrate could benefit from AMSS service. It is also possible that emerging SATCOM technology, including possible Low Earth Orbiting or Medium Earth Orbiting systems, can provide reliable and efficient data/voice capability that meets domestic requirements at a reasonable cost. This project will conduct feasibility studies and evaluations

on lower cost, light–weight satellite communications avionics for general aviation and rotorcraft. Additionally, analysis is underway to determine architecture requirements for future SATCOM use.

Related Projects: 021–140 Oceanic Air Traffic Automation, 023–120 Separation Standards, 031–110 Aeronautical Data Link Communications and Applications, and 032–110 Satellite Navigation Program. Capital Investment Plan projects: 61–22 ATC Applications of Automatic Dependent Surveillance (ADS) and 63–05 Aeronautical Data Link Communications and Applications.

Products:

- International AMSS SARPs with ICAO
- MOPS for AMSS avionics with RTCA
- AMSS voice communications architecture

FY 1992–1993 Accomplishments:

- Published AMSS MOPS Parts A and B.
- Published RTCA AMSS end–to–end guidance document.
- Submitted AMSS SARPs for ICAO approval.
- Completed SARPs validation.

Planned Activities:

Developing Satellite Communications Data Capabilities for Oceanic and Remote Regions

ICAO AMSS SARPs development and validation will be completed in FY 1994, with MOPS and SARPs verification completed in FY 1998. Data collected during operational tests will be used in industry avionics bench testing for SARPs compliance certification and ICAO approval in FY 1998.

Developing Satellite Communications Voice Capabilities for Oceanic and Remote Regions

In FY 1994, engineering trials will be conducted with Northwest Airlines. In FY 1995, RTCA guidance documentation will be published on SATCOM voice avionics. In FY 1996, architecture provisions based on this documentation will be completed for ground interfaces with FAA equipment.

Implementing Satellite Communications Services in Oceanic and Remote Regions

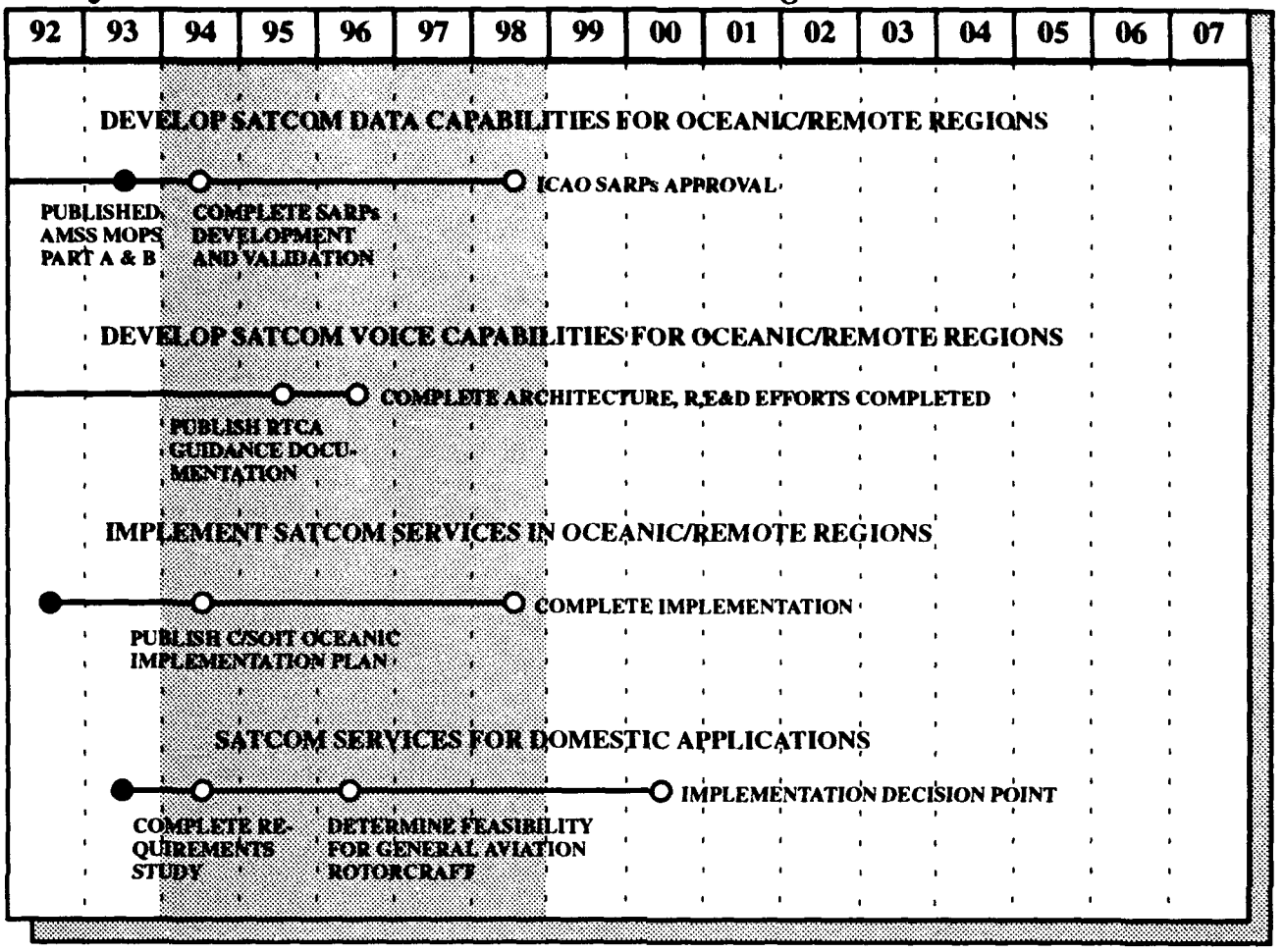
A Communications/Surveillance Operational Implementation Team plan will be published in FY 1994 concentrating on oceanic implementation issues. Also in FY 1994, data collection will continue from Pacific and Atlantic engineering trials. This data will be provided to the C/SOIT for regulatory and procedural implementation guidance. The C/SOIT plan specifies an incremental oceanic SATCOM implementation program that will be completed by FY 1998.

Developing Satellite Communications Services for Selected Domestic Applications

In FY 1994, a requirements study will be completed on alternative SATCOM technologies for domestic applications. Rotorcraft tests of American Mobile Services Corporation equipment will be completed in FY 1994. In FY 1996, a feasibility determination will be completed on lower cost, light–weight SATCOM avionics for general aviation and rotorcraft.

In FY 1994, further research based on the requirements study will be initiated on long–term alternatives for providing SATCOM service in domestic areas. Anticipated completion for this effort is expected in FY 1999. A decision point on implementing proven technologies will occur in FY 2000.

Project 031–120: Satellite Communications Program



031–130 NAS Telecommunications for the 21st Century

Purpose: This project supports the development of the next generation NAS communications system by evaluating alternatives in new communication technology to satisfy future operational NAS requirements and goals. This is a multi–year project that is intended to speed the introduction of new technology into the NAS Communications System. The current priority is to improve the air/ground (A/G) communication system.

A key shortfall in the current VHF A/G system is the lack of capacity to accommodate increasing traffic load. Competition for additional frequency spectrum is intense and will constrain internationally allocated VHF spectrum. Expanding VHF system capacity will require new VHF radios for both the FAA and user communities. To effect an orderly transition, planning for this new radio system must begin well before the spectrum capacity is exhausted in the current system. Also, a U.S. position on VHF system improvement must be presented to the International Civil Aviation Organization at the 1995 Montreal conference.

Approach: This project will demonstrate how new technology will benefit the next generation NAS communications system. Overall objectives include: focusing R,E&D funding on leveraging new technology; reducing communication system cost; and adhering to a disciplined system engineering approach.

New technologies will be explored to quantify their performance in meeting NAS capacity and reliability requirements. Key factors to consider are: using commercial equipment whenever possible, streamlining operations, developing a transition plan, and integrating with other NAS elements. A cost–benefit study will be completed for each potential technology, and a trade–off analysis will be performed among alternatives.

System requirements, operational concepts, system design, and appropriate standards will be developed for an air/ground digital voice and data communication system. Technology transfer efforts will be initiated to facilitate industry participation in system development. High risk system elements will be thoroughly prototyped and tested. Challenges this project will face during system development include: accommodating evolving national and international communication standards and applying global addressing, routing, and network management technologies.

Related Projects: 031–110 Aeronautical Data Link Communications and Applications. Capital Investment Plan projects: 23–05 Aeronautical Data Link and 56–15 NAS Spectrum Engineering Sustained Support.

Products:

- Internationally compatible requirements and standards for a new VHF air/ground communication system
- Operational concept document for the new communications system
- New VHF communication system design specifications
- New VHF communication system prototype, including flight demonstrations
- RFP for system procurement

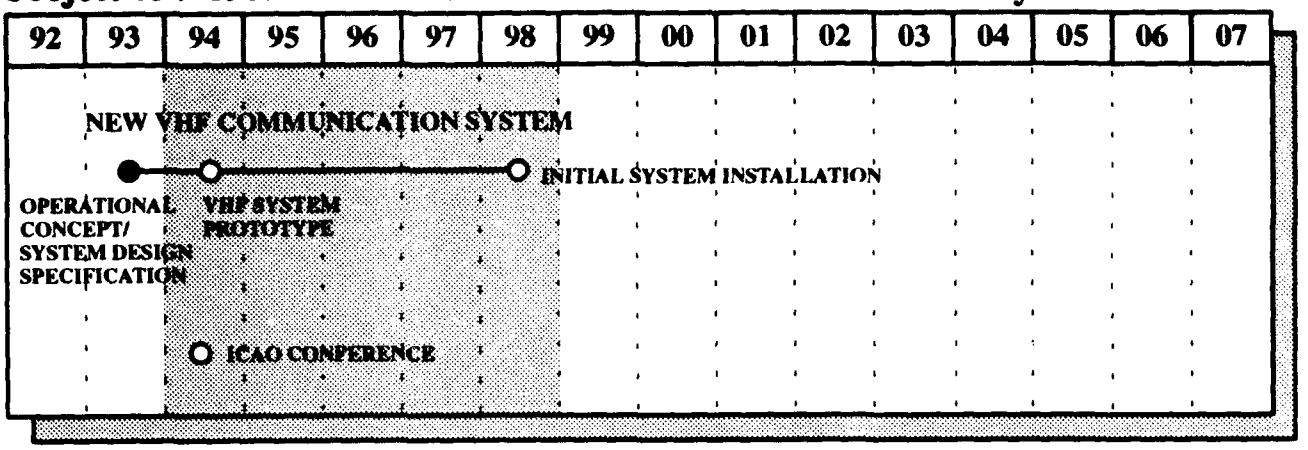
FY 1992–1993 Accomplishments:

- Completed operational concept document.
- Completed preliminary system design specifications.
- Demonstrated selected future air/ground VHF radio system features in an existing terminal ATC laboratory environment.

Planned Activities: In FY 1994, building on previous work to define the system concept and requirements, a prototype radio system will be constructed and flight tested. Related standards support activities will include developing the U.S. position for the 1994 ICAO conference action item to improve VHF spectrum utilization.

Also, beginning in FY 1994, procurement specifications will be prepared to support a request for proposal (RFP) in FY 1996 with contract award expected in FY 1997. Initial installation of the new system is expected to begin in FY 1998.

Project 031–130: NAS Telecommunications for the 21st Century



032–110 Satellite Navigation Program

Purpose: This project will develop augmentation(s) to navigation satellites (e.g, GPS) to support techniques, procedures, and standards to meet all civil aviation navigation needs using a single navigation receiver. Civil aviation navigation needs to be met include oceanic, en route, terminal, nonprecision approach, precision approach, auto–landing, and airport surface navigation. Satellite navigation presents opportunities for standardized worldwide civil aviation operations using a common navigation receiver and for significant improvements in safety, capacity, service flexibility, and operating costs. Adopting satellite navigation systems could lead to phasing out existing National Airspace System ground equipment while maintaining or improving existing service levels. In addition, satellite–based navigation systems provide the potential for new navigation and landing services not currently supported by existing systems.

Approach: The initial focus will be on developing standards and methods to use the Global Positioning System with no augmentations as a supplemental aid to meet civil aviation requirements. Project activities will investigate GPS augmented for Required Navigation Performance (RNP) for en route, airport surface, departure, and precision approach applications, including curved and missed approach guidance. The RNP is an internationally defined measure of a navigation system's performance within a defined airspace, including current navigation system operating parameters within that airspace. GPS augmented for RNP will constitute a "stand–alone" configuration with necessary redundancy. The overall program will be supported by establishing a Satellite Navigation Test Bed at the FAA Technical Center. The test bed will be used to verify theoretical analyses, collect data in a realistic environment, simulate "worst case" scenarios, and provide a means to analyze performance data.

The Satellite Navigation program will be structured with four interrelated and complementary thrusts. These will focus on the Civil Aviation Service, operational implementation of the service, international activities, and related programs.

Related Projects: 021–140 Oceanic Air Traffic Automation and 021–190 Airport Surface Traffic

Automation (ASTA). Capital Investment Plan projects: 61–22 ATC Applications of Automatic Dependent Surveillance (ADS) and 62–21 Airport Surface Traffic Automation (ASTA).

Products:

- Satellite–based instrument approach procedures
- MOPS for GPS supplemental use in the NAS
- Augmentation requirements for GPS to meet civil aviation RNP
- MOPS for avionics to meet RNP
- Minimum avionic system performance standards (MASPS) for special use CAT I

FY 1992–1993 Accomplishments:

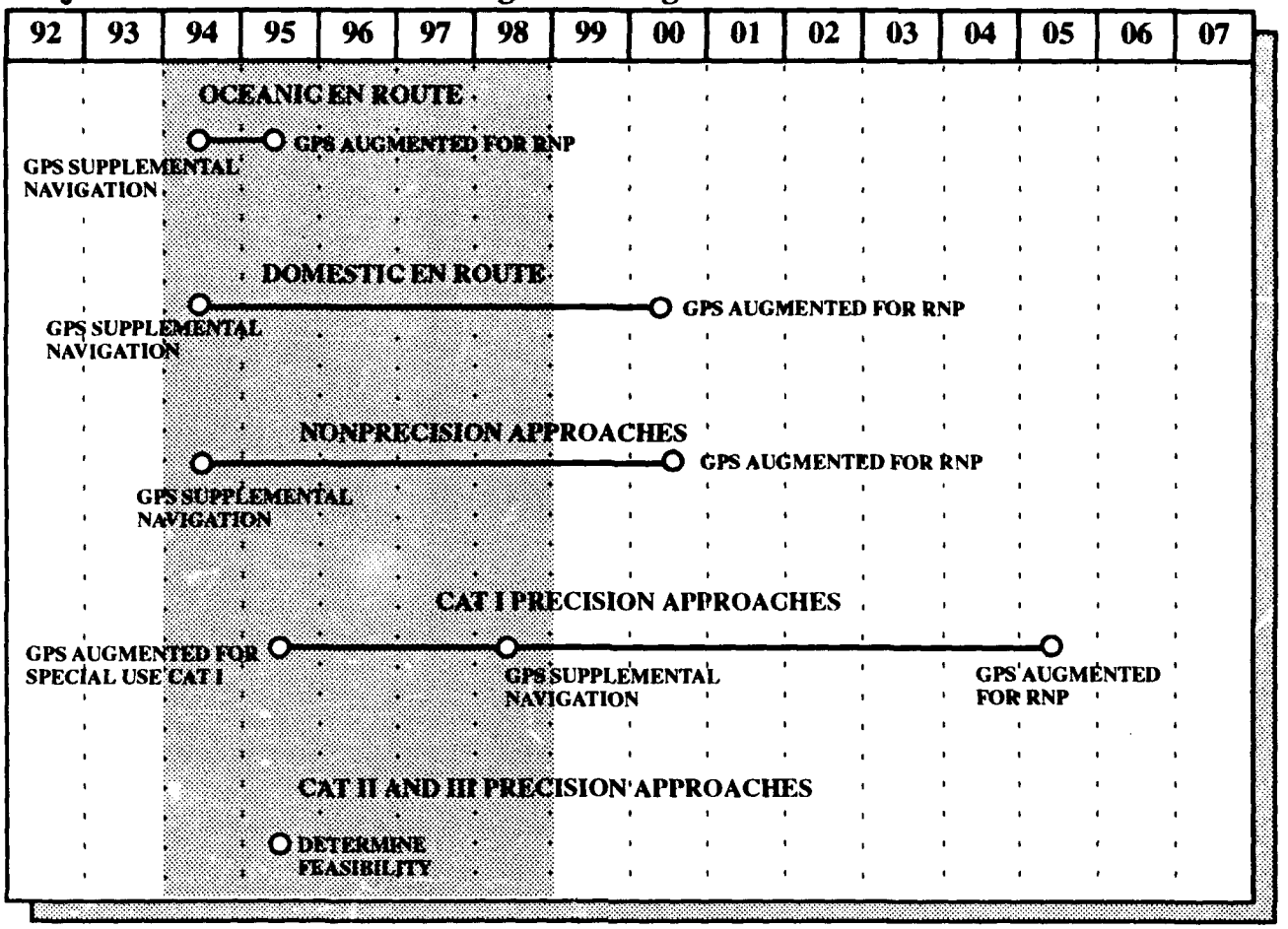
- Supported satellite navigation activities with Air Transport Association, National Business Aircraft Association, and Aircraft Owners and Pilots Association user groups to develop customer capabilities.
- Developed a U.S./GPS and Commonwealth of Independent States (C.I.S.)/ GLONASS common receiver test set to collect data and support developing avionics MOPS.
- Established cooperative research agreements with aviation community organizations such as NASA–Ames, Stanford University, Honeywell, and Alaska Airlines to investigate using GPS for terminal area operations.
- Established international cooperation for developing the Global Navigation Satellite System navigation through the ICAO Future Air Navigation System (FANS) IV research and development working group.
- Published MOPS for GPS supplemental use.
- Published the MASPS for GPS special use CAT I.

Planned Activities: MOPS for GPS augmented for RNP will be completed in FY 1994. Ongoing experiments to assess ground–based integrity monitoring viability will be completed with specifications available in FY 1994. Experiments to evaluate GPS/GLONASS receiver autonomous integrity monitoring techniques will also be completed in FY 1994.

Demonstrations will continue in FY 1994 for CAT I instrument approaches, nonprecision approaches, oceanic, en route, and terminal operations. These activities will support standards and operational procedures development to permit early satellite navigation system implementation for civil aviation. Research will be completed in FY 1995 on GPS CAT II/III approach feasibility. This data will be used to support MLS/GPS tradeoff decisions.

GPS supplemental use will be implemented by FY 1994 for both oceanic and domestic en route airspace along with nonprecision approaches. GPS augmented for RNP will be implemented in oceanic airspace in FY 1995 followed by domestic en route airspace in FY 2000. GPS supplemental precision approaches to CAT I will be approved for private use in FY 1995, public use in 1998, and RNP scheduled for 2005.

Project 032–110: Satellite Navigation Program



032–120 Navigation Systems Development

Purpose: The FAA has the responsibility for the development and implementation of radionavigation systems to meet the needs of all civil and military aviation, except those peculiar to air warfare. This project will identify and evaluate emerging technologies and new concepts for meeting future navigation service requirements. This project also supports the Federal Radionavigation Plan (FRP) biennial revision and provides the FAA input to the Department of Transportation (DOT) and DOD Navigation Working Group.

Approach: Supplemental studies and analyses will be performed to support the DOT/DOD Navigation Working Group. Algorithms for proposed changes and potential systems will be developed and applied in laboratory simulations to test their effectiveness. The different systems' relative merits and deficiencies will be measured against requirements. Based on results, technical and functional design specifications will be developed for the recommended system mix for inclusion in the FRP. A national aviation standard

will be prepared and maintained for each system approved for use in the NAS.

An assessment will be conducted to identify potential operating cost reductions, performance enhancements, or new function additions to ground–based navigation aids now operated by the FAA. Available technology will be identified and the applicability to enhance navigation aids will be examined. An example is improving the VOR antenna system to reduce sensitivity to the site environment.

The RNP Working Group, including representatives from the satellite and separation standards program offices, will develop criteria for reducing separation standards.

Related Projects: 021–140 Oceanic Air Traffic Automation, 023–120 Separation Standards, and 032–110 Satellite Navigation Program. Capital Investment Plan project: 61–22 ATC Applications of Automatic Dependent Surveillance (ADS).

Products:

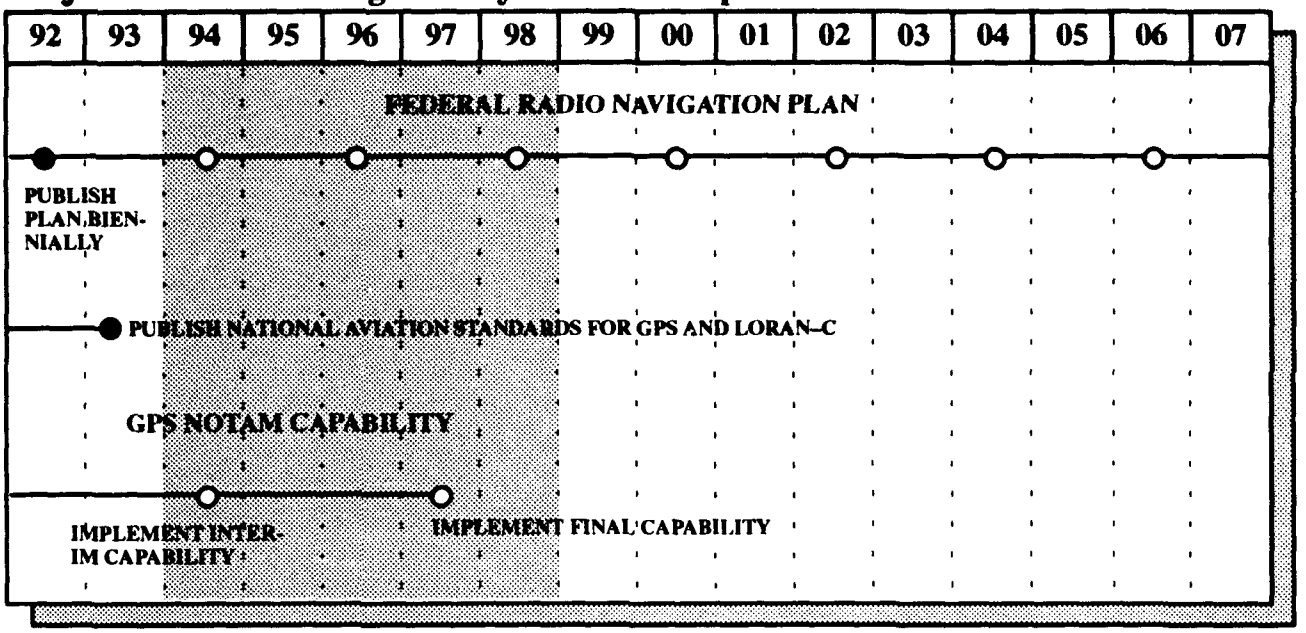
- Biennial FRP publication
- Specified technical and operational design characteristics for the recommended system mix
- National aviation standards for radio navigation systems
- Reports on enhancing performance and reducing costs of existing ground navigation systems
- GPS notice to airmen (NOTAM) capability
- GNSS transition plan
- Procurement specification for implementing each acceptable concept into the NAS

FY 1992–1993 Accomplishments:

- Published seventh edition of the FRP.
- Completed memorandum of agreement with DOD for GPS navigation service.
- Completed memorandum of agreement with U.S. Coast Guard for Omega navigation service.
- Completed National Aviation Standards for GPS.
- Completed National Aviation Standards for Loran–C.
- Completed GPS/Loran–C NOTAM assessment.

Planned Activities: In FY 1994 a radionavigation system users public forum will be held to gather information for the 1994 edition of the Federal Radionavigation Plan. This plan is published on a biennial basis. In FY 1994, engineering models will be assembled and tested for VOR antenna design improvements and advanced VOR data transmission techniques. A decision on the scheduled phase out of Omega, Tactical Air Navigation, DME, VOR, Non–Directional Beacon, and Loran–C will be made before FY 2000. The requirements for the navigation service needed onboard an aircraft (known as RNP) during Instrument Flight Rules will be developed to support separation standards program objectives. An interim GPS NOTAM capability will be implemented in FY 1994, with the final capability in FY 1997, to support GPS RNP requirements. In FY 1998, a VOR/DME to GNSS transition plan will be completed.

Project 032–120: Navigation Systems Development



033–110 Terminal Area Surveillance System

Purpose: This project will develop the next generation terminal surveillance system by: defining system requirements; determining future operational concepts; assessing emerging technology applicability, benefits, and risks; and developing advanced capabilities in weather detection, aircraft detection, and increased data link capacity. The next generation terminal area surveillance system must support a requirement for primary, secondary, and improved weather detection as well as features to support closely spaced runway approaches. Emerging technology will allow the FAA to meet these demands and improve on operational performance limitations imposed by today's technology. The system must have an ability to detect dry microbursts at useful ranges; measure wind fields from which wake–vortex predictions can be made; detect ice, water, hail, and tornadoes; and support aircraft surveillance operations with seamless coverage and flexible routing tailored to the specific terminal site.

Approach: System delays and separation criteria will be reduced through more timely and accurate aircraft detection and improved weather detection capabilities. There will be a strong emphasis on rapidly updating the 3–dimensional weather and aircraft display for controllers. Operations research analysis will be used to assess and identify practical airspace safety and capacity enhancing features in emerging technology. The FAA and industry will assess these technologies, evaluate potential performance against the terminal area sensor primary and secondary surveillance and weather requirements, and assess technical and operational risks.

New terminal surveillance sensors will use a modular architecture to provide for site adaptation and upgrade at minimal cost. A possible option is to combine primary radar, secondary radar, data link, and hazardous/non–hazardous weather detection in a single high data rate multifunction radar. This option will depend on the potential

cost savings balanced against the additional program risk that may be incurred.

Concept development analysis and technology demonstration experiments will be implemented as parallel activities to reduce the potential risk of future development. The results from these experiments will lead to multiple selections for prototype development and testing.

Related Projects: 021–230 Wake Vortex Separation Standards Reduction, 031–110 Aeronautical Data Link Communications and Applications, 032–110 Satellite Navigation Program, and 041–110 Aviation Weather Analysis and Forecasting. Capital Investment Plan projects: 24–12 Mode S, 24–13 Terminal Radar (ASR) Program, 24–18 Terminal Doppler Weather Radar (TDWR) System, 34–13 Terminal Radar Digitizing, Replacement, and Establishment, and 44–46 Air Traffic Control Beacon Interrogator (ATCBI) Replacement.

Products:

- *Operational requirements* and design concepts
- Technical requirements feasibility assessments
- Full–scale development prototype
- Production contract

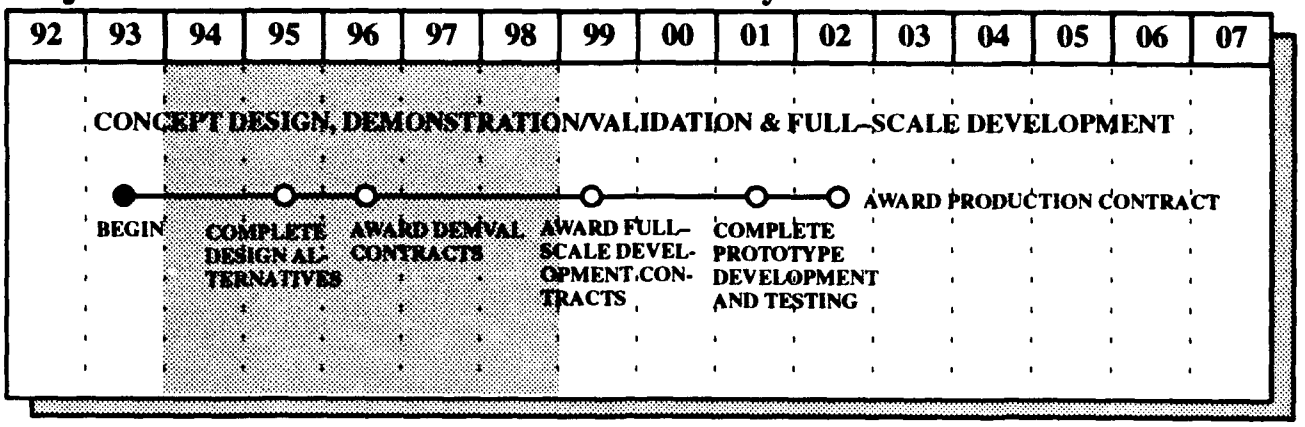
FY 1992–1993 Accomplishments:

- Completed rough order of magnitude cost–benefit analysis.
- Published Terminal Area Concept of Operations and Technology Forecast documents.
- Established research agreements with industry.
- Issued request for proposals for concept designs.

Planned Activities: In FY 1994, data collection and analyses will be completed along with a technology review. Additionally, the Terminal Surveillance Requirements Team will complete a review and validation of the Terminal Area Concept of Operations and system definition. This team, composed of controllers and system engineers, will use data analyses and surveillance simulations.

In FY 1994, multiple contracts will be awarded for TASS concept designs, with designs completed in FY 1995. These alternative concepts will be evaluated in FY 1995 and an RFP will be issued in FY 1996 for selected demonstration/validation (DEMVAL) design(s). The DEMVAL contract(s) will be awarded in FY 1996 with the DEMVAL phase completed in FY 1999. Following this phase, the best design will be selected for full–scale development from FY 1999–2001. Upon satisfactory completion of prototype testing in FY 2001, a production contract award is planned for FY 2002.

Project 033–110: Terminal Area Surveillance System



4.0 WEATHER

The need for weather information in the future air traffic management (ATM) system can be derived from the overall goals for that system: enhance flight safety, increase system capacity, improve flight efficiency, reduce air traffic control (ATC) and pilot workload, improve flight planning, and increase productivity. Weather, perhaps like no other factor, impacts the fundamental aviation mission.

Weather is, and will continue to be, a critical factor in all flight operations. It is the single largest contributor to delays and a major factor in aircraft accidents and incidents. Improved weather forecasts offer the potential for increasing system capacity more cost effectively than most other alternatives, such as new airports and runways. Better short–term forecasts and current information on hazardous weather conditions are critical to ensuring safe flight. Also, timely and accurate weather information is critical to planning fuel- and time–efficient flight plans. Weather service users encompass the entire aviation spectrum, from the student pilot to the operator of the most sophisticated, high–performance commercial aircraft during all flight phases.

The future ATM system will require highly accurate real–time weather warning products and short– and long–term weather forecasts, covering the time period from a few minutes, up to 3, 6, and even 12 hours into the future. Progress in weather research necessary to develop these products, and implementing a system infrastructure to deliver enhanced weather products to end–users, will be critical to addressing this need.

The aviation weather thrust area includes a combination of Research, Engineering and Development (R,E&D) weather projects and new Capital Investment Plan (CIP) weather initiatives that will build upon ongoing weather system development to realize the above needs and goals. Both components are critical to the overall success of the weather system modernization effort. The remainder of this chapter discusses the aviation weather program and is organized as follows:

- Aviation weather mission needs — The overall needs and goals touched upon above are discussed in greater detail.
- Issues associated with satisfying mission needs — Several issues integral to accomplishing the weather mission needs are outlined. Finding solutions to these will be the major emphasis of the FAA's weather research program.
- *New CIP weather developments* — The aviation weather products generator (AWPG), aviation gridded forecast system (AGFS), integrated terminal weather system (ITWS), and other projects are described in terms of their places in the weather research program.
- Weather System Benefits — A brief overview on the weather system's benefits.
- R,E&D Projects — A brief introduction and detailed project write–up are provided for each R,E&D activity.

AVIATION WEATHER MISSION NEEDS

Good flight planning is necessary for all flight operations. The operation starts with an initial flight plan followed by any necessary modifications to the plan as the flight evolves. Decisions are created by pilot decision/action or controller action with pilot decision to modify the flight plan. The aviation weather system needs to provide the necessary weather products and efficiently deliver them to pilots and controllers in a format that will not require interpretation by a meteorologist.

A principal need is the capability to provide weather information to support hazardous weather avoidance. In a planning sense, the aviator needs to have good forecast information to avoid hazards in flight. Current and near–term information on windshear, hazardous cells, heavy rain, hail, icing, lightning, turbulence, and low visibility, when delivered in time to avoid these events, will support the tactical notion of avoidance. Good strategic planning also requires products directly usable by the aviator or specialist. This is especially true in the terminal area where there is less time to interpret local events, such as windshear, that unfold at a rapid rate.

Efficiency is determined by minimizing time in flight or fuel used. Flight efficiency to a large degree implies the capability for economic or pilot–chosen routing. This implies a significant need for timely and accurate strategic weather information during flight planning so that a route can be selected to minimize the need for dynamic rerouting during flight.

In the terminal area, predicting significant wind shifts is needed to optimize runway management. In addition, more accurate wind field analyses will provide terminal air traffic automation systems with optimal descent profiles. Enhanced hazardous weather depiction will mitigate weather impacts on arrival and departure corridors. Improved windshear warnings, microburst detection, thunderstorm predictions, and other products will be particularly important in this regard.

Workload reduction can be accomplished by intelligently applying automated weather information generation and delivery services. Increased direct access to improved weather information will also reduce the negative impact on pilots having to transcribe weather information during critical flight phases (such as Automated Terminal Information Service during arrival). This requires products that are timely and accurate using transparent delivery systems and products that are tailored to the various National Airspace System (NAS) end–user's needs and skills. Systems such as data link and other automated direct delivery will reduce ATC workload, especially for routine weather information. ATC workload would be further reduced by diminishing the tendency to query multiple sectors for weather, especially tactical weather information. Eliminating the need to prepare manually automated broadcasts will also reduce the workload.

Finally, with the increase in oceanic traffic, and in close connection with oceanic air traffic control, there is a need to establish oceanic weather warning and forecast centers that can provide timely weather information. Improved weather information will provide route flexibility commensurate with systems such as Automatic Dependent Surveillance and will enhance trans–oceanic flight safety. This development will be conducted jointly with the National Weather Service (NWS).

ISSUES ASSOCIATED WITH SATISFYING MISSION NEEDS

The FAA has a number of ongoing programs in the CIP that begin to address the need for weather sensing, data communications, processing facilities, and data display. However, many significant shortfalls will remain in meeting the future ATM system goals:

- The time needed for meteorologists to accurately forecast weather may not meet time requirements for aviation.
- Forecast timeliness, accuracy, and utility will still be inadequate. Forecast data will still be

as much as 12 hours old while aviation operations require nowcasts and short–term, 1- to 6-hour, forecasts.

- Important aviation critical weather products such as turbulence forecasts, icing forecasts, enhanced windshear detection and warnings, ceiling/visibility forecasts, and winds aloft do not meet modern airspace system requirements in terms of accuracy and precision.

- Advanced automated air traffic control systems, such as Automated En Route Air Traffic Control, Terminal ATC Automation (TATCA), and Traffic Management System, require enhanced weather products on an increased frequency with higher resolution to support new functionality.

- Ground–based measurements of humidity and turbulence are inadequate to permit accurate aviation weather forecasting. Therefore, airborne measurements are needed to improve critical aviation weather forecasts. This will be accomplished by increasing ARINC Communications Addressing and Reporting System's (ACARS) weather measurement capability.

- Forward–looking airborne windshear hazard detection and warning will provide flightcrews with windshear warnings at locations where ground systems are not installed.

- The FAA needs to develop automation capabilities to take full advantage of the National Weather Service's modernization and restructuring, including improved forecast products and services.

These shortfalls will be overcome by implementing the new CIP developments and the R,E&D projects. Both the CIP and the R,E&D projects are essential for meeting the aviation weather mission needs and providing the infrastructure necessary to meet future aviation weather needs.

NEW CIP WEATHER DEVELOPMENTS

The FAA has greatly enhanced the national aviation weather program by developing three new major initiatives: the ITWS, AWPG, and AGFS. Each of these CIP projects provides critical weather product generation and delivery systems that will be a major value added component to the earlier NAS and NWS modernization programs. These three initiatives were developed to capitalize on the FAA and NWS modernization program that is projected to dramatically increase weather information quality and quantity during the 1990's and beyond.

The AGFS, operated as an NWS system, will generate very high resolution gridded (aviation impact) meteorological analyses and forecasts required to produce aviation–specific weather products. The AGFS will include data from national, regional, and local instrumentation platforms, national numerical guidance products, and regional mesoscale model output.

The ITWS will integrate and process weather data from terminal area sensors and the NWS. It will provide automated products to the air traffic control tower, Terminal Radar Approach Control (TRACON), traffic managers, pilots, and other airport area users of time–critical weather information. In its first phase, ITWS completes the windshear integration task first identified and tested as part of the CIP Terminal Doppler Weather Radar (TDWR) and Low–Level Windshear Alert System (LLWAS) projects. The ITWS will also provide weather data and information to the AWPG system and the NWS.

The AWPG system, consisting of regional (RAWPG) and national (NAWPG) components, will collect, integrate, and process data from both the AGFS and ITWS providing user specific, aviation weather products to regional and national FAA facilities. The RAWPG and NAWPG will reside at the Air Route Traffic Control Centers

and the Central Flow Control Facility, respectively. The major AWPG goals are to generate aviation–specific weather products tailored for a variety of aviation users and to improve product distribution. Initial AWPG capabilities will be installed on existing or planned platforms before initial AWPG system deployment.

Rapid prototyping and operational evaluation capabilities will be provided by the Aviation Weather Development Laboratory in Boulder, Colorado, and the Experimental Forecast Facility at Kansas City. These development and evaluation activities will be further validated in the FAA's National Simulation Capability, resulting in operationally acceptable products and services.

Improved thunderstorm and microburst forecast products will be developed in direct support to AWPG and ITWS, and demonstrated in the Aviation Weather Development Laboratory. Finally, refinements to TDWR, Airport Surveillance Radar –9, and Enhanced LLWAS capabilities will be provided.

An integral part of the CIP weather elements will be providing weather services to other NAS, CIP, and external elements, such as flight service station, airport, and airline operators.

WEATHER SYSTEM BENEFITS

Weather detection and forecasts provide a description of the environment surrounding all aircraft during all flight phases. Improvements in our ability to understand, forecast, and accommodate changes in the weather, particularly hazardous weather, will yield a wide variety of benefits.

Many of this thrust area's quantitative benefits will be realized by implementing projects in the Capacity and ATM Technology thrust area. For example, the AWPG enhances the Traffic Management System's ability to plan efficient traffic flows based on accurate knowledge of present and future weather conditions. Thus, some benefits will be included in the project benefits estimated for the group that includes the Advanced Traffic Management System. Other benefits will be included in those estimated for projects clustered around TATCA.

The Airborne Meteorological Sensors project will provide the ability to detect and measure turbulence and humidity in flight. When coupled with the data link project to down–link this information to forecasting systems on the ground, it will provide improved data for flight planning and improve the weather forecasts used in all flight phases.

The Integrated Airborne Windshear research will be used to detect airborne windshear hazards. When coupled with the ground–based LLWAS and TDWR, this research will provide increased flight safety.

A benefits evaluation on all of the FAA's new weather initiatives was performed by the System Engineering and Integration Contractor. The contractor estimated that the projects in the CIP and R,E&D Plan will together provide benefits between the years 1991 and 2006 that total $12 billion. These benefits are distributed as follows: safety – $3.61 billion; avoided delays – $6.13 billion; accommodating user preferred routes – $0.40 billion; improved productivity air traffic/ airway facilities – $0.16 billion; and operations and maintenance – $1.78 billion.

R,E&D WEATHER PROJECTS

Three R,E&D weather projects are being developed or continued to enhance (in conjunction with the above CIP initiatives) the overall airspace system aviation weather capability.

Aviation Weather Analysis and Forecasting Project

A primary effort is directed at basic and applied research to improve warnings and forecasts for significant aviation weather hazards. This project includes:

- FAA support to national weather research projects or programs, including winter icing.
- Long–term support for the National Weather Research Project.

Both efforts involve funding from many Federal agencies, including the National Science Foundation, National Oceanic and Atmospheric Administration, National Aeronautics and Space Administration (NASA), and other agencies, as well as FAA contributions identified within this project. The intent of this support is to use multi–agency funding to leverage larger basic and applied scientific efforts that are expected to yield a much improved aviation weather warning and forecast capability during the next 5 to 15 years. A second project component is to conduct basic and applied research and development to improve a variety of analysis and forecast techniques that are specifically directed to aviation. Finally, this project will address the need to enhance aviation weather forecaster training. With the substantial increase in modernized weather services, there is a further need to develop training modules that are designed to improve the forecaster's ability to prepare aviation weather forecasts.

Airborne Meteorological Sensors Project

FAA and NWS weather sensor modernization programs have provided a much improved capability to remotely detect significant aviation weather hazards, as well as a much improved capability to describe the atmosphere for aviation needs. Unfortunately, the state–of–the–art for clear air turbulence and humidity remote sensing does not meet aviation requirements. This project addresses the need to develop airborne sensors to detect and measure turbulence and humidity from aircraft in flight, and automatically report these data through appropriate data link systems.

Integrated Airborne Windshear Research Project

This project continues airborne windshear system evaluation and certification efforts for forward–looking detection, warning, and cockpit integration into ground–based TDWR and LLWAS data sources. In addition, elements of this project are directed toward effective windshear education and training for all United States airmen.

4.1 Weather Project Descriptions

041–110 Aviation Weather Analysis and Forecasting

Purpose: This project will enhance the basic understanding of weather as it affects aviation. Since weather impacts on the NAS are spatially small (mesoscale), this project will be integrated with other national research program activities that focus on the atmospheric mesoscale analysis and prediction problem. A further purpose is to concentrate research efforts on developing new algorithms, numerical weather analysis and prediction models, and methods to detect/predict the impact from weather hazards. This will significantly improve weather product and forecast quality, thus enabling aviation weather users to make effective strategic and tactical decisions for aviation operations.

Approach: This project includes three major components: (1) participation in interagency activities to better understand aviation weather phenomena; (2) developing models and algorithms for generating nowcast and short–term aviation–specific products; and (3) developing and testing computer–aided training modules for the users of newly developed forecasting methods and products. These areas include icing forecasts; en route and transition turbulence, ceiling, and visibility; thunderstorm and microburst prediction; wind analysis and forecasting; and oceanic weather observation, analysis, and forecasting.

Our objectives in the weather R,E&D program are similar to the stated goals of the U.S. Weather Research Program (USWRP), which is a congressionally mandated interagency program under the lead of the National Oceanic and Atmospheric Administration. The FAA will participate in the USWRP to address regional and local scale weather phenomena that are unique to aviation. The USWRP's *strategic priorities* of most interest to the FAA are to "improve local and regional weather forecasts" and to "achieve efficiencies by coordinating efforts of federal agencies, state institutions, the academic research community, and the private sector." Cooperation with the USWRP will benefit a significant portion of our R,E&D program.

The Icing Forecasting Improvements Program's objective is to develop an aircraft structural icing forecast capability. This product will provide accurate delineation of actual and expected icing areas by location, altitude, duration, and potential severity. Another element in the structural icing program is to create a capability to forecast the onset, intensity, and cessation of structural icing on the ground to support deicing activities. The project is being accomplished through a cooperative agreement with the National Science Foundation and National Center for Atmospheric Research.

Detecting and avoiding clear air turbulence can improve NAS safety and capacity. This research effort will develop a model for short–term en route and transition turbulence forecasting using wind, temperature, and moisture data. A variety of models will be developed and applied to forecasting wind flow patterns, downbursts, wind direction changes, windshear, and gust fronts for the lower atmosphere.

This research project will provide current analyses, nowcasts, and short–range predictions of relevant atmospheric fields and hazardous weather phenomena. Products derived from the above information will be tested and evaluated by the Aviation Weather Development Laboratory (AWDL) at Boulder, Colorado, and the Experimental Forecast Facility (EFF) at Kansas City, Missouri, to facilitate transition of appropriate products to operational aviation weather services.

Related Projects: 021–140 Oceanic Air Traffic Automation, 031–110 Aeronautical Data Link Communications and Applications, and 033–110 Terminal Area Surveillance System. Capital Investment Plan projects: 21–12 Advanced Automation System (AAS), 61–22 ATC Applications of Automatic Dependent Surveillance (ADS), 61–23 Oceanic Automation System (OAS), 63–05 Aeronautical Data Link Communications and Applications, 63–21 Integrated Terminal Weather System (ITWS), and 63–22 Aviation Weather Products Generator (AWPG).

Products:

- Precise and usable algorithms and/or numerical models related to icing, turbulence, convective initiation, visibility, ceiling, and snowstorm forecasting
- New mesoscale numerical data assimilation and prediction models adapted to aviation needs and new methods for nowcasting
- New prototype aviation weather products for AWDL and EFF test and evaluation
- Automated techniques for detecting, quantifying, and forecasting meteorological events
- Computer–aided training modules for using new forecasting techniques and products

FY 1992–1993 Accomplishments:

- Demonstrated thunderstorm forecast product at Denver control tower and TRACON.
- Tested improved microburst prediction algorithm at Orlando control tower and TRACON using terminal Doppler weather radar data and temperature/humidity vertical profiles.
- Completed report on data analyses and evaluated icing forecasting field effort for the Denver region.

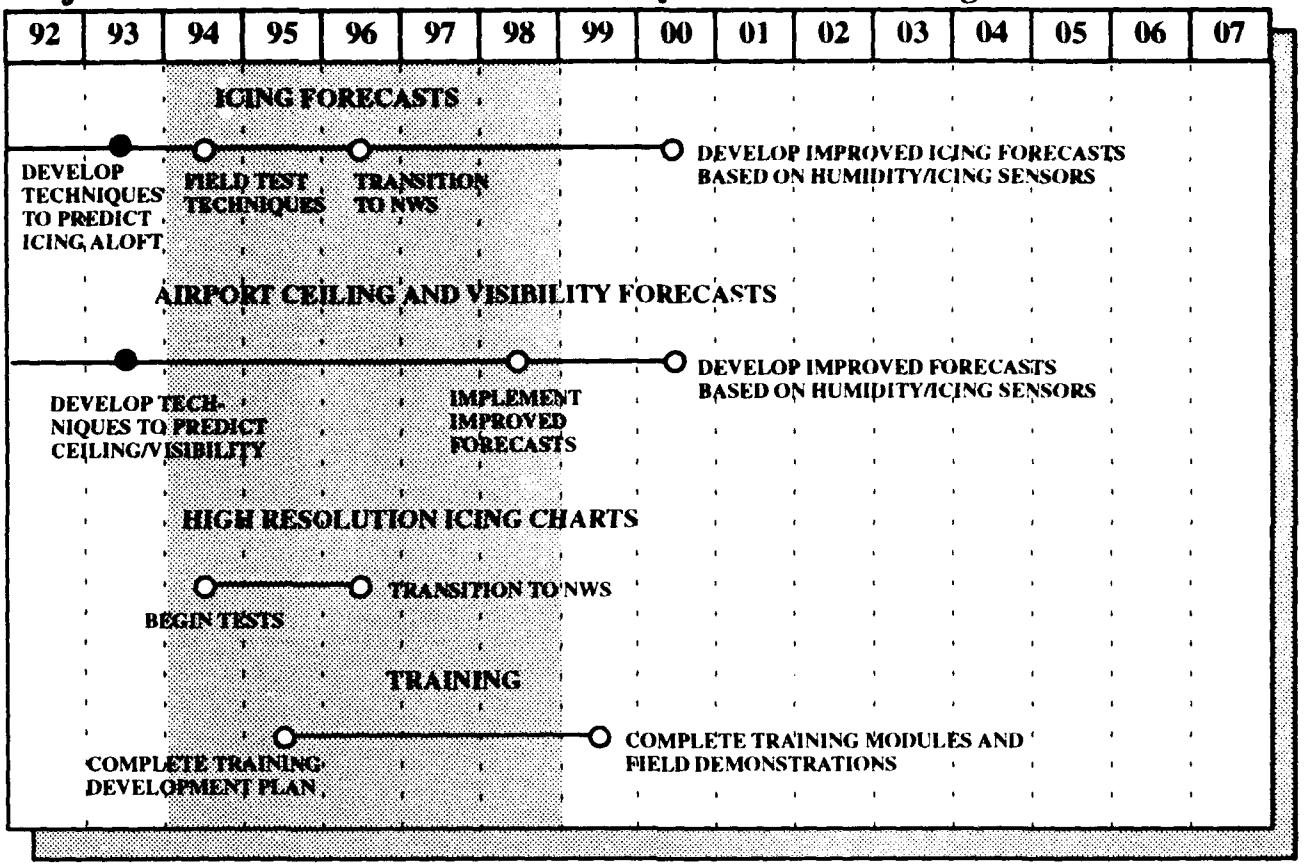
Planned Activities: In FY 1994, a winter icing field project will be conducted to test the techniques developed to predict icing aloft and on the ground. Forecasting techniques that are verified in the field test will transition to the NWS in FY 1996. Improvements in icing forecasts will continue to FY 2000 using the high resolution humidity data available from the airborne humidity sensor developed in Project 041–120.

In FY 1994, research will continue on forecasting changes in ceiling and visibility at airports, with improved forecasts available in FY 1998. Further improvements will be developed between FY 1998 and FY 2000 using the high resolution humidity data from the airborne humidity sensor.

In FY 1994, initial high resolution aviation icing forecast charts will be tested on a national scale with transition to the NWS expected in FY 1996.

In FY 1995, a training development plan will be completed. Individual computer–aided training modules will be developed and demonstrated in FY 1996–1999.

Project 041–110: Aviation Weather Analysis and Forecasting



041–120 Airborne Meteorological Sensors

Purpose: This project will develop specialized airborne meteorological sensors that will meet unique, critical aviation weather requirements for 3–dimensional basic meteorological data and aviation–related weather characteristics. Ground–based sensors alone cannot provide the 3–dimensional information needed to create accurate icing, turbulence, and visibility forecast products. These airborne sensors will provide early hazardous weather warning in the terminal and en route airspace. The improvements will reduce passenger and crew discomfort, in–flight injuries, and aircraft accidents.

Approach: Meteorological sensors to measure humidity and icing will be developed that can be carried aboard aircraft to provide near–real–time 3–dimensional weather data that are currently not available from remote sensors. The data obtained from these airborne sensors will automatically be transferred to FAA and National Weather Service weather processing systems by the meteorological data collection and reporting system (MDCRS) operated by ARINC.

The technology developed will provide design guidelines and engineering data to support industry production and certification initiatives for

airborne meteorological sensors. The FAA will work with manufacturers and operators to accelerate sensor development and deployment. Aviation weather products derived from these sensors will be provided to air carriers in the test and validation phase to validate the user requirements and encourage rapid deployment in the air carrier fleet. Prototype airborne sensors will be developed and evaluated in conjunction with Integrated Terminal Weather System and Aviation Weather Products Generator operational testing. This testing will validate the operational usefulness of adding the airborne data.

An aircraft independent turbulence index can be computed from aircraft dynamic response parameters and pressure field spatial variations. The pressure field variations are aircraft frame independent, but have a complicated relationship to the turbulence index. Airframe motion estimates of turbulence must be corrected for airspeed, wing loading, and airframe type to yield a universal turbulence index. Research will be carried out to determine the most cost–effective approach to providing the desired turbulence index. Candidate designs will be tested simultaneously in a test aircraft and the resulting predictions compared with the results of turbulence encounters. Algorithms to estimate significant turbulence areas will be developed and tested operationally at the ITWS/AWPG prototype test sites.

Airborne and/or ground–based icing sensors will be developed to meet the space and time detection requirements for atmospheric icing. Alternative concepts will be evaluated, prototype sensors will be tested and evaluated, and engineering specifications will be prepared to implement an operational system.

Related Projects: 021–180 Terminal ATC Automation (TATCA) and 031–110 Aeronautical Data Link Communications and Applications. Capital Investment Plan projects: 63–21 Integrated Terminal Weather System (ITWS) and 63–22 Aviation Weather Products Generator (AWPG).

Products:

- Prototype humidity and icing sensors
- Certification of sensors that measure humidity and icing aboard air carrier aircraft
- Design guidelines, engineering data, and functional requirements for the sensors
- Turbulence index algorithms for using the sensor data to provide improved turbulence products
- Automated humidity and clear air turbulence reports downlinked from air carrier aircraft

FY 1992–1993 Accomplishments:

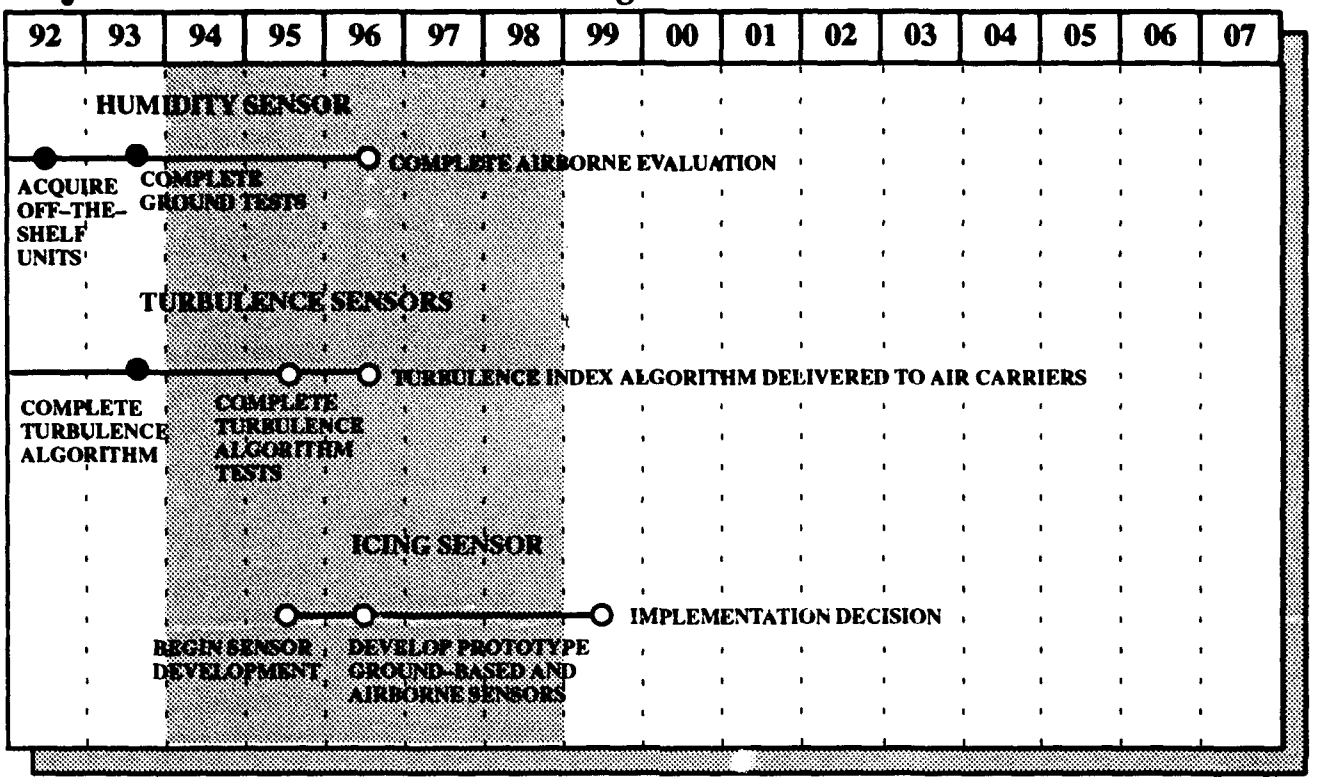
- Completed candidate airborne humidity sensors ground tests.
- Developed algorithm to determine turbulence index using existing onboard ACARS sensors.

Planned Activities: In FY 1994, the humidity sensor will be evaluated in airborne testing by comparing its data with the results of conventional soundings. If the experimental evaluation and operational utility assessment suggests a significant cost/benefit from more rapid humidity profile updates, multiple off-the-shelf sensors will be procured for evaluation on air carrier aircraft in FY 1995–1996.

In FY 1995, work will begin on detecting icing aloft using both ground–based and airborne sensors. In FY 1996, an existing ground–based research radar will be modified to detect icing with testing in FY 1997. An airborne prototype sensor will be developed in FY 1996, with testing and evaluation completed by FY 1998. In FY 1999, a decision will be made on whether ground–based, airborne, or a combination of sensors is required. Once this decision is made, a transition strategy will be developed.

In FY 1994–1995, the turbulence index algorithm will be tested to determine the correlation between the index and aircraft performance. In FY 1996, the turbulence index algorithm will be delivered to air carriers for implementation.

Project 041–120: Airborne Meteorological Sensors



042–110 Integrated Airborne Windshear Research

Purpose: This project will develop, test, and analyze systems to provide and validate airborne technology. Windshear is the major cause of weather–related fatalities in the air carrier community. This research will provide an improved operational capability to detect, monitor, and alert flightcrews to windshear hazards.

Approach: The program is divided into two areas: (1) airborne windshear advanced technology addresses the equipment certification issues, and (2) windshear training applications for Federal Aviation Regulations (FAR) Parts 91 and 135 addresses the training and flightcrew certification issues.

Airborne Windshear Advanced Technology

This work will support airborne windshear equipment development standards and is being accomplished through a cooperative agreement with NASA. The technology developed will provide design guidelines and engineering data to support industry production and certification initiatives for advanced windshear warning systems and flightcrew decision aids. The technology is

transferred to manufacturers and operators to accelerate their development and certification programs resulting from FAR 121.358 requirements. The data are provided to FAA certification, regulatory, and compliance offices.

Flight tests will be conducted to evaluate onboard airborne windshear sensor performance by flying the test aircraft into windshear conditions. Additional flight tests will uplink and evaluate available ground products to support time–critical information processing and display in the cockpit. The ground–based ATC system will be supplied airborne-derived information via downlink.

Further research will investigate new applications for windshear sensor technology with an integrated systems approach developed in the joint NASA/FAA windshear program. Results from this research will be applied to clear air phenomena that pose operational and safety problems for civil transport operations.

Windshear Training Applications for FAR Parts 91 and 135

The first effort is to define the implementing issues of the windshear pilot certification in the field combining all the FAR Parts 91, 135, and 121 products into a comprehensive set of documents. Based on these documents the next task will be to address pilot certification requirements for windshear escape and recovery.

The overall windshear training applications portion is being accomplished in three phases. Phase 1 dealt with crew examination; Phase 2 is developing the four windshear products; and Phase 3 will address windshear training support issues.

Related Projects: 031–110 Aeronautical Data Link Communications and Applications and 033–110 Terminal Area Surveillance System. Capital Investment Plan projects: 24–18 Terminal Doppler Weather Radar (TDWR) System, 43–12 Upgrade Low–Level Windshear Alert System (LLWAS) to Expanded Network Configuration, 63–05 Aeronautical Data Link Communications and Applications, 63–21 Integrated Terminal Weather System (ITWS), 63–22 Aviation Weather Products Generator (AWPG), and 64–13 ASR Windshear Processor.

Products:

Airborne Windshear Advanced Technology

- Recommendations based on study of windshear effects on aircraft performance
- Atmospheric model for lowest 1,000 feet of the atmosphere
- Sensor technology assessments for microwave radar, coherent pulsed lidar, and passive infrared and integrate sensors into flight deck
- Windshear hazard algorithm used with ground–to–air data link to provide information on the flight deck
- Operational requirements for airborne windshear warnings
- Airborne windshear sensor to detect clear air turbulence

Windshear Training Applications for 91/135

- Windshear self–study training aid for general aviation
- Windshear ground school training and simulator aids for air taxi and commuter operators
- Revision to Advisory Circular 00–50A, Windshear

FY 1992–1993 Accomplishments:

Airborne Windshear Advanced Technology

- Completed flight experiments with radar, infrared, windshear data communications, and second–generation in situ algorithms.
- Established operational readiness of next–generation in situ algorithms on flight test aircraft and released to industry.
- Defined crew procedures for microburst avoidance with forward–looking and ground–based information.
- Implemented TDWR data link software improvements.

Windshear Training Applications for 91/135

- Completed flightcrew testing and data collection.
- Completed recommendations for industry review based on data analysis.
- Completed development on the four windshear training applications products.
- Completed Phase 2.

Planned Activities:

Airborne Windshear Advanced Technology

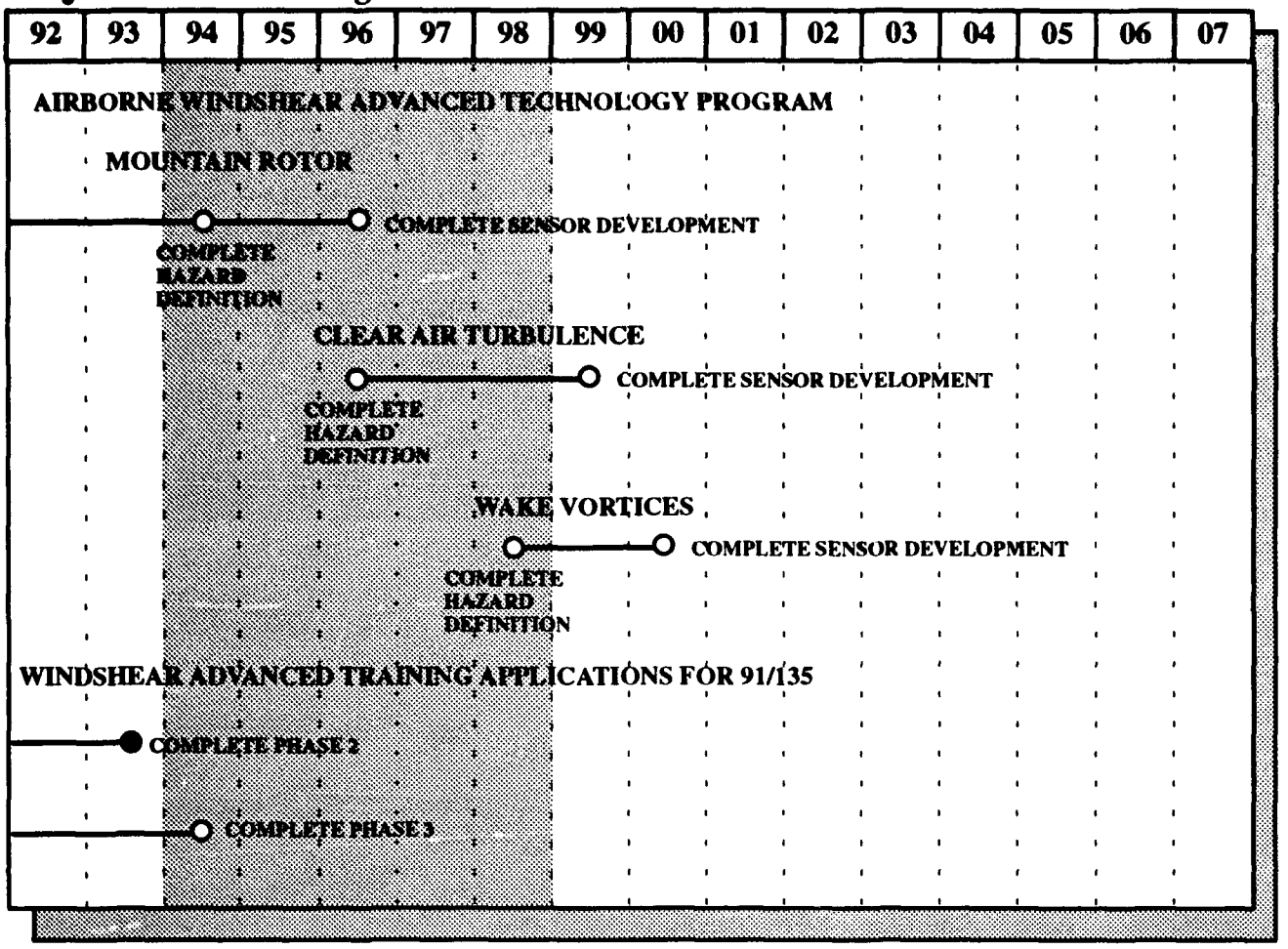
Further research in this project will examine three specific clear air phenomena: mountain rotor, clear air turbulence, and wake vortices. For all three areas, a method will be developed to characterize and measure the phenomena. Then, advanced sensor technology will be applied to detect and provide a hazard warning. Investigations for mountain rotor will begin in FY 1994 with hazard characterization and definition. This activity will be followed by flight tests in FY 1995 with sensor development expected by FY 1996. Hazard characterization and definition for clear air turbulence and wake vortices will begin in FY 1996 and FY 1998, respectively. Flight testing will follow in FY 1997 and FY 1999. Sensor development will be completed in FY 1999 and FY 2000. Following these developments, a final demonstration of sensor capabilities will include a category II low–visibility approach for closely spaced parallel runway operations. Other possible applications are detecting volcanic ash and detecting objects during low–visibility surface operations. The volcanic ash research will run concurrently with clear air turbulence activities. The low–visibility surface detection work will coincide with wake vortex research.

A key objective throughout this project is integrating the output from airborne and ground–based systems to ensure the detection, warning, and avoidance of hazardous clear air phenomena. This integration work will be accomplished in conjunction with air traffic control during the development cycle for the three major areas.

Windshear Training Applications for 91/135

In FY 1994, this subarea will end with Phase 3 completion.

Project 042–110: Integrated Airborne Windshear Research



5.0 AIRPORT TECHNOLOGY

The FAA is responsible for encouraging and fostering safe and efficient national airport system development. The Airport Technology Research and Development Program assists in developing new and improved standards, criteria, and guidelines to plan, design, construct, operate, and maintain the Nation's airports, heliports, and vertiports.

There are over 17,000 aircraft landing areas in the United States. Aircraft are increasing not only in number, but more importantly, in weight, landing speed, and overall dimensions. Many airport facilities are reaching design life, and the capital costs of airport improvements over the next 10 years are estimated to exceed $40 billion. Research will be an important factor in the efforts to control costs. Both passenger enplanements and aircraft operations are projected to experience strong growth for the foreseeable future, leading to airport activity levels two or more times greater than today. However, there are limited possibilities for expanding existing airports or building new airports. Consequently, maximum benefits must be derived by maintaining and improving existing facilities and by supporting research that can reduce congestion and delays at airports. Research can also provide innovative means for improving safety, increasing capacity, improving airport access and passenger services, assessing Federal investment effectiveness, and support introducing U.S.-developed aviation products.

Airport technology research can lead to improved designs, techniques, equipment, and methods to assess system performance that will increase Federal investment effectiveness of the $1.9 billion Airport Improvement Program. For example: pavement and other facility life–cycle costs can be reduced; capacity can be improved and delays reduced; and both airports and heliports can be better integrated into the National Transportation System.

Pavement research has the potential for very large benefits. Approximately $2 billion is spent on constructing, rehabilitating, and maintaining airport pavements each year, whereas only $2 million is spent on research. Increasing the average life of pavements by as little as 10 percent through research would result in a cost benefit ratio of 50 to 1 or more. This objective is not unreasonable or unattainable.

The landside portion of airport design and operation is also addressed in this research area. Projects in this area will help ensure that the systems that bring passengers to the aircraft are also able to handle forecasted traffic levels.

5.1 Airport Technology Project Descriptions

051–110 Airport Planning and Design Technology

Purpose: This project will help improve existing (or develop new) design standards pertaining to runways, taxiways, aprons, and gates. It will also develop standards and advisory information to be used in planning and designing airports, terminals, and ground access systems.

Advances in technology have supported major refinements in the air transportation system and made it possible to transport a large number of people (one-half billion passenger enplanements) each year. But ever–increasing travel demand and projected growth in the next 15 years will influence airport design, layout, and configuration, and require improved landside facilities. A major concern facing the U.S. air transportation industry is how to manage increases in air traffic with improved safety, reduced delays, and minimal operational constraints.

As advances in air traffic control and other airport improvements increase airside efficiency and capacity, passenger facility capacity and access to the airport will become a limiting factor with greater interest for communities. Optimum airport utilization will require that there be a smooth and uninterrupted flow of passengers, cargo, and airplanes between the various elements of the airport system.

Approach: The goal of this program is to eliminate runway acceptance rate as a limiting factor in maximizing airport capacity. This would be achieved by reducing the runway occupancy time as much as it is practical to do. It will also require optimizing the geometry of runway and taxiway exits which will allow aircraft to negotiate turns safely at higher speed. Research will also be needed to optimize existing airport facility designs to balance the relationships between access roads for public and private transportation and parking lots. In addition, it is necessary to identify the clearances and design requirements of future aircraft and review the adequacy of current airport designs for those requirements. Also simplified methods must be developed for determining terminal, curbside, and airside capacities.

Related Projects: 021–220 Multiple Runway Procedures Development, 024–110 Aviation System Capacity Planning, 051–120 Airport Pavement Technology, 051–130 Airport Safety Technology, 073–110 Airport Security, and 074–110 Security Systems Integration.

Products:

- Technical data to support advisory material, regulations, and guidance used by industry and the FAA
- Computer programs and user guides for use by industry and the FAA airport community
- Design standards for terminals and parallel runway configurations
- Terminal design simulation guidance and models
- Aircraft/terminal compatibility analyses

FY 1992–1993 Accomplishments:

- Published report on simulator–based exit design evaluation.
- Completed analysis on the relationship between aircraft separation, runway occupancy time, and runway capacity.
- Published design standards report for terminals.
- Published terminal design simulation.

- Completed development and evaluation on multiple exit and taxiway systems for arrival traffic.

- Published report for airport planners that provides guidance for reviewing terminal plans.

Planned Activities: Initial work on analyzing current airport designs for compatibility with new transport aircraft that are in conceptual and preliminary design stages will begin. This analysis will be completed in FY 1994 and is intended to include airport construction requirements for runway/taxiway widths, runway and taxiway separations, clearances, fillets, taxiway turns, and gate.

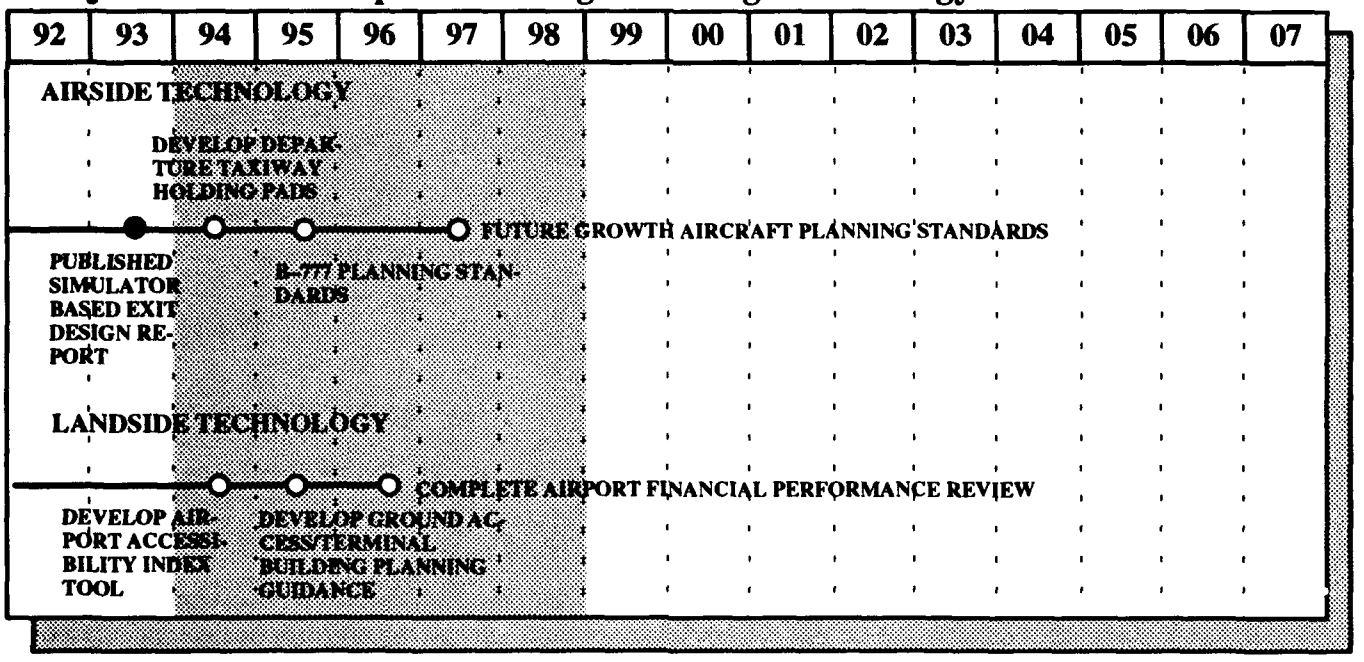
Airside Technology

In FY 1994, development work will be completed on taxiway systems with large holding pads near runway ends for departure traffic. Initial taxiway system design and flow rate evaluation for triple and quadruple parallel runways will continue and design standards will be completed in FY 1995. Design advisory circulars will be re-examined periodically to determine how airports should be planned and designed to accommodate new, unique aircraft configurations with larger wingspans. Standards for the Boeing 777 will be completed in FY 1995 followed by standards for larger growth aircraft in FY 1997.

Landside Technology

An airport accessibility index tool will be developed in FY 1994. Also, planning guidance for ground access to airports and for terminal building design will be completed in FY 1995, with an airport financial performance review completed in FY 1996. These items will efficiently use Airport Improvement Program funds.

Project 051–110: Airport Planning and Design Technology



051–120 Airport Pavement Technology

Purpose: The approximately 650 million square yards of pavement at United States airports represent a precious national resource. Replacement value is expected to exceed $100 billion, and there are only limited practical possibilities for adding to or replacing major pavement systems. Consequently, maximum benefits must be obtained from the existing facilities.

The Federal Government and the aviation community are spending approximately $2 billion in annual pavement expenditure as well as additional costs of delay resulting from operational interruptions due to construction and maintenance. A significant portion of the $2 billion is spent replacing, repaving, rehabilitating, repairing, and maintaining pavement surfaces. In addition, 66 of the top 100 airports in the United States, where large capacity increases are expected, have projected an expenditure of about $6.4 billion over the next 20 years covering the cost of new and extended runways.

The goal of this program area is to reduce the massive costs of pavement expenditure by at least 10 percent by the year 2010. These savings will be achieved through a systematic research program covering three areas: (1) pavement design and evaluation, (2) materials and construction methods, and (3) repairs and maintenance techniques. Specific projects will be carried out to develop a universal pavement design methodology which will reduce pavement design and construction costs, reduce pavement failures, lower the costs of maintenance, and reduce pavement down–time and aircraft delay costs. A universal pavement design based on layered elastic theory will also support U.S. aircraft manufacturer efforts to introduce new and heavier aircraft. This will be accomplished by providing an internationally accepted basis for evaluating if airports are able to receive new aircraft. Other projects will include development of methods for nighttime and cold weather construction, and improved methods of pavement evaluation and failure prediction to extend pavement life by at least 20 percent.

Approach:

Pavement Design and Evaluation

Airport pavement design techniques have evolved from the highway design theory developed in the 1920's and extrapolated in the 1940's and 1950's for application to aviation. While this has worked reasonably well in the past, it will not accommodate the dramatic changes associated with new generation aircraft now on the drawing boards. Research in pavement design and evaluation area will focus on the development of a universal pavement design method which can be applied to the design of both flexible and rigid pavements. Efforts will be concentrated first on the completion of the layered–elastic design method followed by more rigorous design methods such as the mechanistic analysis to accurately model the material properties. As part of the validation of the layered–elastic theory, full–scale pavement testing will be required using a facility which can accommodate multi–wheel configurations simulating the newer aircraft. The facility should provide aircraft response and pavement performance characteristics accurately. Evaluation of aircraft response and pavement performance will also be initiated at major new airports by installing advanced instrumentation and sensor systems in runways and taxiways. In addition, research will also be conducted to develop design criteria and methods for design, evaluation, performance, and serviceability of pavements at airports in cold regions.

Pavement Materials and Construction

Research efforts in this area will include: developing methods to specify and utilize new or improved materials as substitutes for the conventional materials used for pavement construction; identifying factors affecting the

durability of airport pavements and development of criteria for efficient use of devices, construction materials, and construction techniques; performing evaluation of coal–tar mixes; using roller–compacted concrete as a construction technique; and using geotextiles and grid type materials for strengthening airport pavements.

A new program will be initiated for organizing long–term data collection on pavement performance modeled on the Strategic Highway Research Program. This new program will be known as the National Airport Pavement Registry and Demonstration Program and will annually identify significant new airport construction to determine life–cycle costs and other performance factors.

Pavement Maintenance and Repairs

Research efforts in this area will include: determination of probable causes of significant distress and life–cycle cost of pavements and developing criteria and guidance to effectively use seal coating materials for enhancing pavement longevity.

Special life–cycle cost studies on heavy concrete pavements at Dulles and Dallas–Fort Worth airports will be undertaken because these pavements are at the end of their design lives. Pavement sections that show significantly more or less distress than average will be identified and their condition related to the number of stress repetitions, subsurface conditions, or other factors. The results will be used to develop guidelines for concrete pavement average life span, life- cycle costs, and to support developing new design methodologies.

Related Projects: 051–110 Airport Planning and Design Technology and 051–130 Airport Safety Technology.

Products:

- Technical data for pavement design and design life, evaluation, materials, construction, maintenance, and repair
- Software and user guidelines for pavement design and analysis
- National pavement test capability
- Pavement design tool

FY 1992–1993 Accomplishments:

- Completed report on establishing a dynamic pavement test capability.
- Determined the utility of the layered-elastic theory for designing airport pavements.
- Completed report on quality control and pavement adjustment techniques.
- Completed report on using soft grade asphalt in pavements for cold regions.
- Completed report on frost heave case study.
- Completed synthesis report on airport pavement drainage.
- Completed report on roller–compacted concrete.
- Completed report on reinforced sub–base layer.
- Completed pavement sensor installation at the new Denver airport.

Planned Activities: Extensive research is continuing on design and evaluation standards, materials application, construction technology, and pavement maintenance and repair requirements. Major task components include: development of universal pavement design and analysis method-

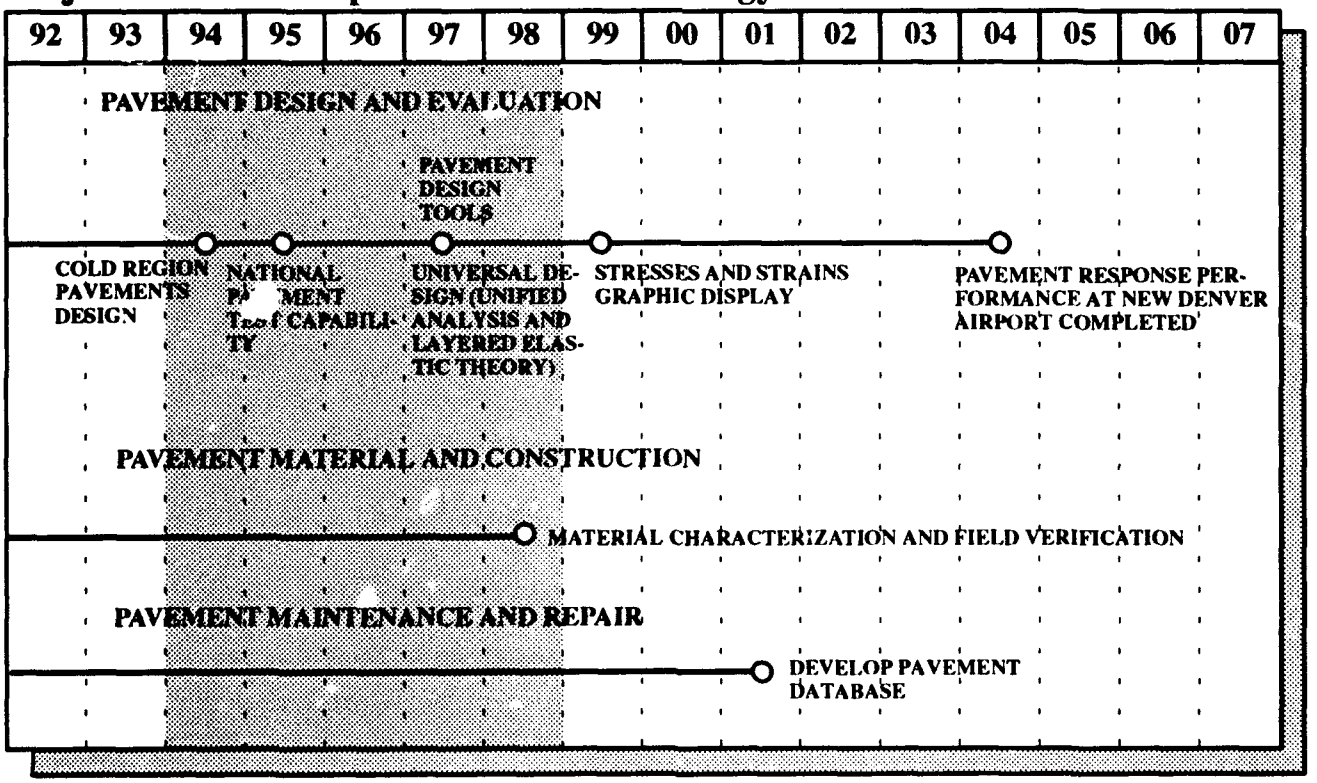
ology on layered elastic theory; instrumentation and monitoring of a pavement section at the new Denver airport; design for cold region pavements; post–tensioned pavement performance; quality control acceptance criteria; geotextile use; specifications for materials, seal coating and joint sealant criteria; and pavement performance data base development.

In FY 1994, a 10–year runway data collection effort will begin at the new Denver airport using the newly installed pavement sensors. These sensors will measure the pavement response to repeated heavy aircraft loading. The data collected will be used to validate pavement design theories. Computer software development using the predictive design and analysis methodology will continue in FY 1994, resulting in a stress/strain graphic display in FY 1999. New tests for material characterization will be completed in FY 1998, and controlled experiments under various applied and environmental loading conditions will be formulated to ensure the methodology's accuracy. In addition, studies will be initiated on durability of asphalt mixes and improved shoulder designs.

In FY 1994, the pavement design method using the Layered Elastic Theory will be fully developed, validated, and ready for application. In FY 1994 , work will continue on collecting and analyzing data that relate pavement performance with FAA design and construction standards. This effort will result in a comprehensive airport pavement data base in FY 2001. Criteria and methods for design, evaluation, performance, and serviceability of pavements at airports in the cold regions will be completed.

In FY 1995, studies will be completed on heavy concrete pavement life–cycle costs and the National Airport Pavement Registry and Demonstration Program. In FY 1995, the national pavement test capability will be completed. Pavement design tools based on layered-elastic analysis and/or finite element analysis will be completed in FY 1997.

Project 051–120: Airport Pavement Technology



051–130 Airport Safety Technology

Purpose: This project will develop new technologies in four research areas: (1) safe and efficient aircraft operations on runway surfaces; (2) new, emerging technologies in lighting, signing, and marking materials for improved visual control systems; (3) new materials, methods, and equipment to improve the capability and cost–effectiveness of airport rescue and firefighting services; and (4) materials, methods, and devices to control birds and wildlife in the airport environment.

Approach:

Runway Surface Technology

A critical safety concern at airports is the runway surface condition. Snow, ice, water, and rubber deposits can result in slipperiness, causing aircraft loss of control during braking as well as making surface movements hazardous. In recent years, grooved runways to control surface water have greatly reduced hydroplaning. However, aircraft accidents from overshooting or veering off contaminated runways remain a problem.

During the last 11 years, there have been 130 accidents involving aircraft overruns and veeroffs. The accidents involved runway surfaces which were either dry or covered with water, ice, snow, or slush. The three major aircraft accidents during the last 10 years have focused national attention to the question of runway slipperiness and loss of control during landings and takeoffs. Accidents at Washington National Airport on January 13, 1982, at Boston Logan International Airport on January 23, 1982, and at John F. Kennedy International Airport on February 28, 1984, have resulted in complete loss of aircraft and 80 fatalities. Runway slipperiness and an inadequate "safety area" beyond the end of the runway were identified as factors contributing to these accidents.

The goals of this program area are to eliminate by the year 2000 runway slipperiness as a cause of accidents and to stop all aircraft within the extent of the runway. To achieve this goal, extensive research, testing, and evaluation will be conducted to develop new techniques, materials, procedures, and equipment to efficiently remove ice, snow, and rubber deposits, and to develop methods to prevent ice and snow accumulation on airport surfaces. In addition, new materials and methods will be investigated to decelerate aircraft safely should there be an overrun.

Visual Guidance

Safe and efficient airport ground operations, especially at night and under low visibility conditions, require that pilots and vehicle operators receive conspicuous and unambiguous information from lights, signs, and other markings. Improvements in these visual aids are one of the key elements in the FAA's Runway Incursion Program.

During the past 15 years, seven air transport surface collision events in the United States have resulted in nine fatalities and substantial property damage. In 1990, a collision at Detroit International Airport between two aircraft killed an additional eight people. These accidents have brought into focus the need for providing visual guidance to aircraft in low visibility conditions.

The goal of this program area is to eliminate by the year 1997 deficiencies in the visual guidance systems and procedures that may contribute to surface collision accidents. This would require research efforts in two general areas: visual guidance "control" technology to develop an automated system for aircraft movement on airport surfaces and developing state–of–the–art in light sources and applications. These will include fiber optics, laser sources, and holographic techniques.

In conjunction with this effort, technology will be developed to evaluate new visual guidance systems and procedures, particularly during low visibility conditions, on a computer–based simulation system.

Rescue and Firefighting

The analysis of aircraft accidents involving external fuel fires has shown that, although external fire is effectively extinguished, secondary fires within the fuselage are difficult to control with existing equipment and procedures. Large amounts of smoke, toxic gases, and high temperature levels in the passenger cabin can cause delay in evacuation and pose severe safety hazards. The February 1, 1991, accident at the Los Angeles International Airport involving two aircraft clearly demonstrated this concern: the rescue and firefighting personnel were faced with a post–crash fuel spill fire, a rapidly growing interior fire, and a structural fire. A rapid response to the accident site was accomplished, but evacuation was hampered by the thick black smoke that filled the cabin following the accident. Reductions in off runway response times will be achieved by developing a new truck suspension system that improves traction in soft sand, wet, and uneven ground conditions.

The goal of this program area is to increase passenger survival rate in post–crash fires by providing a safe evacuation route through the aircraft cabin in a timely manner. This would require research and testing to develop firefighting systems that can effectively be used to control both external and internal cabin fires. Research will be carried out to reduce vehicle response time during nighttime and in low visibility conditions to develop new training techniques for rescue and firefighting personnel. Improvements in response times and proper equipment development are needed for operations in poor visibility conditions.

Improvements in soft terrain and off–road firefighting vehicle capabilities will be needed to cope with expanded airport runway configurations into the year 2000 and beyond. New methods, procedures, and firefighting chemicals will be developed for use with large capacity aircraft, double–decked aircraft, and/or aircraft made from advanced materials.

Chemicals used in firefighting training facilities are raising concerns about environmental damage. Research will investigate methods to maintain a high level of performance for firefighting services, while minimizing air pollution and ground water contamination.

Wildlife

Presence of wildlife at and near airports poses a potential threat to movement of aircraft and other ground vehicles. In spite of various control devices in use to keep birds away, over a thousand incidents of bird strikes are reported every year. Many more incidents are known to occur, but are not reported.

Since 1912, when the first fatal accident of a Wright Flyer was recorded, 104 civil aviation fatalities from bird strikes have been reported in the United States. Worldwide civil aircraft fatalities total approximately 126. Potential for a serious accident continues on an ongoing basis. The cost of bird strike damage has been estimated at $1 billion annually by the Europe Bird Strike Committee.

The goal of this program area is to reduce the likelihood of bird collision with aircraft. This would require research efforts in developing effective wildlife habitat management to minimize bird activities around airports. Research will also be conducted to identify active and passive harassment techniques that can effectively control the presence of birds and other wildlife at airports. These techniques and methods will assist airport owners and operators in complying with FAA airport certification regulations.

Related Projects: 021–190 Airport Surface Traffic Automation (ASTA), 051–110 Airport

Planning and Design Technology , 051–120 Airport Pavement Technology, and 061–110 Aircraft Systems Fire Safety. Capital Investment Plan projects: 62–21 Airport Surface Traffic Automation (ASTA).

Products:

- Technical data supporting rules, regulations, and advisory circulars on runway surface maintenance
- Technical data and design criteria for lighting and marking systems for airports, heliports, and vertiports
- Technical data on tests and evaluation of firefighting agents, full–scale systems, and rapid response all terrain firefighting vehicle
- Technical data and advisory circulars on wildlife habitat management, bird harassment techniques, and landfill studies

FY 1992–1993 Accomplishments:

- Developed software for runway smoothness criteria.
- Published reports on approach path indicators for heliports and on advanced technology lighting needs.
- Published reports on airport smart–power lighting system and tritium runway lighting system evaluation.
- Completed reports on runway anti–icing/deicing chemicals and Type II ground deicing chemicals.
- Published report on prototype stop–bar system at John F. Kennedy (JFK) airport.
- Completed general aviation and helicopter firefighting requirements study and full–scale firefighting tests.
- Developed design criteria for soft–ground arresting system.
- Completed boom–mounted penetration research effort for post crash interior firefighting.
- Published two reports on bird harassment/deterrent techniques and bird affinity for solid waste facilities.

Planned Activities:

Runway Surface Technology

In FY 1994, the standards for installation of a plastic foam arrestor system will be completed. Also in FY 1994, a report will be completed on sand application rates and standards will be issued in FY 1995.

In FY 1996, research will be completed on microwave debonding of runway ice. Also in FY 1996, testing will be completed on innovative methods of ice removal, with a final report in FY 1997 leading to an advisory circular in FY 1998.

In FY 1997, a universal performance specification will be completed for removing runway rubber deposits.

Visual Guidance

U.S. stop–bar standards will be developed in FY 1994, based on evaluations at Seattle–Tacoma Airport. A study will be initiated to investigate application of solar energy for lighting systems. A study will be completed on paints used for airport pavement markings. This study will include factors such as durability, visibility under fog or at night, and dry or wet conditions. In FY 1994, studies on an automated taxiway guidance system and on low–visibility lighting systems will be initiated. A report on low–visibility simulator software will be completed.

In FY 1995, standards will be issued for improved airport pavement markings. Visual simulator enhancements will be completed for testing new and improved lighting systems under all weather conditions. Also, a study on automated traffic control logic and procedures will be initiated, leading to design standards for automated visual systems. Development work on these design standards will be initiated in FY 1996, with completion expected in FY 1998.

In FY 1996 through FY 1997, improved heliport lighting will be developed that includes new fixtures, lighted flat panels, and approach course lighting.

Rescue and Firefighting

In FY 1994, work will continue to evaluate a penetrator nozzle's ability to suppress aircraft cabin fires. Additionally, a study will continue to identify the most cost–effective technology to provide enhanced vision and location definition for rescue vehicles responding to emergencies under poor visibility conditions. A new effort will be initiated to evaluate the rescue firefighting standards against requirements to control and extinguish fires in aircraft containing composite material.

In FY 1994, specifications for a penetrating nozzle boom and standards for new fire extinguishing agents to replace Halon 1211 will be developed. In addition, work will be initiated to provide fire trucks with information for efficient rescue operations following a crash. An advisory circular will also be published for minimum aircraft rescue and firefighting capabilities at general aviation airports.

In FY 1995, an evaluation will be initiated for aircraft rescue and fire fighter training simulators. A study will begin to evaluate a generic, full–scale firefighting training facility that meets both environmental concerns and operational requirements.

In FY 1996, an advisory circular will be published to cover technologies that improve response during poor visibility conditions for firefighting vehicles. Also in FY 1996, research will be conducted to evaluate soil stabilization methods to support airport rescue and firefighting vehicles.

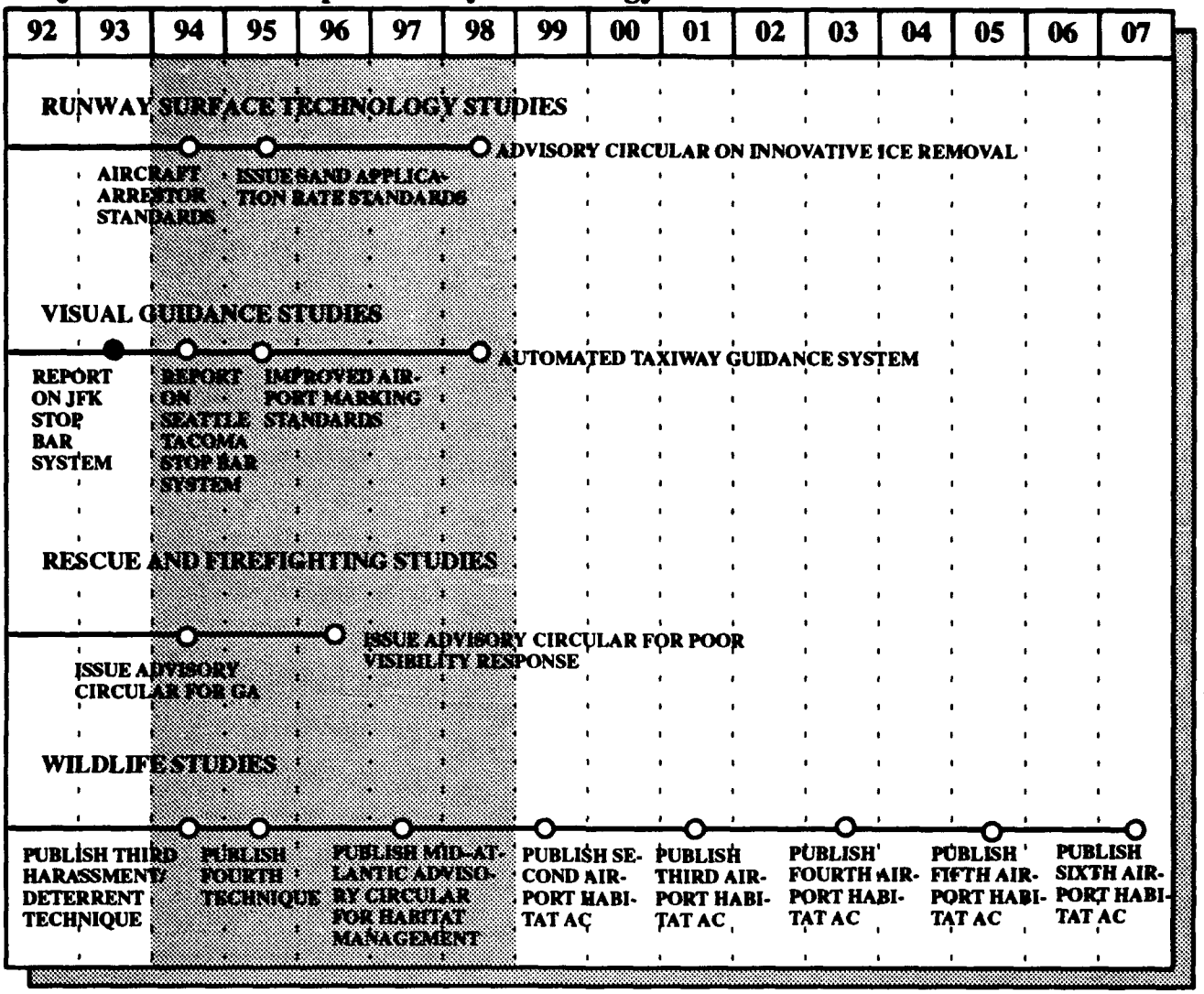
Wildlife

In FY 1994, the second regional airport habitat management study will commence for 4 years and research on a fourth wildlife harassment/deterrent technique will begin. Also, a final report will be published on a third wildlife harassment/deterrent technique previously researched.

In FY 1995, the first regional habitat study at Atlantic City will be completed with a final report in FY 1996, and a Mid–Atlantic U.S. Advisory Circular in FY 1997. Final reports on the fourth and fifth wildlife harassment/deterrent techniques will be finished in FY 1995 and FY 1996, respectively. Regional habitat management studies will be initiated and completed at a rate of every 2 years until the ten regional studies are finished (e.g., the third regional airport study will commence in FY 1996 and end in FY 2000). These regional airport studies will continue through FY 2006, with advisory circulars published 1 year after final reports.

The primary thrust of the above research efforts is to identify and document the effectiveness and applicability of new wildlife habitat management and harassment/deterrent techniques for use on or near airports to mitigate bird and wildlife hazards. Knowledge of bird relationships to existing and new solid waste facilities will establish a sound scientific basis to evaluate potential bird attraction effects on or near airports.

Project 051–130: Airport Safety Technology



051–140 Demonstrations and Concepts Evaluation

Purpose: This project ensures that technology–based airport improvements meet projected user requirements and can be effectively integrated into the operating environment. Product ideas and approaches will be validated, demonstrated, and integrated with other related activities before embarking on expensive, longer range implementation.

Approach: Developing system evaluation and integration requirements will be accomplished through studies, reviews, and demonstrations. This process involves open and continuous dialogue with the user community both of a general basis and through its representative organizations. This process will include conducting demonstrations, conferences, seminars, and

workshops on airport technology research. This activity will emphasize the transfer of technology from the Research, Engineering and Development (R,E&D) phase to operations phase through field validation and demonstration of R,E&D programs.

Safety studies will review historical data to establish research needs directed to enhance airport safety. Analytical computer modeling will be applied to measure research in terms of cost/benefit, capacity/delay parameters and changing demand trends on a local and national basis.

Related Projects: 021–190 Airport Surface Traffic Automation (ASTA), 021–220 Multiple Runway Procedures Development, 021–230 Wake Vortex Separations Standards Reduction, 024–110 Aviation System Capacity Planning, and 073–110 Airport Security. Capital Investment Plan projects: 62–21 Airport Surface Traffic Automation (ASTA).

Products:

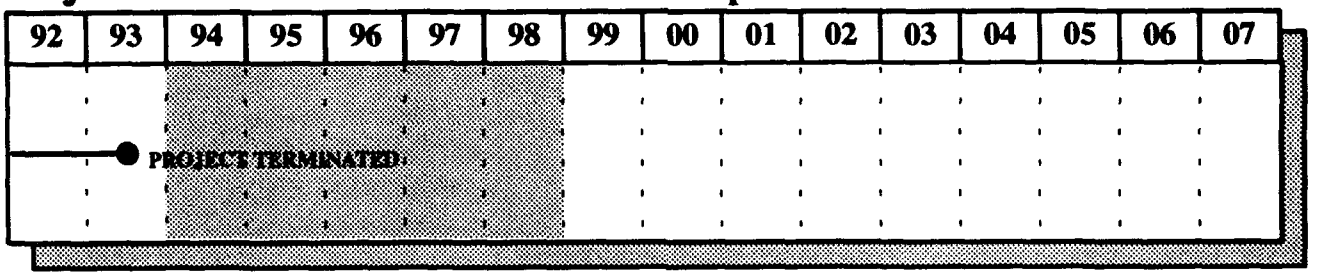
- Requirements documentation
- Capacity/delay and cost/benefit analyses as input to research activities
- Conferences, seminars, and workshops for technology transfer
- System integration planning/design criteria
- Research initiatives based on historical accident/incidents
- Demonstration programs, such as new visual guidance systems, new high–carbon concrete pavement, and enhanced ice/sr prevention techniques

FY 1992–1993 Accomplishments:

- Conducted an airport technology conference.
- Conducted airport guidance system dem nstration program.

Planned Activities: This project terminates in FY 1993.

Project 051–140: Demonstrations and Concepts Evaluation



6.0 AIRCRAFT SAFETY TECHNOLOGY

An important element for public confidence in the air transportation system is the aircraft fleet's continued safety record. This thrust area is focused on developing technologies for certification and maintenance regulations that maintain or improve aircraft safety in an evolving, changing, and demanding aviation environment.

Aircraft safety improvements will reduce fatalities and injuries, reduce hull losses, improve aircraft designs, and impact maintenance and inspection procedures. Each project in this thrust area has the potential to provide significant benefits. For example, more efficient nondestructive airframe testing could produce $40 million per year in benefits. A similar improvement in engine maintenance efficiency could achieve $20 million per year in benefits. An additional $30 million per year could accrue from these two projects due to using more effective inspection techniques and avoiding major engine failure incidences.

Research in aircraft fire safety has the potential for accruing large benefits. Statistics show the United States has about 30 to 35 fire fatalities per year in otherwise survivable accidents, and about 135 fatalities worldwide. At an estimated cost of $1.5 million per life, saving 3 people per year would pay for the entire fire safety research, engineering and development effort.

Over the past 20 years, the aircraft accident fatality rate has been nearly level at just under two deaths per 10 million passengers carried. This statistic is a tribute to aircraft safety provided by the designers, operators, and regulators. Because the civil fleet's size increased over this period, the leveling fatality rate translates into an increase in total fatalities. These statistics indicate that new safety problems have been arising as old ones have been eliminated. Further, some safety problems such as fire and crashworthiness have continued to persist. Other potential problems, such as flight critical digital fly-by-wire systems, have not had sufficient operational exposure.

From 1990 to 2000, the domestic commercial transport fleet is projected to grow from 4,073 to 4,800 aircraft. The air taxi and commuter fleets combined are projected to grow from 1,771 to 2,100 aircraft over the same period. Total commercial operations at controlled domestic airports are expected to increase from 22,800,000 to 29,700,000 over those 10 years. In addition, general aviation and rotorcraft activity is also expected to increase during that time period.

Maintaining the good safety record over the past two decades has required introducing newer safety technologies, such as cabin floor emergency escape lighting and seat fire blocking layers. Such enhancements are in addition to scores of pre–existing safety requirements for aircraft. Examples include design requirements for the aircraft structure so occupants can survive rapid decompression at cruise altitudes, and demonstrations proving that all cabin passengers can evacuate within 90 seconds for each newly certificated transport category model.

The most important purpose of FAA aircraft safety research is to develop technical requirements for safety improvements needed to maintain or improve the safety level in an evolving aviation environment. Examples of this evolution are manifold and include: the two–pilot flightcrew, the aging aircraft fleet, fly–by–wire aircraft, greater composite material utilization, new terrorist threats, new aircraft fire extinguishing chemicals to replace ozone depleting agents, and electromagnetic susceptibility of sophisticated aircraft digital flight control and avionics systems. Keeping pace with these changes through safety–oriented research is a continuing effort unique to the FAA.

Today's passenger safety depends on fault–free maintenance and operation of the Nation's civil aircraft. Tomorrow's passenger safety depends on steps taken now to ensure future aircraft reliability and their operator's competency. The steps taken today by the FAA for future safety are embodied in the Aircraft Safety Technology Program. This program addresses the many hazards that face all aircraft in flight, as well as special hazards endemic to select portions of the civil aircraft fleet. Older aircraft are more susceptible to structural problems associated with fatigue and corrosion. New aircraft, with their digital flight control and avionics systems and associated imbedded software, are more susceptible to upset from external electromagnetic interference.

This program emphasizes safe aircraft operation throughout all flight regimes including airworthiness considerations such as reliable and effective structures, propulsion systems, control systems, and electrical systems. Additionally, the aircraft's ability to counter or absorb external hazards found in flight must be considered. External hazards include lightning, high intensity radiated fields, birds, turbulence, and icing conditions. When human error or systems failures result in an aircraft accident, there are additional design requirements to make the accident more survivable and minimize any post–crash fires. When such fires occur, design considerations include measures both to increase the time available for passenger evacuation and to facilitate their escape. The main hazards the FAA Aircraft Safety Research Program addresses are represented in Figure 6.1.

Fire safety studies will result in specifications for effective fire extinguishing agents to replace currently used ozone destroying agents. They will also lead to developing automated, computer–driven fire management systems that will expedite locating and extinguishing in–flight fires. Additional fire safety enhancements will include developing an onboard water spray fire suppression system and more effective fire retardant materials that further increase the time for passengers to escape from the aircraft cabin.

Similarly, results from current work in crashworthiness will be used in developing guidelines for designing aircraft structures that can absorb severe impact loads and still maintain a habitable environment. Cabin safety improvements will include improved energy–absorbing seat restraint systems and designs for galleys and overhead stowage compartments that reduce their hazard potential in accidents. These improvements, along with strengthened structures around door and window exits, will also enhance emergency evacuations in post–impact situations.

Propulsion system safety research will lead to reductions in the number of lives lost due to turbine engine bird and water ingestion or fragments from uncontained rotor failures that destroy critical systems. This will be accomplished by developing specifications for advanced engine ingestion systems and rotor containment systems.

A new fuel safety program is aimed at preventing or diminishing the critical elements involved in forming the deadly mist fireball fuselage chain: spilled fuel, mist formation, and ignition sources.

The flight safety/atmospheric hazards research program will provide state–of–the–art information to address aircraft icing, electromagnetic environment, digital systems validation and flying qualities, and operations to support regulatory, certification, and flight safety processes.

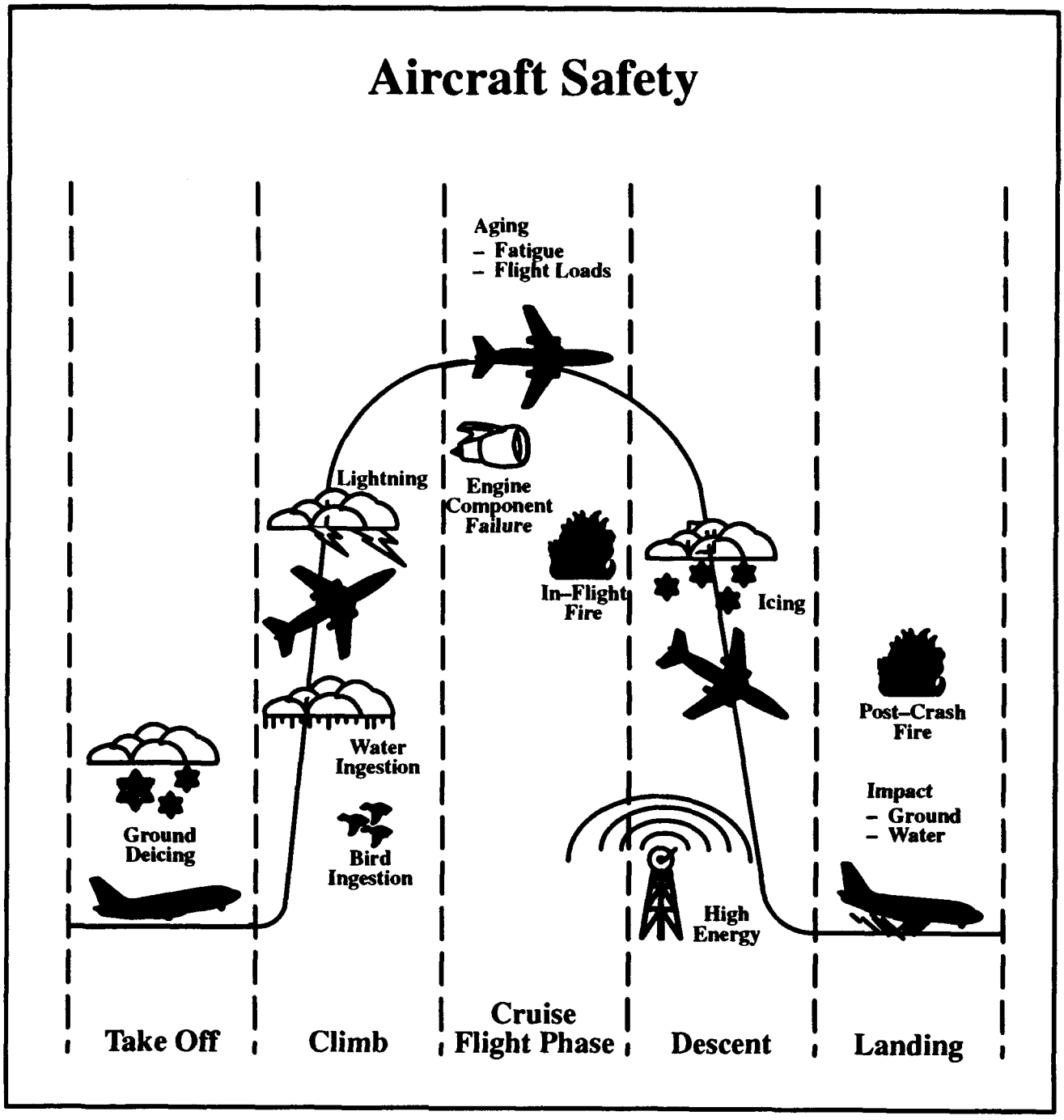


Figure 6.1 Typical Flight Hazards

6.1 Aircraft Safety Technology Project Descriptions

061–110 Aircraft Systems Fire Safety

Purpose: This project will minimize fire–related injuries and increase survival rates for aircraft occupants during in–flight and post–crash fires. It will also improve aircraft fire detection and suppression capability, thereby decreasing the potential for igniting aircraft materials and reducing hull losses in the civil aircraft fleet. The fire safety performance requirements involve fire hardening the fuselage structure and interior cabin materials to increase available evacuation time and reduce fire hazards. Research will lead to new systems and procedures to increase fire safety.

Approach: Aircraft fires are unique when compared to fire safety issues in buildings, residences, and ground transportation. While in flight, the time required for descent and landing requires safeguards to provide sufficient evacuation time. During an aircraft crash, impact energies, coupled with the aircraft fuel load, result in a high potential for exterior fuel fires and injuries or fatalities. Studies will be conducted to determine airplane design characteristics that have the potential to increase fire safety. Research will be performed on more fundamental aspects, such as material flammability, extinguishment chemistry, fire dynamics, and risk analysis, to develop promising fire safety improvements for future aircraft.

Related Projects: 062–110 Aircraft Crashworthiness/Structural Airworthiness and 063–110 Propulsion and Fuel Systems.

Products:

- Upgraded aircraft material fire test handbook
- Guidelines for cargo compartment fire protection
- Upgraded fire performance criteria for aircraft cabin materials
- Guidelines for recycled halon extinguishing agents and alternative agents
- Design and optimize an on–board cabin water spray system
- Auxiliary fuel tank hazard assessment and protection
- Improved fire hardening for fuselage structure
- Enhanced fire detection, fire management, and decisionmaking for in–flight fires

FY 1992–1993 Accomplishments:

- Completed fire suppression/containment tests in main deck cargo compartments for "combi" aircraft.
- Completed optimization tests on water spray nozzle configurations in narrow and wide–body fuselages.
- Completed study on adverse aspects of accidental cabin water spray system discharge on aircraft safety and passenger health.
- Developed new small-scale fire tests for aircraft wiring.

- Completed fabrication of a prototype aircraft command in emergency situations (ACES) system.

- Developed improved fire test requirement to ensure flight recorder postcrash fire integrity.

Planned Activities:

This project will be divided into three major areas: Materials Fire Safety, Fire Management, and Systems.

Materials Fire Safety

In FY 1994, tests initiated in FY 1993 will be completed on fire hardening materials and concepts to protect against fuel fire fuselage penetration and the results will be used to establish improved design criteria.

Long–range research on advanced cabin materials will continue through FY 2001. The goal is to create a practically "fireproof" cabin interior that will resist ignition by an external fuel fire.

Improvements in hydraulic system protection will begin in FY 1994 and be completed in FY 1996.

Fire Management

In FY 1994, design requirements will be developed for installing a water spray system in commercial airplanes.

Alternate agents developed by industry to replace Halon 1301 will be tested in cargo compartment and powerplant applications for the purpose of developing guidelines for equivalent effectiveness by FY 1996.

In FY 1994, tests will be completed that relate to fire containment and suppression in main deck Class E cargo compartments. The efficacy of current design requirements will be determined in FY 1994.

Prototype development and testing of an on–board oxygen generating system (OBOGS), employing selective absorption membranes, will be conducted in FY 1994–1997 with prototype delivery in FY 1998. OBOGS technology, if successful, would virtually eliminate the fire hazards associated with current containers and chemical canisters. In–service performance evaluations will lead to OBOGS design guidelines for industry in FY 2000.

Improvements in oxygen systems protection and enhanced smoke evacuation will begin in FY 1994 and be completed in FY 1996.

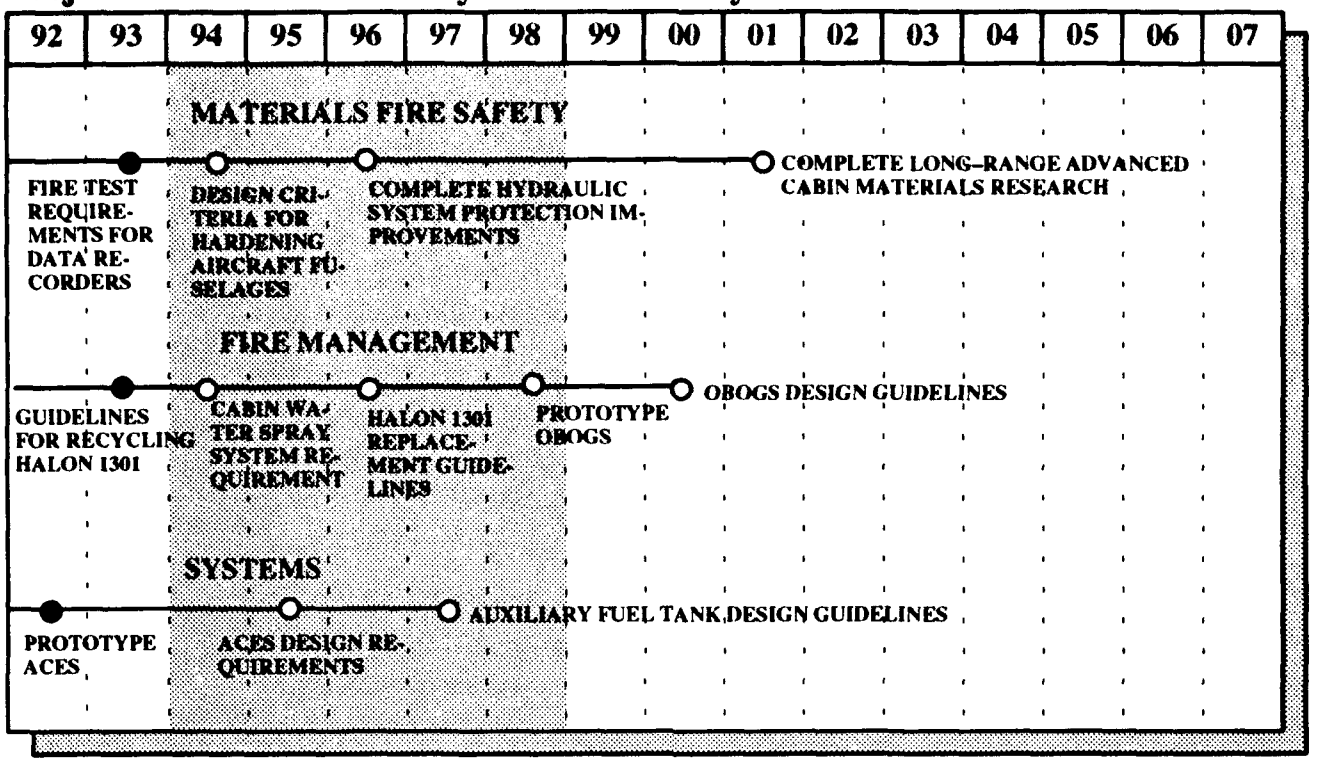
Systems

In FY 1994, tests will be completed on an ACES system designed for early detection of inflight fires and improved, more timely crewmember decisionmaking. ACES flight simulator studies will also be completed in FY 1994. ACES design requirements will be developed in FY 1995.

Full–scale tests related to hardening auxiliary fuselage fuel tanks against postcrash fire will be completed in FY 1996 and will be used to develop installation guidelines in FY 1997.

In FY 1994, support for National Transportation Safety Board aircraft fire investigations will continue, including participation on accident investigation teams, accident material and fluid chemical analysis, and full–scale fire tests to recreate/analyze accident scenarios.

Project 061–110: Aircraft Systems Fire Safety



062–110 Aircraft Crashworthiness/Structural Airworthiness

Purpose: This project will increase protection for both occupants and crew during an accident. Work will be conducted to develop and validate test procedures necessary for generating required research data. These data are needed to support certification standards, performance specifications, advisory circulars, and other regulatory materials necessary to enhance aircraft crashworthiness and occupant safety. The research will focus on advanced composite material structures safety and acquiring the necessary knowledge to support regulations that ensure continued civil fleet airworthiness.

Approach: This project establishes a technical data base to generate aircraft crashworthiness and structural airworthiness criteria for both fixed–wing and rotary–wing aircraft. Experimental and analytical research efforts will be developed to create standard guidelines and performance criteria that ensure continued aircraft structural airworthiness. These efforts will help reduce occupant injuries and fatalities in the crash environment.

Aircraft Crashworthiness

Aircraft crashworthiness includes three areas: airframe structures, cabin interior, and occupant evacuation. Airframe structures will analyze the crash environment, aircraft fuel systems, and structural components to identify and address structural failures. The cabin interior area will analyze seat/restraint systems, interior furnishing, and human tolerance limits. Occupant evacuation analysis will investigate escape devices, environmental factors, procedure effectiveness, and ditching survival equipment. Analytical

modeling will be used in developing structural, occupant, and seat information.

Structural Airworthiness

Structural airworthiness addresses advanced materials research and landing gear systems. It comprises three areas: engineering, operations, and manufacturing/quality assurance. The engineering area will investigate damage tolerance, environment, joints, and other structural or fatigue concerns. The operations area will research issues related to environmental effects on durability, impact damage, nondestructive inspection, and training/repair procedures. The manufacturing/quality assurance area will analyze and develop standard process characterization procedures, control criteria, and production readiness.

These research efforts will be accomplished in part via the University Grant Program, interagency agreements, memorandums of understanding, Centers of Excellence, and the Small Business Innovation Research Program.

Related Projects: 061–110 Aircraft Systems Fire Safety, 063–110 Propulsion and Fuel Systems, 065–110 Aging Aircraft, and 066–110 Aircraft Catastrophic Failure Prevention Research.

Products:

- Data base addressing certification criteria for seat/restraint systems
- Technical data packages on crash–resistant fuel system designs
- Data package and analysis of commuter airplanes and rotorcraft exposed to a water impact environment
- Data base characterizing aircraft structural responses when exposed to various impact terrain environments
- Handbook for FAA personnel on new composite technologies and manufacturing/inspection/analysis techniques
- Data package on nondestructive evaluation technologies in advanced composite/metallic structures
- Data package on damage tolerance for structures constructed using advanced materials
- Data base addressing certification criteria for brake wear limits and aircraft stopping distances

FY 1992–1993 Accomplishments:

- Completed data base development to assess existing rotorcraft airframe energy absorption concepts.
- Conducted commuter/air taxi airplane full–scale drop test to generate structural impact data.
- Completed longitudinal test and analysis investigating fuselage auxiliary fuel system crash resistance.
- Completed equipment evaluation effort to develop reliable nondestructive inspection (NDI) techniques for detecting flawed aircraft structures due to reduced strength bonds.
- Completed an effort to identify operational, maintenance, and repair certification requirements for composite aircraft structures.
- Provided data addressing rotorcraft and commuter airplane water impact accidents for regulatory consideration.

Planned Activities:

Aircraft Crashworthiness

Testing and analysis related to commuter aircraft structures will be completed in FY 1995 and FY 1996, respectively. Composite aircraft testing will be completed in FY 1996.

In FY 1995, an auxiliary fuselage fuel tank system analysis will be completed. The test program will evaluate crash resistance of fuel lines and fittings in FY 1995, empennage and fuel tanks in FY 1996, and wing tanks in FY 2000.

Testing associated with various commuter cabin safety and evacuation issues will continue in FY 1994 with seat restraint system testing and improved seat/occupant model analysis being completed in FY 1995.

Overhead bin testing for various transport category aircraft configuations will continue through FY 1996. The widebody lower lobe crash feasibility study will be completed in FY 1994, leading to regulatory guidelines in FY 1997.

Full-scale water impact testing and analysis for rotorcraft and transport category will be completed in FY 1997.

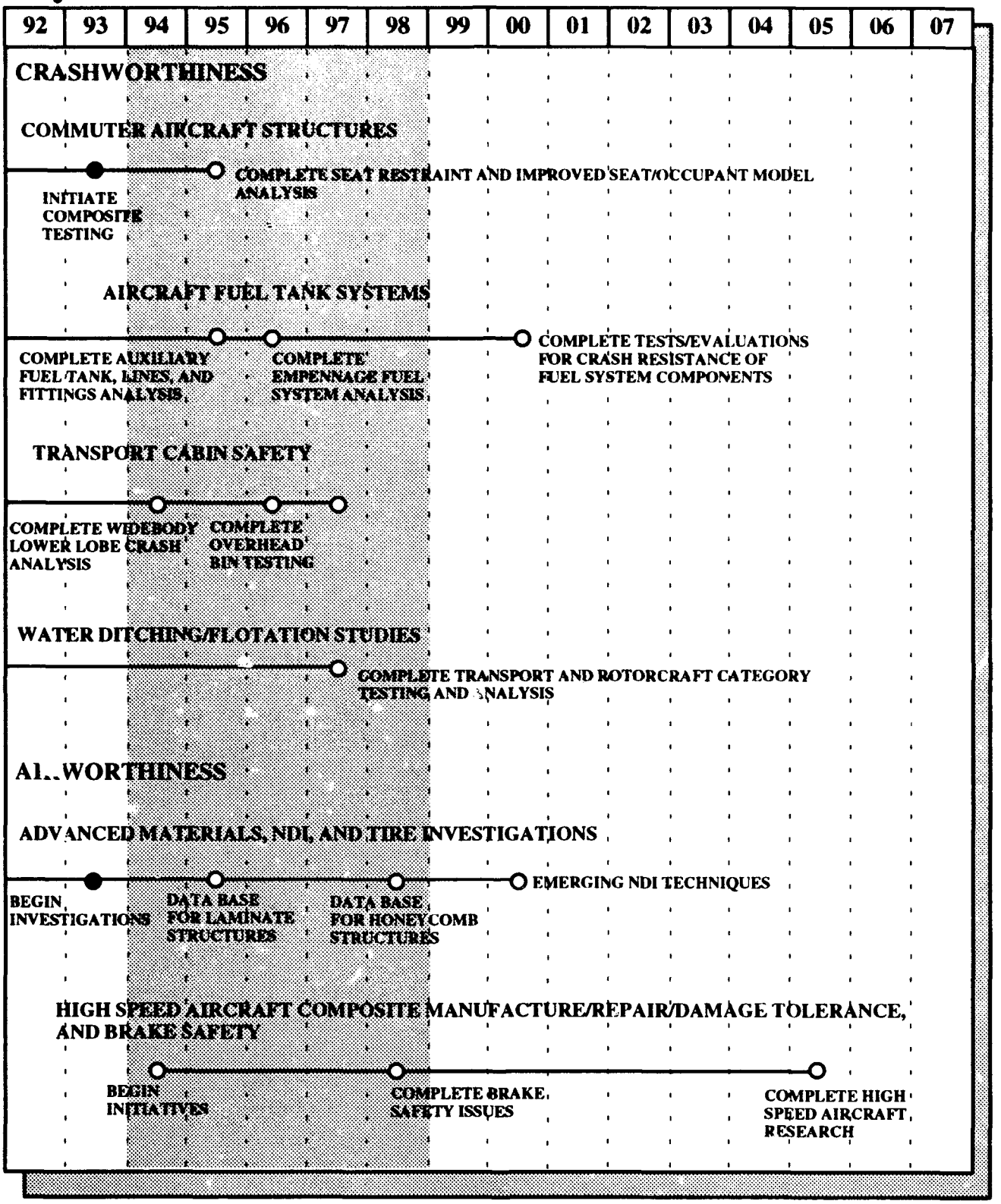
Structural Airworthiness

In FY 1994, investigations will continue on determining structural design service life variability with advanced materials; addressing advanced NDI technology, including smart structures, for metal/composite interface areas; and developing data to compare bias–ply and radial–ply tires using tire temperature data to validate a tire heating model. Work will also continue on the following: investigating composite material test methods; and studying delamination and environmental effects on composite aircraft structure's fatigue/damage tolerance and operational life. A data base addressing laminate structures will be completed in FY 1995 and one addressing honeycomb structures will be completed in FY 1998. Development work on emerging NDI techniques will be completed in FY 2000.

In FY 1994, several initiatives will begin including the following: to evaluate developments/applicability for advanced high speed aircraft design and fabrication technology; to update the FAA's handbook on fiber–reinforced composite manufacturing/repair; to identify and investigate design and manufacturing techniques that optimize damage tolerance for advanced composite/metal aircraft structures; to develop data for evaluating bonded advanced material repairs on damage tolerant structures; to address anti–skid brake certification tests and procedures, brake wear limits, and aircraft stopping distances.

The investigations for advanced composite/metal aircraft structures; the brake safety issues; and the high–speed civil aircraft research will continue into FY 1997, FY 1998, and FY 2005, respectively.

Project 062–110: Aircraft Crashworthiness/Structural Airworthiness



063–110 Propulsion and Fuel Systems

Purpose: This project will increase future engine efficiencies. Superalloys, ceramics, and coatings will permit the engines of the 1990's to operate at much higher temperatures and pressures. Future engine durability is a concern as thermal and mechanical fatigue/fracture problems are likely to become more serious. This project will provide FAA headquarters and regions with the technical data needed to assess current in–service propulsion and fuel system problems. The data are needed to determine if current regulations are adequate. The project will also establish airworthiness criteria and related technical materials to: ensure powerplant safety, reliability, and durability; review changes in aviation fuel specifications/availability; and conduct research necessary to enhance propulsion and fuel system safety.

Approach: This project involves developing criteria, guidelines, and data to support improvements in turbine and piston engine certification requirements. The primary research and development areas are engine reliability, engine structural safety, and fuel safety.

Engine Reliability

Analyses in progress will determine if current standards adequately address engine durability problems under extreme operating temperatures and pressures. Advanced engine safety and reliability will be continuously assessed as these engines are developed for future commercial and general aviation aircraft.

An analytical study on the water ingestion process in the combustion section will also be initiated. This study will compliment a previous study conducted on the compressor section. In–service operation data will be analyzed to identify potential problems from hail or other foreign object ingestion.

A study will be undertaken to determine if sensing flammable mixtures in powerplant installations is feasible and develop engine case burnthrough test standards.

Research will be conducted to develop technology and establish a technical data base for engine component production, in–service inspection methods, and material manufacturing processes.

Engine Structural Safety

Work will continue on developing lightweight containment materials and analyzing turbine engine rotor failures. The materials under consideration include composite weaves, ceramics, and advanced metallics. Technology will be developed to predict or diagnose a turbine engine rotor structural failure.

Fuel Safety

The results from a previously completed fuel risk assessment will be used to evaluate promising approaches to improve post–crash fuel safety. A future study includes analyzing the elevated fuel temperature effects associated with high–speed transports. Additionally, an effort will be undertaken to expand the technical knowledge base on the characteristics and properties of various fuels available in the marketplace. The factors that affect aviation fuel availability will be continuously monitored, and research will be initiated to maintain acceptable safety and reliability levels.

Related Projects: 062–110 Aircraft Structural Crashworthiness/Airworthiness, 065–110 Aging Aircraft, and 066–110 Aircraft Catastrophic Failure Prevention Research.

Products:

- Data base on in–service experience with turbine engine bird and foreign object ingestion
- Analytical design tools to define turbine engine rotor failure fragmentation patterns and engine performance during excessive rain/hail ingestion
- Design criteria and material specifications for containing turbine engine rotor failures
- Develop advanced engine material manufacturing processes
- Advanced fire protection criteria and prototype hardware for turbine engine powerplant installations
- Risk assessment and techniques to mitigate post–crash fuel fire hazards
- Propulsion safety assessments of future aviation fuels and engines
- Improved nondestructive inspection standards

FY 1992–1993 Accomplishments:

- Completed 2–year census of worldwide engine bird ingestions for contemporary high bypass turbofan engines.
- Completed evaluation of techniques to minimize or eliminate postcrash fuel fires.
- Developed testbed for conducting tests on 3–dimensional engine models.
- Completed research in fiber–reinforced structures for turbine engine fragment containment.
- Published annual reports on turbine engine rotor failures in U.S. commercial service.

Planned Activities:

Engine Reliability

Current engine nacelle fire detection systems will be evaluated through FY 1994 to keep pace with advancing technology in engine performance. Fire test standards and equipment will be developed in FY 1995 for power plant installations. Experimental efforts will be completed in FY 1995 to validate an engine water ingestion analytical model. In FY 1996, the analytical model will be expanded to include water and hail ingestion. Current efforts in developing performance data on engine inspection techniques will be completed in FY 1997. Advanced turbine engine maintenance and repair criteria will be developed by FY 1997.

Engine Structural Safety

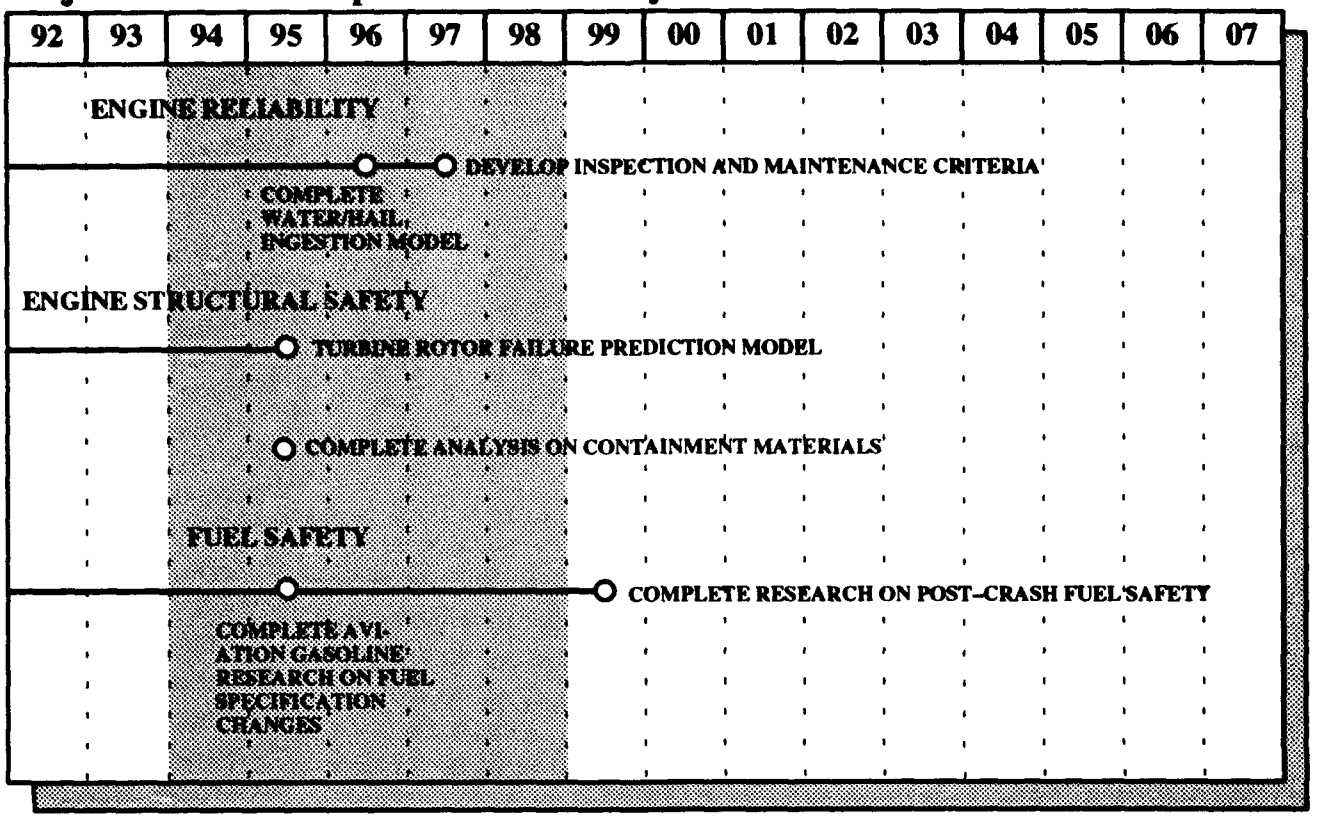
In–service turbine engine rotor failures will be continuously analyzed and engine failure reports published annually. On–going work on developing and evaluating lightweight containment materials will be completed in FY 1995. The materials under consideration include composite weaves, ceramics, and advanced metallics. Work on developing advanced engine failure diagnostic technology using artificial intelligence and in–situ engine inspection techniques will be completed in FY 1996. Analysis in progress will produce an analytical model of rotor failure fragmentation patterns in FY 1995.

Fuel Safety

Promising approaches to improve post–crash fuel safety will be expanded in FY 1994–1999 to include developing techniques which will prevent the ignition and free flowing of significant quantities of fuel after a crash. In FY 1994, the factors that affect aviation fuel availability will be continuously monitored and the unleaded aviation gasoline test program will be completed in FY 1995. New research to maintain acceptable propulsion safety and reliability levels as fuel

specifications change will be initiated in FY 1995.

Project 063–110: Propulsion and Fuel Systems



064–110 Flight Safety/Atmospheric Hazards

Purpose: This project will address new technology, design, and operational issues to provide technical data, guidelines, advisory material, and procedures for the regulatory and certification process. This research also has the potential to identify possible safety problem areas before accidents occur.

Approach: This project comprises four areas: aircraft icing, electromagnetic environment, digital systems validation, and flying qualities and operations.

Aircraft Icing

The worldwide aircraft atmospheric icing environment will be characterized to include supercooled clouds, snow, ice crystals, freezing precipitation, and mixed conditions from ground level through all flight levels. Efforts will be undertaken to develop standard meteorological and aeronautical terminology relating to icing severity. In cooperation with the National Aeronautics and Space Administration (NASA and the Department of Defense (DOD), simulation

methodologies and facilities, analytical techniques, and instrumentation calibration standards will be developed for designing and testing ice protection systems. Technologies associated with ground anti/deicing fluids will also be investigated to determine optimal application procedures, hold–over timetables, and associated aerodynamic effects. Additionally, surface ice detector(s) assessments and evaluations will be conducted.

Electromagnetic Environment

An electromagnetic environment data base will be developed to address atmospheric electrical hazards. Research will continue to determine the adverse effects from lightning and high intensity radiated fields (HIRF) on all advanced technology airframes and systems. Through cooperative efforts with industry and other governmental agencies, efforts will continue with full–scale testing, modeling, simulation, and flight control system susceptibility. The results from these efforts will determine damage/upset levels.

Digital Systems Validation

The digital systems validation area will compare traditional airworthiness/certification techniques with fly–by–wire/fly–by–light (FBW/FBL) concepts. Research will proceed in fault tolerant architecture and electromagnetic effects assessment associated with FBW/FBL and the new power–by–wire (PBW) concepts. This work will be accomplished in coordination with NASA.

Flying Qualities and Operations

The flying qualities area will address certification issues related to improved flight safety assessments for new aircraft that utilize advanced displays, flight management systems, procedures, and modified operational profiles.

Related Projects: 022–140 Vertical Flight Program and 066–110 Aircraft Catastrophic Failure Prevention Research.

Products:

- Pilot's Guide to Aircraft Ground Deicing Advisory Circular (AC)
- Report on field measurements for advanced anti/deicing fluid time of effectiveness
- Report on validating analytical technologies, computer codes, and simulation methodologies
- Lightning AC and user's manual updates
- HIRF AC and user's manual updates
- Digital systems validation handbook update
- Report on flight critical digital systems technology studies for airworthiness certification
- Software development guidelines report and data package
- Provide data to support operational procedures development for advanced rotorcraft/tiltrotor instrument flight rules (IFR) approaches to heliports

FY 1992–1993 Accomplishments:

- Completed the atmospheric data base and recommended design criteria.
- Completed aerodynamic effects of anti–icing fluids on small airplanes.
- Published HIRF Advisory Circular and Users Manual.

- Updated the Digital Systems Validation handbook.

- Provided data package for advanced transport FBW control systems to certification specialists.

- Conducted international symposium on lightning and static electricity for representatives from 12 countries.

Planned Activities:

Aircraft Icing

In FY 1994, efforts will be initiated to develop a prototype device for determining aircraft anti/deicing fluid hold–over time and pilot advisory materials on advanced fluids. Also, efforts will be completed on validating anti/deicing fluid time of effectiveness for various freezing precipitation conditions. Surface ice detector(s) assessment and evaluation will also continue. The prototype device to determine aircraft anti/deicing fluid hold–over time will be completed in FY 1998. Initiatives starting in FY 1994 will include investigations on aircraft ice protection and certification procedures that accommodate technological advances in aircraft components, materials, and propulsion systems.

Electromagnetic Environment

During FY 1994, the electromagnetic modeling effort for HIRF will provide its first demonstration and validation. The HIRF handbook development will continue on schedule, to be completed in FY 1995. Also in FY 1994, developing new standards for aircraft lightning strike zoning will be initiated, and the standard will be incorporated into the advisory material in FY 1995. In FY 1995, the users' manual for protecting electrical/electronic equipment against the indirect effects of lightning will be published. Additional HIRF workshops will be conducted. The 4th International HIRF Conference is planned for FY 1994 – FY 1995.

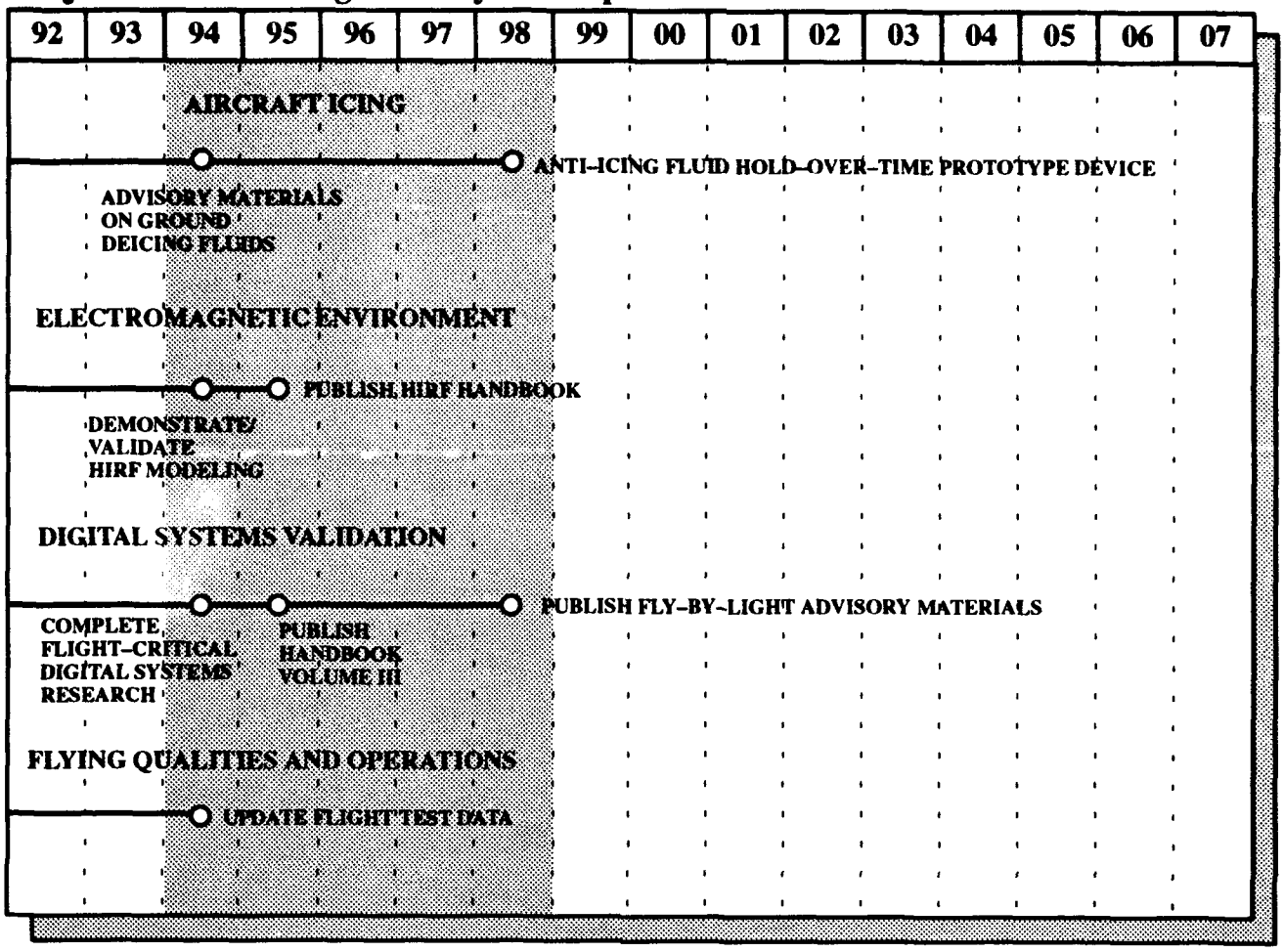
Digital Systems Validation

In FY 1994, the FAA/NASA flight–critical digital systems research, relative to electro–optical technology for Fly–by–Light/Power–by–Wire aircraft architectures will be completed. Research will proceed in assessing fault tolerant architecture and electromagnetic effects. In FY 1995, the Digital Systems Validation Handbook — Volume III will be published. In FY 1998, advisory materials will be published on fly–by–light flight control systems.

Flying Qualities and Operations

In FY 1994, technical emphasis will concentrate on obtaining updated flight test data and analysis of fly–by–wire, computer–based, automated flight control systems and equipment that improve certification/safety assessment techniques. Both type certification and operational certification issues will be addressed for failed–mode flight conditions as well as normal operations. During FY 1994 and FY 1995, work will continue to provide solutions and alternatives for improved access and more efficient utilization of center-city heliports by rotorcraft.

Project 064–110: Flight Safety/Atmospheric Hazards



064–120 International Aircraft Operator Information System

Purpose: This project will deliver an automated information system for airworthiness safety information distribution that provides current aircraft operator information on all United States type certificated aircraft. The system can be accessed by FAA offices for specific inquiries regarding aircraft accidents, locations, or other inquiries. This system will provide improved airworthiness directive and supply information distribution pertaining to aircraft ownership.

Approach: The FAA has a continuing need to distribute timely airworthiness safety information to the operators and owners of aircraft with a United States type certificate. Timely notification of maintenance issues and required modifications are basic tenets of the FAA's eminence as a world leader in aviation safety. The FAA's Flight Standards Service Regulatory Support Division carries out this responsibility by using the United States Civil Aircraft Registry and several air carrier listings. These lists are not all inclusive and require laborious, time–consuming manual cross-checking that is inherently inefficient. A major complicating factor is the fact that the United States Civil Aircraft Registry records

only the legal aircraft owner, not the operator. The current operator, therefore, may not receive important airworthiness safety information. The methods presently employed by the FAA are not adequate to ensure proper airworthiness information notification.

The information system is used extensively by the FAA's Associate Administrator for Regulation and Certification; Assistant Administrator for Policy, Planning, and International Aviation; the Office of Accident Investigation; and the emergency operations staff in the Office of the Deputy Administrator.

The FAA initiated a two–phase program to develop a Master Requirements and Implementation Plan for creating an International Aircraft Operator data base. Phase I consisted of locating and evaluating aircraft operator data sources, determining FAA requirements, and defining the need to track, identify, and retrieve civil aircraft information on a domestic and international basis. Phase II consists of a 23–month program to develop and implement the system.An extension of Phase II is currently planned. This will extend the program through FY 1993. In FY 1994, the program will be operationally funded by the Office of the Associate Administrator for Regulation and Certification.

Related Projects: 065–110 Aging Aircraft.

Products:

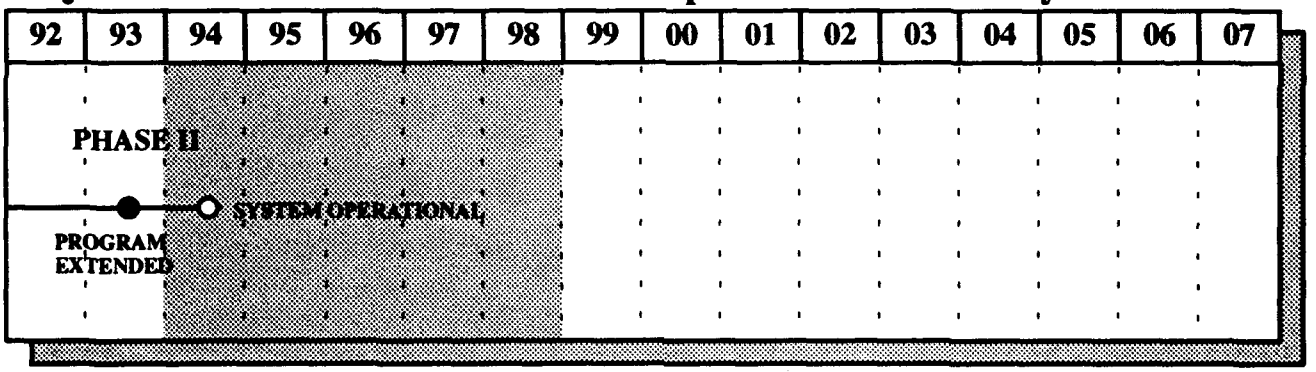
- Program plan
- *Master requirements and implementation* plan
- Evaluation of existing aircraft operator data bases
- Prototype international aircraft operator information systems
- Final report on system operability

FY 1992–1993 Accomplishments:

- Developed prototype international aircraft operator information system.

Planned Activities: In FY 1994, this system will transition to an operational status and this project will be completed.

Project 064–120: International Aircraft Operator Information System



065–110 Aging Aircraft

Purpose: Aging airframe structures have shown increasing susceptibility to widespread fatigue damage and corrosion, that could pose a threat to their structural integrity. Instances of structural failures point to the need for increased reliability in inspection methods. Furthermore, the demands on the aviation safety inspectors due to the aging aircraft fleet require automated data tracking improvements. This research effort will develop the means for evaluating and ensuring safety and reducing the risks associated with aging aircraft structures. The three thrust areas of this project are: structural design, maintenance and inspection, and automated methods for surveillance of information relating to the aging aircraft fleet.

The various research activities will also include technology transfer of technical material and "know–how" to industry and foreign regulatory agencies.

Approach:

Structural Integrity

To address aging aircraft structural design problems, improved methodologies and test data are needed. Models and data will be developed to correlate service experiences with test and analysis results. Design alternatives that delay or eliminate widespread fatigue damage will be identified.

The corrosion effects on fatigue and fracture will be quantified and evaluated. The results from this work will be used as a basis for rulemaking.

Means for evaluating the effect of repairs on airframe structural integrity will be developed. This work will benefit independent repair stations and smaller air carriers. Modern flight and ground load data collection systems will be developed to measure the current fleet operations' structures loading histories.

Maintenance and Inspection

Improvements in maintenance practices and training, as related to repair and corrosion control, will be developed and offered to heighten awareness of structural degradation modes among the aviation community, particularly the FAA inspectors. A job task analysis will be conducted to identify critical maintenance inspector tasks.

Existing and emerging NDI equipment and methods will be evaluated in relation to their capability to detect structural defects. Prospective technologies are being developed that offer improvements in relation to reliability, ruggedness, automation, human performance, and cost. The most promising technologies will be prototyped for testing, leading to cooperative research and development agreements (CRDAs) with industry for technology transfer. Additionally, standards will be developed for inspection equipment and personnel.

Information Systems

In this thrust area, safety analysis and data management systems will be developed. These systems will be designed to audit critical performance indicators, identify safety risks, and maintain information for air crew qualification. These systems will have the capability to interrogate data relating to air operators, aircraft, air agencies, and airmen.

Related Projects: 062–110 Aircraft Crashworthiness/Structural Airworthiness, 063–110 Propulsion and Fuel Systems, 064–110 Flight Safety/Atmospheric Hazards, 066–110 Aircraft Catastrophic Failure Prevention Research, and 085–110 Aircraft Maintenance Human Factors.

Products:

- Testing to assess structural fatigue, corrosion effects, and establish proper inspection procedures
- Damage tolerance training material for FAA engineering certification personnel
- Airframe repair design and analysis software
- Corrosion prevention/control design and maintenance handbook
- Analytical models that can be used to minimize airframe structural component susceptibility to multi–site damage
- Reporting system to monitor the aging fleet and provide basis for structural life management
- Automation of NDI procedures through robotics
- Data base for flight and ground loads encountered by transport and commuter airplanes that can be used for design and certification
- NDI procedures and equipment design, commensurate with inspection work environment
- Automatic training systems for repair/maintenance personnel

FY 1992–1993 Accomplishments:

- Formalized recurrent corrosion protection training course for FAA inspectors.
- Developed Damage Tolerance Handbook for engineer and maintenance personnel.
- Established limits and requirements for aircraft structure visual inspections.
- Developed flight and ground load data collection system.
- Developed updated training and course materials for FAA and industry NDI personnel.
- Completed evaluations of current NDI techniques and equipment for airframe and engine inspection.
- Established an NDI validation and demonstration center at Albuquerque International Airport.

Planned Activities:

Structural Integrity

In FY 1995, model development will be completed and tests conducted to predict airframe structural component susceptibility to multiple–site damage. Factors affecting fatigue quality and fracture resistance of airframe designs will be studied to develop design guidelines. Also, a computer–based methodology will be developed for structural repair design and evaluation. The structural performance of bonded composite repairs as candidate strategies will be evaluated for conformance to existing FAA regulations. Analytical/predictive methodologies will be developed to estimate the residual life of repair and non–repair stationary turbojet engine components.

In FY 1996, corrosion fatigue interaction investigations will be completed to determine if existing regulations need to be modified.

In FY 1994, flight and ground load data collection will continue for inflight data collection/analysis programs. The data base and collection/analysis programs will be completed for several specific aircraft models in FY 1997.

Maintenance and Inspection

In FY 1994, annual evaluations of emerging NDI techniques and equipment for airframe and engine inspection will continue. The most promising technologies will be taken to full-scale development. This includes infrared, magneto optics, and ultrasonic wave technologies.

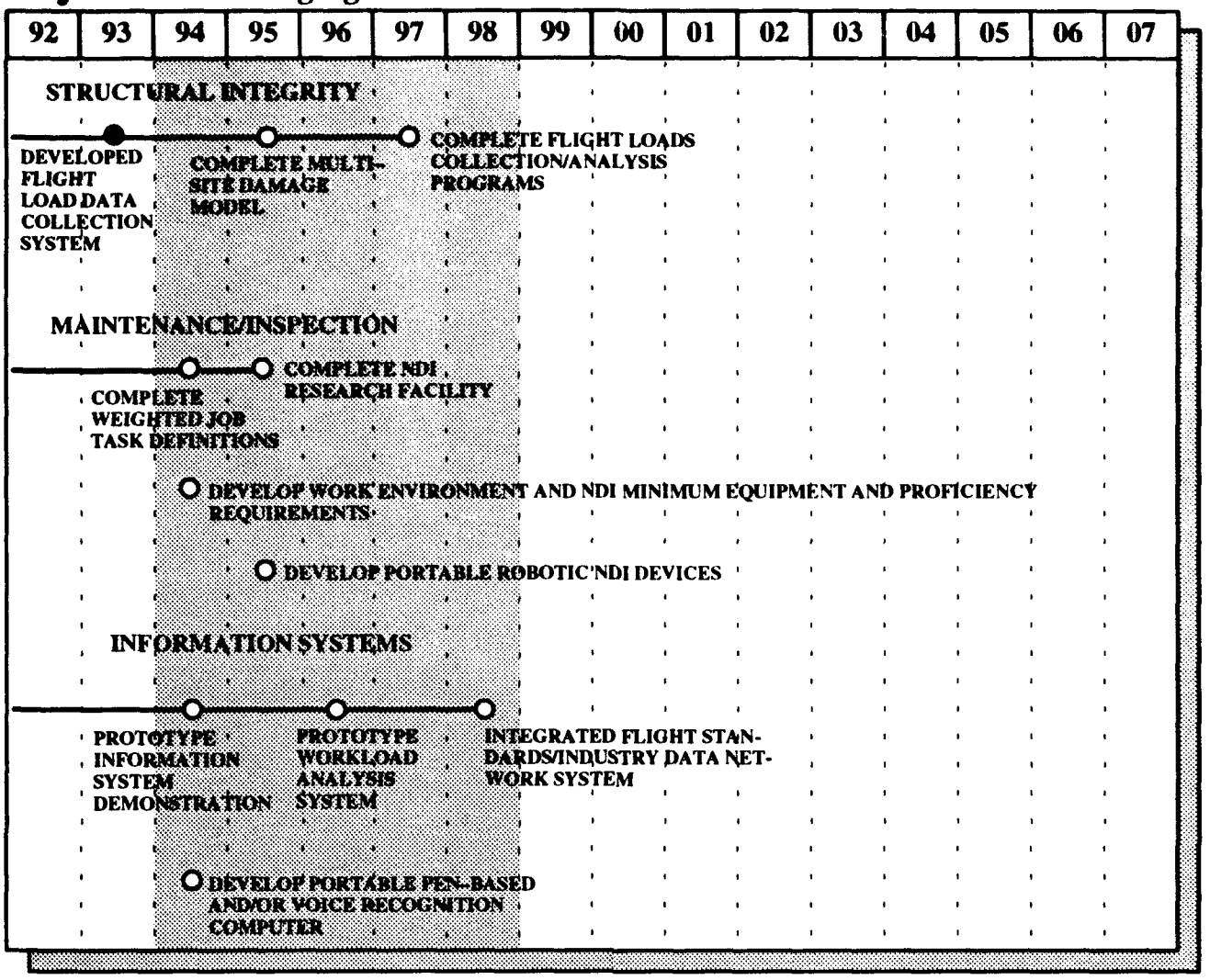
In FY 1994, weighted job task definitions will be developed for the aircraft maintenance technician. This work will support regulations that mandate oversight by FAA inspectors. Also in FY 1994, inspection work environments and NDI equipment designs will be examined, followed by development of minimum equipment and proficiency requirements. This work will ensure adequate aircraft inspections and certified repair station performance.

In FY 1995, a facility will be established and equipped which can be used for independent, quantitative, and systematic assessment of reliability and implementation costs associated with NDI equipment/procedures suitable for aircraft structures. Also, portable robotic devices will be developed to automatically position NDI probes to scan large areas of aircraft structures.

Information Systems

In FY 1994, conceptual designs will be developed and a prototype of a candidate information system will be demonstrated. These system designs will integrate flight standards-related data. Also, a portable computer utilizing pen-based and/or voice recognition technology will be developed for FAA field inspectors. In FY 1995, a data base will be developed for integrated flight standards management. FAA inspectors will be able to access the data base using portable field computers. This data will be used by aviation inspectors for safety audits. In FY 1996, a prototype system will be developed to manage the flight standards service's technical analysis work load. In FY 1998, an integrated flight standards and industry data network system will be implemented.

Project 065–110: Aging Aircraft



066–110 Aircraft Catastrophic Failure Prevention Research

Purpose: This project will establish and direct a research effort with the objective to identify, reduce, and prevent aircraft system problems that could result in a catastrophic aircraft failure. This failure prevention research will reduce catastrophic accident risks and the number of hull losses, injuries, and fatalities. Information developed from this project will be disseminated to the aircraft industry on a regular basis. This research is required by Title IX of the Omnibus Budget Reconciliation Act of 1990 (Public Law 101–508), "Aircraft Catastrophic Failure Prevention Research Program."

Approach: This project will conduct research to develop methodologies that characterize and assess the risks associated with potentially catastrophic aircraft hardware/software problems. Technologies will then be identified to prevent or minimize these hazards. Centers of

excellence will be established at universities and/or nonprofit national research laboratories as research focal points. The research will concentrate on three individual technical areas: turbine engine/auxiliary power unit failure hazards prevention, fuselage structural failure prevention, and damaged/failed flight control system airworthiness.

Turbine Engine Failures

A failure in turbine engine and auxiliary power unit (APU) rotating components can be a serious safety hazard to critical aircraft systems because high energy fragments can be released. The traditional approach to minimize these hazards is to isolate individual engines and APUs from other engines and flight critical systems. More effective containment or protective shields are an under utilized approach due to weight and complexity penalties. This project will develop a high energy fragment containment and/or protective shield material technology. A comprehensive advanced lightweight material technology state–of–the–art review will be conducted and new material concepts will be developed for absorbing high kinetic energy fragments in the largest turbofan engines. Further efforts will provide a methodology to determine catastrophic failure probability and risk assessment. This methodology will be used to develop an analytical model of liberated fragments from gas turbine engine and APU rotating components. This model will assist in assessing the catastrophic failure risk in current and future designs.

To reduce the occurrence of rotating component failures, advanced computational technology will be used to develop expert/neural network/artificial intelligence systems. These systems will monitor, acquire, and interpret parameters to predict, forecast, and/or trend rotor system abnormalities or impending failures. Sensor technology will be developed to measure critical parameters. This capability will be integrated into a total aircraft parameter monitoring system. In addition, research will be applied to advanced critical engine material manufacturing and inspection technologies. A turbine engine titanium consortium has been established to evaluate and improve current state–of–the–art inspection technologies. This consortium is comprised of the FAA, academia, and industry to provide a thorough background in NDI technology.

Structural Failures

Research will be directed toward advanced means to predict and prevent catastrophic structural failures on future commercial transport aircraft. Emphasis will be placed on: forming accurate, quantitative definitions of dangerous aircraft loading conditions; structural failure prevention through improved airframe design and maintenance; and structural failure survivability through an improved understanding of failed airframe loading conditions.

A joint effort with the aircraft hardening project will be undertaken to develop a vulnerability assessment for wide and narrow–body transport aircraft. Advanced analytical and computational design tools and concepts will be developed and applied to future airframe system designs. Automated maintenance/inspection monitoring devices and artificial intelligence training systems will be developed, tested, and implemented. Interagency agreements will be established for determining composite component structural quality and composite/advanced component inspection and repair procedures.

Flight Control Failures

This project will address specialized technology fields that concentrate on preventing catastrophic flight control failure after an in–flight accident/incident. Research will assess what failed–mode flight control options are practical for any control failure case to ensure continued safe flight and landing . This project will concentrate on studies that include areas such as: substitute, alternate and reconfigurable control systems; flying qualities criteria; stability and control; situational awareness; and human factors. A program of

modeling analysis simulation and variable stability aircraft flight tests is planned to provide technology that could be beneficial in failed–mode flight control situations. The proposed approach will test both aerodynamic aspects and aircraft stability/control. This approach will: develop technology to improve aircrew emergency procedures; provide aircrew training that simulates damaged aircraft handling qualities; conduct research on damaged flight control airworthiness issues; and provide a real–time flight control cockpit advisory system.

Related Projects: 062–110 Aircraft Crashworthiness/Structural Airworthiness, 063–110 Propulsion and Fuel Systems, 064–110 Flight Safety/Atmospheric Hazards, 065–110 Aging Aircraft, and 075–110 Aircraft Hardening.

Products:

- Full–scale prototype turbine engine diagnostic system(s)
- Advanced containment material(s) suitable for airframe and/or engine applications
- Advanced airframe and engine structures maintenance/inspection/monitoring/advisory systems
- New NDI inspection technologies for advanced engine and structural materials
- Aircrew emergency procedures and new systems for damaged or failed flight control systems
- Failure modes risk assessment analysis methodology tools
- Computational models of airframe loads during impact or depressurization scenarios
- Quantification and analysis of gust loading conditions on transport aircraft

FY 1992–1993 Accomplishments:

- Completed program plan.
- Established academic/industry consortium for improved engine rotor inspection techniques.

Planned Activities: Failure characterization and risk assessment methodologies will be completed in FY 1995.

Turbine Engine Failures

Feasibility and design concepts will be initiated in FY 1994 and completed in FY 1995. A prototype diagnostic system and advanced containment material concepts will be developed and demonstrated in FY 1995 and FY 1996, respectively.

Structural Failures

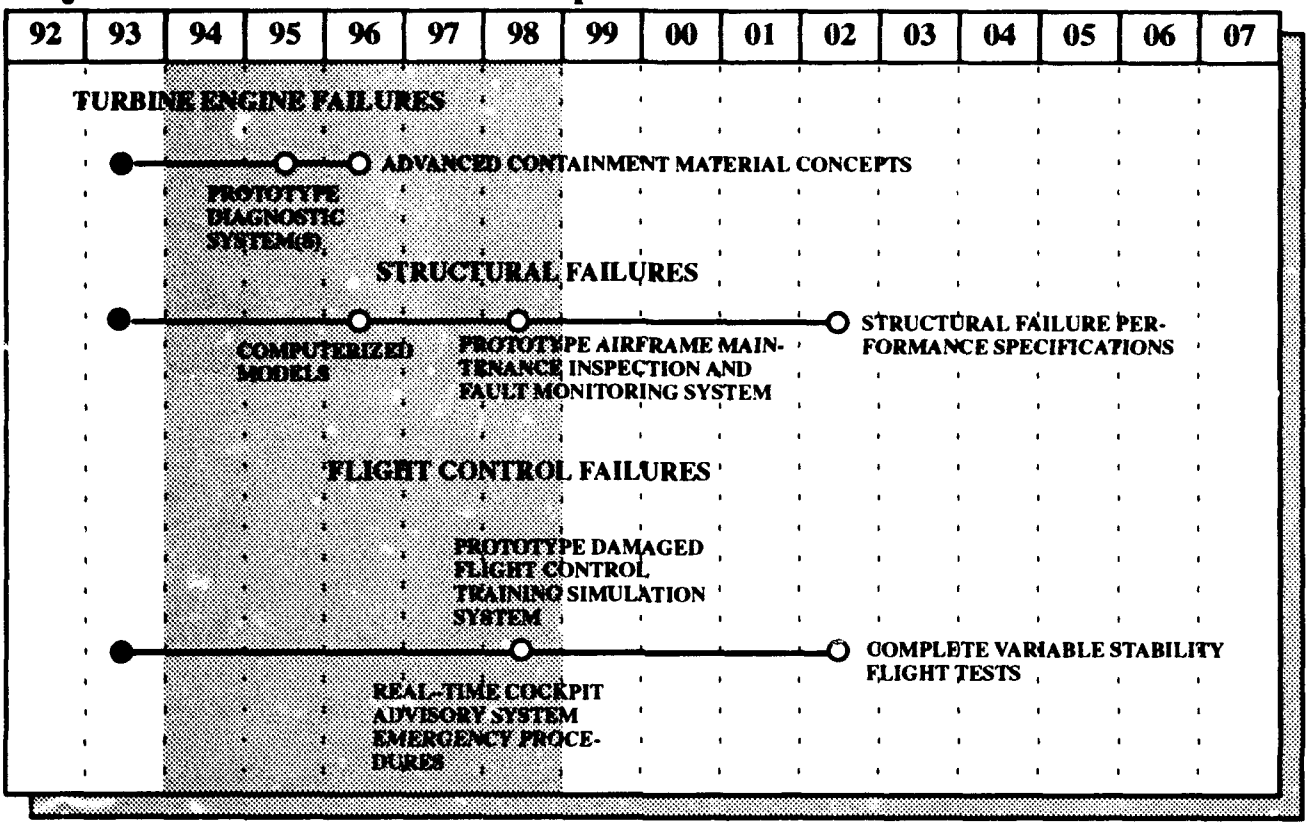
The risk analyses studies will result in computerized models by FY 1996. These codes will undergo validation from FY 1996 through FY 2002. Contemporary and future airframe load testing will begin in FY 1996 and run through FY 1998. Structural failure vulnerability reduction through design improvements and new repair and inspection specifications will be ongoing through FY 2002. A prototype airframe maintenance inspection and fault monitoring/advisory system demonstration will be conducted in FY 1998.

Flight Control Failures

In FY 1994, continued research will assess the viability of failed–mode flight control options for emergency operational conditions. A prototype damaged flight control training simulation and aircrew emergency cockpit advisory system will be developed in FY 1998. Wind tunnel testing on a representative transport aircraft model will be conducted from FY 1995 through FY 2002. Variable stability aircraft flight tests are planned from

FY 1996 through FY 2002 to provide technology which could be beneficial in failed-mode situations.

Project 066–110: Aircraft Catastrophic Failure Prevention Research



7.0 SYSTEM SECURITY TECHNOLOGY

This thrust area is driven by the requirement for a safe and secure aviation system. The direct benefit from an effective security system is preventing fatalities, injuries, and property losses resulting from intentional criminal acts. The indirect benefits include preventing a variety of disruptions to air traffic services and their attendant economic impact. Developing new security technologies is necessary to achieve a high security level without incurring excessive costs or inconvenience to the air transport industry or passengers.

Civil aviation continues to be an attractive target for terrorists or individuals with other criminal motives because it is highly visible. The threat level has escalated from hijacking in the mid–1970's to terrorist activities aimed at disrupting or destroying specific air transportation elements. The tragedy that befell the 270 victims of Pan Am Flight 103 over Lockerbie, Scotland, is one such act. In the United States, the immediate impact from this event was to double airline security costs from $500 million to almost $1 billion per year.

Even a threat on a specific target is sufficient to cause significant disruptions and economic impact. For example, events in the Persian Gulf during the first 3 months of 1991 reduced consumer confidence in the air transport system's security. As a result, scheduled air miles for domestic flights decreased by 5.2 percent, with international flight miles on U.S. carriers decreasing by 16.2 percent. Continued public confidence in the aviation system's security from terrorist threats, in general, and U.S. airports and carriers in particular, is key to the public using these services and the resulting economic benefits.

The Federal Aviation Administration initiatives in system security are designed to provide this confidence and achieve these benefits by developing systems that prevent or deter hijacking and sabotage. An initial thrust area assessment indicates that benefits as high as $40 million per year can be achieved from reduced airport security service costs while providing increased protection. The benefit from avoiding the direct costs of just one major incident would be approximately $18 – $150 million for a wide–body aircraft plus $450 million for the approximately 300 lives lost.

Research in security technology is needed to counter threats that are becoming more sophisticated. The spread of international terrorism makes it imperative for the FAA to identify and develop the most effective technologies that can be practically applied in security systems. Those who pose a threat to the traveling public are intelligent, committed, and innovative, striking where the system is most vulnerable. Protection must therefore be comprehensive, addressing all potential vulnerability in the airport and air traffic control facilities, as well as on board the aircraft.

The Aviation Security Improvement Act of 1990 directs the FAA to:

- Accelerate its system security program over a 36–month period;
- Expand its system security program to address current and future threats; and
- Expand the security initiatives in the aircraft hardening and human factors areas.

The continued emphasis for research in this thrust area has been on developing automated capabilities to prevent introducing explosives onto aircraft.

A broad agency announcement and solicitations for proposals have been used to identify and fund over 30 different organizations to conduct security–related Research, Engineering and Development (R,E&D). These contracting mechanisms allow the FAA to identify and exploit innovative concepts and technologies

from both industry and academia. Currently, explosive detection and pattern recognition research is underway.

The FAA's work in aviation security also involves cooperative efforts with many other Government agencies such as the Departments of State, Defense, and Energy; U.S. Customs Service; Bureau of Mines; and intelligence and law enforcement agencies. International working agreements to exchange security R,E&D information are in place with Canada, the United Kingdom, and France.

To support operational security systems deployment, the security R,E&D Program includes tasks to devise standard test protocol and performance criteria for testing automated explosives detection systems and for giving advice on credible systems architecture for various detection techniques. Technology assessments will be performed on commercially developed security equipment utilizing the standard test protocol and a list of approved automated explosives detection technologies will be developed for implementation by air carriers.

The R,E&D projects are organized into six areas: Explosives Detection, Weapons Detection, Airport Security, Security Systems Integration, Aircraft Hardening, and Aviation Security Human Factors. Weapons Detection is presently directed at detecting hijack weapons and will be expanded in the future to address non–conventional weapon types. Airport Security presently includes airport security design and access control. Security Systems Integration addresses current and future threats, identifies technologies to deal with them, and stimulates research areas that require developing new technologies. Systems integration also coordinates with the Air Traffic and Airway Facilities programs in optimizing security for facilities and the operational National Airspace System. The Aircraft Hardening program attempts to identify aircraft structural failure modes when subjected to an onboard explosion and then change the design to mitigate these effects. The Human Factors project addresses operator interfaces with new detection technologies, training, screening areas, and procedures acceptable to the flying public, passenger profiling, and post–threat activities.

The results from the Security R,E&D Program are technologies, specifications, rules, and guidance to be used by airports and air carriers to perform their aviation security functions. The FAA does not, except for human factors and air traffic control (ATC) facility protection, procure the hardware that results from the Security R,E&D Program.

7.1 System Security Technology Project Descriptions

071–110 Explosives Detection

Purpose: This project will develop improved systems and operational procedures for detecting explosives on passengers and in checked and carry–on baggage, air cargo, and mail. These improved, fully automated systems will allow rapid passenger and baggage screening to occur without interrupting passenger or baggage flow. These systems will have high detection/low false–alarm probabilities, thereby increasing airport and air carrier safety.

Approach: Current systems are intrusive and labor intensive. Design goals are for systems that are fast and effective and provide a uniform, high performance level through computer assistance. The challenge is to select sensor systems appropriate to the threat and scenario, then integrate them within the constraints of an airport.

The FAA is developing two basic types of explosives detectors. One is designed to collect, analyze, and identify vapors from different explosives, and the other is designed to use electromagnetic energy or nuclear radiation to penetrate and identify bulk explosives based on their elemental or structural composition. Since they are passive devices, vapor detectors are currently the only detectors that can be used for screening passengers. In the near–term, both vapor and bulk prototype detectors will be developed to provide an immediate response to today's terrorist threat. In the long–term, the emphasis will be on identification, feasibility demonstration, and subsequent development of more efficient and effective new technologies.

Development of several prototype systems for screening checked baggage and cargo has been completed. A vapor portal to screen passengers is in development. Several new chemical detection technologies using chemiluminescence, mass spectrometry, ion mobility spectrometry, surface acoustic wave modulation, and biosensor techniques have been identified and evaluated. Several new technologies are advancing to the prototype development phase; these include nuclear resonance absorption and biosensor technologies. The search for new concepts and innovative approaches from industry and academia continues to be a major project priority.

Related Projects: 073–110 Airport Security, 074–110 Security Systems Integration, and 076–110 Aviation Security Human Factors.

Products:

- Feasibility studies
- Prototype hardware
- Project evaluation reports
- Engineering procurement specifications
- Data to support rulemaking

FY 1992–1993 Accomplishments:

- Deployed operationally dual–sensor, nuclear and X–ray technology systems at international gateway airports in the United States and overseas.
- Developed laboratory prototype vapor portals for screening passengers.
- Developed portable vapor detector feasibility model based on biotechnology to screen passengers and baggage.

- Completed computer tomography prototype testing in an airport environment.

- Completed lab demonstration of nuclear resonance absorption system.

- Completed congressionally mandated operational combined test with enhanced X–ray and vapor technologies at Miami International Airport.

- Conducted controlled operational tests of commercially available vapor and enhanced X–ray systems and provided data to support rulemaking.

- Completed construction on explosives detection laboratory.

Planned Activities:

First generation detection systems will continue to be deployed, while new detection systems development, including prototype vapor portals, will continue with operational testing scheduled from FY 1994 through FY 1998.

In FY 1994, airport testing will be conducted for an operational prototype coherent X–ray scattering system, the vapor detection systems for baggage, the residual polarization detection system, and the nuclear quadrupole resonance detection system.

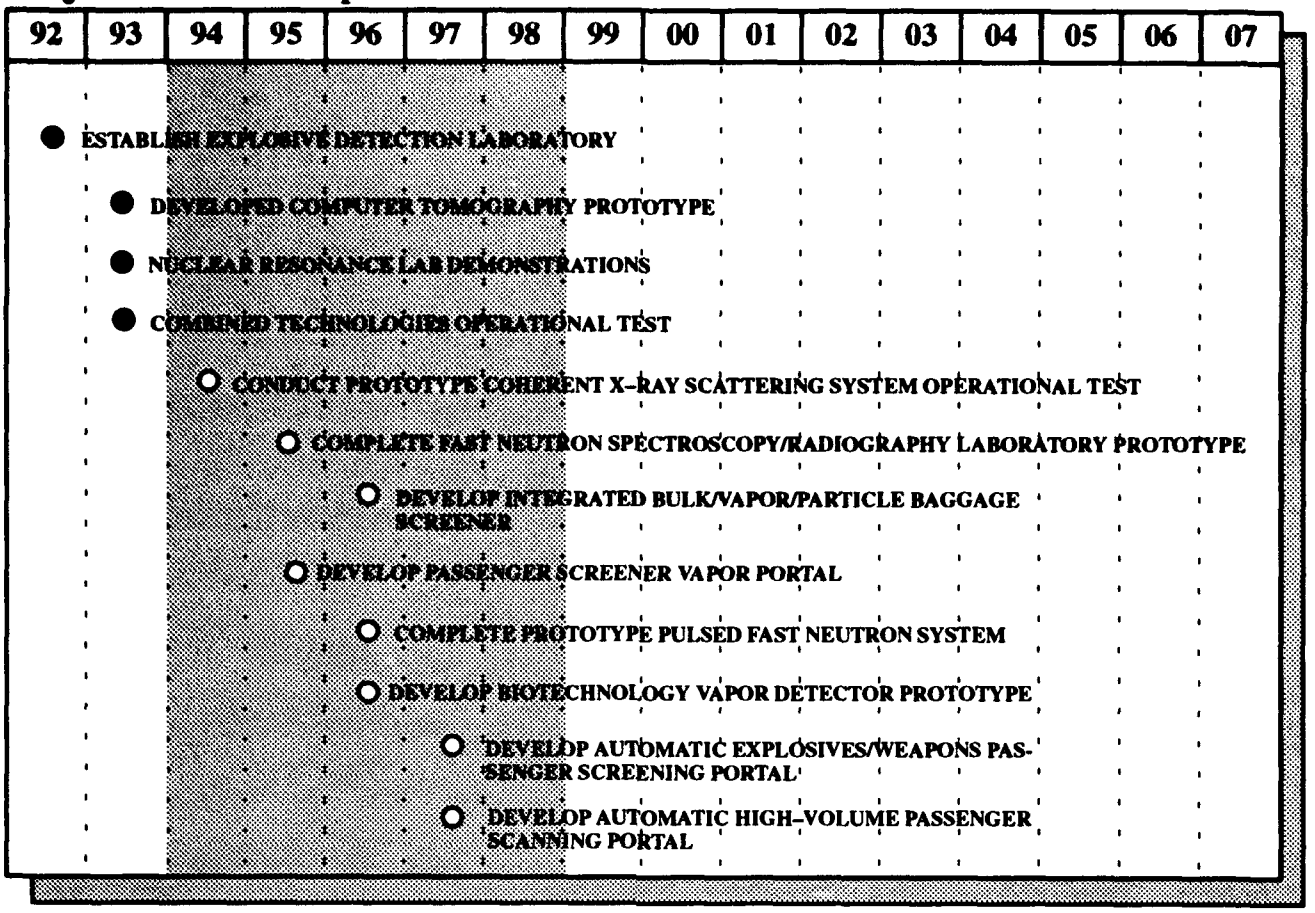
In FY 1995, a nuclear resonance absorption prototype will be completed. Evaluations on this device will begin in FY 1996, and continue into FY 1997. In FY 1995, testing will be performed on prototype systems for fast neutron spectroscopy/ radiography, alternate nuclear systems that can potentially integrate with multiple technologies, and the nuclear magnetic resonance squid system. Enhanced X–ray systems integration with vapor systems will be initiated for carry–on screening. Additional vapor portal prototypes will be completed and testing will begin at airports in the United States. Vapor detector prototypes based on surface acoustic wave, frequency modulated infrared, and ion mobility spectroscopy technologies will be completed and undergo evaluation. A cargo container/mail x–ray scanning system laboratory prototype will be initiated with estimated completion in FY 1998.

In FY 1996, prototype testing for the pulsed fast neutron system will be completed and a biotechnology vapor detector prototype will be developed for explosives detection. Also, an integrated vapor, bulk, and new prototype threat detection system for baggage inspection will be developed to replace multiple detection systems in airports.

In FY 1997, an automatic high–volume passenger scanning portal will be developed to combine explosives and weapons detection systems.

New technologies will be identified and developed based on emerging threats. These will be explored and those showing promise will be taken to the laboratory and airports for operational testing. broad agency announcements, the grants program, or similar vehicles, will continue to identify innovative approaches to this challenging problem and examine synergistic combinations of the sensor systems identified.

Project 071–110: Explosives Detection



072–110 Weapons Detection

Purpose: This project will enhance current concourse security systems used to detect potential weapons on people and in carry–on baggage. The current trend in firearm and some grenade manufacturing is toward using nonmetallic components and nonferrous alloys. These weapons may escape detection by current airport metal and weapon detection systems. This project will also develop screening systems based on alternate technologies that are capable of detecting "plastic" and other unconventional weapons.

Approach: Methods to enhance current generation screening system performance are being investigated. Commercial weapons detection devices are being evaluated for deployment in airports and new standards are being developed to ensure that these screening systems continue to be effective. Alternate methods to detect nonmetallic handguns, as well as flammable liquids and liquid explosives, are also being investigated. Passenger–screening system development based on alternate technology has been initiated.

Related Projects: 073–110 Airport Security, 074–110 Security Systems Integration, and 076–110 Aviation Security Human Factors.

Products:

- Prototype hardware
- Project evaluation reports
- Engineering procurement specifications
- Data to support rulemaking

FY 1992–1993 Accomplishments:

- Completed weapons screening feasibility model to detect nonmetallic weapons based on millimeter–wave technology.
- Evaluated enhanced commercial X–ray systems and issued guidance to air carriers on their use.
- Developed and tested dielectic bottle screening system and a linear array millimeter wave passenger screening portal.

Planned Activities: Operational testing on a liner array millimeter wave passenger screening portal will begin in FY 1994. In FY 1995, lessons learned from the linear array technology will be applied to the 2–dimensional array system development.

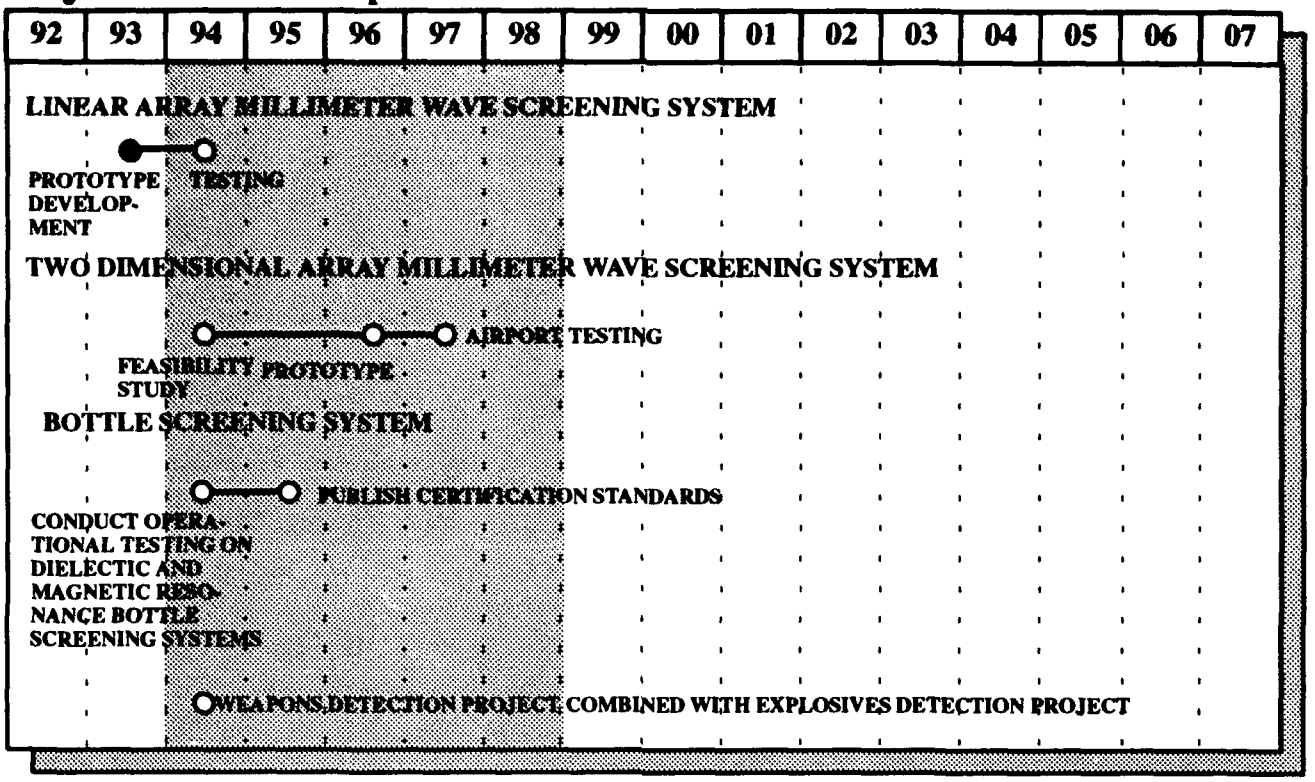
In FY 1994, operational testing will be conducted on dielectic and nuclear magnetic resonance bottle screening systems. In FY 1995, bottle screening certification standards will be published.

In FY 1996, a prototype 2–dimensional millimeter wave passenger scanner will be evaluated in the laboratory and tested at an airport in FY 1997.

In FY 1997, an automatic high–volume passenger scanning portal will be developed to combine explosives and weapons detection systems. These systems are being developed in conjunction with the explosives detection project since they will detect both weapons and explosives.

New technologies will be identified and developed based on emerging threats. These will be explored and those showing promise will be taken to the laboratory and airports for operational testing. Broad agency announcements, the grants program, or similar vehicles, will continue to identify innovative approaches to this challenging problem and examine synergistic combinations of the sensor systems identified.

Project 072–110: Weapons Detection



073–110 Airport Security

Purpose: This project will determine the operational effectiveness, impact, and cost for enhanced airport security by using a demonstration airport. Establishing a demonstration airport will provide a testbed for evaluating new security technology and procedures integration into an operational environment.

Approach: Technology and procedures system integration and operational testing will determine whether these technologies and procedures are ready to be implemented in the operational aviation system, or whether further development is needed. New or enhanced training and operational procedures will be validated. Operational test results will be fed into the Security System Integration project to provide timely updates for threat/risk assessment and requirements definition.

Protection for aviation targets has been prioritized based on current and predicted future terrorist threats to airports and operations. The prioritized targets have been correlated with existing FAA regulations and actual airport security plans. Enhanced system design and operational procedures will be developed to effectively counter higher threat levels while maintaining economic viability, responsiveness, and normal passenger flow. The security design and operational procedures will be implemented and evaluated in a testbed environment at a major airport and, if successful, deployed throughout the system as appropriate.

Related Projects: 071–110 Explosives Detection, 072–110 Weapons Detection, 074–110 Security Systems Integration, and 076–110 Aviation Security Human Factors. Capital Investment Plan projects: 56–60 Integrated Security Management Systems (ISMS).

Products:

- Airport vulnerability reports based on current and future threat definitions
- Integrated airport security conceptual design
- Upgraded airport security testbed
- Project evaluation reports
- Operational guidelines

FY 1992–1993 Accomplishments:

- Developed industry guidelines for a compatible system–wide access control environment at airports.
- Completed security design and implemented an enhanced airport security system.
- Developed an integrated airport security system design guide.
- Conducted full–scale security system and procedures demonstration to evaluate various security strategies and their impact on airport operations.
- Conducted a vulnerability assessment of FAA facilities, such as Terminal Radar Approach Controls (TRACONs) and Air Route Traffic Control Centers (ARTCCs), to support the ISMS project in the Capital Investment Plan.

Planned Activities:

In FY 1994, new operational equipment will be integrated into the Baltimore–Washington International Airport operational testbed. This testbed will be used to test new technology in an operational environment for performance characteristics and operational procedures through a cooperative research and development agreement with the Maryland Aviation Administration.

In FY 1994, the airport security program will expand to include security of FAA facilities in the National Airspace System and will be titled NAS Security. A cost/benefit analysis will be conducted on implementing positive passenger baggage matching and profiling alternatives to secure checked baggage. This work will be used to support rulemaking. An update for airport physical security design will be completed.

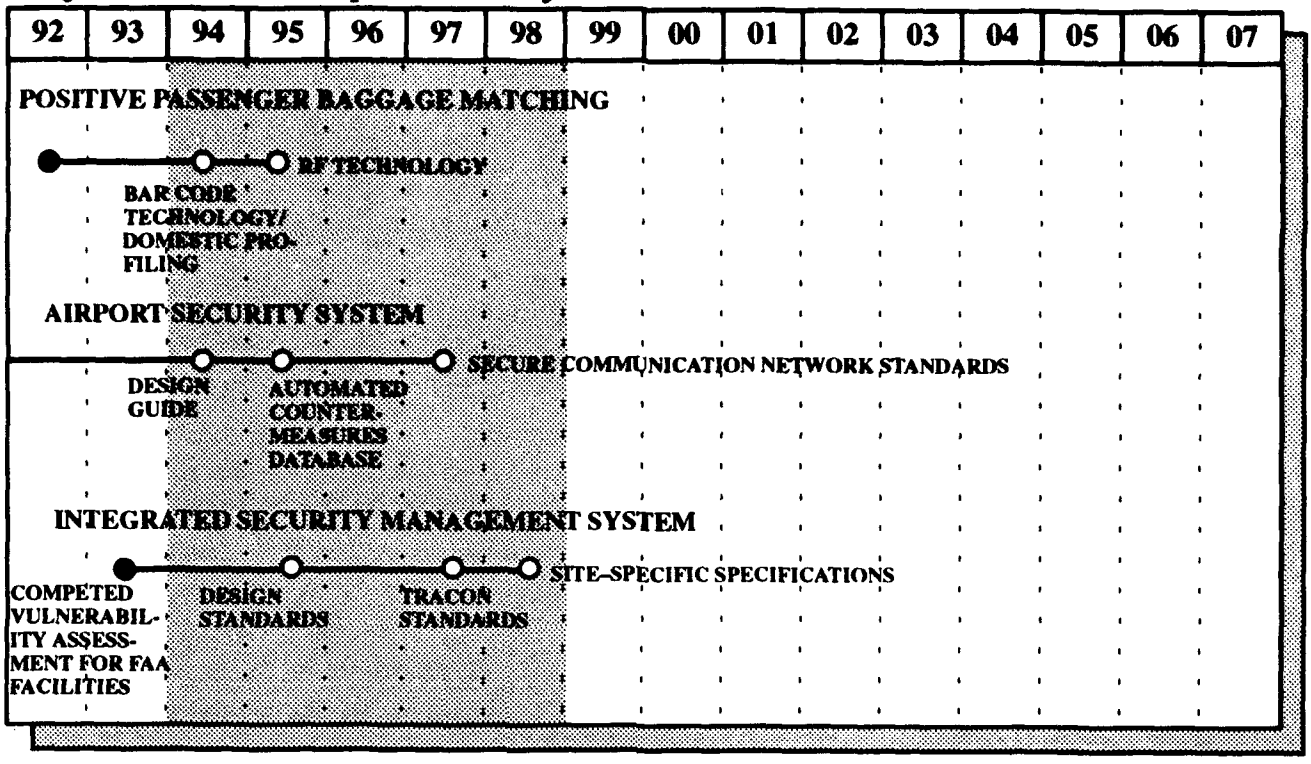
In FY 1994, an international task force planning group will be hosted to identify current and future technologies to counter airline industry threats. This group, consisting of Government representatives, will exchange information on current technologies and R,E&D initiatives that support joint development efforts.

In FY 1995, an automated countermeasures data base will be developed to assist in the threat/risk analysis for airports worldwide. Radio frequency technology will be developed to replace bar–codes for baggage and passenger tracking.

In FY 1995, design standards will be developed for a prototype ISMS to protect ARTCCs. Standards for TRACONs will be developed in FY 1997 with site–specific specifications being developed during FY 1996–FY 1998.

In FY 1996, a telecommunications security order will be issued followed in FY 1997 by standards for secure communications networks.

Project 073–110: Airport Security



074–110 Security Systems Integration

Purpose: This project will evaluate aviation security from a systems approach, determine if current systems integration is adequate, identify alternatives to counter evolving security threats, and identify requirements for research and development. A cost–effective and unobtrusive security system will become an integral part of normal civil aviation operations resulting from the various security research efforts that are currently underway.

Approach: This project will interpret and translate threat information into functional security system requirements using accepted analytical methods and tools. Modeling and applied research necessary to define security system parameters and constraints will be conducted. The model will contain information on current and future threats as well as technologies to counter each threat.

A long–range, strategic plan for developing and deploying aviation security system components will be developed to ensure that all components, attributes, and relationships needed to achieve a higher security level are identified and integrated into the system. The long–range plan will include physical, fiscal, and staffing forecasts for resource requirements. These will be time phased to provide inputs to the FAA and user community for facility planning, budgeting, staffing recruitment, and support contracting.

Alternative security system design approaches will be evaluated through system cost–effectiveness analyses and trade–off studies. A feedback

mechanism will be established for updating system requirements on a continuing basis as new threat or technology issues are identified through intelligence activities, research developments, and/or operational equipment and procedures testing.

Related Projects: 071–110 Explosives Detection, 072–110 Weapons Detection, 073–110 Airport Security, 075–110 Aircraft Hardening, and 076–110 Aviation Security Human Factors.

Products:

- Revised operations concepts and system requirements for an integrated enhanced aviation security system and responses to new threats
- Analytic models for threat/risk assessment
- Long–range, strategic plan for research, engineering, development, and deployment in an integrated aviation security system
- Resource requirement forecasts for developing and deploying an integrated aviation security system
- Recommendations for threat management in the Air Traffic Management System
- Mechanism for exploiting future technologies and for continuing aviation security system upgrades
- Mechanism for technology transfer

FY 1992–1993 Accomplishments:

- Developed operational guidelines for new security–related communications equipment.
- Evaluated current threat/risk models for possible FAA use.
- Developed classified aviation security threat report.

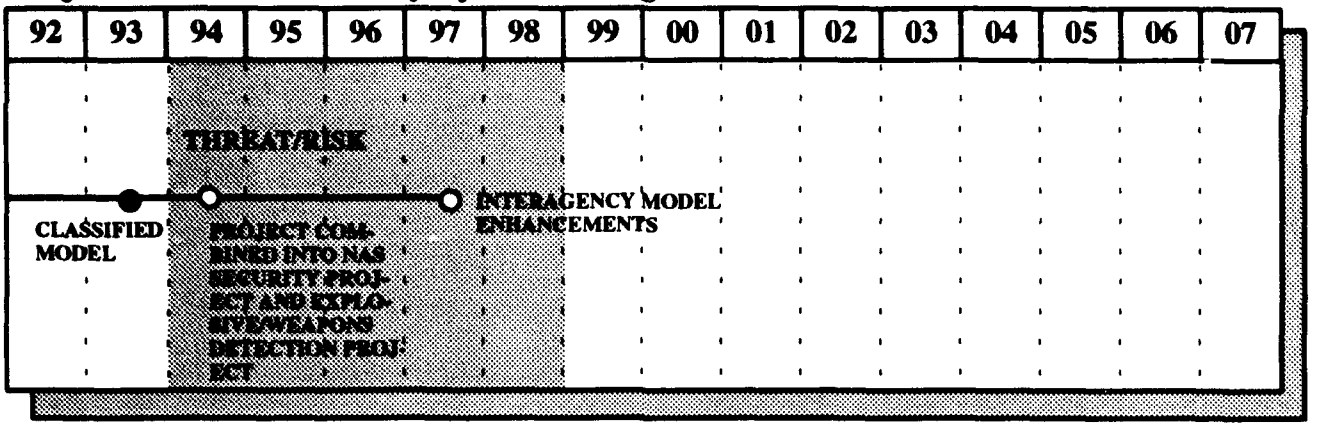
Planned Activities:

In FY 1994, threat/risk model work with other Government agencies will continue, and interfaces with other Government agency systems will be expanded. This work will continue through FY 1997. Sensor integration analytic evaluations will be performed as new technologies emerge.

As new threats emerge, an analysis process and modeling tools will be utilized to evaluate countermeasures and initiate requirements for research and development in the System Security Technology program.

In FY 1994, the Security Systems Integration Project will be incorporated into the National Airspace System (NAS) Security Project and the Explosives/Weapons Detection Project.

Project 074–110: Security Systems Integration



075–110 Aircraft Hardening

Purpose: This project will identify methods to increase aircraft survivability by reducing damage and lethality caused by small explosive detonation on a commercial airliner. The threat to commercial aircraft and passenger survival due to the in flight detonation of a small explosive device is significant. The urgent need to balance current technology detection capability and aircraft hardening to withstand damage from a detonation in flight will be accelerated as required by the Aviation Security Improvement Act of 1990.

Approach: Blast loading parameters caused by various explosive types and quantities will be determined. Models will be developed to predict damage to an aircraft resulting from explosive detonations. Explosives testing will be conducted on aircraft and/or other test devices to verify models and assess damages using various scenarios. These tests will also be used to help determine aircraft vulnerability and validate blast mitigation/structural hardening techniques. Additionally, testing will be used to evaluate least–risk guidelines. Once failure mechanisms are identified, methods to protect an aircraft against catastrophic structural failure due to an in–flight explosion will be developed.

Related Projects: 064–110 Flight Safety/Atmospheric Hazards, 065–110 Aging Aircraft, and 071–110 Explosives Detection.

Products:

- Project evaluation reports
- Prototype hardware
- Guidelines for blast mitigation/aircraft hardening
- Engineering design specifications for aircraft and support equipment

FY 1992–1993 Accomplishments:

- Sponsored first international aircraft hardening symposium attended by government/industry representatives from six countries.
- Developed and successfully tested prototype explosive resistant LD–3 baggage container.

- Conducted explosive blast loading analysis and tests.

- Enlisted aircraft manufacturers' participation in hardening efforts.

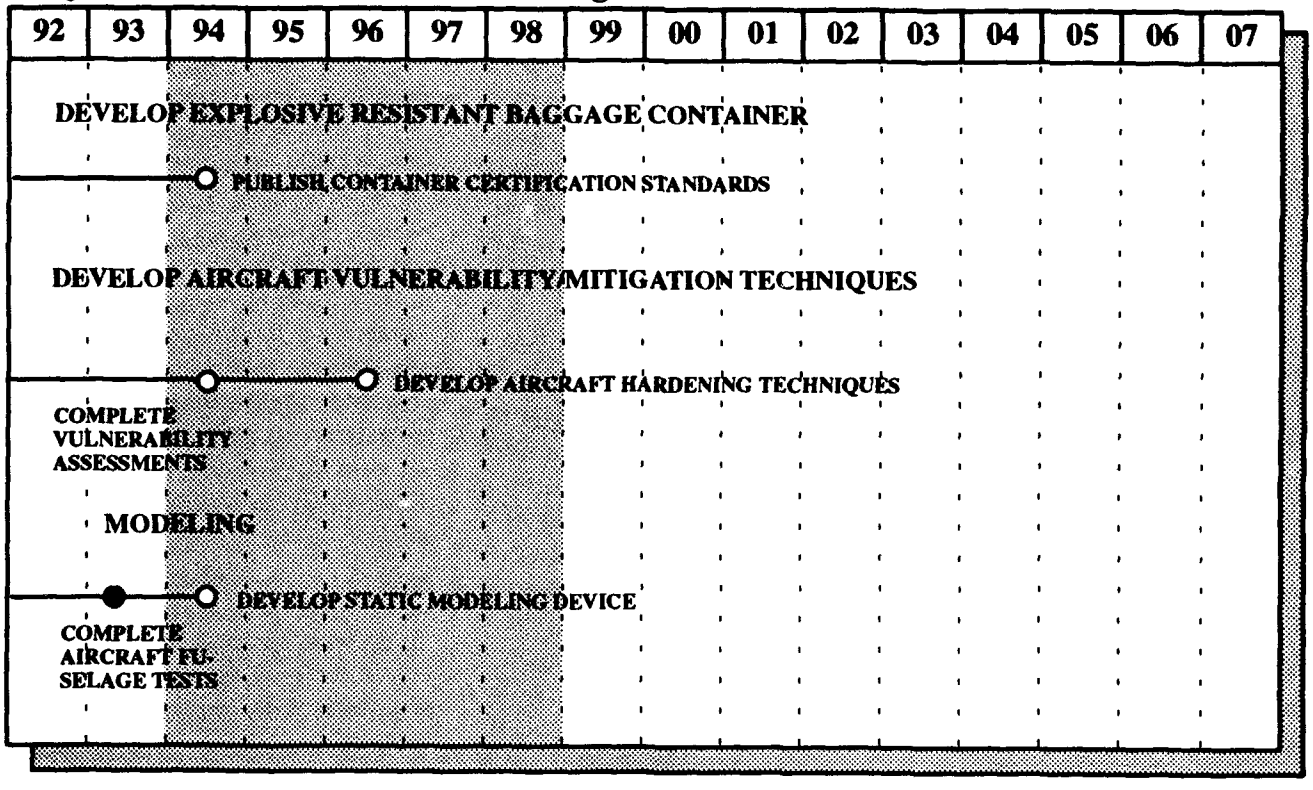
Planned Activities:

In FY 1994, container prototypes will be introduced into commercial aircraft for operational evaluation and life-cycle cost considerations will be determined. Once operational evaluations are completed, certification standards will be published.

Aircraft analytical and empirical vulnerability assessments will continue through FY 1994. A static test modeling device will be delivered in FY 1994 thus reducing the need for actual aircraft fuselage sections as test assets.

Modeling, including the dynamic interactive effects of airflow over damaged sections and the resultant aeromechanical considerations, will be completed in FY 1994. Development of new explosive resistant hardening techniques will continue through 1995 with recommendations for design specifications in FY 1996. Identification of methods and techniques to reduce vulnerability to other threats will continue through FY 1996 as well. These efforts will be coordinated with other R,E&D projects as appropriate.

Project 075–110: Aircraft Hardening



076–110 Aviation Security Human Factors

Purpose: This project carries out the mandate of the Aviation Security Improvement Act of 1990, Public Law 101–604. This law's intent is to "maximize human performance" within the aviation security system and "include research and development of both technological improvements and ways to enhance human performance."

This project will develop guidelines, specifications, and certification criteria for human performance within an aviation security system(s). Effective human–machine interface and the human input to decisionmaking will be improved through a focus on selection, training, motivation, and job design. In this way, errors made through inattention, boredom, or inadequate performance standards will be minimized as both system and operator performance is strengthened. In order to enhance aviation security human factors capabilities, the explosives detection systems (EDS) will design and deliver appropriate human factors training to the FAA work force. The EDS programs will have in–house human factors analyses and recommendations available to them. Additionally, the Engineering, Research and Development Service (ACD) and the Aviation Security Research and Development Service (ACA) will develop and implement a program of joint human factors research. This joint, in–house human factors R,E&D program gives the FAA/Federal Aviation Administration Technical Center (FAATC) a new, unique, and strong capability in human factors.

Approach: Human factors R,E&D will define, develop, and implement objectives, methods, and products to improve human performance consistent with a broad system integration perspective. Current and future technologies that significantly impact human performance in aviation security will be evaluated and improved. These human factors activities will cross technology, application, and organizational boundaries. FAA work force human factors awareness and training needs will be established and the requisite training developed and delivered. The FAATC's EDS programs will have in–house human factors personnel matrixed to their work. This effort involves collaboration with Government, airlines, security companies, equipment suppliers, and industry.

Research is being planned and coordinated in the following areas: security system passenger/baggage screener selection, training, and performance evaluation; adversary identification and counteraction by security personnel and aircrews; FAA work force training; and human factors aspects of new and emergent EDS and NAS security technologies.

Related Projects: 071–110 Explosives Detection, 072–110 Weapons Detection, 073–110 Airport Security, and 074–110 Security Systems Integration.

Products:

- Empirical data and reports for use in rules, standards, and certification and guidelines on airport X–ray screener selection, training, and performance
- Functional requirements specification document for X–ray screener training and assessment equipment
- Report on analyses of commercial off–the–shelf (COTS) X–ray screener training equipment
- Report on cost/benefit analyses on tradeoffs and interactions among human factors, equipment, and environmental variables

- FAA work force performance improved via the design and delivery of human factors training

FY 1992–1993 Accomplishments:

- Produced empirical data for baggage screener time–on–position proposed rulemaking.
- Developed functional requirements specification for screener performance evaluation and reporting system (SPEARS).
- Developed taxonomy of abilities and traits necessary for optimum baggage screener performance with test template in process.
- Published report on screener performance empirical data analyses using computer assisted instruction (CAI) training at nine major airports.
- Developed recommendations for X–ray screener CAI–based training.
- Completed memorandum of agreement (MOA) with ACD and plan for joint human factors R,E&D (1993–1999).
- Completed agreement with ACA human factors staff to provide in–house human factors expertise and guidance as needed to the EDS programs.

Planned Activities:

In FY 1994, an FAA security work force needs analysis for human factors training will be accomplished. This analysis will support developing and delivering human factors training on an as needed basis.

In FY 1994, the work on screener abilities/traits and the template for a test battery to select X–ray screeners will be used to compile suggested methods and techniques for developing security personnel selection tests.

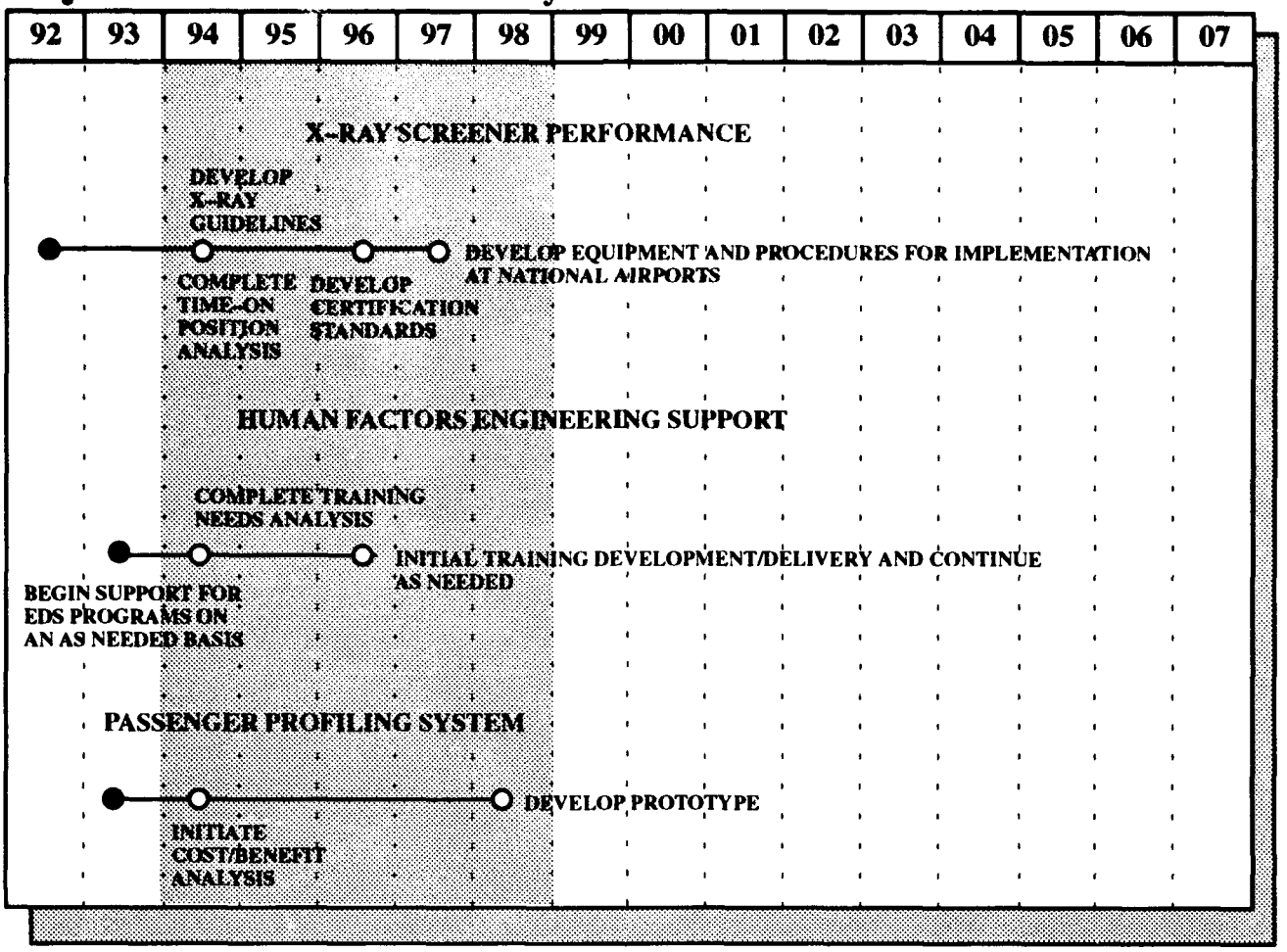
In FY 1994, a domestic passenger profiling project will be initiated to develop approaches that identify passengers requiring greater scrutiny. This project will be completed in FY 1997.

In FY 1994, different types of X–ray equipment will be evaluated on their ability to show threat objects concealed in baggage. Based on these evaluations, X–ray equipment guidelines will be issued in FY 1994. Also, a cost/benefit performance analysis of alternative profiling approaches will be completed.

In FY 1995–1996, human factors criteria will be established for screener selection standards, training, equipment design, and performance evaluation. These criteria will be followed in FY 1996 by guidelines for selecting screening personnel using computer–based performance testing. Final certification of SPEARS equipment will also be accomplished in FY 1996. In FY 1997, SPEARS analyses, simulation, and engineering efforts will be broadened to support developing SPEARS equipment and related procedures for implementation at national airports.

In FY 1998, prototype methodology and protocols will be developed to increase passenger profiling system effectiveness.

Project 076–110: Aviation Security Human Factors



8.0 HUMAN FACTORS AND AVIATION MEDICINE

Human factors–related aviation incidents and accidents have been the subject of increasing public concern. Much of the concern stems from the fact that despite the aerospace industry's success at developing ever more sophisticated and reliable technology, the human error–related incident and accident percentage has remained remarkably constant. However, recent human error analyses suggest that attention should be focused on developing error tolerant systems.

As a result, human factors research programs have received considerable attention over the past several years. In 1988, the United States Congress Office of Technology Assessment published the results from an in–depth investigation in a report titled "Safe Skies for Tomorrow: Aviation Safety in a Competitive Environment" that concluded human factors–related research was not well coordinated among Government agencies and that research funding was inadequate considering the problem's magnitude. In addition, the Air Transport Association of America (ATA) organized a Human Factors Task Force composed of industry and Government representatives, from both the research and operational communities, that offered similar conclusions and proposed developing a national plan to enhance aviation safety through human factors improvements. The ATA task force also made recommendations regarding the national research priorities.

In response to the dramatic increase in public concern, the U.S. Congress in November 1988 enacted new legislation, the Aviation Safety Research Act of 1988 (Public Law 100–591), that called for the FAA to augment its research efforts in human factors and to coordinate programs with the National Aeronautics and Space Administration's (NASA) efforts.

The National Plan for Aviation Human Factors

It is generally accepted that many productive research efforts in aviation human factors have been underway for many years at FAA, NASA, the Research and Special Programs Administration's Volpe National Transportation Systems Center, the Department of Defense (DOD), and in academia and industry. However, these efforts have not been well coordinated. It is also widely accepted that funding for human factors research, in general, has not been adequate and has suffered from a noticeable absence in long–term, high–level management support in most Government and industry organizations. Also, it is recognized that human factors efforts must be integrated with system design and development efforts much earlier in the acquisition process.

The response from the human factors community over the years has been to suggest that increased funding would result in performance enhancements in the aviation system. Unfortunately, these requests for additional support have occurred without an overall plan for human factors work, making the commitments for additional support difficult to obtain. Moreover, the products from Government–funded human factors research have not been effectively transferred to the aviation community in the past—a situation that has further hindered additional support development.

Publishing the two–volume National Plan for Aviation Human Factors represents the initial stages in an extensive effort to address these deficiencies. The National Plan proposes a 10–year program that, if properly implemented and adequately supported, will significantly alleviate many operationally significant human performance issues facing the aviation system. The National Plan for Aviation Human Factors contains the detailed scientific and technical agenda that is to be used as a roadmap for project planning,

budget requirements, and developing implementation plans.

The National Plan's purpose is to:

- Identify the technical efforts necessary to address the most operationally significant human performance issues in aviation and acquire the necessary resources to fund these efforts.
- Allocate resources efficiently by coordinating research programs at various Government laboratories.
- Communicate research needs to academic and industrial Centers of Excellence.
- Promote the means by which human factors knowledge is transferred to Government and industry.

The National Plan for Aviation Human Factors resulted from an extensive 1–year research and development planning effort. After reviewing both FAA and industry human factors issues in detail, eight areas were selected for organized research planning. These emphasis areas are to:

- Encourage developing principles of human–centered automation and designing advanced technology that will capitalize upon the relative strengths of humans and machines.
- Improve aviation system monitoring capability with an emphasis upon human performance factors.
- Encourage improving basic scientific knowledge and facilitate understanding both positive and negative factors that significantly influence human performance in aviation.
- Develop better techniques for assessing human performance in the aviation system.
- Determine the most effective air/ground information transfer methods for the National Airspace System.
- Encourage developing controls, displays, and workstations for aviation applications that facilitate the interface between humans and machines.
- Develop enhanced training and selection methods for aviation system personnel.
- Develop human factors–oriented validation and certification standards for aviation system hardware and personnel that will enhance both safety and efficiency.

The FAA and NASA have established an executive level coordinating committee chaired by the Director of Aeronautics in the NASA Office of Aeronautics, Exploration, and Technology and by the FAA Associate Administrator for System Engineering and Development. Efforts are also underway to establish similar working relationships with the DOD. The FAA/NASA Executive Coordinating Committee has executed a memorandum of understanding for collaborative research in all aviation human factors areas, and this plan provides the framework for interagency coordination.

The technical agenda was developed with assistance from 50 of the Nation's leading human factors researchers. Scientific Task Planning Groups (STPGs) were organized for five primary aviation system environments:

- Aircraft Flight Deck.
- Air Traffic Control.
- Aircraft Maintenance.
- Airway Facilities (AF).

- Flight Deck/Air Traffic Control (ATC) Integration.

The STPGs for these environments, working with requirements, project descriptions, recommendations, and priorities developed by the FAA and industry, completed a comprehensive technical agenda focused on developing operationally useful products.

This national planning document's publication represents an unprecedented effort for the human factors and aviation communities, but it is only the beginning. If adequately implemented and supported, the National Plan for Aviation Human Factors should lead to significant improvements in overall system safety, efficiency, and capacity.

FAA Involvement in the National Plan for Aviation Human Factors

The technical agenda developed in the National Plan forms the basis for future detailed implementation plans in each participating organization. These plans will involve collaboration among the sponsoring, managing, and performing organizations to specify research priorities, final technical approaches, organizational management plans, anticipated operational impacts, milestones, deliverables, and resources required.

The FAA/NASA Executive Coordinating Committee has created a technical subcommittee to oversee coordination between NASA and FAA research projects to accomplish the plan's objectives. The Research, Engineering and Development (R,E&D) projects articulated in this chapter represent the portion of the National Plan which should be supported by FAA R,E&D funding. Some programs described in the National Plan will be accomplished largely by NASA or other funding sources. Currently a large portion of the National Plan does not have committed funding from any source. The FAA must accomplish its research portion specified in the National Plan to address the critical priorities identified by the FAA's operational community and the entire aviation community.

Project Organization in this Chapter

Projects described in this chapter are organized by R,E&D environment with separate sections for Aircraft Flight Deck, Air Traffic Control, Aircraft Maintenance, Airways Facilities, and Flight Deck/ATC System Integration. These projects are cohesive collections of research tasks, and they have concrete goals, products, and schedules for completion. They address the priorities recognized by the FAA operational community and identified as National Plan priorities.

The FAA has ongoing projects addressing National Plan needs. Thus, within an environment, ongoing and planned projects are represented.

Benefits

Each thrust area (i.e., Aircraft Flight Deck, Air Traffic Control, Aircraft Maintenance, Airways Facilities, and Flight Deck/ATC System Integration) can significantly impact NAS safety, efficiency, and effectiveness. Although benefits quantification in this thrust area is in an embryonic stage, early human factors considerations during the development phase in many Research, Engineering and Development and Facilities and Equipment projects would produce benefits worth many times the project costs.

While the future system's outline is fairly clear and new technology breakthroughs are always available and welcome, a major design challenge in realizing system improvements center on the human operator's roles. For example, as new higher automation levels are introduced into the cockpit and in ground systems, the pilot's, controller's, and technician's roles will change dramatically. Human factors research is required to ensure that this transition is effected smoothly and safely. In the cockpit, as on the ground, new

technologies will introduce digital and analog signal mixes, graphics displays, procedures that will change the nature of displayed information, and the pilot's and controller's actions/responsibilities.

Testing and evaluating these new concepts, systems, and equipment will require much greater attention to human factors considerations than ever before. Simulation laboratories will need to address the pilot's interaction with the aircraft systems, the controller's interaction with the aircraft systems, the controller's interaction with the air traffic management systems, and the interaction between pilots and controllers. Training facilities and approaches must be developed to handle new, sophisticated equipment and procedures introduction and operation. This research thrust area is directed toward ensuring that this design challenge, effectively integrating the human being and the machine, is addressed so that expected benefits will accrue.

8.1 Human Factors and Aviation Medicine Project Descriptions

081–110 Flight Deck Human Factors

Purpose: This project will improve human performance and reduce the adverse effects of error in the cockpit through improved systems design, procedures, and training. An important element in this research is, when possible, applying existing knowledge of human capabilities and limitations to the flight deck environment. Where existing knowledge is inadequate, this project will develop a better understanding of human performance factors. Statistics show that approximately 65 percent of all fatal civil air transport accidents and a higher proportion of general aviation accidents list human error as a probable cause. Since flightcrew errors contribute to the majority of aircraft accidents, a continuing program directed toward improved flight deck human engineering, flightcrew performance standards, airman selection, and initial and recurrent training can pay for itself many times over by preventing a single accident. New technology developments and better flightcrew performance using existing technology will provide further benefits by increasing operational efficiency.

Approach: FAA and NASA share the responsibility for research in this project. Some of the current work is being accomplished under NASA's Aviation Safety/Automation Program, and some work is being accomplished as a collaborative effort.

Analytical, laboratory, simulation, and field studies will be conducted in the following National Plan for Aviation Human Factors areas: automation, advanced technology, controls and displays, system safety monitoring, human performance, training and selection, and certification and validation standards. Information in data bases will be used to analyze the effects of selected human factor improvement methods, training, individual and operational stressors, and implementing increased automation. Research reports, conferences, recommendations, and direct assistance to the operational organizations will be used to support operational evaluations and develop advisory circulars, technical standard orders, and Federal Aviation Regulations (FAR) changes. Participation in the Society of Automotive Engineers and other technical committees will assist with developing industry practices and standards.

Related Projects: 022–140 Vertical Flight Program, 082–110 Air Traffic Control Human Factors, 084–110 Flight Deck/ATC System Integration, and 086–110 Aeromedical Research.

Products:

- Guidelines for the human factors design, evaluation, and certification of advanced technology flight deck displays and control systems
- Research data base integrating information on pilot medical history, age, prior experience, airmanship history, and information on accidents and incidents
- Pilot and flightcrew behavioral coding techniques that can be used to assess flightcrew training program effectiveness
- Guidelines for improved training programs in crew resource management (CRM), and aeronautical decisionmaking, instrument flight skills, and other critical pilot skills
- Human factors reference materials, checklists, courses, and evaluation procedures for FAA aircraft certification personnel

- Model Advanced Qualification Program (AQP) for FAR Part 135 operators, ab initio training modules, and simulator standards for training/airman certification

FY 1992–1993 Accomplishments:

- Completed global positioning system (GPS) and Loran–C equipment and procedures human factors evaluation.
- Developed a prototype flight deck information management system.
- Published introductory CRM training handbook.
- Developed an advisory circular on controlled in–place crew rest periods.
- Completed analytical tool for predicting the effects of automation features on workload.
- Developed and evaluated a personal computer (PC)–based flight management system training device.

Planned Activities:

In FY 1994, flight deck information management guidelines will be published. Factors that influence flightcrew decisions on automation features will be identified and an analytical tool will be developed for predicting flightcrew decisions on automation use.

In FY 1994, human factors guidelines for electronic and paper chart design will be developed. Work will continue on developing a model AQP for FAR Part 135 operators with publication expected in FY 1996.

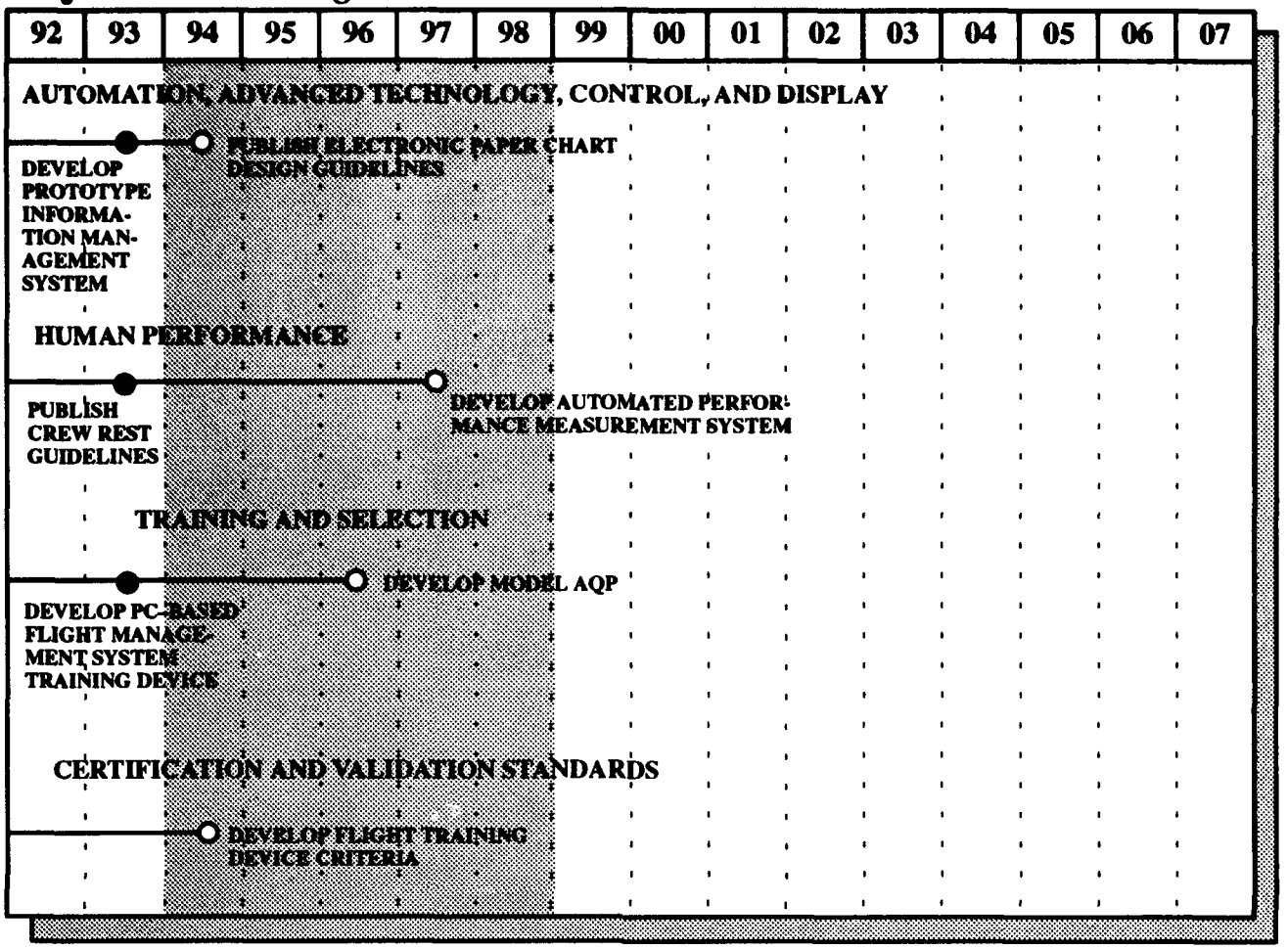
In FY 1994, three flight training device efforts will be completed: visual scene content requirements; PC–based flight training device evaluations; and an automated simulator revalidation method.

In FY 1994, development work will continue on an automated performance measurement system for evaluating training program effectiveness. A prototype system will be completed in FY 1997.

In FY 1994, a program of research to study specific general aviation pilot performance problems will be initiated using a dedicated research simulation device.

From FY 1994 to FY 1999, civil aviator selection techniques and instruments will be developed.

Project 081–110: Flight Deck Human Factors



082–110 Air Traffic Control Human Factors

Purpose: This project will determine the effects of automation and work environment on current and next generation air traffic controller's performance, develop improved controller selection and training methods, develop methods to reduce the adverse effects of controller errors, and develop methods and standards for developing and implementing National Airspace System (NAS) systems.

System safety and efficiency will be enhanced by ensuring that automation and other advanced technologies are introduced in a manner that is appropriate, effective, and properly supportive of the controller with no adverse side effects. Proper attention to human factors in system design and operations will provide a substantial return on investment by allowing the FAA to maintain a high level of safety and system capacity with a minimum work force and training expense.

This project delivers products that address air traffic human factors needs throughout all R,E&D and Capital Investment Plan (CIP) programs.

Approach: The FAA has recognized not only the importance of human factors for preventing operational errors, but also the critical relevance of human factors for effectively designing, integrating, and evaluating equipment and procedures for use in air traffic operations. This project addresses the following areas in the National Plan for Aviation Human Factors: Air Traffic Control and Human Performance; Impact of Automation on Controllers and ATC Teams; Selection, Training, and Certification of ATC Personnel; and Safety Monitoring of ATC Activities.

Analysis of surveys, test scores, supervisory rating, error reports, demographic characteristics, task analyses, laboratory and simulation studies, and operational evaluations will be conducted in the following areas: the physical and psychological effects of automation on air traffic controllers, causes and remedies for controller error, information management techniques, human perceptual capabilities and limits, workload management strategies, standards, and guidelines for applying human factors engineering, and performance measurement methods and criteria. Data bases and tracking systems will be developed to monitor and evaluate personnel selection, training, and performance. Research data bases will be developed to monitor variations in personnel performance resulting from the introduction of new equipment, illness, drug use, and other job–related stressors.

A tracking system is being developed to relate air traffic controllers' on–the–job performance to FAA selection procedures and training programs. Alternative air traffic control specialist (ATCS) selection and training programs, such as the air traffic control specialist/pretraining screen (ATCS/PTS) and the university/college–based programs, will also be evaluated.

Related Projects: 081–110 Flight Deck Human Factors, 084–110 Flight Deck/ATC Integration, and 086–110 Aeromedical Research.

Products:

- Guidelines for human factors requirements specification for designing, integrating, and evaluating ATC systems for human operators
- Analysis tools and standards for assessing/predicting controller work activity and performance
- Guidelines and models for optimally allocating operational functions and tasks to controllers and their equipment
- Real–time simulations, computational models, and reference data that support FAA specifications, acquisitions, and tests for improving air traffic control equipment and procedures
- Capability to re–create en route operational errors and incidents
- Tools and reference information for improved performance–based controller selection, training, certification, and retention

FY 1992–1993 Accomplishments:

- Demonstrated laboratory feasibility of a system that projects critical information on the air traffic control tower cab windows.
- Completed evaluation on an auditory signal system to attract controller's visual attention in the tower cab.
- Completed validation and implementation of a computer–based technique for use as a controller selection aid.
- Conducted field evaluations of two prototype stand–alone computer systems for controller radar training in Level 3 and 5 facilities.

- Conducted experiments and evaluated flight data information uses by controllers to support design standards for electronic data display.

- Published human factors handbook for controllers.

- Developed situational awareness through re–creation of incidents (SATORI) model to re–create en route operational errors and incidents.

- Developed, validated, and implemented practical color vision tests to screen air traffic control applicants.

Planned Activities:

In FY 1994, a report will be published comparing tower cab controller workload when using paper flight data strips versus electronic flight data displays. A controller performance model for advanced automation services will be developed and used to investigate workload, productivity, and failure modes. A communications error study will be published to aid in designing operational procedures.

In FY 1994, controller memory enhancement aids will be evaluated for effectiveness and training methods/memory aids will be developed. Furthermore, to improve visual radar/display scanning by controllers, training methods, and guidelines will be developed. Also, visual scanning of the displays in the initial sector suite system (ISSS) will be studied. Also, research will be conducted to determine if 3–dimensional holographic displays have advantages over 2–dimensional display systems for air traffic control use. Recommendations for aiding and enhancing controller performance in advanced automation services will be developed.

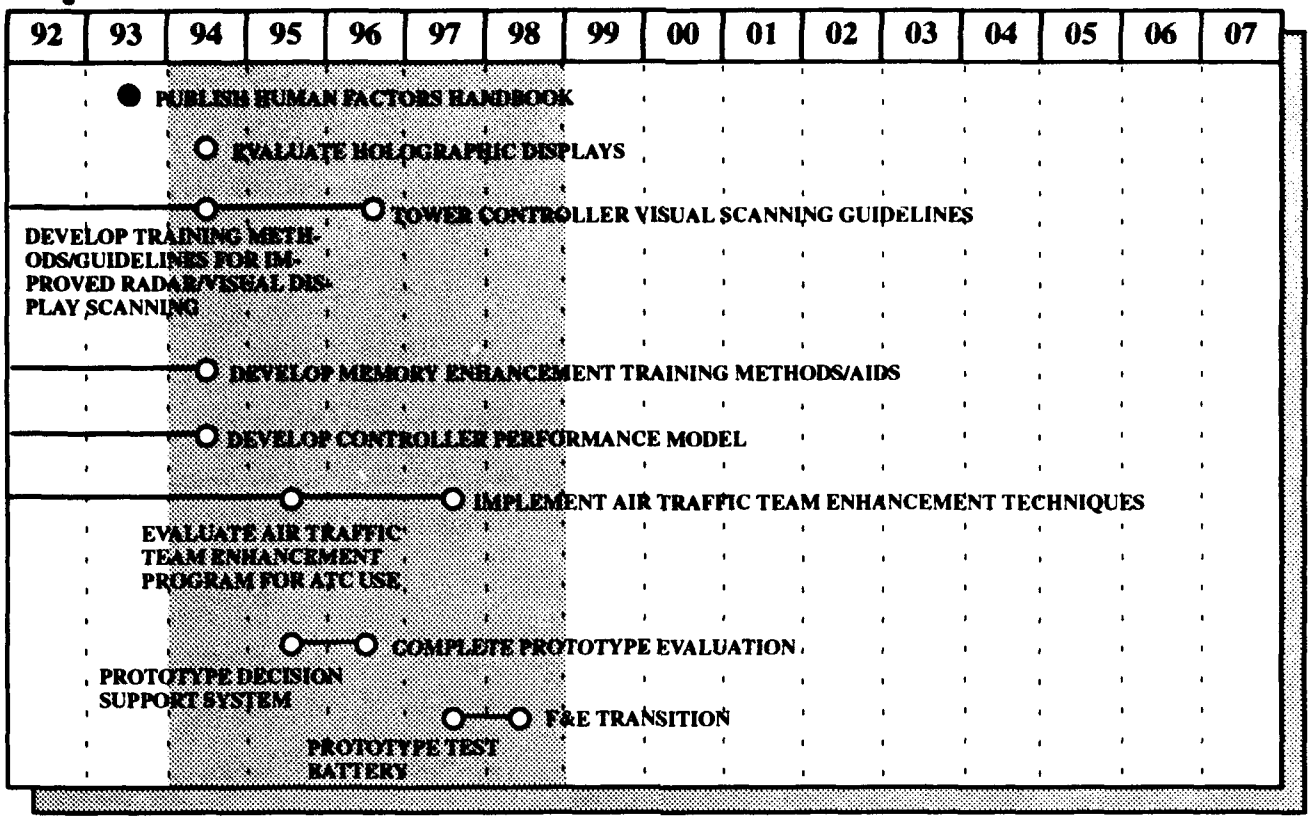
In FY 1994, a SATORI application will be developed for re–creating Terminal Radar Approach Control (TRACON) operational errors and incidents. SATORI will be applied to en route operational errors to identify the job tasks most closely associated with those errors.

In FY 1995, research will be conducted to determine how Air Traffic Team Enhancement techniques used by aircrew members are applicable to air traffic control sector teams. Training applications and procedures will be developed for Air Traffic Team Enhancement Program implementation in FY 1997. Additionally, the program's findings will help to define future products. Also in FY 1995, a decision support system prototype will be developed for analyzing controller staffing requirements, attrition, and training requirements. The prototype will be evaluated through FY 1996, leading to future field implementation.

In FY 1996, guidelines will be implemented to improve tower controller visual scanning techniques to help reduce runway incursion incidents.

In FY 1997, a prototype future automated ATCS selection test battery will be developed. An operational system will be ready for facilities and equipment (F&E) transition in FY 1998.

Project 082–110: Air Traffic Control Human Factors



083–110 Airway Facilities Human Factors

Purpose: The Airway Facilities organization has developed a strategic plan to manage change that is occurring as AF grows into a more system management oriented organization. This plan addresses the vision of the Airway Facilities organization of the future. The plan also provides the outline for transition to this new operational concept. The AF Human Factors project provides means by which user–system interfaces inherent in the strategic plan can be validated and alternatives for implementation can be addressed.

The purpose of this project is to reduce the impact of change on the organization and to provide the necessary information for implementing the strategic plan. By conducting research in future work force selection and training; organizational effectiveness; user–centered maintenance automation; and human performance, the AF Human Factors project will provide the input necessary to make informed decisions regarding the best methods to implement the strategic plan and achieve the goals.

Approach: Task analyses will be conducted to provide the necessary data for developing knowledge, skills, and abilities, position descriptions, and training criteria for current and future positions. These analyses will also be used to develop human to computer/machine interfaces for new systems, and for determining where artificial intelligence and expert systems can best be incorporated into the maintenance environment.

Simulations will be developed for different work environments to determine the impact of policy and/or procedural changes on work load and staffing. The evolving AF system specialist's role and workload in an automated system will be analyzed and appropriate interfaces developed to take advantage of advanced technology. Expert systems applications as job performance aids will be evaluated. Acceptability of computer synthesized speech in the AF environment will be evaluated.

Related Projects: 026–110 Airway Facilities System Technology Concepts and Methodologies, 026–120 Airway Facilities Diagnostic Tools and Future Technology, 082–110 Air Traffic Control Human Factors, and 085–110 Aircraft Maintenance Human Factors. Capital Investment Plan projects: 26–01 Remote Maintenance Monitoring System (RMMS).

Products:

- Higher order Airway Facilities task analysis on knowledge, skills, and abilities requirements for jobs/positions in the AF system; and training and selection requirements for AF personnel
- Criteria for effectively using intelligent systems in AF maintenance
- Error taxonomy for AF tasks with data base and error recording systems to be used for tracking and quantifying human performance errors
- An error control program for reducing the incidence and impact of errors
- Human factors design interface specifications for future systems, including workstations, control centers, and job aids
- AF personnel knowledge, skills, and abilities considerations suitable for inclusion in the specifications for new Airway Facilities procurement

FY 1992–1993 Accomplishments:

- Completed job task analysis for the NAS Operations Manager (NOM) and NAS Area Manager (NAM) positions for the En Route Maintenance Control Center (EMCC) functions and responsibilities.
- Developed prototype intelligent tutoring system to aid and improve proficiency training methods and techniques for Airway Facilities system specialists.
- Completed a human–system integration standard to be used to define Airway Facilities human factors requirements in procurement specifications.
- Developed standard for Airway Facilities Human–Machine Interface Design Criteria for NAS equipment and systems.
- Developed a set of symbols, icons, and colors to be considered when defining screen presentations and designs for alarm and status information depiction for Airway Facilities system specialists.
- Completed initial evaluation of an outage assessment inventory (OAI) for classifying and weighing the cost of downtime in general national airspace system sector (GNASS) facilities.

Planned Activities: In FY 1994, a prototype information system, including a job aid, intelligent tutoring system, and electronic documentation, will be developed and evaluated for usability in proficiency training and problem identification/resolution. The types of errors made by Airway Facilities personnel will be determined and a classification system will be developed. This initial effort will be used to develop remediation

methods and techniques for future system design and training. Beginning in FY 1995, an effort will be initiated to determine how artificial intelligence/expert system technology can best be used to assist Airway Facilities system specialists in their system management and restoration activities. Situational awareness studies will be conducted to investigate the automated control room environments effects on human performance.

In FY 1995, data previously collected will be used to develop a prototype error recording and tracking system and to form the baseline for recording and tracking errors made by Airway Facilities system specialists in the future. The data collected by this system will be used to develop methods to remedy the causes of the errors, and to ensure that these errors do not propagate into the future functions and activities. Proof of concept operational models will be developed to simulate, test, and evaluate future operational concepts, procedures, and functions defined by AF through the strategic planning process.

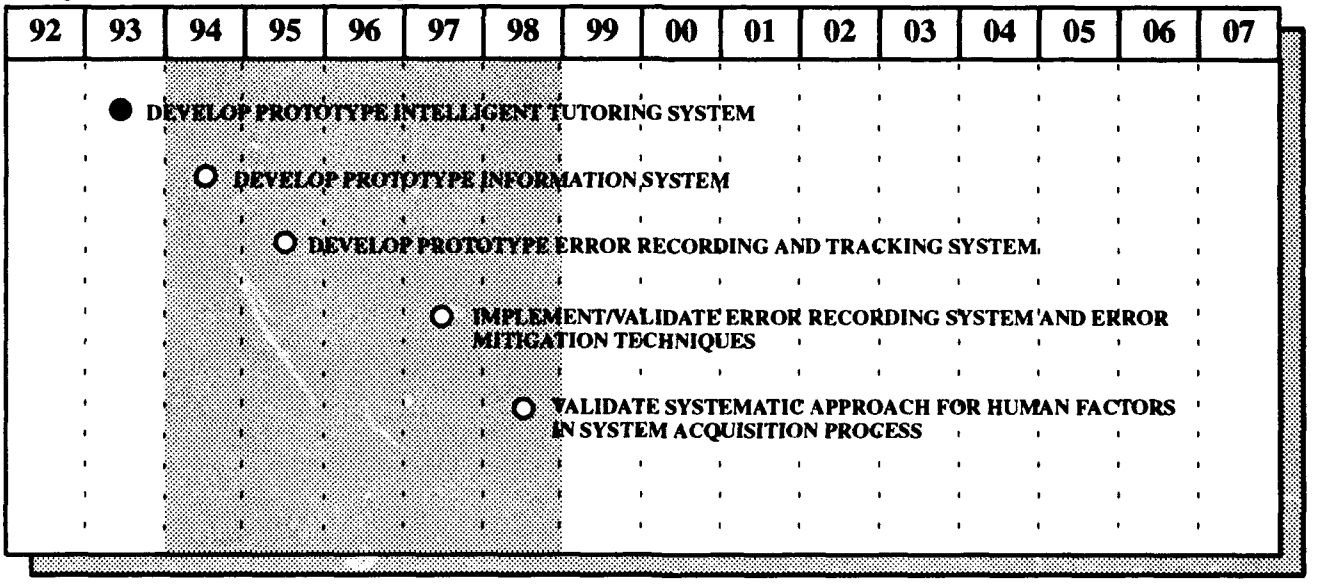
In FY 1996, the effects of adverse conditions on the performance of the system specialists will be examined. Travel time, bad weather, and facility access conditions will be specifically examined to determine how they impact the performance of AF personnel. A study to determine the effects of satellite-based operational environments on AF personnel will be undertaken. Areas included in this study are system status monitoring and performance management, knowledge required, and operational procedures to support the satellite–based environment.

Results of the research conducted in FY 1994, 1995, and 1996, as well as Airway Facilities' strategic plan, will influence the direction of projects in FY 1997 and beyond.

In FY 1997, implementation and validation of error recording system and mitigation techniques will begin. Development of a prototype operations control center environment will include intelligent systems for alarm acknowledgement and resolution, computer–based models and NAS management scenarios, and alternative staffing configurations.

In FY 1998, validation of the systematic approach for including human factors in the systems acquisition process will be completed. Also in FY 1998, the impact of the changing AF organization information flow and communications management will be determined.

Project 083–110: Airway Facilities Human Factors



084–110 Flight Deck/ATC System Integration

Purpose: This project will ensure new generation aircraft compatibility with the evolving automated NAS and decrease the frequency of flight deck/ATC communications errors through a total system approach. Flight Deck/ATC Integration raises unique considerations that are distinct from ATC or flight deck issues and will be greatly affected by the technological improvements that are expected to occur simultaneously within the Flight Deck and ATC areas. For example, advanced computer aiding, such as the automated en route air traffic control (AERA), will facilitate controller handling of increased traffic but will also influence flightcrew performance. Data link, and ultimately satellite–based air traffic systems, have the potential to enhance system capacity, but will also influence controller and pilot workload in ways that are not currently understood. NAS safety and efficiency will be enhanced through system–wide analyses that integrate current and emerging airborne and ground subsystems.

Approach: This project's objective is to enhance flight deck/ATC information transfer and management; decrease frequencies and consequences of flight deck ATC errors; determine appropriate allocation of authority of functions between flight deck and ATC; and develop the required methods, tools, and guidelines for integration of NAS components into the flight deck ATC environment.

The information transfer area will focus on identifying and resolving issues associated with transferring and managing information exchanged between the flight deck and ATC system. The areas to be studied include ATC clearances, traffic, weather, facility and equipment status, and related information. Both air–to–ground and ground–to–air information and data exchanges are of equal importance. The goal is to reduce the frequency of information transfer errors and minimize their impact when they do occur.

Verbal communications in ATC operations have been identified as causal factors in over 70 percent of operational errors and pilot deviations. Consequently, one of this project's major research areas focuses on developing means to decrease the frequencies/consequences resulting from pilot and controller communication errors. Efforts will be focused on three areas: a pilot/controller communications analysis examining ATC voice tapes; analyses of Aviation Safety Reporting System reports; and a series of laboratory experiments to assess the effectiveness of recommended changes in procedures and/or phraseology.

As the application of intelligent automation increases on the ground as well as the flightdeck, allocating authority between pilots and controllers becomes less well defined. This project will develop a decision support system (DSS) to predict different authority allocations for various TRACON events. The DSS will help the FAA make decisions on future pilot/controller selection, training, and operational authority allocation.

Both FAA and NASA currently operate aging Boeing 727 simulators that represent a diminishing number of obsolete aircraft. Developing and acquiring new simulation capabilities, and enhancing existing capabilities, will be required to assist in transitioning today's NAS to the advanced automation system of the future. Through a cooperative agreement with NASA, the FAA will jointly purchase a modern, high fidelity Boeing 747–400 research simulator representing aircraft that will be predominate in airline fleets during the next decade. It will be capable of stand–alone use, or linked via satellite to FAA ATC simulation facilities. Simulation studies involving this advanced technology cockpit will eventually integrate into the National Simulation Capability.

Related Projects: 025–110 National Simulation Capability (NSC), 031–110 Aeronautical Data Link Communications and Applications, 081–110 Flight Deck Human Factors, 082–110 Air Traffic Control Human Factors, and 086–110 Aeromedical Research.

Products:

- Human factors guidelines needed to set policies for data link architectures and procedures
- Human factors guidelines for developing, testing, and certifying interface designs of various data link applications
- Operational and training recommendations to reduce pilot/controller verbal communication errors
- Revised selection and training criteria to ensure that pilot and controller trainees have the prerequisite skills to operate in the future automated NAS environment
- Capability to assess human performance in a highly integrated future automation environment

FY 1992–1993 Accomplishments:

- Completed 5-year plan for pilot/controller data link interface research.
- Completed interagency agreement with NASA to jointly acquire a high fidelity cockpit training simulator.

Planned Activities:

In FY 1994, the new Boeing 747–400 simulator will undergo acceptance testing. Work will begin to interface the cockpit simulator with the FAA Technical Center's existing ATC simulation facilities. In FY 1995, the first system integration experiments will begin on this simulator to support the National Plan for Aviation Human Factors and the National Simulation Capability Operating Plan.

In FY 1994, standards will be developed for data link functions in air carrier and general aviation aircraft. These standards include display content, menu design, message displacement, location, and control functions. Data link certification guidelines will follow in FY 1995. As new data link applications emerge, standards and certification guidelines will continually be developed and/or revised.

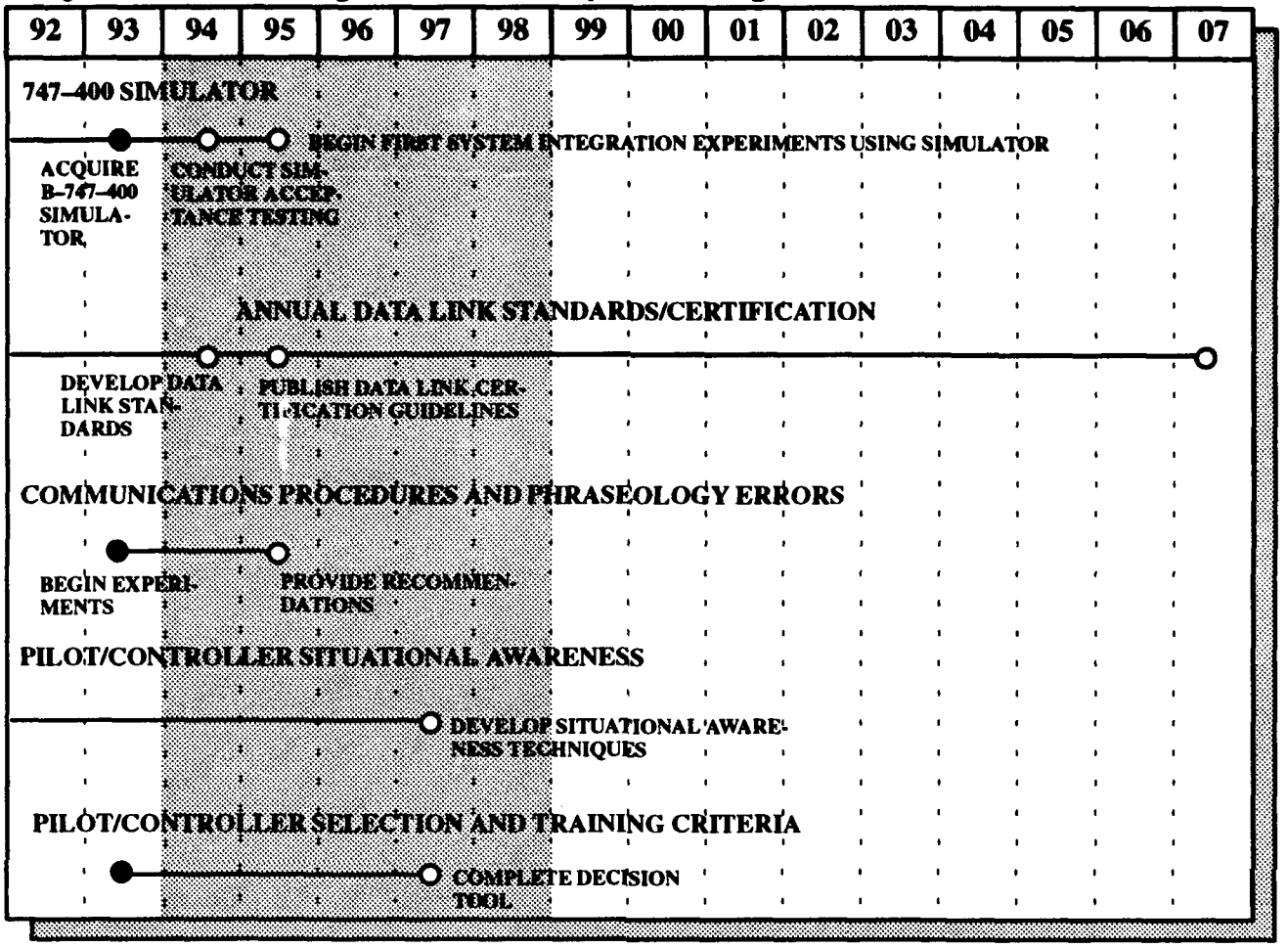
In FY 1994–1995, a series of laboratory experiments will be conducted to assess the effectiveness of recommended changes in pilot/controller communication procedures and phraseology. These recommended changes will be developed in FY 1994 and provided to regulatory personnel for implementation in FY 1996.

In FY 1994, research will continue on developing compensation techniques to ensure pilot/controller situational awareness. As automation and data link systems come online, techniques must be developed to keep human beings in the decisionmaking loop. The current line of research is expected to be completed in FY 1997.

In FY 1994, work will continue on developing pilot/controller selection and training criteria. One key element of this research is developing a decision tool that aids in predicting shifting allocation of authority between the flight deck and ATC due to intelligent automation. This decision tool will be completed in FY 1997 and used in developing and revising pilot/controller selection and training criteria.

It is important to recognize that system integration research will never produce a definitive product which will close out this research domain; rather, it is a continual process that must be applied to every new generation of technologies as they emerge.

Project 084–110: Flight Deck/ATC System Integration



085–110 Aircraft Maintenance Human Factors

Purpose: This project will develop and validate training methods to improve aircraft maintenance and inspection personnel performance; develop regulatory support materials to revise Federal Aviation Regulations (FAR) Parts 65 and 147; develop information on advanced technology, techniques, and job performance aids for industry aircraft maintenance personnel and FAA Aviation Safety Inspectors (ASI); and develop information on how workplace environment and organization affect technician performance. A better understanding of these variables will lead to enhanced training methods, improved human engineering of equipment, and improved FAA regulations/oversight. Accidents and incidents in air carrier operations attributable to maintenance and inspection human factors will be reduced as a result of this effort.

Research conducted in this area will ensure that future maintenance technicians will be optimally prepared for their roles. This research will develop guidelines and advisory materials for use by air carrier maintenance organizations concerning work environment factors that influence maintenance personnel performance. Also, information

will be developed concerning the effects of management and organizational factors in aircraft maintenance.

Approach: This project addresses the following areas of the National Plan for Aviation Human Factors: Personnel and Training Systems, Advanced Technology Systems, and Environmental and Organizational Systems.

This work has been initiated with a job/task analysis of the aircraft maintenance technician's work activity. As part of this activity, demographic factors will be studied to determine who will comprise the future technician work force, where they will be located, and what their preparation will be for this career field. With this knowledge, appropriate training systems and methodologies will be developed and enhancements to appropriate Federal Aviation Regulations can be effected. A demonstration intelligent tutoring system (ITS) will be developed that will show the safety and training effectiveness benefits available through advanced training technology applications.

Work environment research will be initiated with a survey to determine existing knowledge of visual, auditory, thermal, and biomechanical requirements or limitations concerning skilled psychomotor activity in general. Subsequent work will seek to apply this knowledge to a specific aircraft maintenance case. Organizational/management research will examine the influence of management practices, expectations, and norms as well as personnel practices, team operations, and organizational structure on maintenance performance.

Related Projects: 065–110 Aging Aircraft.

Products:

- Job task and training analyses
- Intelligent tutoring and job aiding systems
- Supporting data for FAR Parts 65 and 147 revisions
- Human factors engineering design criteria
- Human factors guidelines for industry/Government communication, data exchange, and support infrastructure
- Industry guidelines for using systems, technology, tools, and techniques
- Organizational design guidelines
- Advanced documentation technology to provide rapid access to technical information

FY 1992–1993 Accomplishments:

- Developed prototype ITS and completed software package.
- Developed criteria for a user–centered technical information exchange system.
- Developed software for testing inspection performance.
- Published human factors issues guidebook, first edition.
- Developed hand held, pen–based computer job aid for FAA ASIs.

Planned Activities: In FY 1994, a report will be completed on aircraft inspection equipment design human factors, regulatory support package for changes to FAR Part 147. These efforts are part of an FAA, NASA, and industry effort to provide improved safety in aircraft maintenance and inspection. Further ASI job aid testing and evaluation will be completed.

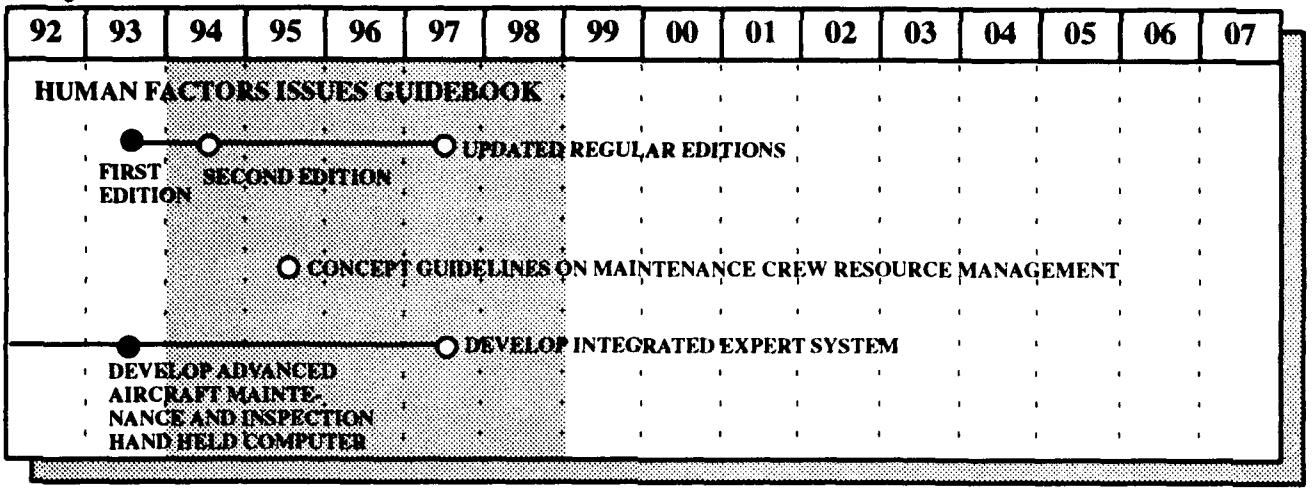
In FY 1994, ITS airline testing and nondestructive inspection (NDI) guideline development will be completed. A second edition of the human

factors issues guidebook will also be published with regular updates through FY 1997.

In FY 1995, guidelines on aircraft maintenance crew resource concepts will be developed to reduce maintenance errors.

In FY 1997, an expert system will be developed for integrated training/job aiding/information retrieval. This system will use a hand-held advanced technology aircraft maintenance and inspection job aid developed in FY 1993.

Project 085–110: Aircraft Maintenance Human Factors



086–110 Aeromedical Research

Purpose: This project will assess types of injury and death patterns in civilian flight environments, recommend and develop protective equipment or procedures, and provide guidance to FAA regulatory and medical certification staff. The component tasks of this research will identify human physiological and bioengineering failure modes in uneventful flight and during civil aircraft incidents/accidents while simultaneously assessing counteracting measures. The research will also identify pilot and passenger medical conditions that are incompatible with civilian flight demands. This detailed information will be used to determine if existing equipment and procedures optimally protect the human occupant; make technical recommendations contributing to improved performance standards; and support bioengineering, biochemistry, and biomedical aspects of certification actions and rulemaking. Since prioritizing subtasks is directly responsive to Federal Air Surgeon guidance and to unique injury and death characteristics in contemporary accidents, the FAA and National Transportation Safety Board can effect expeditious corrections of unsafe and dangerous conditions.

Approach: Tasks in this research area are derived from requirements generated within the FAA by the Aircraft Certification Service, the Flight Standards Service, the Northwest Mountain Region Transport Airplane Directorate, the Southwest Region Rotorcraft Directorate, the Central Region Small Airplane Directorate, and the Offices of Aviation Medicine, Aviation Safety, and Accident Investigation. Organizations outside the FAA generating requirements through FAA channels include the National Transportation Safety Board, the military

services, and the Society of Aerospace Engineers. All project activities are coordinated with Government agencies and industrial representatives having related technical interests. The new FAA research process ensures project coordination among the FAA performing organizations, such as the Civil Aeromedical Institute and the Technical Center.

This project broadly encompasses laboratory and field studies on the performance of aircraft passengers, cabin crew, and medically certified airmen. Furthermore, equipment and procedures approved by the FAA and designed to protect personnel in accident situations are evaluated. The studies include evaluating injury mechanisms that might result from system failures or from hazardous conditions such as smoke or toxic gas environments. The studies support rulemaking or certification actions by developing performance standards and evaluating the merits, deficiencies, costs, and benefits of specific safety–related procedures and appliances. The same research generates educational spinoffs that, in cooperation with industry and airspace users, guide the aviation participant in optimal use of the safety equipment or procedure. Protecting humans in decelerative environments, protective breathing equipment, toxicological assessment, cabin evacuation, water survival, and radiation are currently being investigated in the Protection and Survival Track. Sudden and subtle medical incapacitation in pilots, new vision corrective methods by aviation personnel, new antihypertensive treatments for pilots, and onboard emergency medical response capability, represent the current clinical investigations in the Aeromedical Program Support Track.

Related Projects: 061–110 Aircraft Systems Fire Safety and 062–110 Aircraft Crashworthiness/Structural Airworthiness.

Products:

- Quantitative bioengineering criteria to support aircraft seat and restraint system certification
- Quantitative biomedical criteria to support protective breathing equipment and operational procedures certification
- Quantitative biochemical and toxicological criteria supporting the use or certification of aircraft interior fire, smoke, and toxicity limits
- Quantitative biomedical criteria to support flotation and onboard rescue equipment certification
- Revised aircrew medical criteria, standards, and assessment procedures
- Identify medical causative factors in aviation incidents and accidents
- Occupational health assessments for unique populations in the aviation community

FY 1992–1993 Accomplishments:

- Developed viable and cost–effective child flotation devices and procedures.
- Developed guidelines for aircrew using beta blocker antihypertensives, as well as guidelines to prevent both carbon monoxide and cyanide incapacitation during cabin fires.
- Applied new cognitive function test to evaluate airmen after brain injury or disease.

- Provided clinical and bioengineering assessments at over 25 aviation accident sites.
- Provided toxicological assessments and published trend reports for over 1,000 aviation fatalities.
- Provided hypothermia data to FAA Technical Center for assessing passenger risk when subjected to cabin water spray systems.
- Provided airlines and the public with a computer program that calculates aircrew and passenger cosmic radiation risk.
- Developed certification guidance for airmen with aphakia (absent natural lens).
- Developed certification guidance for glare vision testing equipment.
- Demonstrated feasibility of head injury protection at aircraft bulkheads.
- Provided over 300 aircraft seat and restraint system crashworthiness test reports to support airworthiness initiatives.
- Developed compliance options for the new Type III (overwing) exit regulations.

Planned Activities: In FY 1994, several key protection and survival efforts will be completed. New techniques will be developed to reduce head injury in aircraft crashes. In FY 1995, similar data will be developed to prevent cervical (neck) injuries in crashes. This data will improve compliance with existing crashworthiness regulations and assist the FAA in developing new certification criteria based on technology improvements. Also in FY 1994, research on protective breathing gear will continue. A key emphasis will be on conducting long–term research to improve high altitude breathing equipment biomedical standards by FY 1997. In the water survival area, a new infant/small child flotation device will be developed in FY 1994. This will permit developing and applying a new technical standard order for such devices. Research tests will be developed that realistically simulate cabin evacuation directly into water. These tests will permit the FAA to develop specialized evacuation approval guidelines in FY 1994. In FY 1994, work will continue on emergency medical equipment, leading to standardization regulations by FY 1997.

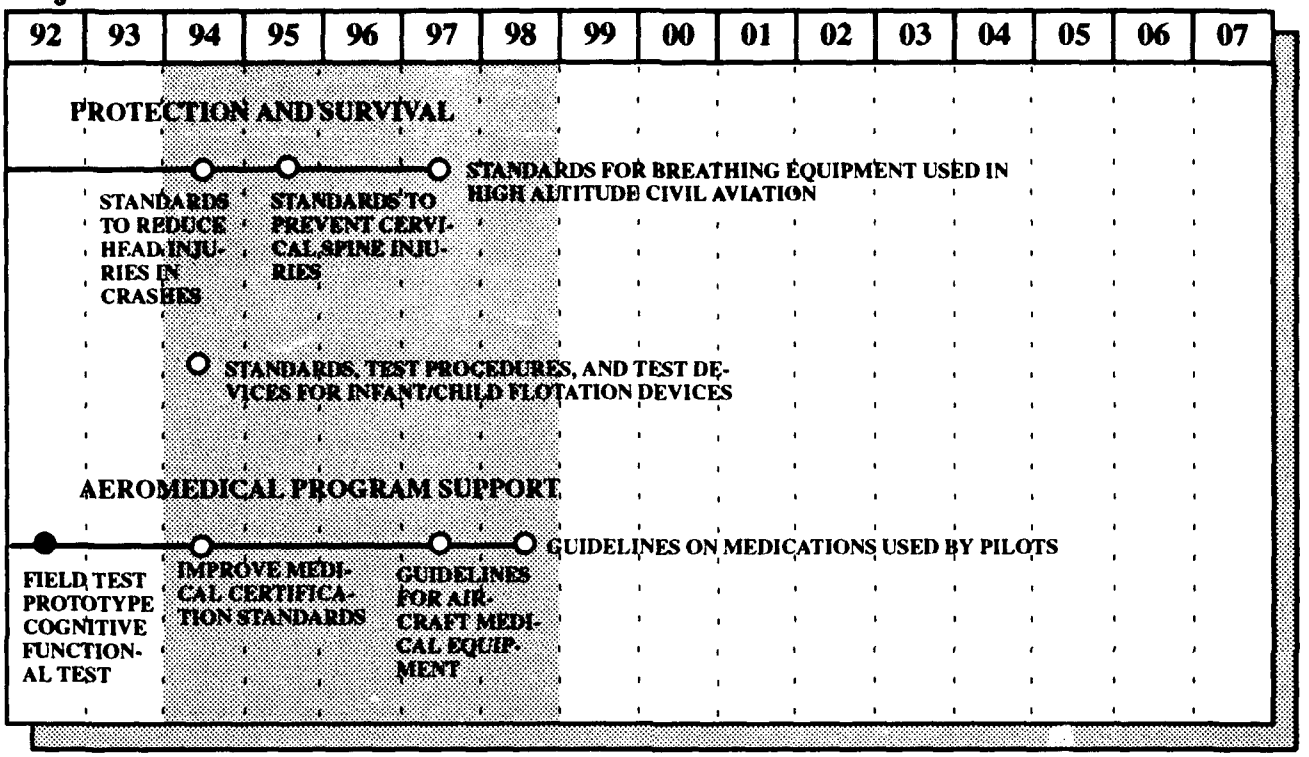
In FY 1996, a computer model will be developed to assess emergency evacuation from dual aisle aircraft cabins. This model will serve as a design and regulatory compliance tool. With model validation, it will be possible to eliminate cabin evacuation demonstrations that expose human subjects to dangerous test conditions.

In FY 1994, several key Aeromedical Program Support efforts will be completed. Particular emphasis will be given to clinical research on vision, cardiovascular, and neurological certification standards. This clinical research ensures that standards are relevant and reflect state–of–the–art diagnostic approaches. Additionally in FY 1994, field clinical research will be conducted to determine causative human factor elements in aircraft accidents. The FAA Office of Accident Investigation continually requires this data to complete its investigations of complex and diverse aircraft accidents. In FY 1994, specialized cabin crew occupational health assessments will be conducted in cooperation with the National Institute of Occupational Safety and Health (NIOSH). This joint FAA/NIOSH research will determine the need for new guidelines to protect aircrew members by FY 1996.

In FY 1996, a tool will be developed to permit toxicologists to determine whether alcohol detected in accident victims was ingested or was generated post–mortem. This data will clarify medical and legal uncertainties surrounding the cause of the accident. Long–term research is targeted to develop updated guidance for use of over–the–counter and prescription medications by civil aviation pilots in FY 1998.

Other long-term research to support the FAA's mission necessitates ad hoc studies on seat and restraint systems; optimizing aircraft exit configurations; maintaining cabin safety and anthropometry databank; assessing human factors in aircraft accident causation; performing toxicity studies; profiling chemical abuse in aviation; examining effects of drugs and physiological stressors on performance; evaluating new vision corrective devices, and testing medical equipment in civilian aircraft.

Project 086–110: Aeromedical Research



9.0 ENVIRONMENT AND ENERGY

Research, Engineering and Development (R,E&D) projects in this thrust area support national goals to protect the environment, conserve energy, and keep the U.S. air transportation industry strong and competitive. Currently, approximately 2.7 million individuals live within areas that are considered to be exposed to significant airplane noise (a day–night average sound level of 65 decibels or more) and more than 400 U.S. airports have adopted some type of airport restriction to reduce aircraft noise or mitigate its effects. In some cases these restrictions have little impact on airport capacity, but in others the potential airport capacity has been reduced by as much as 30 percent. While there is an effort underway to ensure an early phase–out of older, noisier aircraft, there will clearly be a demand for even more stringent limitations on aircraft noise. Air pollution from aircraft is also becoming a major concern in airport expansion and proposed new airport construction. New aircraft and new aircraft engine types offer potential relief to the public; however, substantial R,E&D will be required to support future regulations.

The future aviation system envisions one that is a "good neighbor" to the people living near airports. The challenges revolve around issues associated with how this good neighbor policy is implemented. While noise and pollution are the primary challenges, other issues associated with the atmospheric effects from new aircraft types, and new or alternative fuels, will require analysis and investigation.

The value gained from project in this thrust area will derive from reducing both direct and indirect costs associated with meeting the national goals. Discovering ways to build quieter engines that have fewer noxious emissions is the direct approach. The indirect approach is to develop ways to use existing equipment more appropriately. Both approaches are reflected in this thrust area's projects.

A benefits assessment associated with these projects is underway. Noise reduction assessment strategies will be built around meeting local noise restrictions in ways that have less impact on airport capacity and, therefore, on system delays. Finding improvements in the ways to reduce aircraft engine emissions will also yield significant benefits.

The FAA's policy for environment and energy issues is to provide strong leadership in mitigating aviation's adverse impact on the public, consistent with sound energy planning and an effective aviation system. The FAA has adopted the following strategies:

- Lead a cooperative development effort that balances noise reduction with adequate airport capacity.
- Manage FAA activities to minimize adverse environmental consequences and comply with all Federal statutes.
- Develop sound aviation energy plans.
- Stimulate private industry and Government–sponsored research to reduce noise, emissions, and energy consumption by the aviation sector.

The Research, Engineering and Development Plan for the Environment and Energy thrust area responds directly to these strategies, and the recently passed Aviation Noise and Capacity Act of 1990, and the Clean Air Act Amendments of 1990.

Through joint efforts with industry, the FAA will improve regulatory standards for noise and air pollution. It will also develop better technologies for predicting, measuring, and abating the environmental impact from aircraft emissions. Research will help define global standards for noise

and air quality that are now being developed by the International Civil Aviation Organization (ICAO).

The research within this thrust area consists of the following major disciplines:

- Aviation Environmental Analysis
- Aircraft Engine Emissions Reduction and Control
- Noise Reduction and Control
- Aviation Fuel Shortage Contingency Planning

9.1 Environment and Energy Project Descriptions

091–110 Environment and Energy

Purpose: This project will develop various tools and methods that will be used to evaluate the environmental impact from alternative aviation policies and strategies. The focus will be on aviation noise, a major constraint on airway and airport capacity, and air pollution/aircraft emissions in the upper atmosphere, a growing public concern. The project will also ensure FAA compliance with all Federal environmental statutes, such as the Airport Noise and Capacity Act and the Clean Air Act Amendments of 1990.

Approach: Environment and Energy R,E&D consists of the following major disciplines: Aviation Environmental Analysis, Aircraft Noise Reduction and Control, Aircraft Engine Emissions Reduction and Control, and FAA Energy Conservation and Aviation Energy Emergency Contingency Planning.

Aviation Environmental Analysis

The Aviation Environmental Analysis and the Aircraft Noise Reduction and Control activities will eliminate many constraints on aviation growth, especially on airport capacity, through technology and expertise aimed at mitigating or controlling aircraft noise. This will include continually updating and improving the integrated noise model (INM), the heliport noise model (HNM), the area equivalent method (AEM), and the nationwide airport noise impact model (NANIM). These noise models are used to predict and assess the impact from FAA policies and Federal actions. Research will be conducted to develop better tools for assessing the costs and benefits associated with noise reduction and control activities.

A cooperative research program with the National Aeronautics and Space Administration (NASA) will investigate human response to noise levels and frequencies as part of a longer range program aimed at developing a better understanding of community response.

Aircraft Noise Reduction and Control

The FAA has entered into a joint research program with NASA to investigate technology advances in source noise reduction. The research will include engine design parameters, advanced acoustic absorption materials, and active noise control devices. Aircraft technology advances will include high lift devices and methods to reduce airframe generated noise.

Noise testing will be conducted to simplify existing certification procedures and develop new procedures for future aircraft. Noise requirements for heavy helicopters, tiltrotor aircraft, advanced subsonic transports, high speed civil aircraft, and hypersonic research vehicles will be evaluated in cooperation with industry.

Aircraft Engine Emissions and Control

The FAA will undertake a joint high altitude pollution research (HAPR) program with NASA's Lewis Research Center to investigate new technologies in jet engine combustor designs that reduce engine emissions, specifically, nitrogen oxide emissions. These emissions generate particular concern due to their potential impact on the upper atmosphere. The results from these investigations will be used in developing future engine emission regulations and international

standards. Studies with NASA will also investigate both current subsonic and high speed civil transport's (HSCT) effect on the ozone layer and global climate change. These studies are intended to determine the HSCT's future viability and the need for aircraft engine emission standards at cruise altitude conditions.

Energy Conservation and Aviation Energy Emergency Contingency Planning

This project will support achieving a 20 percent energy use reduction or a 20 percent increase in efficiency in FAA buildings by the year 2000 as compared to fiscal year 1985. It seeks to minimize petroleum use in Federal facilities to comply with Executive Order 12759. The FAA also will review and evaluate the present Energy Management Reporting System. Based on this review, the system will be upgraded and enhanced, or replaced with another tracking and reporting system. A user's training program will also be developed. The reporting requirement is mandated by Executive Order 12759 and the National Energy Conservation Policy Act, as amended.

The FAA Aviation Energy Emergency Contingency Plan will also be reviewed and updated. An Aviation Energy Statistics/Fuel Survey will be developed, and a method to continually update the data base will be incorporated in the plan. Energy support studies will be conducted as required to support the plan.

Related Projects: 021–220 Multiple Runway Procedures Development, 024–110 Aviation System Capacity Planning, and 025–130 Air Traffic Models and Evaluation Tools.

Products:

- Mathematical models to compute the impact from aviation noise for both airports and heliports
- Mathematical models to compute aviation contributions to airport and upper atmospheric air pollution
- New, simplified aircraft certification procedures for contemporary airplanes and helicopters that will be used to revise certification regulations
- Handbooks and guidance material for FAA field personnel involved in aircraft certification
- Certification standards for new technology aircraft including propfans, ultra high–bypass engines, and HSCTs that will be used to promulgate new regulations
- Studies to identify feasible technologies leading to potential noise certification standards
- Improved FAA energy contingency plan and computerized reporting system to meet FAA and Department of Energy reporting obligations to Congress
- Revised and updated Advisory Circular AC–36, Aircraft Noise Levels

FY 1992–1993 Accomplishments:

- Developed personal computer noise contour plotting program and census data base interface module developed from continuing INM.
- Released INM data base number ten.
- Upgraded the interactive sound information system to include additional aircraft types.

- Distributed improved emissions and dispersion modeling system version for field testing.

- Published manual for FAA field personnel on community involvement in the environmental impact assessment process.

- Completed light helicopter flight testing to support simplified noise certification procedures.

- Implemented Appendix J to Federal Aviation Regulation Part 36, a new simplified noise certification procedure for light helicopters.

Planned Activities:

Aviation Environmental Analysis

In FY 1995, a system of airport noise analysis and impact assessment tools/processes will be developed. These tools and analyses will be used to: identify optimal airport development alternatives, avert public controversy, and accommodate Federal guidelines. This system will be expanded in FY 1997 to include major air traffic management and airspace improvement projects.

Aircraft Noise Reduction and Control

In FY 1996, simplified noise certification procedures will be developed for large helicopters. Also, vertical flight noise assessment tools will be completed for use in heliport/vertiport development.

Aircraft Engine Emissions and Control

In FY 1994, airport air quality assessment tools and procedures will be completed to support development and capacity enhancements.

In FY 1998, an updated version of the global aircraft emissions forecasting model will be developed to predict the atmospheric effects from subsonic and HSCT emissions on the ozone layer and global climate change.

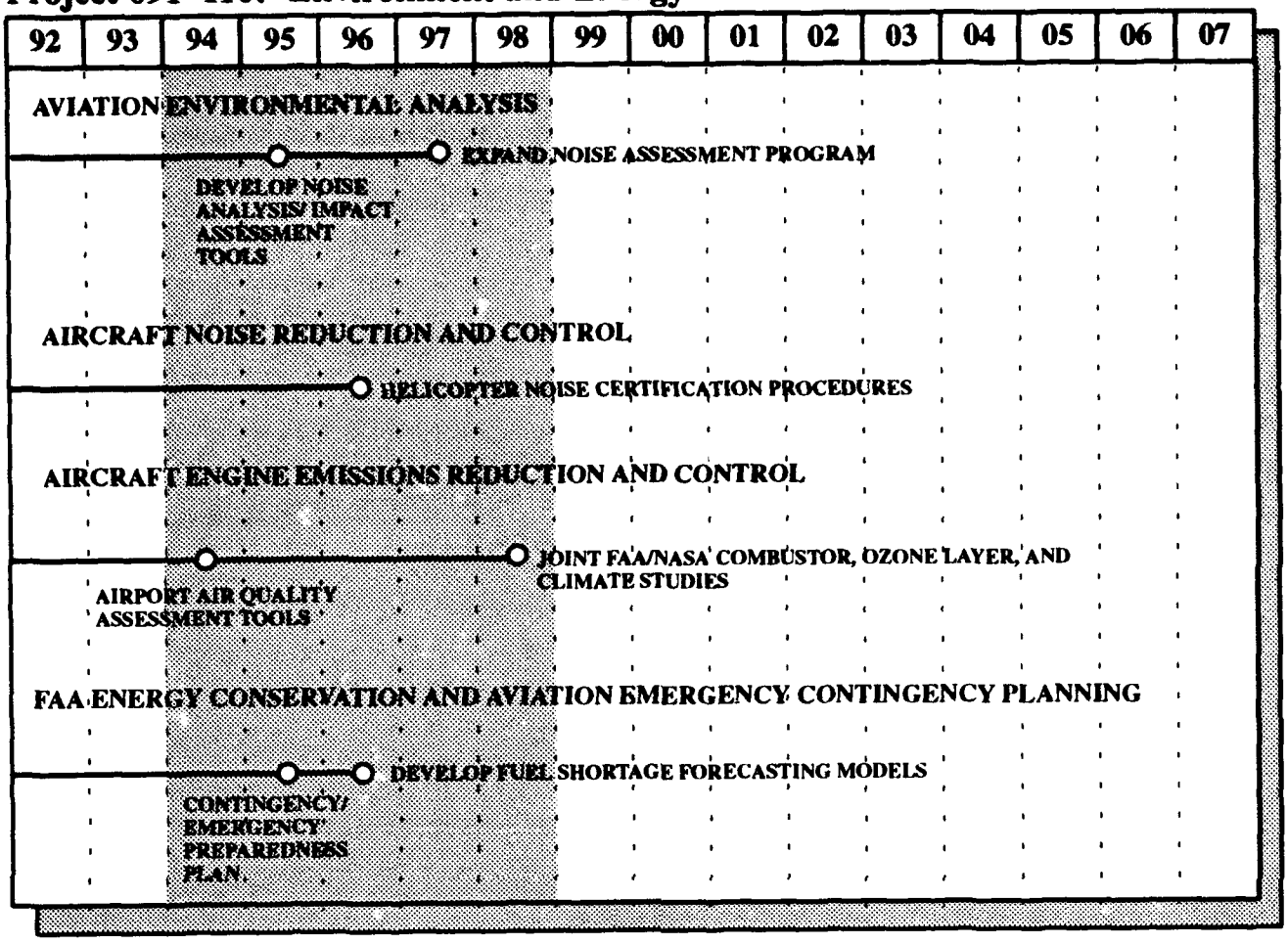
To ensure consistency with known changes in the Clean Air Act, the FAA will update the Federal Aviation Regulations on aircraft emissions. The FAA's data base on emissions characteristics will be expanded by collecting data on new technology and newly certificated engines.

Energy Conservation and Aviation Emergency Contingency Planning

In FY 1995, procedures and a reporting system will be implemented to monitor the FAA's compliance with Executive Order 12759 on energy conservation, planning, and reporting obligations.

In FY 1996, aviation fuel shortage forecast and assessment models will be developed. These models will support contingency planning and emergency preparedness during a national fuel crisis.

Project 091–110: Environment and Energy



APPENDIX A

Innovative/Cooperative Research

The Federal Aviation Administration's Research, Engineering and Development (R,E&D) program is committed to supporting the vision of a technologically advanced future aviation system. The agency's innovative/cooperative research activities provide a vehicle to test new and innovative ideas and examine the potential for new technology applications to the national air transportation system.

The individual programs described here provide a variety of vehicles for accomplishing research, providing for cooperative efforts with industry, academia, and other Government agencies.

Challenging industry, Government, and educational institutions to develop ideas and concepts for aviation can have large benefits beyond direct research applications. For example, the University Fellowship Research Program gives students the opportunity to become involved in the research programs at the FAA Technical Center, including Air Traffic Control technology, aviation safety, and security. This has led to recruiting and hiring very talented graduate students into the FAA. This program also allows interaction and contributions from university faculty members. The FAA/National Aeronautics and Space Administration (NASA) Cooperative Program allows both agencies to share research ideas and concepts while preventing duplication of research activities. This has the benefit of preserving scarce, valuable resources while building on each other's technology efforts.

Through cooperative agreements, small business and university research grants, and technology transfer, the FAA exploits outside expertise and encourages community participation in the R,E&D Program. Programs supporting these initiatives are listed below.

101–110 Transportation Research Board (TRB)

Purpose: This program stimulates research concerning the nature and performance of aviation transportation systems, disseminates the information produced by the research, and encourages applying appropriate research findings. This research influences the FAA's future policy direction. The TRB is a National Research Council unit that serves the National Academies of Sciences and Engineering. The products from this research help the public sector focus on technical and management innovations developed by the academic and private sectors to resolve current and future critical issues. The TRB also provides an independent perspective on means that could be used to improve safety, manage the national aviation system, increase capacity and productivity, and stimulate interest in highly qualified students to pursue careers in aviation.

Approach: The FAA determines specific research to be conducted and awards research contracts to the TRB. This program is carried out largely by committees, task forces, and a panel staffed by industry, public officials, and university experts who serve without compensation. The FAA provides one or more analysts to participate on these committees, task forces, and panels. The Board's efforts also include research on

aviation's future by conducting an annual Graduate Research Award Program. This program focuses on technical and management innovations for civil aviation facilities in the next century and other special research projects to further the national aviation system's safety and efficiency. Completed products are normally transmitted to the FAA, industry, and general public as an official TRB circular. The Graduate Research Award Program papers are also presented at a special session of the annual TRB meeting.

101–120 FAA/NASA Joint University Program

Purpose: This program conducts research that is germane to the entire spectrum of National Airspace System (NAS) activities at recognized American universities in cooperation with NASA. It also assists in educating professional personnel needed to develop and manage the future NAS components. Solutions to large scale systems problems related to the national air transportation system ultimately come only after the technological foundations have been laid through basic research. The Joint University Program has provided an interdisciplinary team approach to research and education in those areas necessary for fundamental advances at the forefront of aviation technology. This program provides results to the FAA from scientific and technology advances through research and development at American colleges and universities. Also, the program is a source of talented engineers and scientists skilled in aviation–related fields.

Approach: The FAA/NASA Joint University Program for Air Transportation Research is a coordinated set of three grants sponsored jointly by the FAA and NASA Langley Research Center. Grants are awarded annually to the Massachusetts Institute of Technology, Ohio University, and Princeton University. Principal investigators at each institution prepare an annual research proposal that is based, in part, on suggested topics that are responsive to FAA and NASA long–term needs. The principal investigators are responsible for assembling the research teams, managing the research, and publishing the results. A program expansion through NASA Ames would complement the research currently underway.

101–130 Small Business Innovative Research (SBIR) Program

Purpose: This program stimulates technological innovation, uses small business to meet Federal research and development needs, increases private sector commercialization of innovations derived from Federal research, and encourages participation by small disadvantaged companies in developing technological innovations. The SBIR program is congressionally mandated by the Small Business Research and Development Enhancement Act of 1992 (Public Law (P.L.) 102–504). It is funded through a 1.5 percent assessment on the agency's extramural R,E&D budget plus administrative costs. Project R,E&D funds also may be applied to the SBIR program on an ad hoc basis by individual R,E&D programs. By virtue of its FAA–wide scope, the SBIR program benefits the entire program spectrum that makes up the national air transportation system. The budgetary and technical resources can be applied to these programs in a timely and cost–effective manner. By enabling small, high technology corporations to start up

and prosper, the SBIR contributes in a larger sense to the domestic economy and technology infrastructure.

Approach: Research topics are solicited from the various organizational elements throughout the agency. These topics then appear in an annual solicitation for proposals issued by the Department of Transportation. Individuals who submit the topics evaluate the proposals and winners are chosen based on evaluations and agency needs. Firms selected to receive an award embark on the following three–phase process: Phase I – conduct feasibility–related experimental or theoretical research for R,E&D efforts up to $75,000; Phase II – perform principal research effort (a performance period of approximately 2 years and funding up to $500,000); and Phase III – perform commercialization of the research conducted under Phases I and II.

101–140 FAA/NASA Cooperative Programs

Purpose: This program provides a synergistic and cost–effective R,E&D Program with NASA in areas of mutual interest. FAA engineering field offices have been established at NASA's Ames and Langley Research Centers to support joint FAA/NASA programs and provide coordination on aviation–related NASA work. The FAA engineering field offices represent a unique resource for the FAA due to their proximity and access to NASA facilities, their knowledge of NASA personnel and ongoing NASA research, and their understanding of FAA needs. Benefits realized when the agencies work together include an enhanced perspective on joint research activities, reduced duplication of similar efforts, and conservation of scarce funds and resources.

Approach: Cooperative activities are accomplished via memoranda of agreement (MOA) that incorporate statements of work setting forth specific research thrusts. Joint research activities are performed via memoranda of understanding (MOU) that set forth general areas for cooperative endeavor. Individual research programs are negotiated and undertaken in a manner tailored to meet program–specific objectives, foster cooperative interaction, and share resources and unique facilities. The MOU's encompass Human Factors, Severe Weather, Cockpit/Air Traffic Control (ATC) Integration, Airworthiness, Environmental Compatibility, and Program Support.

Human Factors research develops technology to reduce the consequences from human error in flight operations. Severe Weather improves aircraft operational safety during hazardous weather conditions. Cockpit/ATC Integration improves flight operations safety and efficiency. Airworthiness pursues technologies that support developing and certifying new aircraft and ensure the continued safe operation of existing aircraft. Environmental Compatibility reduces or eliminates aircraft noise and emission concerns. Program Support conducts individual and joint research activities, shares in using unique facilities, and plans orderly information transfer between the two agencies.

101–150 University Fellowship Research Program

Purpose: This program expands the education and research activities associated with emerging concepts and technologies related to air traffic control, aviation safety, and security systems. A corollary purpose is to assist in attracting and recruiting qualified graduates to work for the FAA. The University Fellowship Research Program gives well qualified and highly motivated graduate students an opportunity to conduct thesis research on FAA topics of interest while working with FAA engineers and scientists and university professors. This program provides technology advancements to enhance the National Airspace System capability and improve aircraft safety and security. Educational opportunities will be provided for talented engineers and scientists with the skills, interests, and abilities necessary to accomplish this work. Opportunities will exist to recruit these and other talented, qualified graduates to work for the FAA.

Approach: Participants in the program engage in formal course work at their respective universities and conduct research in FAA laboratories on FAA–directed topics. The program includes expanding universities education and research activities in areas related to air traffic control systems and aircraft safety. Companion education and training activities are included to develop and enhance existing capabilities within the FAA.

101–160 Technology Transfer Program

Purpose: This program promotes technology sharing among Government, industry, and academia, and it transfers FAA R,E&D results into the mainstream of the United States economy. Technology transfer refers to the process by which existing knowledge, facilities, or capabilities developed under Federal funding are used to fulfill public or private domestic needs. The United States is facing increasing challenges to its worldwide technical and economic primacy. A major problem in meeting these challenges is the extremely small return on the $60 billion annual Federal research and development (R&D) investment. The central obstacle to increasing this return has been identified by Congress as the Federal Government's inability to transfer a significant portion of federally funded R&D results into the private sector for commercialization. Several key pieces of legislation have been enacted to overcome this obstacle.

The Stevenson–Wydler Technology Innovation Act of 1980 (P.L. 96–480) mandated that all Federal laboratories assume technology transfer as a primary mission area. It provided the legal foundation for a technology transfer infrastructure within the Federal laboratory system and established an Office of Research and Technology Applications at every Federal R&D activity.

The Technology Transfer Act of 1986 (P.L. 99–502) established the formal tools and mechanisms to accomplish technology transfer and mandated the following elements: (1) establish cooperative research and development agreements (CRDA) between Federal and non–federal parties; (2) establish the Federal Laboratory Consortium, an affiliation of Government laboratories, to support the technology transfer mission; and (3) provide a cash incentive program to promote and encourage individual participation in meaningful technology transfer projects through awards and royalty sharing.

Executive Order 12591 of April 10, 1987, directed all Federal laboratories to establish Technology Transfer Programs. In response to the laws and the Executive Order, the FAA

developed Technology Transfer Order 9550.6 of October 30, 1989, which promulgates the FAA's Technology Transfer Program.

Approach: The FAA Technology Transfer Program goals are to: increase the return on the Federal R&D investment, increase the Nation's base for technical knowledge and experience, translate technical developments into private sector applications, reward technical creativity, and comply with the letter and the spirit of Federal technology transfer legislation.

101–170 Independent Research and Development (IR&D) Program

Purpose: This program encourages contractors to do Independent Research and Development on topics relevant to the FAA's long-term interests. This activity is a joint Government/industry program legislated by Public Law 102–190.

The Government recognizes IR&D as a necessary cost of doing business in a high technology environment and provides for cost recovery in the Federal Acquisition Regulations (FAR). Major contractors doing IR&D projects are requested to provide the FAA with information describing these projects. Descriptions are also submitted to the Defense Technical Information Center (DTIC) on a yearly basis in the prescribed format.

New IR&D legislation no longer requires yearly on–site review evaluations, but encourages IR&D technical interchange meetings. These meetings are arranged by mutual agreement between the contractor and Government to review and discuss a focused set of technology and/or product development projects. The purpose of these meetings is to: promote face–to–face detailed technical interaction between the contractors and the Government; provide opportunities for Government presentations on relevant technical needs and activities; and provide opportunities for Government participants to visit the contractor's facilities and operations.

The IR&D program's benefits are:

- Access to industry views about technical and business directions for the future.
- A broader range of technical options in an R&D project's early phases.
- An available pool of qualified contractors who can respond competently and competitively to Government requirements.
- Spreading the risk and cost of encouraging new ideas and concepts.
- An enhanced capability for continuous innovation to meet technical challenges for the future.

Approach: Generally, a company participating in the IR&D program must prepare an annual report incorporating current projects in progress and proposed for the future. The report is reviewed and evaluated by experts within the participating agency. This review forms part of the basis for awarding future work to the firm and determining the amount of R,E&D costs the company can charge against its Government contracts. At least every third year, a technical review is held at the company's facility. This review provides the agency and the company with feedback on the performance of its programs.

101–180 Aviation Research Grant Program

Purpose: This program provides the FAA with the ability to directly access and influence the considerable resources existing at American colleges, universities, and nonprofit institutions to perform long–term research in aviation–related basic knowledge areas. This is accomplished by awarding grants for aviation research and establishing Air Transportation Research Centers of Excellence. Two pieces of legislation, the Omnibus Budget and Reconciliation Act, Public Law 101–508, and the Aviation Security Grants Act, Public Law 101–604, were enacted and contain provisions authorizing the FAA to issue research grants. Public Law 101–508 establishes three separate programs. These programs are the Aviation Research Grants Program, the Catastrophic Failure Prevention Research Grant Program, and the Air Transportation Research Centers of Excellence Program. Public Law 101–604 authorizes establishing the Aviation Security Research Grants Program.

Collectively, the legislation directs that:

- The FAA be given the authority to award single and multiyear research grants to colleges, universities, and nonprofit institutions.
- The FAA be authorized to establish Centers of Excellence for research into aviation–related areas of unique interest to the FAA.
- Research areas shall cover, at a minimum, ATC automation, aviation artificial intelligence applications, aviation control simulation and training technologies, human factors, airport and airspace planning and design, airport capacity enhancement, aviation security, and aviation aircraft safety.
- At least 3 percent of the total FAA R,E&D budget be devoted to fund the research grant program.
- The FAA shall contribute to creating a talented pool of technical professionals trained in the sciences, engineering, and mathematics, pilotage, and mechanics related to aeronautics and aviation.

Approach: Program execution rests on a set of established internal and external procedures that are updated continuously. A process for advertising, soliciting, and evaluating Aviation Research Grant proposals was developed and initiated. This process, together with a companion process for awarding, administering, and closing out grants, is detailed in FAA Directive 9550.7, Aviation Research Grants. Computer data bases have been established to insure that eligible institutions are notified of the program and that proposals and grant awards are properly tracked. A network of capable proposal technical evaluators and grant technical monitors has been put in place.

An anticipated 40 grant awards will be made during the initial months of program operation. These grants are funded via individual program sponsorship. A Center of Excellence in Computational Modeling in Aircraft Structures was started in FY 1993 at Rutgers/Georgia Tech. Procedures for identifying and initiating follow on Centers of Excellence have been defined and are about to enter the agency coordination process.

101–190 Innovation Development and Engineering Applications (IDEA) Program

Purpose: This program will provide the FAA with a formal structure to ensure that novel ideas for innovative R,E&D projects, proposed by FAA employees or the private sector, will be evaluated and, if feasible, sponsored. The FAA IDEA program is designed to expedite and facilitate technological innovation. This will be accomplished by sponsoring innovative applied research and engineering development projects, both in the FAA and the private sector, through a variety of implementation vehicles. This thrust area is expected to promote: an innovative R,E&D environment, new technology applications to FAA programs, an increase in FAA patents and licenses, increased access to private sector expertise, increased technology transfer, increased employee satisfaction, and total quality management implementation.

Approach: The approach to this program is to establish a focal point within the Office of Research and Technology Applications, ACL–1, that will have discretionary R,E&D funds available. This focal point will act as a catalyst to accomplish research on innovative ideas from within and outside the FAA. The IDEA program will utilize various vehicles such as grants, CRDAs, broad agency announcements, task–order contracts, employee exchange, total quality management, and employee details to aid in timely implementation of these innovative ideas.

The criteria used to evaluate potential innovative research projects will include, but are not limited to:

- Projects that represent ideas or technologies that are promising and should be pursued but are outside the charter of the originating organization.
- Projects that are outside the stated responsibilities of a researcher's position description but seem promising and should be pursued for the FAA's benefit.
- Projects that are not feasible for an organization to pursue because of constraints imposed by time, current project workloads, limited manpower, financial resources, risk factors, or other such limitations.

An ad hoc "council of peers" consisting of experts in various technology areas will be recruited by the program and will serve in a consulting capacity to provide expert advice on proposed projects relating to technologies in their area of expertise. Based on the council's findings, a determination will be made on individual projects.

APPENDIX B

Research, Engineering and Development (R,E&D) Management, Plan, Control, and Support

A process was initiated in FY 1990 to provide more in–depth analysis and control for R,E&D activities. The process emphasizes developing a systems engineering approach to define, implement, and manage the research required for National Airspace System (NAS) development. This process' maintenance and enhancement is critical to the R,E&D Program efficiency and effectiveness. Supporting the R,E&D infrastructure contributes to virtually every project within the R,E&D environment.

The R,E&D infrastructure provides the vehicle to ensure that the total R,E&D Program is conducted as a cohesive, integrated entity and permits evaluating progress across the thrust areas. This is critical due to the integrated nature, both technical and fiscal, of the individual R,E&D projects with each other, with the future aviation system, and with the Aviation System Capital Investment Plan.

R,E&D resources are required for the following efforts:

Research, Engineering and Development Plan

The Aviation Safety Research Act of 1988 mandates that the FAA develop, maintain, and publish the FAA's R,E&D Plan. The Plan describes the R,E&D process, relationships with other R,E&D organizations, National Airspace System and its evolution, and FAA's R,E&D Program.

R,E&D Management, Plan, and Control

The R,E&D management and control process and automated support system will be maintained, refined and further integrated into the R,E&D planning and budgetary processes. Specific products will include publishing the annual R,E&D Plan, associated report to Congress on R,E&D accomplishments from the previous year, technical/engineering schedule support for the R,E&D Program, and the annual R,E&D conference.

R,E&D Advisory Committee

The committee will provide the agency with reports, advice, and recommendations regarding the needs, objective, plans, approaches, contents, and accomplishments with respect to the aviation research program. The committee considers aviation research needs to support the FAA mission and addresses such areas as airport capacity, system safety, aircraft safety, aeromedical research, aviation security, and future ATC technology.

R,E&D Program Support

Provides for in–house support for system engineering and development, international requirements, and NAS program analysis activities.

Technical Laboratory Facility

The FAA Technical Center operates and maintains laboratory facilities to perform test, evaluation, and integration efforts. Funding is required for maintenance, software licensing fees, support costs, and other costs associated with operating the technical laboratories.

System Analysis and Evaluation

This project encompasses system planning, capacity, delay, and performance analyses in the R,E&D Program. NAS–related issues will be analyzed, and cost/benefit studies or other studies to support system investment, planning, engineering, development, and operation will be performed. Major products include cost/benefit assessments to make prudent R,E&D Program investments; management tools; methods and strategies for R,E&D cost containment; and effective delivery of R,E&D benefits. Analyses will be conducted to review major R,E&D initiatives and impacts on system–wide performance and to improve air traffic management.

APPENDIX C

List of Acronyms and Abbreviations

A

AAS	Advanced Automation System
AC	Advisory Circular
ACA	Aviation Security Research and Development Service
ACARS	ARINC Communications Addressing and Reporting System
ACD	Engineering, Research and Development Service
ACE	Aviation Capacity Enhancement
ACES	Aircraft Command in Emergency Situations
ACL	The FAA's Office of Research and Technology Applications
ADR	Automated Demand Resolution
ADS	Automatic Dependent Surveillance
AEM	Area Equivalent Method
AERA	Automated En Route Air Traffic Control
AEX	Automatic Execution Function
AF	Airway Facility
A/G	Air/Ground
AGFS	Aviation Gridded Forecast System
AIP	Airport Improvement Program
AMASS	Airport Movement Area Safety System
AMSS	Aeronautical Mobile Satellite Services
AOC	Airline Operation Control
AOR	The FAA's Operations Research Service
APU	Auxiliary Power Unit
AQP	Advanced Qualification Program
ARINC	Aeronautical Radio, Incorporated
ARTCC	Air Route Traffic Control Center
ARTS	Automated Radar Terminal System
ASD	Aircraft Situation Display
ASDE	Airport Surface Detection Equipment
ASI	Aviation Safety Inspector
ASP	Airfield Smart Power
ASR	Airport Surveillance Radar

ASTA	Airport Surface Traffic Automation
ATA	Air Transport Association of America
ATC	Air Traffic Control
ATCBI	Air Traffic Control Beacon Interrogator
ATCS	Air Traffic Control Specialist
ATCSCC	Air Traffic Control System Command Center
ATCT	Air Traffic Control Tower
ATIS	Automated Terminal Information Service
ATM	Air Traffic Management
ATMS	Advanced Traffic Management System
ATN	Aeronautical Telecommunications Network
AWDL	Aviation Weather Development Laboratory
AWOS	Automated Weather Observing System
AWPG	Aviation Weather Products Generator

B

BAA	Broad Agency Announcement

C

CAA	Civil Aeronautics Administration
CAI	Computer Assisted Instruction
CASA	Controller Automation Spacing Aid
CAT	Category
CCDS	Consolidated Cab Display System
CDTI	Cockpit Display of Surface Traffic Information
CDU	Cockpit Display Unit
CIP	Capital Investment Plan
C/N/S	Communications, Navigation, and Surveillance
CONDAT	Conterminous United States Data Model
COTS	Commercial off–the–shelf
CRDA	Cooperative Research and Development Agreement or Converging Runway Display Aid
CRM	Cockpit Resource Management
CSD	Critical Sector Detector
C/SOIT	Communications/Surveillance Operational Implementation Team
CTAS	Center–TRACON Automation System
CTR	Civil Tiltrotor

D

DA	Descent Advisor
DARPS	Dynamic Aircraft Route Planning Study
DASI	Digital Altimeter Setting Indicator
DDAS	Daily Decision Analysis System
DEMVAL	Demonstration/Validation
DFW	ICAO designator for Dallas–Fort Worth Airport
DGPS	Differential corrected Global Positioning System
DME	Distance Measuring Equipment
DOD	U.S. Department of Defense
DOT	U.S. Department of Transportation
DOTS	Dynamic Ocean Track System
DSS	Decision Support System
DSUA	Dynamic Special Use Airspace
DTIC	Defense Technical Information Center

E

EDP	Expedite Departure Path
EDS	Explosives Detection System
EFF	Experimental Forecast Facility
EMCC	En Route Maintenance Control Center
EPA	Environmental Protection Agency
ETMS	Enhanced Traffic Management System

F

F&E	Facilities and Equipment
FAA	Federal Aviation Administration
FAATC	Federal Aviation Administration Technical Center
FANS	Future Air Navigation System
FAR	Federal Aviation Regulation(s)
FAST	Final Approach Spacing Tool
FBL	Fly–By–Light
FBW	Fly–By–Wire
FDAD	Full Digital ARTS Display
FDIO	Flight Data Input/Output
FLOWSIM	Flow Simulation Model
FMA	Final Monitor Aid

FMS	Flight Management System
FRP	Federal Radionavigation Plan
FTMI	Flight Operations and Air Traffic Management Integration
FY	Fiscal Year

G

GA	General Aviation
GDP	Gross Domestic Product
GLONASS	Global Orbiting Navigation Satellite System
GNASS	General National Airspace System Sector
GNSS	Global Navigation Satellite System
GPS	Global Positioning System

H

HAPR	High Altitude Pollution Research
HARS	High Altitude Route System
HF	High Frequency
HIRF	High Intensity Radiated Fields
HNM	Heliport Noise Model
HSCT	High Speed Civil Transport

I

I–Lab	Integration and Interaction Laboratory
ICAO	International Civil Aviation Organization
IDEA	Innovation Development and Engineering Applications
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
INM	Integrated Noise Model
INS	Inertial Navigation System
IR&D	Independent Research and Development
ISMS	Integrated Security Management System
ISN	Intelligent Service Network
ISSS	Initial Sector Suite System
ITS	Intelligent Tutoring System
ITWS	Integrated Terminal Weather System

J

JFK	ICAO designator for John F. Kennedy International Airport

L

LIDAR	Light Detection and Ranging
LIP	Limited Installation Program
LLWAS	Low–Level Windshear Alert System
LOFT	Line–Oriented Flight Training
Loran	Long–Range Navigation

M

MA	Monitor Alert Function
MASPS	Minimum Avionic System Performance Standards
MCC	Maintenance Control Center
MDCRS	Meteorological Data Collection and Reporting System
MEM	ICAO designator for Memphis Airport
MLS	Microwave Landing System
MOA	Memorandum of Agreement
Mode S	Mode Select Discrete Addressable Secondary Radar System with Data Link
MOPS	Minimum Operational Performance Standards
MOU	Memorandum of Understanding
MRI	Magnetic Resonance Imaging

N

NAM	NAS Area Manager
NANIM	Nationwide Airport Noise Impact Model
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NASPAC	National Airspace System Performance Analysis Capability
NASSIM	NAS Simulation
NAWPG	National Aviation Weather Products Generator
NDI	Nondestructive Inspection
NDT	Nondestructive Testing
NEXRAD	Next Generation Weather Radar
NIOSH	National Institute of Occupational Safety and Health
NMR	Nuclear Magnetic Resonance
NOAA	National Oceanic and Atmospheric Administration

NOM	NAS Operations Manager
NOTAM	Notice to Airmen
NRC	National Research Council
NSC	National Simulation Capability
N-SDAT	National Airspace Sector Design Analysis Tool
NTP	National Transportation Policy
NWS	National Weather Service

O

OAI	Outage Assessment Inventory
OAS	Oceanic Automation System
OBOGS	On-Board Oxygen Generating System
OCC	Operations Control Center
ODAPS	Oceanic Display and Planning System
ODF	Oceanic Development Facility
OPTIFLOW	Optimized Flow Planning
OR	Operations Research
ORD	Operational Readiness Date
ORTA	Office of Research and Technology Application
OSI	Open Systems Interconnection
OT&E	Operational Test and Evaluation
OTFP	Operational Traffic Flow Planning

P

PADS	Planned Arrival and Departure System
PBW	Power-By-Wire
PC	Personal computer
PDC	Pre-Departure Clearance
P.L.	Public Law
PRM	Precision Runway Monitor
PTS	Pre-Training Screen

R

R&D	Research and Development
RAWPG	Regional Aviation Weather Products Generator
RDU	ICAO designator for Raleigh-Durham airport
R,E&D	Research, Engineering and Development

RF	Radio Frequency
RFP	Request for Proposal
RMMS	Remote Maintenance Monitoring System
RMP	Rotorcraft Master Plan
RNAV	Area Navigation
RNP	Required Navigation Performance
RSLS	Runway Status Light System
RTCA	Radio Technical Commission for Aeronautics
RVR	Runway Visual Range

S

SARPs	Standards and Recommended Practices
SATCOM	Satellite Communications
SATORI	Situational Awareness Through Re–creation of Incidents
SBIR	Small Business Innovation Research
SC	Special Committee
SDAT	Sector Design and Analysis Tool
SE	Strategy Evaluation
SIDP	Supervisory Identification Development Program
SIMMOD	A trademark name for the FAA's Airport and Airspace Simulation Model
SMARTFLO	Knowledge–based Flow Planning
SORS	Seats or Restraint System
SPEARS	Screener Performance Evaluation And Reporting System
SSR	Secondary Surveillance Radar
STPG	Scientific Task Planning Group

T

TACAN	Tactical Air Navigation
TASS	Terminal Area Surveillance System
TATCA	Terminal ATC Automation
TCAS	Traffic Alert and Collision Avoidance System
TCCC	Tower Control Computer Complex
TDWR	Terminal Doppler Weather Radar
TERPS	Terminal Instrument Procedures
TFM	Traffic Flow Management
TIDS	Tower Interim Display System
TMA	Traffic Management Advisor
TMS	Traffic Management System

TMU	Traffic Management Unit
TNA	Thermal Neutron Analysis
TRACON	Terminal Radar Approach Control
TRB	Transportation Research Board
T–SDAT	Terminal Airspace Sector Design Analysis Tool
TSR	Terminal Surveillance Radar

U

U.S.	United States
USWRP	United States Weather Research Program

V

VERTAPS	Vertical Flight Terminal Area Procedure Development Plan
VertOps	Vertical Flight Operations and Certification program
VF	Vertical Flight
VFR	Visual Flight Rules
VHF	Very High Frequency
VMC	Visual Meteorological Conditions
VNTSC	Volpe National Transportation Systems Center
VOR	VHF Omnidirectional Range
VORTAC	Collocated VOR and TACAN

2D	2–Dimensional
3D	3–Dimensional
4D	4–Dimensional

APPENDIX D

Alphabetical Index of R,E&D Projects

APPENDIX E

Project Changes Since The 1991 R,E&D Plan

Projects that have been completed, renamed, combined, or withdrawn since the 1991 R,E&D Plan publication are listed by chapters.

PROJECT NUMBER	PROJECT TITLE	LAST ACTIVITY
	Capacity and Air Traffic Management Technology	
021–110	Advanced Traffic Management System sections pertaining to Dynamic Ocean Track System (DOTS)	Combined With Project 021–140
021–140	Oceanic ATC Automation to Oceanic Air Traffic Automation	Name Change
021–150	ATC Applications of Automatic Dependent Surveillance (ADS)	Combined With Project 021–140
021–160	ATC Automation Bridge	Completed in FY 1993
021–170	Advanced Automated En Route ATC (AERA) Concepts	Withdrawn in FY 1992
021–200	Surface Movement Safety and Guidance	Combined With Project 021–190 FY 1992
021–210	Tower Interim Display System to Tower Integrated Display System	Name Change FY 1992
021–220	Airport Capacity Improvements to Multiple Parallel Approach Procedures	Name Change
021–230	Wake–Vortex Avoidance/Advisory System to Wake–Vortex Separation Standards Reduction	Name Change FY 1992
025–110	National Simulation Laboratory (NSL) to National Simulation Capability (NSC)	Name Change FY 1992
026–110	System Technology Concepts and Methodologies to Airway Facilities System Technology Concepts and Methodologies	Name Change FY 1993
026–120	Diagnostic Tools and Future Technology to Airway Facilities Diagnostic Tools and Future Technology	Name Change FY 1993

PROJECT NUMBER	PROJECT TITLE	LAST ACTIVITY
026–130	Functional Models and Evaluation Tools to Airway Facilities Functional Models and Evaluation Tools	Name Change FY 1993
	Communications, Navigation, and Surveillance	
033–120	Mode S Sensor Data Link Enhancement	Withdrawn in FY 1993
	Weather	
	Airport Technology	
051–140	Demonstrations and Concepts Evaluation	Terminating in FY 1993
	Aircraft Safety Technology	
064–110	Flight Safety/Atmospheric Hazards Research to Flight Safety/ Atmospheric Hazards	Name Change FY 1992
	System Security Technology	
	Human Factors and Aviation Medicine	
083–110	Airway Facilities Maintenance Human Factors to Airway Facilities Human Factors	Name Change FY 1992
	Environment and Energy	

For information on the subjects discussed in this document, contact the Manager, NAS Planning Division, APM-300, NAS Program Management Service, Federal Aviation Administration, 800 Independence Avenue, Washington, D.C. 20591.

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