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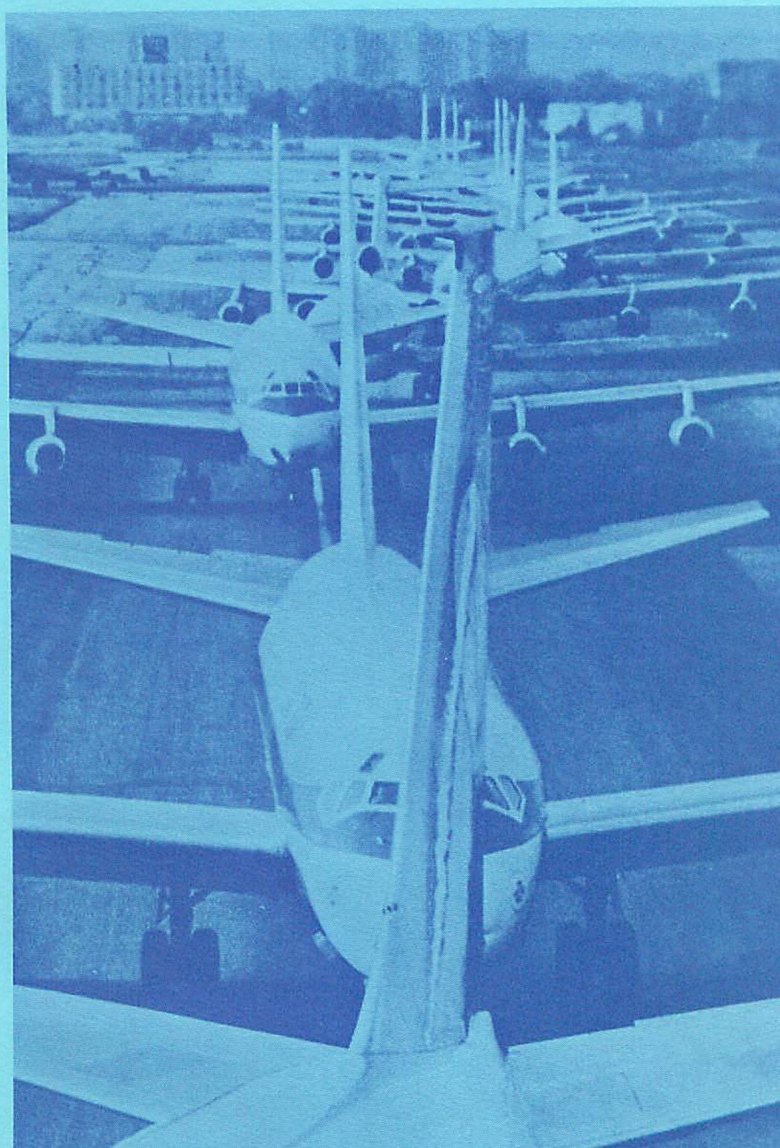

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16. Abstract

The first edition of the Airport Capacity Enhancement Plan has been developed by the Federal Aviation Administration's newly established Airport Capacity Program Office (ACPO). The plan is intended to increase the capacity and efficient utilization of airports, and to alleviate current and projected aircraft operating delays in the nation's airport system without compromises to safety or to the environment.

This plan delineates the goals of the capacity enhancement program. It identifies the concerns of air system users and defines the extent and causes of the capacity and delay problem as it currently exists and is projected for the next decade. The allocation of responsibility for capacity and delay activities within the FAA is discussed. The 53 planned and ongoing FAA projects intended to reduce capacity-related problems are identified.

The plan provides descriptions of each of these projects, significant milestones, estimates of their capacity-related benefits, and references to more detailed descriptions of each project.

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PREFACE

The Federal Aviation Administration has sponsored the first edition of this Airport Capacity Enhancement Plan. The plan was developed by the FAA's newly established Airport Capacity Program Office (ACPO). By delineating projects aimed at reducing airport operating delays, the plan is designed to increase the capacity and efficiency of airports without sacrificing safety and enviromental concerns.

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EXECUTIVE SUMMARY

This plan provides a framework for the Federal Aviation Administration's airport capacity improvement program. The program is intended to increase the capacity and efficient utilization of airports, and to alleviate current and projected aircraft operating delays in the nation's airport system without compromises to safety or to the environment.

THE AIRPORT CAPACITY ENHANCEMENT PLAN (ACEP)

This plan:

- Identifies the concerns of air system users and other constituents which affect the causes of, and potential solutions to, the capacity and delay problem;
- Defines the extent and causes of the capacity and delay problem as it currently exists and is projected for the next decade;
- Delineates the goals of the capacity enhancement program;
- Discusses the allocation of responsibility for capacity and delay activities within the FAA; and
- Identifies and describes the 53 planned and ongoing FAA projects intended to reduce capacity-related problems.

The plan provides descriptions of each of these projects, significant milestones, estimates of their capacity-related benefits, and references to more detailed descriptions of each project.

THE PROBLEM

Air transport is a vital part of the United States transportation system, dominating long-distance passenger travel and serving as a major mode for cargo shipment. The wide availability of safe and timely air travel at a reasonable cost, which has been essential to the nation's economic growth, has been possible because of the extensive national system of airways and airports. Approximately 3,200 airports are available to the public, but most aviation activity is concentrated at a much smaller number of airports serving population centers.

It is these airports that have absorbed most of the big traffic increases of recent years. As an example, <u>for the first few months of 1984, seven of the major U.S. airports accounted for 60 percent of the reported delays of more than 15 minutes</u>. While weather remains the principal cause of

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aircraft delay, airport congestion has become an important delay-causing factor. Historically, serious congestion problems had been confined to a small number of airports serving the nation's largest metropolitan areas. Airline deregulation has allowed an increase in the concentration of air carrier service at these hubs, and a general expansion of the airline industry.

It is expected that capacity-related delays will become a problem at more and more airports. Population growth, air industry deregulation, the gradual lifting of traffic restrictions imposed in the wake of the 1981 air traffic controllers' strike, and a strong economy spurred a 12 percent increase in aircraft operations between 1982 and 1984. Commuter operations rose by 29 percent over this period, air carrier operations grew by 20 percent, and there was an eight percent increase in general aviation operations. These high traffic levels have been accompanied all too often by rising numbers of delayed operations. Between 1983 and 1984, average delay per flight rose nearly 12 percent to 12.8 minutes.

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Delays tend to be concentrated at peak travel times during the day and during the year. Schedule adjustments that would enable airport capacity to be used more consistently throughout the day may inconvenience passengers and disadvantage some carriers. The desire to accommodate passengers' demand for peak-hour travel has been a factor in promoting the airlines' expanded use of the "hub and spoke" concept, which was instituted to make more efficient use of airline resources but also has contributed to the delay problem.

In 1985, there was some reduction in delays from 1984 levels; this reduction may be largely due to airspace improvements (e.g., rerouting and resectoring) and other air traffic control initiatives. However, the delay problem is likely to worsen as a healthy economy stimulates further demand for air transport over the next decade. Air traffic is projected to grow at a 4.5 percent annual rate for the next ten years; this estimate may be conservative, given that growth over the previous 12-year period averaged 5.5 percent annually. Forecasts of continued growth in air traffic raise the prospect that more flights will be delayed for increasingly longer periods of time at more airports unless actions are taken to expand airport capacity.

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More flights will be delayed for increasingly longer periods of time at more airports unless actions are taken to expand airport capacity.

Delays are undesirable because they are costly to the airlines, to the airport operators, and to the passengers; even short delays may have relatively high costs to passengers if they result in missed connections. Delays have a negative impact on the communities and industries whose economic vitality depends on timely and efficient air travel. To ensure the continued growth of the air transport industry and the nation that it serves, it is important that action be taken to alleviate the delay problem.

THE CONSTRAINTS

The civil aviation community is large and varied; all members are affected by, and have an impact on, the delay problem. This community includes the traveling public, the regional and national air carriers, commuter and air taxi operations, general aviation, the aircraft manufacturing industry, airport operators, the communities served, state and local authorities, and the FAA. It will take a cooperative effort involving all of these parties to resolve the capacity and delay problem.

The delay problem, and its solutions, are multi-dimensional. In addition to the requirement that methods of capacity enhancement and delay reduction may not degrade safety, potential solutions to the problem are constrained by a variety of economic, technical, environmental, and socio-political factors. These constraints include the following:

- The construction of new airports and the expansion of the physical plant of existing airports is extremely expensive and frequently encounters resistance from residential and commercial interests.

- The development of technical solutions is a lengthy process requiring careful planning and long lead times to ensure safe and effective implementation.

- The quality of life and the environment of areas adjacent to airports may not be diminished; few communities will accept increased noise levels or other adverse environmental impacts solely to achieve reductions in delay.

- Land use patterns, particularly with respect to the presence of terrain obstructions, often form a major impediment to capacity enhancement actions.

- Increasing demands by military users for restricted use airspace and establishing military installations, particularly in the west and southwest, severely constrain the expansion of civil airport and airspace capacity.

THE SOLUTIONS

The available solutions to the capacity and delay problem fall into four general classes:

- Airspace procedure improvements:

  The development of new technology, and the enhancement of existing procedures and technology, to make more efficient use of existing capacity;

- Airport improvements:

  The development of new, and expansion of existing, airport facilities;

- Aircraft improvements:

  The development of aircraft with operating characteristics that enable existing procedures and capacity to be used more effectively; and

- Demand management:

  The management of demand for access to airports.

Generally, the implementation and application of some available solutions are the responsibility of the non-Federal elements of the civil aviation communities. Decisions regarding the construction, development, and maintenance of local airports ultimately must be made by local airport authorities. Aircraft manufacturers choose to produce certain kinds of aircraft. Aircraft operators specify the types of aircraft and equipment they will purchase, and make decisions regarding flight scheduling.

FAA ROLE

The primary role of the FAA is to promote safety and provide for the safe and efficient use of airspace; it is also must work to "encourage and foster the development of civil aeronautics and air commerce." Even though the FAA's role and resources in effecting the above-mentioned solutions is limited, the FAA provides major assistance in resolving the delay problem through its management of the Air Traffic Control system; its provision of grants-in-aid to airport authorities; and its research, engineering, and development activities.

The FAA has embarked on a major system modification program, the National Airspace System Plan, which will provide the tools for a more efficient and effective national airspace system. Congressional funding for the Airport Improvement Program, which is the major airport development program and is included in this plan, has been increased from about $450 million per year in 1982 to over $1 billion in fiscal 1986. The FAA works with the aviation community in the development of the National Plan for Integrated Airport Systems, but recognizes that the critical initiative for airport improvement and change rests with the communities which own and operate the airports. In 1986, the FAA will spend over $600 million on more than 50 capacity-related projects. Although this may appear to be a large expenditure in absolute terms, it is small relative to other aviation-related expenditures. For example, annual aircraft sales are estimated at $18 billion, scheduled passenger and air cargo traffic amounted to $36 billion in 1984, the cost of building the major new airport at Dallas-Fort Worth was $2 billion, and the FAA will spend $12 billion over the next decade to upgrade the National Airspace System.

In 1986, the FAA will spend over $600 million on 50 capacity-related projects.

The FAA's efforts to reduce delay and enhance capacity represent a broad range of activities and are performed by various elements of the FAA. To coordinate and focus the impact of the projects, the Administrator has established an Airport Capacity Program Office (ACPO) under the FAA's Associate Administrator for Airports. The ACPO is the FAA's major internal advocate on airport capacity matters and, on behalf of the Associate Administrator for Airports and the FAA Administrator, coordinates the development, testing, demonstration, and implementation of programs and procedures aimed at improving airport capacity. The ACPO also acts as the agency's liaison with the airport and aviation community in dealing with airport capacity issues. The ACPO will formulate and annually update the Airport Capacity Enhancement Plan, which encompasses short-term, medium-term, and long-term objectives, and guides the FAA's capacity enhancement activities.

PROJECTS WITH HIGHEST CAPACITY IMPACT

NEAR-TERM (1-5 YEARS)

Airport Improvement Program (A.I.P.)

New airports and the expansion and improvement of existing airports under the A.I.P. presently provide the greatest opportunities for airport capacity improvements. The program requires congressional re-authorization in 1987.

IFR Approaches to Converging Runways

FAA has adapted an interim criterion for conducting converging runway operations that will permit converging IFR operations at a limited number of airports. The only major disadvantage of the interim solution is that the conservatism built into the airspace requirements restricts its applicability and prevents its use when ceilings are much below 500 feet. Work continues on methods for achieving lower decision heights.

Independent Closely-Spaced Parallel Approaches

An effort to develop and demonstrate safe simultaneous operations to parallel runways separated by at least 3000 feet is underway. If successful, many airports can achieve capacity gains during IFR operations. Efforts are continuing on the identification of a surveillance sensor (or some alternative means) which can provide sufficient accuracy and displays to allow the aircraft to respond to deviations on approach and landing.

Separate Short Runways

The goal is to increase the IFR capacity of major airports by developing procedures and equipment (if necessary) to allow smaller aircraft to use shorter runways (4000 to 6000 feet) without mixing with other operations. The benefits fall into two categories. First, more aircraft will be able to use the airport during IFR. The increase in the number of smaller aircraft capable of using shorter runways would free the longer runways for larger aircraft. Second, by segregating the traffic between long and short runways, the smaller aircraft will be grouped together; the average in-trail separations will be smaller because wake vortices will not be a factor on the shorter runway. Implementation of these procedures could have a substantial impact on capacity.

Triple IFR Approaches

Because of the increased use of the hub and spoke concept, arrivals come in bunches requiring occasional needs for arrival capacities which are much higher than the average arrival rate. The use of three simultaneous arrival streams to an airport implies that about 75 aircraft per hour could land. If used during IMC weather conditions where triple runway combinations are available, that much capacity would eliminate current delays caused by insufficient airside capacity; ground-side capacity would become the constraining factor, even at an airport as large as Chicago O'Hare.

The development of procedures to support triple IFR approaches is underway. Acceptable missed approach procedures and adequate surveillance systems must be developed prior to implementation.

LONG-TERM (OVER 10 YEARS)

4D Navigation in the Terminal Area

The use of time as a method for ensuring separation while increasing efficiency will be a major part of the terminal ATC automation program. The current time variability of aircraft following a trajectory requires that actual separations be increased above the minimum in order to account for early and late arrivals at congestion points (fixes, runways, taxiways). Because of the variability in arrival times in today's environment, it is too difficult for the controllers and pilots to coordinate alternating approaches (except in the special case of dependent parallel approaches). One major advantage of 4D navigation is that it may allow coordinated, alternating approaches to several runways (parallel or non-parallel) at airports where runway spacing is less than the minimum for independent operations.

Terminal ATC Automation

Through the use of computer-aided decision-making to assist the controller and pilots in sequencing and scheduling arrivals and departures, the variability in arrival/departure times can be reduced. The reduced variability may allow a safe reduction in certain separation standards leading to capacity gains but, even if no reduction is possible, the reduction in variability increases the use of resources and simplifies the pilot's and controller's jobs. Terminal automation programs require careful planning and coordination among the industry, airspace users, FAA offices, aircraft manufacturers, avionics manufacturers, and others. Consequently, the immediate goal is to generate a system description and requirements document that provides a logical basis for future development and program coordination.

PROJECTS WITH MODERATE TO SIGNIFICANT CAPACITY IMPACT

NEAR-TERM (1-5 YEARS)

Microwave Landing System (MLS)

The implementation of the new common civil/military approach and landing system to meet current and anticipated user operational requirements will produce capacity gains based on the greater flexibility afforded by MLS coverage.

Runway Configuration Management System

Implementation and evaluation of an aid to the Traffic Management Unit that will assist in the selection of the runway configuration yielding the greatest capacity.

Terminal Radar Enhancements

This project will provide development and support for the Automation Radar Terminal System (ARTS) to ensure that its availability, reliability, and capacity remain acceptable as demand increases, thus reducing delays to airspace users.

Wind Measuring Equipment/LLWAS

Installation of LLWAS to monitor winds and alert the controller to the existence of wind shear conditions will allow the controller to smooth the transition between different runway configurations. Improvement of the detection probability and reduction of the false alarm rate of the LLWAS will improve flight planning and reduce disruptions at LLWAS airports.

Rotorcraft ATC Procedures

Providing technical methodologies, tools, and a data base to support improvements to the ATC system for fuller integration of rotorcraft into the NAS may relieve congestion in dense traffic areas for both rotorcraft and fixed-wing aircraft.

Rotorcraft Landing and Navigation

The development and evaluation of navigation and landing capabilities for future implementation of systems that will provide basic IFR services for rotorcraft operations is necessary for providing primary system capacity.

Approach Lighting

Improved approach and runway lighting and visual aids will support landings under reduced-minimum weather conditions.

Establish Visual NAVAIDS

The goal of this project is to provide visual navigation aids (e.g., runway end identification lights) that allow operations during adverse weather conditions.

RVR Establish/Upgrade

The upgrading of existing RVR systems and establishment of new systems will allow operations to lower weather minimums.

Airport Design and Configuration Improvements

Development of improved airport designs and configurations will provide greater airport capacity, as well as increased safety and efficiency of ground movement for current and future aircraft.

MEDIUM-TERM (6-10 YEARS)

Airport Surface Surveillance, Guidance and Control Systems

Several projects fall in this category: Airport Surface Surveillance, All-Weather Taxiway Guidance, and Airport Surface Traffic Automation. The completion of these projects will allow efficient separation assurance during low visibility operations on the airfield. They will improve safety by allowing more careful monitoring of runway taxiway intersections to prevent runway incursions. The management of ground movements will reduce congestion by providing precise gate release times and sequencing of departures.

Next Generation Weather Radars

Development of a new generation of Doppler weather radars will improve hazardous weather detection, improve flight planning and reduce delays.

Upgrade Arrivals/Demand Algorithms

Modification of the Central Flow Control Estimated Departure Clearance Time algorithm to account for prediction uncertainties will enable more efficient use of an airport's capacity.

Departure Flow Metering

The goal of this project is to refine the coordination process between airport, terminal, and en route controllers so that departure slots and times can be determined more precisely to minimize delays for departing aircraft. Prototype systems are being developed and field-tested.

Traffic Management With Arrival Time Commitments

This includes the development of operational procedures and associated processing to enable the traffic management system to plan for, negotiate, and honor airport landing time commitments.

Wake Vortex Operational Solutions

This project focuses on the development of procedures that use the increased precision and flexibility of MLS to provide multiple approach paths that enable planes to avoid each other's wake vortices. This will allow a reduction in the separation requirements, thus increasing airport capacity.

Methods of Reducing Runway Occupancy Time

This project will investigate technologies to reduce both the average runway occupancy time and its variability. With the introduction of automation in the terminal area, runway occupancy time will be one of the limiting factors on runway capacity; a decrease will allow runways to be used more efficiently, thus increasing capacity.

LONG-TERM (OVER 10 YEARS)

Wake Vortex Avoidance, Forecasting, and Alleviation

This project aims to improve current methods of avoiding hazardous wake vortex encounters by adopting general separation standards and procedures that more accurately reflect the actual hazard, and by adapting the separations to the real-time duration of the hazard.

Sensor Improvements

Improvement of the detection, accuracy, and resolution of current FAA radar sensors in support of procedures that allow separations between aircraft to be reduced would increase capacity in the terminal area.

Low Altitude Surveillance for Rotorcraft and G.A. Aircraft

This project is to provide surveillance for rotorcraft and fixed wing aircraft at low altitudes not covered by existing surveillance systems through the use of LORAN-C and other dependent surveillance schemes. This project will be particularly useful in certain high-density urban areas and off-shore operations where rotorcraft play a predominant role.

Mode S Data Link Program

The Mode S data link system offers benefits for projects including 4D navigation, terminal automation, and automated weather reporting. This project will develop, test, and validate operational concepts for data link applications.

Computer-Aided Decision-making Assisted Air Traffic Management Techniques

This project will develop, test, and validate techniques for using expert systems to aid controller decision-making.

Advanced Wind Shear Sensor Development

This project involves research on the measurement of wind fields using advanced technology sensors to determine their effectiveness in an operational airport environment and, if cost and performance warrant, development for airport deployment.

Weather Sensor Development

The evaluation of new systems for weather detection and assessment will provide better forecasting and planning, which will result in improved system efficiency and throughput.

THE OUTLOOK

In 1984, 11 major airports were seriously congested; given projected increases in operations, it is predicted that 22 airports will suffer serious congestion in 1995 unless their capacities are increased. As congestion increases, delay becomes exponential, and the costs of delay rise. It is estimated that **the cost of delay to passengers and air carriers was more than $4.6 billlion in 1984**. While the magnitude of the delay cost in 1995 may be unknown, the trend clearly is toward higher costs.

In 1984, 11 major airports were seriously congested; given projected increases in operations, it is predicted that 22 airports will suffer serious congestion in 1995 unless their capacities are increased.

The cost of delay to passengers and air carriers was more than $4.6 billion in 1984.

The improvement in the delay situation in 1985 relative to 1984 does not mean that the capacity problem is being resolved; more than 900 operations were still being delayed every day in 1985. Despite all the FAA efforts on airspace procedure development, systems development, and airport improvements, congestion will continue to increase unless communities are more aggressive with respect to airport development (including the acquisition of land to meet projected future airport needs) and aircraft operators shift demand to less congested airports and to off-peak hours.

It appears that the airport capacity problem is a result of the great success of aviation. Solving the problem will require a shared effort by airport operators, aircraft operators, state and local authorities, and the FAA. The ACPO will be an advocate and coordinator of these efforts.

1.0 INTRODUCTION

1.1 OVERVIEW OF THE AIRPORT CAPACITY PROBLEM

Air travel is a vital part of the United States transportation system. Each year over 350 million passengers and billions of dollars worth of merchandise are flown throughout the country. The availability of safe and timely air travel at a reasonable cost has been important to domestic economic growth and to the growth of international trade. Air transport is a major consideration in business marketing, investment and organizational strategies.

The economic impacts of civil aviation are considerable. Scheduled passenger and cargo traffic generate approximately $36 billion in annual revenues, and it is estimated that civil aircraft sales amount to over $18 billion annually. Air carriers and general aviation provide direct employment for approximately 500,000 people.

The direct and indirect economic impacts of civil aviation are important not only to the nation as a whole but also to regional economies. The existence of a local airport expands trade with other regions, attracts new businesses, and promotes tourism. For example, the Florida Department of Transportation estimated in 1983 that general aviation alone created 10,000 jobs in the state; the Air Transport Association estimates that scheduled airlines serving Massachusetts generate $2 billion annually for the state's economy.

Safe and efficient aviation would not be possible without the nation's extensive system of airways and landing areas. There are currently some 3,200 airports available to the public with at least one paved and lighted runway. Of these, 552 airports enplane more than 2,500 passengers annually. Table A-1 in Appendix A describes standard airport and hub classifications.

Nonetheless, aviation activity is highly concentrated at a relatively few airports serving large urban areas. In 1983, 50 primary commercial airports accounted for over 80 percent of all passenger enplanements (see Figure 1-1 and Appendix Table A-2). The top fifty commercial and general aviation airports handled over 30 percent of all 1983 aircraft operations (see Figures 1-2 and 1- 3 and Appendix Table A-3).

In 1983, 50 primary commercial airports accounted for over 80 percent of all passenger enplanements.

The top fifty commercial and general aviation airports handled over 80 percent of all 1983 aircraft operations.

Traffic levels at several of these large hub airports reached record highs in recent years, and it is anticipated that a healthy economy will stimulate further air traffic growth throughout the system during the next decade. Rising numbers of delayed operations have all too often accompanied these high traffic levels. Operations delayed for at least 15 minutes reached 1,600 per day in October, 1984. Delays in October, 1985 averaged about 1,200 per day.

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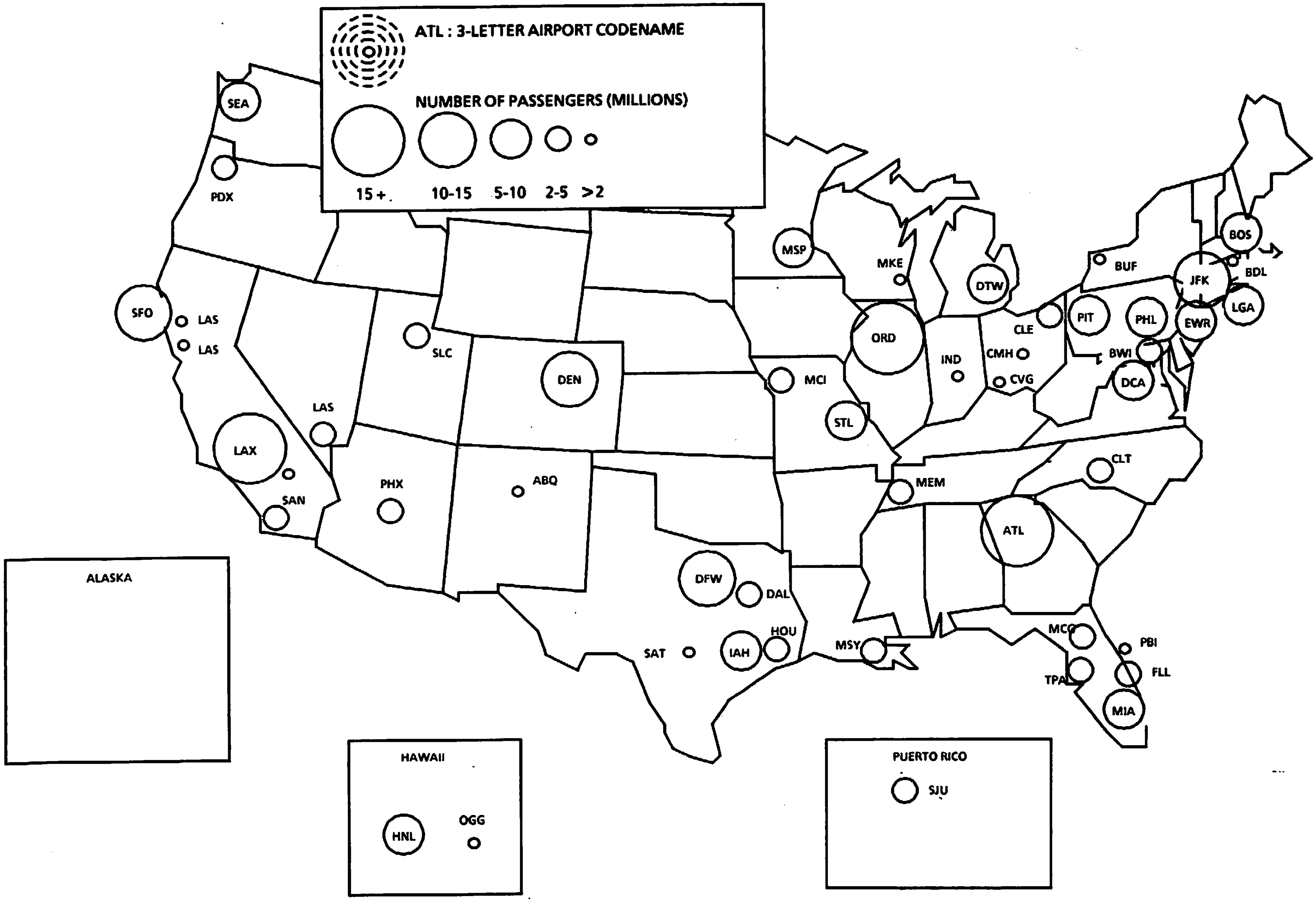


FIGURE 1-1 TOP 50 AIRPORTS RANKED BY TOTAL 1983 PASSENGER ENPLANEMENTS

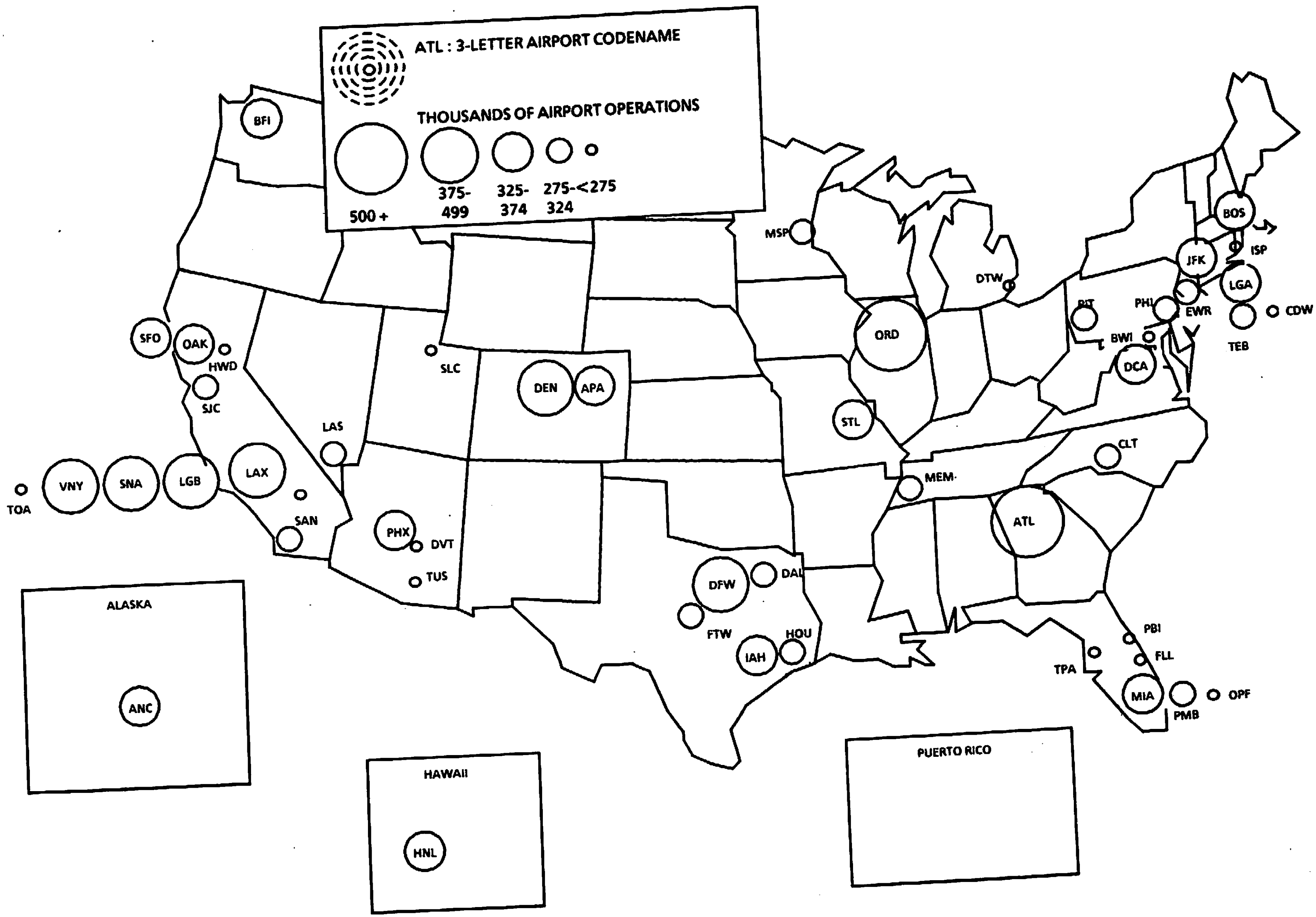


FIGURE 1-2 TOP 50 AIRPORTS RANKED BY TOTAL 1983 AIRPORT OPERATIONS

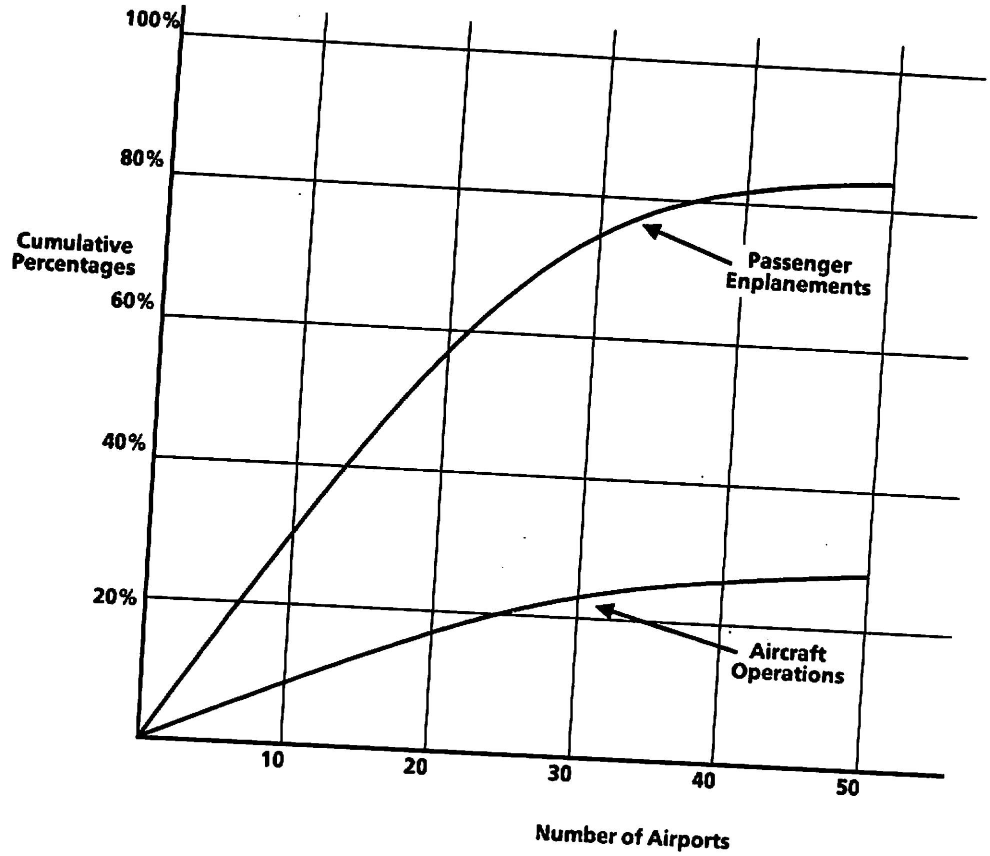


FIGURE 1-3 CUMULATIVE PERCENTAGES OF TOTAL 1983 PASSENGER ENPLANEMENTS AND AIRCRAFT OPERATIONS

In response to the 1983-84 delays, airlines made more than 1,300 schedule changes to alleviate peak-hour congestion at six airports. Many airlines instituted two-tiered fare structures to encourage off-peak travel. The FAA also made efforts to reduce delays through refinements in the air traffic control system. These efforts combined to reduce delays from the highs reached in 1984; nonetheless, forecasts of continued growth at our major airports raise the prospect of growing numbers of flights delayed for longer and longer periods of time.

1.2 HISTORY OF FAA INVOLVEMENT IN AIRPORT CAPACITY

Delays are costly to all who use the airport system. To the airlines and other aircraft operators, delay results in wasted fuel and additional costs for crew, maintenance, and rescheduling. To the traveling public, delays represent wasted time, and missed connections and appointments. Those who bear the heaviest cost of increased airport delay are the communities and industries whose prosperity is closely linked with the availability of dependable air travel.

Unless further action is taken to enhance the capacity of the nation's airports, it is clear that delays will worsen and may eventually pose a serious obstacle to the continued growth of the air transport industry.

The improvement of airports' abilities to handle traffic is a major FAA goal. Guided by the National Plan of Integrated Airport Systems, there has been a major Federal investment in the United States airport system through the Airport Improvement Program's (AIP) grants-in-aid for the provision and improvement of airport facilities. Over the last decade, Federal grants averaging approximately $450 million annually have been provided to publicly-owned airports nationwide - a considerable investment that has been concentrated on the provision of airport pavements, taxiways, and safety equipment. Expenditures have increased steadily over recent fiscal years.

Over the last decade, Federal grants averaging approximately $450 million annually have been provided to publicly-owned airports nationwide.

The AIP is the most recent version of a Federal airport grants program, but Federal grants to airports began with the passage of the Federal Airport Act which created the Federal-Aid Airport Program (FAAP) in 1946. In 1970, a more comprehensive program was established with the passage of the Airport and Airway Development Act of 1970. This Act provided for two separate programs: the Planning Grant Program (PGP) for airport planning, and the Airport Development Aid Program (ADAP) for airport development. Unlike the FAAP, which was subsidized by the general fund of the Treasury, these programs were funded from a new Airport and Airway Trust Fund, supported by revenues from several aviation user taxes on such items as airline fares, air freight, and aviation fuel. This trust fund concept guaranteed a stable funding source whereby users paid for the services they received. The Act, after several amendments and a one-year extension, expired on September 30, 1981. From 1970 through 1981, 8,089 grants totalling $4.5 billion were approved for airport planning and development.

From 1970 through 1981, 8,089 grants totalling $4.5 billion were approved for airport planning and development.

The commitment of these resources provided additional capacity to accommodate air traffic. Through FAA and industry efforts, new runways were constructed, instrument landing systems were installed, and airport and air route surveillance systems were increased. Progress also was made in reducing airport noise, as airlines purchased quieter planes and the FAA assisted in developing noise abatement policies.

In 1974, the FAA initiated a program of sponsoring local capacity enhancement task forces at congested airports. Each task force developed a coordinated government/industry/community/airport action plan for reducing airport delay. Task force action plans were developed for eight airports before this activity was largely suspended at the time of the air traffic controllers' strike. In 1982, the FAA requested the aviation community to study the problem of airport congestion. In response, an industry task force on Airport Capacity Improvement and Delay Reduction, chaired by the Airport Operators Council International, developed a number of near-term and long-term recommendations for increasing the capacity of the airport and airway system.

Efforts to enhance airport capacity and relieve congestion must continue to involve airport operators and airport users as well as the FAA.

Efforts to enhance airport capacity and relieve congestion must continue to involve airport operators and airport users as well as the FAA. Decisions regarding the construction, development, and maintenance of local airports ultimately must be made by local airport authorities. Aircraft operators make the final decisions on the types of aircraft and equipment they will purchase and on the scheduling of flights. However, the FAA, through its management of aviation trust funds and of the air traffic control system, plays a crucial role in the nation's airport and airway system and can provide considerable assistance in resolving the delay problem.

1.3 CURRENT FAA INVOLVEMENT IN AIRPORT CAPACITY

The FAA Administrator has established the Airport Capacity Enhancement Program, which is designed to enhance airport capacity over the short-term (less than five years), medium-term (five to ten years), and long-term (over ten years).

The delays recorded in 1984 highlighted the need for more centralized management and coordination of FAA activities to relieve airport congestion. To this end, the FAA Administrator has established the Airport Capacity Enhancement Program, which is designed to enhance airport capacity over the short term (less than five years) medium-term (five to ten years), and long-term (over ten years) so that current and projected traffic levels can be accommodated with minimal delay and without impairing aviation safety or the environment.

As part of this program, the FAA has established an Airport Capacity Program Office, which will maintain current information on capacity and delay, coordinate the various FAA efforts to increase capacity, assist airport users and operators in their efforts to relieve congestion, and serve as a central planning body for developing and advocating capacity enhancement policies and programs.

1.4 STRUCTURE OF THE AIRPORT CAPACITY ENHANCEMENT PLAN

One of the ACPO's responsibilities is to prepare an annual Airport Capacity Enhancement Plan, which provides a framework for the capacity enhancement program. This document serves as an important step in the FAA's short-term and long-range capacity efforts. The Airport Capacity Enhancement Plan is organized in six sections:

- Section 1.0 provides an overview of the airport capacity problem;
- Section 2.0 defines the extent and causes of the capacity and delay problem as it currently exists and discusses the impacts of projected traffic growth on airports over the coming decade;
- Section 3.0 discusses the goals of the Airport Capacity Enhancement Program and the role of the Airport Capacity Program Office in achieving those goals;
- Section 4.0 evaluates the anticipated benefits of 53 planned and on-going FAA projects relating to reducing delay and increasing capacity; and
- Section 5.0 presents descriptions and milestones for the 53 projects.

2.0 CAPACITY AND DELAY: PROBLEM DEFINITION

In recent years, commercial air traffic has grown dramatically. Airline industry deregulation, the gradual lifting of traffic restrictions imposed in the wake of the 1981 air traffic controllers' strike, population growth, and a strong economy all contributed to a 12 percent total increase in aircraft operations at towered airports between 1982 and 1984. Expanded air carrier and commuter operations accounted for the bulk of this increase, rising 19.8 and 29.2 percent respectively over the three-year period, while general aviation traffic rose by 8 percent.

Between 1982 and 1984, air carrier operations rose 19.8 percent, while commuter operations rose 29.2 percent.

The upsurge in air traffic is taxing the capacity of many airports, resulting in a significant increase in both the number and duration of delays reported by airlines and Air Route Traffic Control Centers. Delay problems have become particularly acute at several of the large hub airports. Airline deregulation has increased the utilization of these airports by allowing an increase in the concentration of air carrier service at large hubs and a further expansion of the commuter airline industry.

Historically, more serious congestion problems had been limited to a small number of airports serving the nation's largest metropolitan areas. However, with the general growth in air traffic and with the increased use by airlines of "hub-and-spoke" systems, lengthy and frequent delays have been experienced at a growing number of airports.

FAA forecasts of aviation activity predict continued air traffic growth over the coming years. Between 1984 and 1996, the FAA currently projects that operations will grow 62 percent. At many airports, the projected traffic levels cannot be accommodated without creating or adding to congested conditions. As air traffic expands over the next decade, it seems inevitable that airport users will experience longer and more costly delays unless capacity improvements are made.

Between 1984 and 1996, the FAA currently projects that operations will grow 62 percent.

2.1 CAPACITY, DELAY, AND CONGESTION

Capacity

Airport capacity is the maximum number of operations (takeoffs and landings) that can be processed at an airport within a given period of time without regard to any delay that might be incurred. This definition of capacity, referred to as the maximum throughput capacity, assumes that the demand for service is continuous (i.e., that there are always aircraft ready to takeoff or land).

Maximum throughput capacity assumes that the demand for service is continuous.

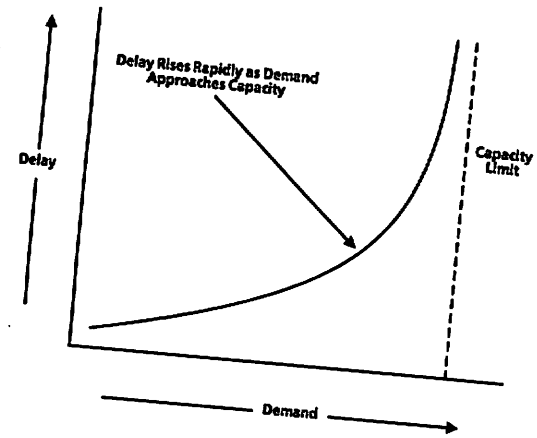


FIGURE 2-1 INTERRELATIONSHIP OF DELAY, DEMAND, AND CAPACITY

The number of operations an airport actually processes usually is less than the airport's, maximum throughput capacity.

The throughput capacity of an airport is not a single value. Instead, it is rather a set of values, each of which is associated with a particular combination of active runways (called a runway configuration); airport operating conditions, including ceiling and visibility; the mix of aircraft types using the airport; and the proportions of arrivals and departures.

The Delay Curve

During a given hour, if aircraft using an airport sought service at a continuous rate exactly equal to that at which aircraft operations could be processed, and if operating conditions at the airport were constant throughout the hour, then operations could reach the airport's maximum capacity without any delays. However, the rate at which aircraft arrive and depart is never continuous. There will be periods within any hour when several aircraft demand service at the same time and periods when none arrives or departs. Therefore, the number of operations an airport actually processes usually is less than the airport's throughput capacity. In addition, as demand approaches capacity, delays increase at an increasing rate. This relationship between capacity, demand, and delay is depicted in Figure 2-1. Clearly, for a given capacity, there is a tradeoff between demand and delay, with increases in demand being accommodated only at the cost of increased delay.

Delay and Variation In Capacity

Even when demand is quite low with respect to the capacity of a particular runway configuration, a change in an airport's operating conditions may reduce capacity, altering the relationship between capacity and a given level of demand, and increasing delay. A change in operating conditions may involve a change in wind or visibility conditions, an equipment outage or aircraft mechanical failure, or any of a variety of factors which might necessitate the use of a lower capacity runway configuration. (These factors will be discussed in more detail in Section 2.2.)

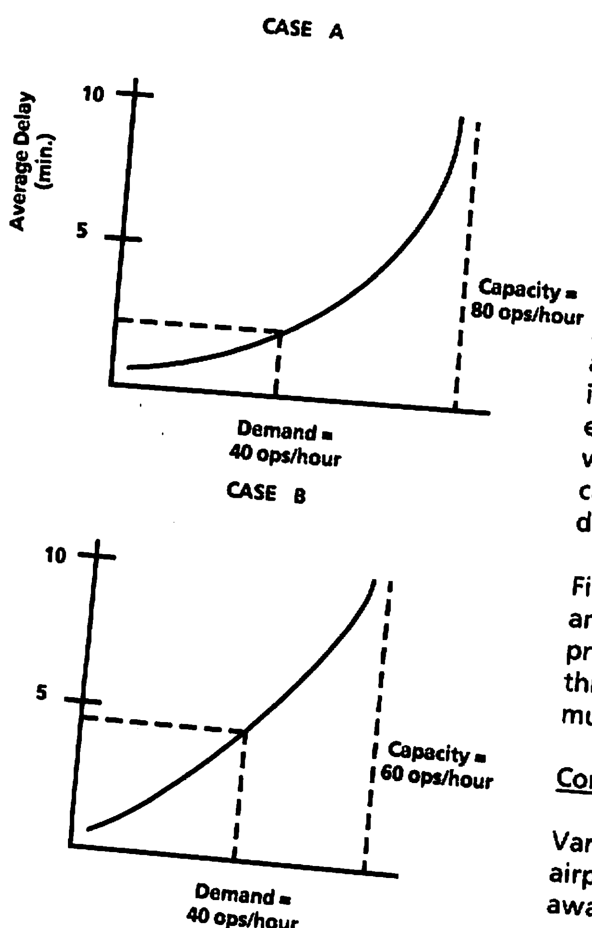


FIGURE 2-2 RELATIONSHIP BETWEEN CAPACITY AND DELAY

Figure 2-2 depicts the interaction between capacity, demand, and delay. In Case A, a demand of 40 operations-per-hour is processed with little average delay. In Case B, the airport's throughput level is lower and the same demand results in much higher delays.

Congestion

Variability in capacity and in the pattern of demand results in airport congestion -- the formation of queues of aircraft awaiting permission to arrive or depart. If demand, on average, is low with respect to capacity, then occasional surges in demand will be followed by periods of relative idleness during which queues can be dissipated. When demand at an airport approaches or exceeds capacity for extended periods, however, it becomes increasingly difficult to eliminate backlogs. Any unexpected increase in demand or disruption that reduces capacity, even if it is relatively short-lived, can result in rapidly rising levels of delay that may persist throughout the day.

2.2 FACTORS AFFECTING CAPACITY AND DELAY

The primary determinant of an airfield's capacity is its physical design.

The primary determinant of an airfield's capacity is its physical design -- the number, length, and location of runways, intersections, taxiways, and gates. Nevertheless, capacity varies greatly within the absolute limitations of an airport's physical design, and this variability of capacity is an important cause of delay.

A variety of factors affect decisions as to the appropriate runway configurations to be used in particular circumstances, the type of aircraft that the airport can accommodate, and the rate at which operations can be processed. These factors can be grouped into five categories:

- Airfield Resources;
- Visibility and Meterological Conditions;
- Air Traffic Control Procedures;
- Noise Considerations; and
- Aircraft Demand.

Airfield Resources

The number, length, and configuration of an airport's runway/ taxiway system determine the operational practices that can be used under different weather or demand conditions. The lighting and navigational aids (NAVAIDS) available at an airport determine whether a particular operating configuration can be used when visibility is poor. Displaced thresholds, obstructions in the approaches, runway length or weight limitations, and pavement condition affect runway occupancy times and may limit the types of aircraft permitted to use a runway. In addition, limitations on the availability of these resources (e.g., runway closures or NAVAID outages) also affect capacity.

Visibility and Meteorological Conditions

Changes in wind, weather, and visibility are the most important causes of variations in capacity. Particular wind directions can mandate the use of lower capacity runway configurations. Low ceilings, precipitation, and accumulations of snow and ice on the runway can severely restrict aircraft operations or close the airport altogether.

When visibility is poor, pilots must rely on NAVAIDS to determine their positions, and aircraft operations must be conducted under Instrument Flight Rules (IFR). Capacity during IFR conditions may be dramatically lower than capacity under Visual Flight Rules (VFR). Because air carrier schedules are based on operating in VFR conditions, the difference between VFR and IFR capabilities is a cause of many traffic disruptions and delays. The extent to which changes in weather and visibility affect capacity depends to a large degree on the type of navigational systems installed on an airport's runways.

Aircraft Traffic Control Procedures

ATC procedures, which are devised to ensure safe separations between aircraft leaving and entering the terminal area, provide greater separations under IFR conditions than are commonly maintained under VFR conditions. Rules regarding the use of converging and parallel runways during instrument operations reduce the useability of runways, often limiting an airport to single runway operation when visibility is poor.

Noise Considerations

Noise abatement procedures adopted by the FAA and local airport authorities can reduce available capacity during certain hours of the day. These procedures generally involve restricting the use of departure and approach paths that pass over residential areas or limiting airport operations at certain times of day. Such restrictions may limit the use of those runway configurations with the highest capacity.

Aircraft Demand

The pattern of aircraft demand -- which refers not only to the number of aircraft seeking access, but also to their size, weight, performance characteristics, and desired access time - is an important determinant of capacity and delay. It has been noted that as demand approaches capacity, delays increase sharply. Even for a given level of demand, however, the performance characteristics of aircraft affect the rate at which operations can be processed. For example, to protect small planes from wake vortex turbulence, in-trail arrival separation between small and large aircraft must be greater than that which is required between two large aircraft. Differences in the runway occupancy times of different types of aircraft also affect separation requirements and thus capacity.

The distribution of arrivals and departures affects available capacity. The extent to which arrivals and departures are bunched, rather than evenly spaced, affects delay. In recent years, airlines have made extensive use of "hub-and-spoke" systems in which a large number of aircraft arrive at an airport within a brief period of time, exchange passengers with connecting flights, and then depart. This type of demand pattern generally results in higher delays than would occur with the same level of demand spaced more evenly throughout the day.

2.3 DELAY TRENDS

The FAA maintains two types of data on delay

- Delay by cause, and
- Delay by stage of flight.

Delay by Cause:

The National Airspace Performance Reporting System (NAPRS) compiles reports on delays of 15 minutes and longer broken down by cause for 42 airports. Detail on delayed operations is provided for 22 airports.

In the years prior to 1982, when NAPRS tracked only delays of at least 30 minutes duration, weather was judged responsible for about 80 percent of delays. Lowering the reporting threshold to 15 minutes in 1982 had an immediate effect both on the number of delays reported (reportable delays were estimated to have doubled or tripled) and on the distribution of delay by cause: about 60-70 percent of reported delays have been attributed to weather since 15 minute delays were included in the NAPRS data set. Apparently, extreme delay situations of 30 minutes and longer are much more likely to be the result of disruptive weather conditions than are shorter delays. The 1982 change in NAPRS reporting criteria created a break in the data set, rendering pre- and post-1982 comparisons meaningless.

About 60-70 percent of reported delays have been attributed to weather.

Because NAPRS excludes delays of less than 15 consecutive minutes, it does not actually measure total delay; thus it is impossible to infer the value of average delay from NAPRS statistics. Nevertheless, NAPRS delays are useful in measuring delay trends.

Table 2-1 lists trends in the number and cause of delayed operations for the years 1983-1985. In general, delays rose much faster than operations, but the changes in the pattern and level of delay from 1983 to 1984 were significantly different than the changes from 1984 to 1985. Total delays rose 66 percent in 1983-84 while total operations at towered airports rose by 6.5 percent and operations at 22 major airports rose 9 percent. Total delays dropped 17 percent in

Many, perhaps most, flights encounter some delay at major airports

These statistics provide further evidence of the trend, apparent from NAPRS delay figures, toward growing airport congestion. They also indicate that congestion is not simply a problem of a small number of flights delayed for long periods of time, but that many, perhaps most, flights encounter some delay at major airports. This point is clear from the data presented in Table 2-4.

TABLE 2-2 NUMBER AND CAUSE OF OPERATIONS DELAYED BY MONTH 1984 - 1985

MONTH	DELAYS	AVERAGE DAILY DELAYS	PERCENT DELAYS CAUSED BY WEATHER	PERCENT DELAYS CAUSED BY TERMINAL VOLUME	PERCENT DELAYS CAUSED BY CENTER VOLUME	PERCENT DELAYS CAUSED BY CLOSED RUNWAYS/ TAXIWAYS	PERCENT DELAYS CAUSED BY NAS EQPMT INTER-UPTIONS	PERCENT DELAYS CAUSED BY OTHER EVENTS
JAN 85	28828	929.9	76.1	4.3	14.1	1.3	2.3	1.8
FEB 85	22819	815	75.7	5.6	13.9	2.6	1.2	.9
MAR 85	18761	605.2	67.9	12	17.7	1.2	1.1	.1
APR 85	22395	746.5	55.8	19.6	10.7	11.9	1.2	.8
MAY 85	27297	880.5	56.8	13.1	10.2	17.3	2	.6
JUN 85	22791	759.7	66	11.6	12.2	9.5	.6	.1
JUL 85	31630	1020.3	74.8	10.3	8.8	2.9	3	.2
AUG 85	33861	1092.3	62.1	17.3	11.6	6.1	2.7	.2
SEP 85	28036	934.6	62.1	13	11.3	10.8	2.2	.6
OCT 85	36674	1183	63.4	13.5	10	8.8	3	1.3
NOV 85	37127	1237.6	75.5	12.2	8.3	1.3	2.3	.5
DEC 85	23598	761.2	74.5	13.1	9.2	2.1	.7	.3
	333817	914.6	67.7	12.2	11.2	6.3	2	.6
JAN 84	22366	721.5	80.3	7.4	9.2	.8	1.4	.9
FEB 84	22086	761.6	65.9	15.8	14.1	1.2	1.7	1.2
MAR 84	33520	1081.3	69.8	13.6	13.7	.9	1	.8
APR 84	35344	1178.1	66.6	11	13.4	7.5	1.2	.3
MAY 84	35359	1140.6	56.9	22.1	11.5	5.1	2.7	1.7
JUN 84	40852	1361.7	55.1	20	14.8	3.9	3.4	2.8
JUL 84	39113	1261.7	62.1	20	14.6	.9	1.9	.7
AUG 84	44372	1431.4	61	19	16.1	1.2	2.1	.6
SEP 84	31569	1052.3	39.9	32.7	20.7	4.1	1.6	1.1
OCT 84	49036	1581.8	48.7	18.4	26.4	3.0	3.1	.6
NOV 84	22245	741.5	49.5	19.3	25.2	.3	4.5	1.2
DEC 84	28423	916.9	70.2	11.9	15.3	.4	1.5	.7
	404285	1104.6	59.6	18	16.5	2.6	2.2	1.1

TABLE 2-3 AVERAGE MINUTES DELAY BY PHASE OF FLIGHT: TOTAL SYSTEM: SDRS CARRIERS COMBINED*

Flight Phase:	1976	1978	1980	1982	1983	1984
ATC Gate Hold	0.06	0.12	0.17	0.84	0.56	0.69
Taxi Out	4.46	4.78	5.10	6.25	6.24	6.53
Airborne	4.28	4.36	4.13	2.50	3.76	4.00
Taxi-In	2.16	2.41	2.43	2.32	2.38	2.37
Average per flight	10.96	11.67	11.82	11.91	12.44	13.59
Average per Operation	5.48	5.83	5.91	5.96	6.22	6.80

*Source: FAA Office of Aviation Policy and Plans.

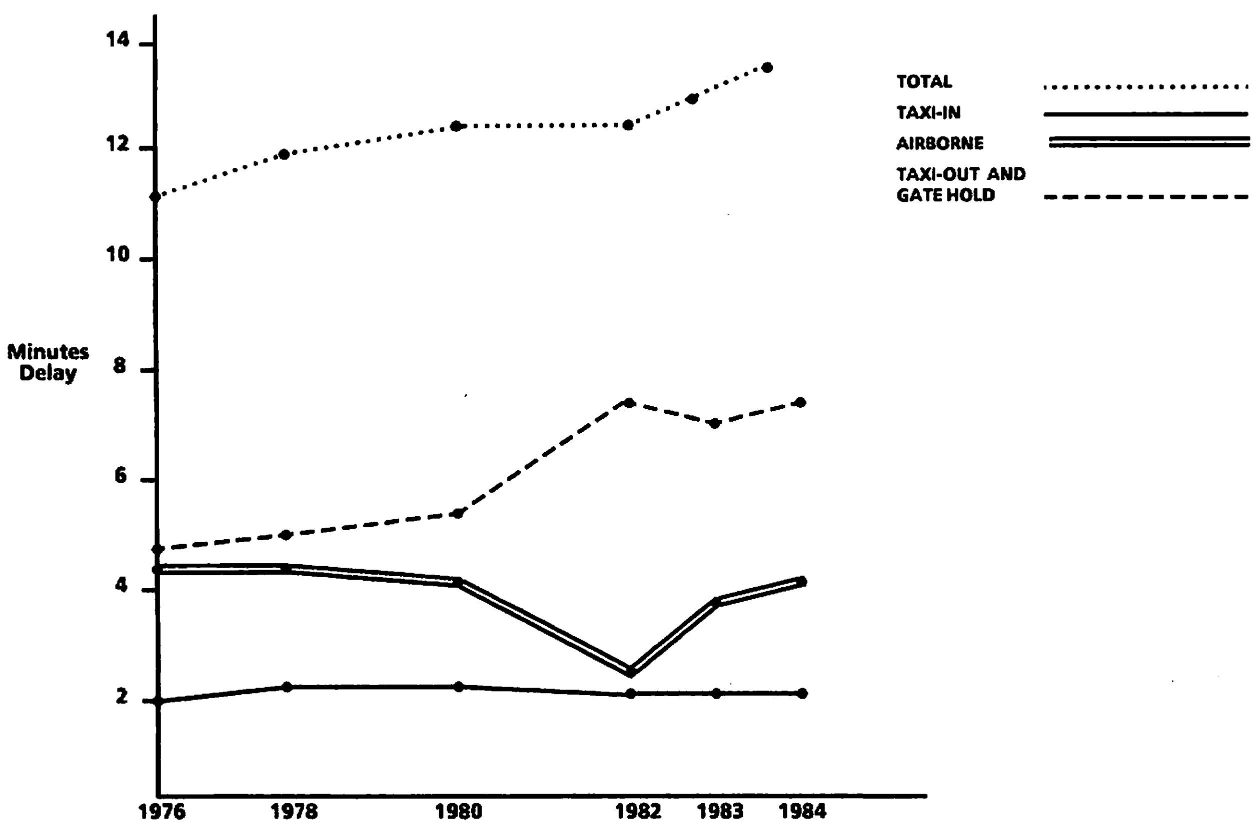


FIGURE 2-3 TRENDS IN DELAY BY PHASE OF FLIGHT SDRS DATA

Table 2-4 shows the distribution of SDRS delays by length of delay in July, 1984. While a relatively small proportion of flights by SDRS carriers encountered delays of more than 15 minutes in any phase of flight, almost all flights encountered some delay: 90.8 percent were delayed in taxi-out, 61.9 percent were delayed in air, and 78.8 percent were delayed in taxi-in.

TABLE 2-4 PERCENT OF FLIGHTS DELAYED BY LENGTH OF DELAY: TOTAL SYSTEM: JULY, 1984*

	Percent Of Flights Delayed:			
Delay:	Gate-Hold	Taxi-Out	Airborne	Taxi-In
None	94.9	9.2	38.1	21.2
1 - 14 Min.	2.7	80.0	56.6	77.3
15 - 29 Min.	1.4	8.6	4.4	1.3
30 - 59 Min.	0.7	1.8	0.8	0.2
60 + Min.	0.3	0.4	0.1	0.0
Total	100.0	100.0	100.0	100.0

*Source: FAA Office of Aviation Policy and Plans

Airport Congestion

Congestion and delay vary considerably from airport to airport. The likelihood that an operation would be delayed more than 15 minutes at the 22 major air carrier airports in 1985 ranges from about 14 percent at New York's LaGuardia to practically nil at Las Vegas' McCarran. (See Table 2-5.) The delay situation improved significantly at most of these airports in 1985. The bulk of NAPRS delays are concentrated among a relatively small group of airports, with nine airports reporting more than three-quarters of all NAPRS delay. Although the number of badly congested airports may be small, the number of passengers affected by congestion is not; these nine airports account for nearly one-third of all domestic passenger enplanements.

The likelihood that an operation would be delayed more than 15 minutes at the 22 major air carrier airports in 1985 ranges from about 14 percent at New York's LaGuardia to practically nil at Las Vegas' McCarran.

Futhermore, as a result of aviation traffic growth in recent years, the number of airports experiencing congestion is growing. Table 2-6 shows changes in average minutes delay and in airport traffic for 25 airports served by SDRS carriers. From 1976 to 1984, each of these airports experienced significant traffic growth and all but five incurred increased delay as a result. The number of airports at which an average flight was delayed for 15 minutes or longer (7.5 minutes per operation) has doubled, from five to ten, since 1976.

Because they combine delays encountered in both peak and slack periods, average delay figures tend to obscure the severity of airport congestion during times of heavy demand. Figure 2-4 shows the considerable variation in taxi-out delays experienced by selected flights departing Atlanta Hartsfield Airport on July 5, 1984. In the very early morning and late evening hours, flights were delayed in taxi-out for only a few minutes. At most desirable peak-hour departure times, delays were much longer, reaching highs of almost 30 minutes.

Average delay figures tend to obscure the severity of airport congestion during times of heavy demand.

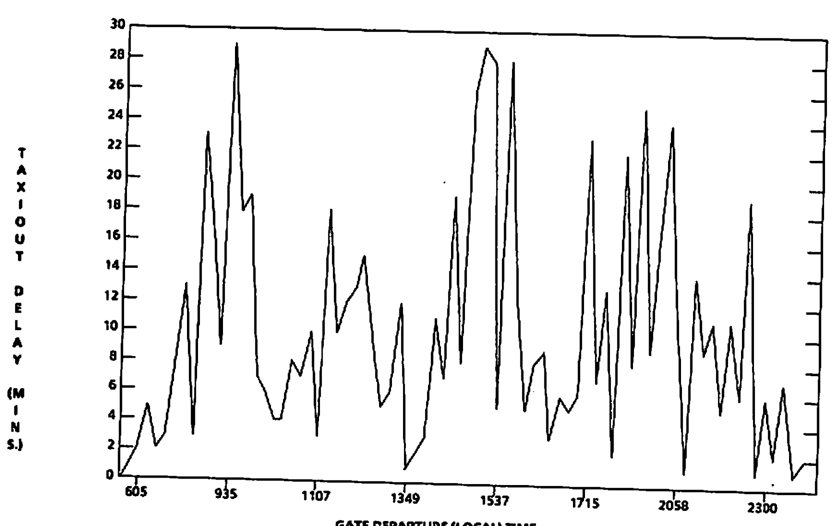


FIGURE 2-4 SELECTED ATLANTA DEPARTURES

Percentage of operations delayed ranges from 14.4 percent to 0.1 percent at 22 major airports.

Delays decreased at 17 of 22 major airports in 1985.

TABLE 2-5 PERCENT OPERATIONS DELAYED 1984 - 1985 22 MAJOR AIRPORTS

AIRPORT	PERCENT OPERATIONS DELAYED 1985	PERCENT OPERATIONS DELAYED 1984	PERCENT CHANGE 1984-1985
La Guardia	9.2	14.5	-36.55
Newark Int.	9.2	10.6	-13.21
Atlanta-Hartsfield	6.2	5.3	16.98
John F. Kenedey	6.1	12.3	-50.41
Boston-Logan	6.1	5.1	19.61
Denver-Stapleton	4.6	7.1	-35.21
St. Louis-Lambert	4.6	5.4	-14.81
Chicago-O'Hare	4.1	5.7	-28.07
San Francisco Intl.	3.4	4.4	-22.73
Minneapolis Intl.	2.2	1.5	46.67
Detroit Metropolitan	2.1	1.2	75.00
Washington National	2.0	2.5	-20.00
Greater Pittsburgh	1.7	2.1	-19.05
Dallas/Ft. Worth	1.7	1.5	13.33
Philadelphia Intl	0.9	1.1	-18.18
Los Angelas Intl.	0.8	1.0	-20.00
Miami International	0.3	1.7	-82.35
Kansas City International	0.3	0.8	-62.50
Houston International	0.3	0.4	-25.00
Cleveland-Hopkins	0.1	0.4	-75.00
Fort Lauderdale	0.1	0.2	-50.00
Las Vegas McCarran	0 0	0.1	-100.00
TOTAL	3.4	4.2	-19.05

Source: NAPRS

TABLE 2-6 AVERAGE MINUTES DELAY PER OPERATION AT SDRS AIRPORT

AIRPORTS:	AVERAGE MINUTES DELAY 1976	AVERAGE MINUTES DELAY 1984	%CHANGE MINUTES DELAY 76-84	%CHANGE OPERATIONS 76-84
Atlanta	8.7	8.0	-8.0	41.6
Baltimore	4.2	4.3	2.4	28.0
Boston	6.4	8.4	31.2	32.3
Cleveland	4.4	4.4	0.0	16.1
Washington Nat'l	6.2	7.7	24.2	9.6
Denver	6.4	9.2	43.8	26.7
Dallas/Ft. Worth	5.1	9.2	80.4	43.6
Detroit	4.0	6.1	52.5	30.0
Newark	7.5	10.3	37.3	87.4
Dulles	5.2	5.2	0.0	4.5
Houston Int'l	4.1	5.1	24.4	62.3
Kennedy	10.5	12.0	14.3	7.4
Los Angeles	4.6	7.4	60.9	16.8
LaGuardia	9.2	12.1	31.5	8.0
Memphis	3.3	4.1	24.2	3.5
Miami	5.2	6.5	25.0	23.3
Minneapolis	2.7	4.2	55.6	26.5
O'Hare	9.0	9.0	0.0	3.0
Philadelphia	6.8	5.7	-16.2	12.6
Phoenix	3.4	6.0	76.5	15.5
Pittsburgh	5.3	4.8	-9.4	19.7
Seattle	3.7	4.7	27.0	34.7
San Francisco	5.3	8.2	54.7	18.3
St. Louis	4.7	6.1	29.8	24.8
Tampa	3.7	4.5	21.6	44.8

Source: FAA Office of Aviation Policy and Plans

2.4 PROJECTING THE FUTURE

There is little doubt that airport congestion is a growing problem. Each year, the FAA issues forecasts on national aviation activity and of activity at the nation's 3,424 public-use airports; current forecasts indicate that the problem will worsen over the next decade.

As a first step in developing these projections, forecasts are made of the demand for travel in terms of air carrier passenger enplanements. With steady economic growth and stable aviation fuel costs, domestic passenger enplanements are expected to grow by an average 4.5 percent annually between 1984 and 1996; enplanements in 1996 are expected to be 69 percent above the 1984 level. While a 69 percent increase over 12 years may seem high, this estimate may be rather conservative in terms of historical growth patterns. Over the previous 12-year period (1972 to 1984) for example, air carrier passenger enplanements grew by 90 percent (see Figure 2-5). Aircraft operations at towered airports are expected to increase by 62 percent between 1984 and 1995, including a 28 percent increase in air carrier operations, a 70 percent increase in commuter operations, and a 69 percent increase in general aviation operations.

Domestic passenger enplanements are expected to grow by an average 4.5 percent annually between 1984 and 1996; enplanements in 1996 are expected to be 69 percent above the 1984 level.

Aircraft operations at towered airports are expected to increase by 62 percent between 1984 and 1995.

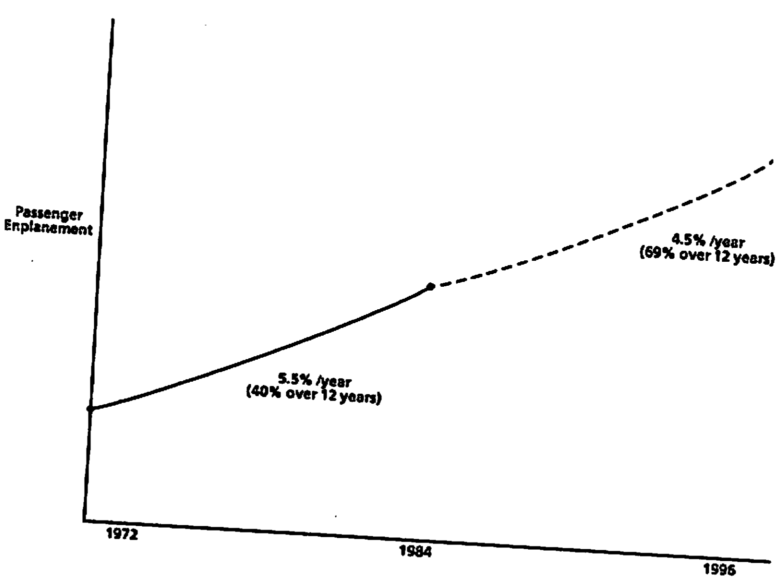


FIGURE 2-5 TRENDS IN ENPLANEMENTS

Table 2-7 lists the total projected growth in operations from 1983 through 1995 at 34 primary commercial airports. At a few of the most active and congested airports -- Washington's National, New York's LaGuardia, and New York's Kennedy -- only modest growth, or even a slight decline, in operations is projected, because these airports already are used intensively and cannot accommodate large increases in traffic levels given current facilities and technologies. At most of the other airports listed in Table 2-7, however, significant traffic growth is projected over the next decade. Large increases in operations are anticipated at several secondary airports serving metropolitan areas where the primary airport is already heavily used (e.g., at Dulles and Baltimore-Washington airports serving the Washington, D.C. area, Houston Hobby serving the Houston area, and at Dallas Love Field serving the Dallas area). Airports serving smaller metropolitan areas, such as Charlotte, Memphis, Salt Lake City, Kansas City, also expect substantial growth as airlines establish hubbing operations in these cities.

Some measure of the impact of air traffic growth on airport congestion and delay can be obtained by comparing projected operations levels with an estimate of airport capacity. The estimate used here is Annual Service Volume (ASV). ASV is derived by weighting the throughput capacity of each of an airport's runway configurations by the frequency with which each configuration is used in a typical year. The result is then adjusted to reflect airport peaking patterns. ASV is not the maximum level of operations attainable, but the level that can be achieved under assumptions regarding an airport's typical fleet mix, meteorological conditions, and peaking patterns.

If airport operations reach the levels projected for 1995, 22 airports will have average delays of more than eight minutes if no capacity improvements are made.

Although not a perfect measure of airport capacity, ASV is a good predictor of airport delay. In general, higher delays are associated with higher ratios of operations to ASV. At airports where the operations-to-ASV ratio was greater than 100 percent in 1984, the delay per operation averaged 8.6 minutes; where the ratio was less than 100 percent, delay averaged 5.2 minutes (see Figure 2-6). If airport operations reach the levels projected for 1995, capacity at many of the 34 airports will be exceeded. By 1995, 22 airports will have average delays of more than eight minutes, compared with 11 airports in 1984 without capacity improvement (see Table 2-8).

TABLE 2-7 ACTUAL AND PROJECTED GROWTH IN OPERATIONS AT 34 PRIMARY COMMERCIAL AIRPORTS 1983-1995 (Thousands of Operations)

AIRPORTS	TOTAL OPERATIONS FY 1983	ACTUAL 1984	FORECAST OPERATIONS FY 1995	FORECAST % CHANGE 83-95	% FORECAST GROWTH ALREADY ACHIEVED BY 1984
Chicago O'Hare	659.3	713.4	906	37.4	21.9
Atlanta	599.5	666.1	765	27.6	40.2
Los Angeles	498.1	543.1	629	26.3	34.6
Denver	466.8	488.3	602	29.0	15.9
Dallas-Ft Worth	426.8	503.7	543	27.2	66.2
San Francisco	349.0	401.3	395	13.2	113.6
St Louis	343.3	392.6	460	34.0	42.4
New York Kennedy	342.1	360.6	370	8.2	65.8
Miami	341.2	354.9	438	28.4	14.1
Phoenix	341.1	391.1	491	43.9	33.5
New York LaGuardia	340.4	362.1	335	-1.6	n.a.
Boston	340.3	380.5	469	37.8	31.2
Houston	330.9	321.0	489	47.8	-6.3
Washington National	327.4	321.0	405	23.7	19.8
Honolulu	326.7	342.8	450	37.7	13.5
Philadelphia	321.4	343.4	444	38.1	14.7
Pittsburgh	315.0	349.5	425	34.9	31.5
Houston/Hobby	309.8	328.4	419	35.2	17.0
Dallas/Love	302.1	319.7	511	69.1	8.4
Minneapolis	300.3	330.8	455	51.5	19.8
Las Vegas	297.2	296.6	438	47.4	-0.4
Memphis	292.5	297.3	420	43.6	3.7
Charlotte	280.7	308.4	414	47.5	20.8
Salt Lake City	273.1	251.1	428	56.7	-14.3
Tampa	272.1	294.7	365	34.1	24.3
Detroit Metro	271.4	316.8	420	54.8	30.5
Newark	263.9	335.5	350	32.6	106.4
Baltimore-Wash	239.1	278.1	390	63.1	25.8
Ft Lauderdale	236.4	238.5	330	39.6	0.3
Cleveland	211.3	240.7	315	49.1	28.3
Seattle-Tacoma	209.7	220.2	264	25.9	19.3
Indianapolis	175.9	189.2	260	47.8	15.8
Dulles	158.9	176.2	329	107.0	10.2
Kansas City	147.6	190.4	271	83.6	34.6

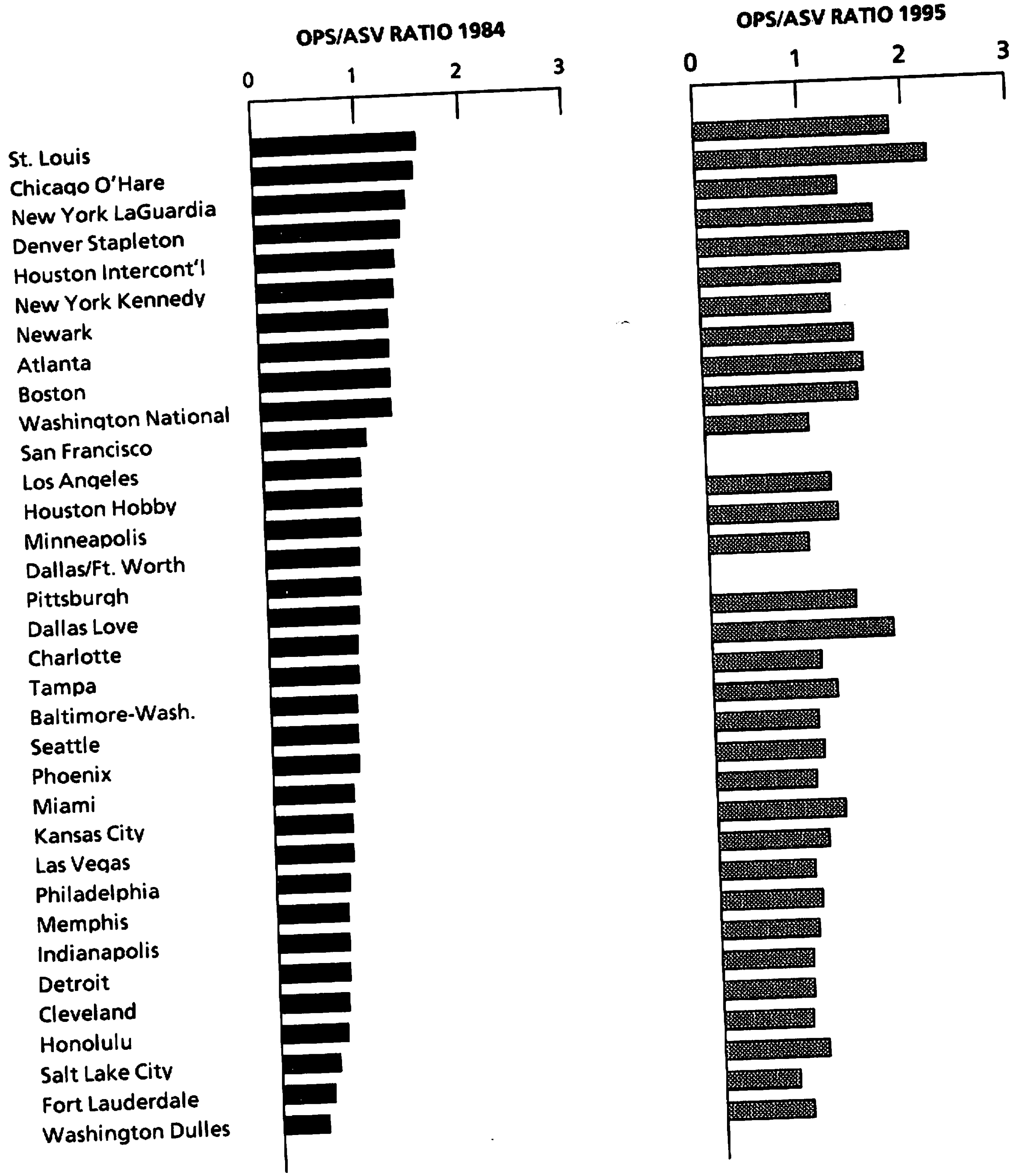


FIGURE 2-6 TRAFFIC DENSITY AND DELAY: RATIO OF OPERATIONS TO ANNUAL SERVICE VOLUME 34 AIRPORTS, 1984 AND 1995

TABLE 2-8 CAPACITY AND DEMAND AT 32 SELECTED AIRPORTS, 1984 AND 1995

	Operations as a Percentage of ASV: Projected 1995	Actual 1984
1. Chicago O'Hare	223%	155%
2. Houston International	204	134
3. St. Louis	188	160
4. Charlotte	176	87
5. Denver Stapleton	170	138
6. Boston Logan	155	126
7. Washington National	148	126
8. Atlanta	146	127
9. Dallas Love	141	88
10. New York La Guarda	136	146
11. New York Kennedy	136	133
12. Minneapolis	126	92
13. Newark	125	127
14. Kansas City	123	76
15. Houston Hobby	120	94
16. Baltimore-Washington	119	85
17. Las Vegas	107	94
18. Tampa	106	86
19. Phoenix	106	84
20. Seattle-Tacoma	102	85
21. San Francisco	101	102
22. Salt Lake City	100	58
23. Memphis	98	70
24. Dallas-Ft. Worth	97	90
25. Miami	97	79
26. Indianapolis	94	69
27. Philadelphia	93	71
28. Detroit	88	67
29. Cleveland	88	67
30. Honolulu	86	65
31. Washington Dulles	84	45
32. Fort Lauderdale	72	52

It is likely that many airports which are relatively uncongested today will begin experiencing serious delay problems over the coming decade. Furthermore, congestion will worsen at airports where delay problems already are quite severe, such as St. Louis, Chicago, Atlanta, Denver and Boston. Unless action is taken to expand capacity at these airports, delays may reach levels that will be intolerable to airport users.

2.5 COST OF DELAY

The cost of delay in 1984 is estimated at over $4 billion.

Delay represents a considerable cost to the aviation community in terms of passenger inconvenience and increased airline operating costs. The magnitude of these costs can be estimated from data on airline operating costs supplied by SDRS and from FAA statistics on the cost of lost time to passengers. As shown in Table 2-9, the cost of delay in 1984 is estimated at over $4 billlion, an increase of 73 percent from 1982. (Detail on the construction of this estimate can be found in Table B-2 in Appendix B.)

TABLE 2-9 ANNUAL SYSTEM-WIDE COST OF DELAY

	1982	1984	PERCENT CHANGE
COST OF DELAY TO AIRCRAFT			
AVERAGE DELAY/OPERATION (MIN)	5.95	6.8	23.6
AIR CARRIER OPERATIONS (000S)	9,049.2	10,839.5	19.8
TOTAL HOURS DELAY (000S)	897.4	1,228.5	36.9
AVERAGE DELAY COST/HOUR ($)	1,643.0	1,647.0	0.2
TOTAL COST OF DELAY TO AIRCRAFT ($M)	1,474.0	2,023.0	37.2
COST OF DELAY TO PASSENGERS			
PASSENGER HOURS LOST (MILLIONS)	72.6	117.9	62.4
VALUE OF PASSENGER TIME ($/HOUR)	20.5	22.3	8.8
TOTAL COST OF DELAY TO PASSENGERS ($M)	1,488.0	2,629.3	76.7
TOTAL COST OF DELAY (PASSENGERS PLUS AIRCRAFT) ($M)	2,692.0	4,652.0	72.8

Note that this estimate counts only the costs of delay for scheduled air carrier operations. Data on delays to general aviation and commuter traffic are not available, but it is certain that this traffic also is affected by airport congestion and contributes additional delay costs.

There is every reason to believe that delay will become an increasing burden on all airport users over the next decade unless appropriate actions are taken to enhance airport capacity. The traffic growth of recent years has increased average delay and has greatly increased the number of airports experiencing lengthy and frequent delays. Traffic growth projections make it clear that demand will approach or exceed capacity at many more airports over the next decade, and that this demand will be accommodated only at the cost of greater delay.

Some portion of delay-related costs may be unavoidable. For example, there may be little that can be done within the forseeable future to counter the lengthy and expensive delays resulting from severe weather. Deciding what portion of delay costs may be avoidable can be done only by examining the options and technologies available to airport operators, users, and the FAA for reducing delays.

3.0 THE AIRPORT CAPACITY ENHANCEMENT PROGRAM

3.1 GOALS OF THE AIRPORT CAPACITY ENHANCEMENT PROGRAM

The central goal of the FAA's Airport Capacity Enhancement Program is to provide for capacity enhancements so that current projected increases in aircraft operations can be handled by the National Airspace System with a minimum of delays and without compromising safety or the environment. Specific program objectives include the following:

- Maintain or improve the efficiency of operations; improve capacity and minimize delay.
- Update regulations, operational standards, and procedures to facilitate reductions in delay or increases in capacity. Emphasize the establishment of meaningful, enforceable standards that allow maximum efficiency while maintaining or improving safety.
- Ensure the coordination and centralization of capacity-related research, activities, and directives within the FAA.
- Consider and integrate the needs of various airport and airspace system users and constituents to ensure that their requirements are considered.
- Reduce environment-related constraints on the growth of the national air transportation system.
- Maintain the FAA's position as the world's aviation authority by providing technical guidance for operating and maintaining airports and ATC procedures/standards.
- Establish higher priority within the AIP grant program for projects with direct capacity-generating potential at major airports having, or projected to have, capacity problems.

3.2 ROLE OF THE AIRPORT CAPACITY PROGRAM OFFICE, (ACPO) IN ACHIEVING CAPACITY ENHANCEMENT GOALS

3.2.1 CREATION OF THE ACPO

Solving the multi-faceted airport capacity problem requires coordination between all the diverse elements of the aviation community, including the Federal and state governments, airport management, airlines, general aviation, and aircraft manufacturers. Given the complexity of the interrelationships among these groups, effective programs to increase airport capacity cannot be developed or implemented without a focal point for planning efforts. Recognizing the critical importance of airport capacity to the transportation industry, and acting on the recommendation of the Industry Task Force on Capacity Improvement and Delay Reduction, the FAA Administrator has established an Airport Capacity Program Office (ACPO) under the Associate Administrator for Airports to coordinate all activities affecting airport capacity.

3.2.2 RESPONSIBILITIES OF THE ACPO

The ACPO serves as the FAA's major internal advocate on airport capacity matters. It coordinates the development, testing, demonstration, and implementation of programs and procedures aimed at improving airport capacity. The ACPO also acts as the agency's liaison office with the aviation community in dealing with airport capacity issues. Table 3-1 details the responsibilities of the ACPO.

One of the ACPO's most important functions is to provide an annual update of the Airport Capacity Enhancement Plan. This plan will include resource requirements, project descriptions, policy decisions and milestones. Updated requirements for improving airport capacity will be received on a continuing basis from the FAA and from user and industry groups. The ACPO will review these requirements with the appropriate functional organizations to determine what actions will be taken. The action may be a procedural change, a technical solution, or the initiation of a research project.

3.2.3 RELATIONSHIP OF THE ACPO TO OTHER FAA ORGANIZATIONS

- MANAGEMENT STEERING GROUP ON CAPACITY AND DELAY

The Management Steering Group on Capacity and Delay will provide advice and counsel to the Associate Administrator for Airports and the Director of the ACPO on capacity issues, policies, and programs that cross functional lines of authority and responsibility. This group is composed of office and service directors involved in capacity issues, as recommended by the Associate Administrator for Airports and approved by the Administrator. The group will seek to provide agency-wide consensus regarding technical matters and the resources required to develop, test, demonstrate, and implement new initiatives in the area of airport capacity enhancement.

The Management Steering Group will meet at least quarterly to review ACPO activities and to receive information on the status of airport capacity programs. Capacity issues to be resolved by an organization other than the ACPO may be addressed during the Management Steering Group quarterly

TABLE 3-1 RESPONSIBILITIES OF THE AIRPORT CAPACITY PROGRAM OFFICE

- Develops, establishes, and coordinates agency airport capacity enhancement goals and objectives.
- Develops, manages, and maintains a comprehensive Airport Capacity Enhancement Plan, which encompasses all FAA activities designed to improve airport capacity (including activity milestones and resource requirements).
- Oversees and coordinates the development of other plans, procedures, and documents necessary for program management of airport capacity issues.
- Guides, oversees, and coordinates the FAA activities necessary to develop, test, demonstrate, and implement programs and procedures for airport capacity enhancement, relying where possible on existing organizations to accomplish specific tasks.
- Performs or delegates tasks necessary to achieve approval at all levels for agency policy, plans, and other activities relating to airport capacity enhancements.
- Recommends budget levels for the formulation of decision packages on national programs, and recommends appropriate resource allocations.
- Implements and maintains a program control and tracking system to support the program management process with respect to airport capacity enhancements; provides status reports and briefings to the Administrator and all levels of management on FAA activities related to airport capacity enhancement.
- Serves as the FAA's technical spokesperson on airport capacity and provides coordinated agency interface with the Congress, other departments and agencies, U.S. and foreign industry, and the international airport development community.
- Monitors and coordinates regional, local, and industry programs and activities in support of airport capacity enhancement; establishes guidelines for the creation and management of regional and industry airport capacity action groups.
- Serves as the FAA's focal point for gathering, evaluating, and disseminating information about airport capacity enhancement activities and plans.
- Initiates, guides, and contributes to legislative and regulatory recommendations, advisory circulars, and agency directives as they relate to airport capacity enhancement.
- Identifies requirements for special studies and research and development efforts in support of airport capacity enhancement; coordinates, monitors, and reviews proposed projects, study reports, and other products of these efforts.
- Maintains continuing liaison and communication with government agencies and the aviation industry on airport capacity matters.
- Represents the Associate Administrator for Airports and the FAA Administrator on airport capacity enhancement matters.

meeting. The Chairmanship of the Management Steering Group will be designated by the Associate Administrator for Airports.

- OFFICE OF AVIATION SAFETY

The goal of the projects included in the plan is to increase system capacity while maintaining or improving the present level of safety. The lead FAA office for each project included in the ACEP has the primary responsibility for identifying and addressing safety considerations associated with the project. The Office of Aviation Safety (ASF), acting through the ACPO, will serve in a monitoring and evaluation role to assure that all safety issues associated with a program have been identified and adequately addressed.

The extent of the Office of Aviation Safety's role will depend on the nature of each project. For example, projects to increase capacity at existing airports through capital improvements constructed to meet present standards may require little, if any, involvement; projects involving changes in current operating procedures or standards may require considerable involvement.

When a project includes a demonstration, it is expected that the ACPO will obtain from the lead FAA office and forward to ASF the identified safety considerations and the methods for addressing them in the demonstration. ASF will review the identified issues and proposed methods for addressing them to ensure their consistency with the agency's safety goal.

As part of their analysis of the data from a demonstration, the lead office should verify that the previously identified safety considerations were adequately accommodated during the test. The lead office also should identify any unforeseen safety issues that arose during the test and how these issues were addressed. The ACPO will forward this analysis to ASF, which is responsible for determining that the measures taken have maintained or improved the current level of safety.

To ensure that all projects included in the plan maintain or improve the present level of system safety, the FAA's Office of Aviation Safety, acting through the ACPO, has the overall responsibility for monitoring and evaluating the projects to assure that all safety considerations associated with each program have been identified and addressed. The responsibility for identifying and addressing the safety issues associated each individual projects rests with the lead FAA office for each project.

- OTHER ORGANIZATIONS

The ACPO will rely as much as possible on existing FAA organizations to accomplish specific tasks. These organizations include the Offices of Aviation Safety, Budget, Aviation Policy and Plans, and Environment and Energy; the Associate Administrators for Airports, Air Traffic, Aviation Standards, Development and Logistics, and Policy and International Aviation; the FAA Technical Center in Atlantic City, New Jersey; and the Monroney Aeronautical Center in Oklahoma City, Oklahoma.

Technical program offices and FAA regional offices will continue to determine requirements for, plan, support, and execute capacity enhancements within their functional area. These responsibilities relative to airport capacity include:

- Recommending additions to, deletions from, or changes in the Airport Capacity Enhancement Plan.
- Preparing and submitting for review and agency approval proposed program and project plans that support capacity enhancements. These plans will include a definition of the program or project need, objective, and scope; the milestones, schedule, budget and environmental constraints, and resource requirements; and any interfaces with other programs and projects.
- Identifying and budgeting for adequate resource levels to support capacity enhancements reflected in the Airport Capacity Enhancement Plan.
- Accomplishing approved programs and projects in accordance with the established work program schedule.
- Reporting periodically on the status of actions in airport capacity enhancement.

3.2.4 ACPO ACTIVITIES: RESPONSES TO THE AIRPORT CAPACITY ACTION PLAN

The FAA Administrator has designated increasing airport capacity as a major FAA national goal. Recommendations have been developed and endorsed by the Administrator with the counsel of the aviation community to be used as guidance for the development of the FAA's overall capacity enhancement program. Those recommendations and the ACPO's responses to them are as follows:

ACTION PLAN RECOMMENDATIONS	ACPO RESPONSES
1. Undertake an internal effort to clarify the Federal policy on the management of available capacity.	1. ACPO participated with other FAA departments in developing a "Notice of Proposed Policy on Airport Access and Capacity." The NPP was published in the Federal Register for industry comment.
2. Continue efforts to establish a higher priority within the Airport Improvement grant program (AIP) for projects which have direct capacity-generating potential at major airports. Include such priority in the National Plan for the Integrated Airport System (NPIAS).	2. ACPO recommended language changes in the legislative proposal to continue the AIP beyond 1987. These changes would emphasize the need to give a higher priority to capacity-related projects in a future AIP.
3. Explore an airport development land banking policy related to both the yearly airport development grant program and NPIAS. If appropriate, develop a legislative initiative to establish a specific funding category for such a purpose.	3. ACPO recommended the establishment of a specific "set-aside" for future capacity in the legislative proposal for the renewal of the AIP and a revolving loan program for land banking.
4. Undertake efforts to obtain national consensus on the need for new airports.	4. ACPO will continue to stipulate the need for new airports to mitigate congestion and delays which are projected to occur regardless of improvements to existing airports
5. Use the recommendations of the Industry Task Force on Airport Capacity Improvement and Delay Reduction and other interested industry elements to examine new airport use proposals intended to optimize throughput.	5. ACPO participated in Industry Task Force subcommittee meetings in 1985 to discuss airspace procedures and other capacity enhancements, and will continue to update the response to the recommendations of the Task Force.
6. Fund and expedite the development and demonstration of airport improvement concepts.	6. ACPO funded the continued development of computer models for groundflow and terminal airspace capacity enhancements.
7. Establish a mechanism for providing financial incentives to airports for the implementation of short runways in locations where construction is possible and where commuter/general aviation traffic is high. Examine currently available alternatives and those that will be available after the current AIP program expires in 1987.	7. ACPO participated in Industry Task Force activity related to the implementation of IFR converging runway programs scheduled for 1986 implementation. ACPO will investigate MLS installation with regard to separate runway utilization.

ACTION PLAN RECOMMENDATIONS	ACPO RESPONSES
8. Establish new airport-specific task forces (FAA/industry) at congested and soon-to-be-congested airports to involve airport operators, airlines, general aviation, and FAA in resolving specific problems at specific airports. If necessary, develop new analytical tools, or modify existing ones, for use by airport-specific task forces, airport planners, and FAA engineers in analyzing specific problems and assessing potential improvements.	8. Three airport task forces were initiated in 1985. ACPO plans to sponsor an additional three to six task force efforts in 1986.
9. Continue development of criteria and terminal instrument procedures (TERPS) for uses of the microwave landing system to achieve airport capacity increases.	9. ACPO will continue to encourage and monitor MLS procedures developments.
10. As part of the FAA's longer-range research and development plan, develop new initiatives that address improvements in terminal ATC automation, airport surface traffic control, and aircraft capabilities which could lead to gains in capacity.	10. ACPO will coordinate new initiatives with FAA offices and the Industry Task Force.

4.0 BENEFITS FROM CAPACITY ENHANCEMENT ACTIVITIES

The projects described in Section 5.0 will alleviate some congestion and enhance airport capacity. Some projects, such as those funded by the AIP grant program, may yield significant capacity gains by promoting the expansion of airport facilities -- assisting in the construction of runways, taxiways, and aprons; other projects will enhance capacity by equipping airports with more precise radar and navigational aids; and many programs are directed toward making more effective use of existing airport facilities while maintaining or improving safety standards. While these projects will help, they are not in themselves a complete solution to all airport capacity problems. That issue is addressed in this section through an examination of the capacity benefits expected from specific projects. This section defines four categories of capacity-related benefits, presents data on the benefits of current projects, and concludes with an assessment of the adequacy of future airport capacity. The discussion omits, for the most part, project benefits unrelated to capacity and does not attempt quantitative project evaluations.

4.1 TYPES OF PROJECT BENEFITS

Each of the 53 projects can be categorized in terms of the capacity-related benefits defined below:

- Increasing Overall Airport Capacity

  Even under VFR, capacity at many major airports is inadequate relative to current and projected traffic demands. Eighteen percent of delays longer than 15 minutes at the 22 pacing airports were attributed to airport congestion in 1984. A primary purpose of some FAA programs is to expand or enhance airport facilities, thus increasing overall airport capacity and reducing delays. They also enable an airport to accommodate additional traffic without incurring an increase in delay.

Eighteen percent of delays longer than 15 minutes at the 22 pacing airports were attributed to airport congestion in 1984.

- Increasing IFR Capacity

  When meteorological conditions dictate the use of IFR, airport capacity declines, sometimes by as much as 50 percent or more from VFR capacity. When an airport is operating close to VFR capacity, a shift to IFR operations results in the formation of queues and subsequent delays. More than two-thirds of delays of 15 minutes and longer are directly attributable to the reduced capacity (or reduced effective throughput) which occurs in poor weather. Additional delay results

More than two-thirds of delays of 15 minutes and longer are directly attributable to the reduced capacity (or reduced effective throughput) which occurs in poor weather.

indirectly from poor weather, as delays at one airport create system-wide scheduling disruptions. Many FAA programs are intended to improve airport capacity under IFR conditions, reducing the difference between IFR and VFR capacity.

- Reducing Delay

  Various factors prevent airports from operating at maximum throughput capacity, and as operations approach the capacity level, delays generally increase. A number of projects are aimed at permitting an airport to operate closer to capacity without incurring the full delay penalties that usually are associated with such an activity level. The projects in this category are distinguished from those projects that increase overall or IFR capacity in that they increase effective throughput without changing theoretical airport capacity.

- Developing Improved Planning and Information Systems

  A thorough understanding of the factors affecting safety, capacity, and delay is essential to the development of effective plans for airport expansion or capacity enhancement. A purpose of many FAA programs is to improve the analytical tools and information sources that are available to planners so that they may better anticipate, analyze, and resolve congestion problems. Projects in this category, although important to the overall capacity program, have only an indirect effect on airport capacity.

Table 4-1 lists the 53 projects described in Section 5.0 and identifies the timeframe in which their benefits are expected to be achieved.

TABLE 4-1 EXPECTED IMPLEMENTATION OF AIRPORT CAPACITY ENHANCEMENT PROJECTS

NO.	PROJECT TITLE	TIME FRAME
BENEFIT CATEGORY: INCREASE CAPACITY		
1.2.2d	REDUCED LONG STANDARDS/SPACING	SHORT
1.1.1	AIRPORT IMPROVEMENT PROGRAM	ONGOING
3.2.2	PAVEMENT STRENGTH/DURAB/REPAIR	ONGOING
3.2.1f	ESTABLISH VISUAL NAVAIDS	ONGOING
3.1.2	METHODS OF REDUCING ROT	INTERMED
BENEFIT CATEGORY; INCREASE IFR CPACITY		
1.1.2	INSTRUMENT LANDING SYSTEM	SHORT
1.1.4	MLS STEP	SHORT
1.1.6	MLS F&E	SHORT
1.2.1	SIMULT OPS/INTRSCTING WET RWAYS	SHORT
1.2.2.a	IFR APPROACHES/COVERGING RWAYS	SHORT
1.2.2b	SEPARATE SHORT RUNWAYS	SHORT
1.2.2c	INDEPENDENT CLOSE PARALLEL IFR	SHORT
1.2.3	MLS TERPS/PROCEDURES	SHORT
3.2.1e	APPROACH LIGHTING	ONGOING
3.2.1g	RVR ESTABLISH/UPGRADE	ONGOING
2.1.1	TRIPLE APPROACHES	INTERMED
2.1.4	WAKE VORTEX OPERATIONAL SOLNS	INTERMED
2.2.2	LANDING MONITOR FOR CLOSE RWAYS	INTERMED
2.1.7	WAKE VORTEX AVOID/FCAST/ROTORC	LONG
2.2.1b	PRECISION APPROACH AND LANDING	LONG
2.2.7	ADVANCED MLS APPLICATIONS	LONG
BENEFIT CATEGORY: REDUCE DELAYS		
1.1.3	MODE S DATA LINK TECH ENHANCE	SHORT
1.1.5	LLWAS ENHANCEMENTS	SHORT
1.1.8	TERMINAL RADAR ENHANCEMENT	SHORT
1.1.9	WIND MEASURING EQUIPMENT	SHORT
1.1.10	RUNWAY CONFIG MGMT SYSTEM	SHORT
3.2.1d	AIRPORT LIGHTING/VISUAL AIDS	ONGOING
2.1.2c	DEPARTURE FLOW METERING	INTERMED
2.1.2d	TRFC MGMT W/ARRIVTIME COMMIT	INTERMED
2.1.6	UPGRADE ARRIV/DEMAND ALGORITHM	INTERMED
2.2.3	ADVANCED WEATHER RADARS	INTERMED
2.1.2a	TERMINAL ATC AUTOMATION	LONG
2.1.2b	CADM-ASSTD AIR TRFC MGMT TECH	LONG
2.1.3	MODE S DATA LINK APPLIC DVLPMT	LONG
2.2.1a	4D NAVIGATION IN TERMINAL AREA	LONG
2.2.4	SENSOR IMPROVEMENTS	LONG
2.2.5a	ADV WIND SHEAR SENSOR DVLPMT	LONG
2.2.5b	TERMINAL DOPPLER WEATHER RADAR	LONG
3.1.1	AIRPORT SURFACE TRAFFIC AUTO	INTERMED
3.2.1a	ASDE	INTERMED
3.2.1b	AIRPORT SURFACE SURVEILLANCE	INTERMED
4.1	LOW ALTITUDE SURVEILLANCE	INTERMED
3.2.1c	ALL WEATHER SURFACE GUIDANCE	LONG
2.2.6	WEATHER SENSOR DEVELOPMENT	LONG
BENEFIT CATEGORY: IMPROVE PLANNING		
1.1.7	ROTORCRAFT LANDING/NAVIGATION	SHORT
1.2.4	ROTORCRAFT ATC TERMINAL	SHORT
3.1.3	AIRPORT DESIGN/CONFIGURATION	ONGOING
4.2	AIRPORT CAP ENHANCE TASK FORCES	ONGOING
4.4	ENVIRONMENTAL PROGRAMS	ONGOING
4.5	ADVANCED CONCEPT STUDIES	ONGOING
4.6	NAS DEVELOPMENT STUDIES	ONGOING
4.3	AIRPORT CAPACITY MODEL	INTERMED

4.2 EXAMPLES OF AIRPORT-SPECIFIC BENEFITS: MULTIPLE INSTRUMENT APPROACH CONCEPTS

Quantifying the benefits of the FAA projects requires detailed study at specific airports, benefits are site-specific.

Quantifying the benefits of the FAA projects in terms of increased throughput capacity or reduced delay requires detailed study of the effect of each program at specific airports. Benefits are site-specific for a number of reasons. First, not all projects are applicable to all airports. Revisions in ATC rules regarding converging runways, for example, will benefit only airports having converging runways. Second, the potential benefits are influenced by the existing runway configuration, navigational equipment, and typical fleet mix of an airport. Third, when benefits are measured in terms of reduced delay, they will be strongly affected by an airport's current traffic level and density. At a congested airport with high average delays, an increase in hourly throughput of only three or four operations per hour can result in significant delay savings; on the other hand, an increase in throughput at an underutilized airport may have little measurable impact on delay since the additional capacity is not currently required.

The FAA, in conjunction with airport operators and users, has sponsored studies to determine the applicability of various capacity enhancement projects and their likely benefits. A number of these studies have focused on the impacts of implementing multiple instrument approach concepts such as parallel approaches, converging approaches, and triple approaches. These concepts have been considered to have significant potential for increasing arrival capacity and reducing delay under IFR conditions.

Table 4-2 illustrates the potential benefits of some of these concepts under IFR conditions at selected airports. It is clear that arrival capacity would be increased significantly and arrival delays substantially reduced through the application of these concepts. It is important to note that such improvements may be realized only under IFR conditions, which apply less than 20 percent of the time in each of these cases. However, given the tendency for delays to escalate under IFR conditions, the improvements are significant.

4.3 ESTIMATES OF SYSTEM-WIDE BENEFITS

The airport-specific nature of capacity improvement benefits makes it difficult to estimate the system-wide benefits of a particular project from an analysis of its effects at selected locations. Nonetheless, some attempt must be made to view benefits in system-wide context, since congestion and delay have system-wide repercussions. Measures that reduce delay

TABLE 4-2 POTENTIAL IFR CAPACITY GAINS AT 15 AIRPORTS

AIRPORT	%IFR	BEST CURRENT CONFIG	ALTERNATE PROCEDURE	PERCENT POTENTIAL INCREASE CAPACITY[1]	PERCENT POTENTIAL REDUCTION DELAYS[2]
BOSTON	15	SINGLE RWAY	DEP PARALLEL	44	75
PHILADELPHIA	15	SINGLE RWAY	DEP PARALLEL	42	86
MEMPHIS	9	DEP PARALLEL	INDEP PARALLEL	40	67
NEW YORK/KENNEDY	14	DEP PARALLEL	INDEP PARALLEL	33	71
NEW YORK/KENNEDY	14	DEP PARALLEL	DEP CONVERGING	18	50
NEW YORK/NEWARK	16	SINGLE RWAY	DEP CONVERGING	73	97
NEW YORK/NEWARK	16	SINGLE RWAY	INDEP CONVERG	100	98
HOUSTON	15	SINGLE RWAY	INDEP CONVERG	100	98
DALLAS/FT. WORTH	8	INDEP PARALLEL	TRIPLES	50	89

1 - PERCENT POTENTIAL INCREASE IN ARRIVALS/HOUR
2 - PERCENT POTENTIAL REDUCTON IN DELAY HOURS/DAY

Source; Silva, A.C. and Dr. J.N. Barrer, Potential Applications of Multiple Instrument Approach Concepts at 101 U.S. Airports (Mclean, VA; the MITRE Corporation 1985), pp. 4-6-4-9.

at one airport also will reduce schedule disruptions and resulting delays at other airports. Measures that enhance the capacity of underutilized airports may make such airports more attractive to potential users and enable them to draw traffic from congested airports.

Another difficulty in estimating the system-wide impact of capacity improvement concepts is that the benefits of particular procedures or types of equipment also may be compounded when they are used in combination. For example:

- The potential for capacity gains from converging or dependent parallel approaches is greatly improved by MLS.

- The possibilities for runway construction or extension are greatly expanded if ATC rules are changed to allow converging IFR approaches or to allow parallel runways separated by fewer than 4,300 feet to operate independently in IFR conditions.

- The number of runway configurations available in a Runway Configuration Management System is augmented when runways are equipped with precision radar or when controllers have more reliable wake vortex information.

Relationships such as these must be studied so that their impacts on airport capacity and delay can be more accurately estimated.

Despite these ambiguities, the relative importance of the projects in terms of time frame and expected benefits can be determined. This is illustrated in Table 4-3. Although it appears that high payoffs can be expected from only a few projects, this does not mean that the projects with lower expected benefits should be discounted. The system-wide impacts of such projects may be important because of the significant delay reduction that may be realized by airports operating near saturation level. It is important to recognize that the cost savings realized from even small capacity increases may be substantial at some major airports.

The following discussions attempt to put some perspective on the system-wide benefits that may accrue from some of projects with relatively higher expected benefits:

TABLE 4-3 RELATIVE TIMEFRAME AND EXPECTED BENEFITS OF CAPACITY IMPROVEMENT PROJECTS

BENEFITS	ONGOING	SHORT	TIME INTERMEDIATE	LONG-TERM
HIGH	AIP AIRPORT TASK FORCES*	IFR APPROACHES TO CONVERGING RWAYS SEPARATE SHORT RUNWAYS SIMULTANEOUS OPS/INTERSECTING WET RUNWAYS TRIPLE APPROACHES MLS F&E* INDEP CLOSELY-SPACED PARALLEL IFR		40 NAV IN TERMINAL AREA TERMINAL ATC AUTOMATION
MEDIUM	AIRPORT LIGHTING/VISUAL AIDS AIRPORT DESIGN/CONFIG IMPROVEMENTS APPROACH LIGHTING ESTABLISH VISUAL NAVAIDS RVR ESTABLISH/UPGRADE	RUNWAY CONFIG MGMT SYSTEM WIND MEASURING EQUIPMENT/LLWAS ILS MLS TERPS/PROCEDURES MLS STEP AIRPORT CAPACITY/DELAY MODELS ROTORCRAFT LANDING/NAVIGATION ROTORCRAFT ATC PROCEDURES TERMINAL RADAR ENHANCEMENT	NEXT GENERATION WEATHER RADAR LANDING MONITOR CLOSE RUNWAYS WAKE VORTEX OPERATIONAL SOLNS DEPARTURE FLOW METERING TRFC MGMT/ARRIVAL TIME COMMIT AIRPORT SURFACE TRFC AUTOMATION METHODS OF REDUCING ROT AIRPORT SURFACE SURVEILLANCE ASDE UPGRADE ARRIVAL/DEMAND ALGORITHM	CADM-ASSTD AIR TRFC MGMT TECH MODE S DATA LINK APPLIC/DVLPMT ALL WEATHER TAXIWAY GUIDANCE ADVANCED MLS APPLICATIONS WAKE VORTEX AVOID/FCAST/ROTORCRAFT SENSOR IMPROVEMENTS WEATHER SENSOR DEVELOPMENT LOW ALTITUDE SURVEILLANCE ADVANCED WIND SHEAR SENSOR DVLPMT
LOW	ENVIRONMENTAL PROGRAMS	MODE S DATA LINK TECH ENHANCE LLWAS ENHANCEMENTS REDUCED LONGITUDINAL SPACING	AUTOMATED AIRPORT CAPACITY CALCS	TERMINAL DOPPLER WEATHER RADAR PRECISION APPROACH/LANDING
UNDET	ADVANCED CONCEPTS STUDIES NAS DEVELOPMENT STUDIES			PAVEMENT STRENGTH/DURAB/REPAIR

* MEANS PROJECT IS RANKED HIGH/MEDIUM IN TERMS OF POTENTIAL BENEFITS

IFR approaches to converging runways: Potential application to 74 airports.

The acceptance of converging procedures could double the IFR capacity at some airports. New procedures have been developed to overcome the problem of simultaneous missed approaches, which has been the major drawback to the implementation of such approaches. Denver is developing a demonstration program that will permit simultaneous approaches to two converging runways, resulting in a 50 percent increase in IFR capacity over their current dependent parallel operations. It has been estimated that the use of IFR converging approaches at Denver would save $1.5 million annually in airline delay costs. Similar capacity gains may be possible at other airports that have nonintersecting converging runways at least 6,000 feet long.

Separate short runways: Potential application to 60 airports.

If the list of feasible converging runway pairs is expanded to include intersecting and shorter runways capable of allowing commuter aircraft landings, there are many more potential applications. The primary advantage of using shorter runways is that it allows the segregation of slower-moving, lighter regional and general aviation aircraft from the higher-speed air carrier traffic.

Triple approaches: Potential application to 6 airports.

Research continues on ways to permit IFR approaches to triple runway configurations. Chicago O'Hare often uses triple arrival streams (weather permitting) to absorb peak arrival demands on the airport. The acceptance of triple arrivals during IFR conditions would have a significant impact on delays at airports that have existing triple runway layouts and sufficient airspace to allow for missed approaches. These airports include Pittsburgh, Detroit, Chicago, Atlanta, Dallas/Fort Worth and Washington Dulles. Triples also can apply to an untold number of new runways.

Independent closely-spaced parallel approaches: Potential application to 25 airports.

The parallel runway standard is now 4,300 feet for simultaneous IFR use. The FAA is studying dependent parallel approaches at runway spacings of down to 1,000 feet, and independent parallel spacing of 3,000 feet. Parallel approaches to runways separated by less then 4,300 feet provide benefits of capacity increases to existing airports and savings in land acquisition costs for new construction. For example, several airports (e.g., Denver and Baltimore) are considering building new parallel runways. For every 100 feet of reduction in required spacing, there is a 20 acre savings in land. Since land costs can exceed $500,000 per acre in densely populated areas, this represents a significant potential savings. A reduction in spacing of 1,200 feet has the potential to save $130 million in land acquisition costs alone.

Airport Improvement Program.

The FAA currently distributes nearly $1 billion each year for airport surface improvement projects. The AIP program supports the development of airport facilities to accommodate anticipated future demand and the upgrading of existing facilities to meet recommended standards for current use. Typical capacity-related projects include the extension, widening, grooving, and strengthening of runways; the installation of runway, taxiway, and apron lighting; and the purchase of land.

MLS.

The initial capacity benefits of MLS will be achieved with installations at secondary runways at hub airports to allow more separation of aircraft types. Gains also will be achieved initially with installation on runways that are currently without instrumentation. Ultimately, the use of the microwave landing system (MLS) offers potential capacity benefits at many major airports with the use of multiple and curved approaches. Among these benefits are reductions in route length, procedures to avoid noise-sensitive areas, and the ability to reduce inter-airport conflicts. In New York, for example, an MLS installation at LaGuardia could reduce some arrival route lengths significantly, and elimination of the airspace conflicts between La Guardia and Kennedy airports would, under certain conditions, enable the use of an additional runway at La Guardia. By using the curved approach capability of MLS, properly equipped aircraft could avoid noise-sensitive areas, allowing the airports to operate with higher capacity configurations which may be impossible given current noise abatement procedures.

The FAA continues to develop estimates of program benefits. While much work remains to be done, the studies performed to date, supported by discussions with airport operators and users, provide ample evidence that the programs in this plan will relieve at least some congestion and expand capacity at the nation's airports.

4.4 ASSESSMENT OF CAPACITY ENHANCEMENT EFFORTS

The airport capacity problem has neither a single cause nor a simple solution. The FAA, through its operation of the air traffic control system, influences the number of aircraft operations that can occur during a given time at a specific airport, and many of the FAA projects covered in this plan are expected to increase the effective throughput of airports. Assisted in some cases by Airport Improvement Program grants, airport and aircraft operators can take action to reduce delays. Despite the best efforts of all parties, it is likely that the demand for travel at a number of busy airports will increase faster than will the airports' ability to accommodate increased aircraft operations.

Changes in airspace procedures (such as the implementation of multiple instrument approaches), in systems development (such as the deployment of the MLS system), and in demand shifts (such as reductions in peak hour scheduling) can go only so far in alleviating the capacity problem. The most effective way to increase capacity is to build more airport facilities. However, the FAA's efforts to add capacity to the airport system through airport and runway construction grants are limited by land availability, environmental constraints, and the willingness of airport operators to expand; additional capacity, therefore, cannot always be built where it is needed.

A significant problem is the acquisition of land on which to develop airport facilities. It is estimated that over 30,000 additional acres of land will be needed by the year 2000 to expand facilities at existing airports and to build new airports. The purchase of land to meet short-term needs (within five years) has been eligible for Federal grant assistance under the AIP and its predecessor grant programs. Land acquisition for longer-term capacity needs also is eligible for Federal grant assistance. However, because of funding limitations, only projects for which an immediate need can be demonstrated are normally programmed. Similarly, airport operators generally have not applied for grant funds for advance land acquisition, or land banking.

Land banking has obvious advantages in terms of meeting future capacity demands. It ensures the availability of the required land, and may reduce the cost of acquiring it. Federal support of land banking could take one of several forms: a dedicated funding category for airport capacity land acquisition could be specified in new airport grant program authorization; or a revolving loan program, such as one modeled on the highway land acquisition program, could be established. A revolving loan program could minimize outlays by airport operators since reimbursements would involve credits against future grant eligibility.

4.5 SUMMARY

Early in his tenure Administrator Engen said, "There will be more demand and competition for limited airspace and airport capacity, and a major effort is required to increase the utilization of both airspace and airport resources safely."

The National Airspace System (NAS) Plan and the Research, Engineering, and Development (R,E&D) Plan contain many efforts that have a direct and indirect impact on the achievement of airport and system capacity. Implementation of the NAS Plan will bring a number of basic improvements to the terminal area and airport system. An increase in "direct" operations, the increasing ability to separate aircraft from aircraft rather than airspace, a sophisticated information-based traffic management system, significant improvements in the quality of winds aloft and weather information, implementation of airport surface detection equipment and, of course, increasing capability in many aircraft to use flexible fuel-efficient four-dimensional flight path control--will all improve terminal and airport operations.

Following these comments is a listing of a number of projects which are part of FAA's current planning, and an indication of whether they are improvements which might be expected in the near-term or further away. The prospective capacity gains from any one of the improvements is small, often only a few percent, compared to the much larger gains achievable from more runways and new airports. Yet even small capacity gains are valuable; <u>delay costs go down about five percent for every one percent capacity gain on a congested runway.</u>

Delay costs go down about five percent for every one percent capacity gain on a congested runway.

Quantitatively assessing capacity gains, and thus benefits, in the context of terminal and airport capacity has proven to be difficult. Each airport is unique. A particular procedure which may provide significant increases in capacity may be useful only under certain visibility conditions and only during certain hours of the day or with certain aircraft mixes. For example, the "St. Louis sidestep" procedure, a special approach procedure involving a visual segment, has produced a capacity increase of 13 operations per hour--but only under certain conditions, and achieved only after years of study. The benefit of other procedures or other techniques may be heavily dependent on the level of implementation of avionics in the aircraft using the airport; in other cases, on the ratio of large-to-small aircraft using an airport.

The FAA/industry airport specific task forces, which have been of great value in identifying practical improvements, are particularly useful in sifting possible improvements to identify the prospectively most fruitful, and their analysis and judgment may be the most valuable resource in identifying benefits.

In the final analysis, decisions on investments in airport and terminal airspace capacity improvement systems and procedures are judgmental, although they may be aided by analysis. For example, in considering closely spaced parallel IFR operations and the resources and equipment required to make them possible, only a relatively limited number of current airports and runway pairs may be affected. A much greater benefit, however, may accrue because airport planners, recognizing that closely spaced parallel IFR operations are practical and safe, can plan new airports, and new runways at existing airports using the reduced separation criterion to achieve capacity not previously practical in an economical way.

Considering that there are only three major approaches to gaining optimum capacity using existing airport resources, (i.e., safe reduction in minimum separation requirements, reduction in variability of aircraft performance, and optimal resource management), the following areas of effort may be the most fruitful for further development and implementation and, therefore, the most deserving of community support and priority in a constrained budget situation:

Simultaneous IFR Approaches to Converging Runways. Important capacity improvement is possible in the near-term at a large number of airports with the implementation of IFR approaches to converging runways at reduced minimums. Simultaneous converging runway operations have been studied and strongly supported by the Industry Task Force on Airport Capacity Improvement and Delay Reduction. Implementation of the first step of such operations is expected in the spring of 1986.

The procedure requires that both runways of the converging pair must be equipped with ILS or MLS. A recent study showed that 40 airports met that requirement; 63 airports would require precision approach service to be implemented on only one of the pairs prior to implementation. The current activity, likely to lead to significant improvement in the near term, is not the end of the road. Work must continue to achieve lower approach minimums for converging IFR operations. An assessment is underway of acceptable methods to safely reduce the minimum ceiling and visibility conditions in which IFR converging approaches can be conducted--including the use of MLS for missed approach and departure guidance, improved surveillance, and possible use of automated monitoring techniques.

Reduced Longitudinal Spacing. The longitudinal separation effort will reduce in-trail separation on landing from 3 nm to 2.5 nm for certain aircraft pairs. Significant data has been taken at three major airports, with no reported wake vortex encounters and no go-arounds during the demonstrations. Because of its application to many airports, it is likely to be a valuable capacity gainer in the near-term under high arrival demand conditions.

Independent Parallel IFR Operations at Reduced Runway Spacings. Work is far along on the development of safe reduction in parallel IFR runway minimum spacing from the present 4,300 feet. It is likely to be implemented in the near-term and will have major impact on several existing pairs of runways and in new airport and new runway planning at existing airports.

Other Concepts and Alternative Techniques. Successful completion of the work on the three concepts described immediately above will pave the way toward beneficial use of triple approaches under IFR conditions and more effective use of short runways at major airports based on extensions of current routine VFR operations.

Closely related also is work on sensors required to achieve closely spaced parallel and reduced minimums coverging operations, and the work on alternatives to new sensors, such as the "almost parallel" concept in which one or both aircraft can be offset slightly from centerline in order to maintain assurance of safe separation. MLS may be the key ingredient to beneficial application of the "almost parallel" concept.

Exploitation of MLS Capabilities. A major long-term capacity gainer is the introduction of the Microwave Landing System (MLS), with its capability to provide high flexibility with precision in both approach and departure operations. MLS has the prospective capability to reduce approach minimums in difficult terrain and the possibilty of curved approaches to eliminate approach noise problems and inter-airport ATC interference. Precision curved approach and departure paths may be the key ingredient in getting optimum use of short runways using separate arrival and departure streams under separation standards made possible by the precision of MLS.

Triple approaches and departures and converging runway operations at low minimums will be simplified significantly when MLS approach and departure guidance is available and in wide use in aircraft. The flexibility of MLS will undoubtedly lead to exploitation of procedures not yet thought of, and should lead to improved poor weather operations, since virtually all MLS systems will provide the capability equivalent to Category III ILS signal quality.

Flow Optimization in the Terminal Area. While improvements in the management of aircraft flows into and out of major terminal areas and airports cannot improve airport capacity per se, they can have a major impact on the best utilization of available capacity. Improvements in flow control and delay management, improvements in information flow that provide better data on current and projected airport capacity to the en route and transition resolve problems contributing to construction-related delays at congested airports.

Improved materials and methods for rapid nighttime and cold-weather construction must be pursued. Better materials and techniques must be developed for new pavements to prolong their useful life, maximize their availability, and possibly reduce investment and life-cycle costs. There are additional opportunities to enhance airport safety, efficiency, and often capacity through improved research and development of equipment and techniques in airport design, and operations.

Funding Restrictions and Requirements. Funding must be available to achieve these gains. All of FAA's capacity-related efforts, whether in R&D, procedures development, equipment procurement, or elsewhere, are subject to funding limitations in a time of stringent and constrained budgets. These budget limitations establish the timing of beginning the work, its intensity, and the project completion time.

The priority with which such work can proceed depends in large measure on the priority with which the aviation community gives these activities.

Capacity-Related Projects in FAA Plans. Many projects and activities in FAA's modernization plan and R,E&D Plan have an impact on system or airport capacity. In a number of cases, such as the items described above, the impact is major and the motivation for the project is predominantly for the achievement of more capacity. In other cases, the primary motivation for the project may be safety or to meet a navigation requirement or other purpose, and its impact on the achievement of terminal area or airport capacity may be smaller, although valuable.

A listing of these projects is useful in the appreciation of the number of efforts in FAA plans which have a capacity impact and, to a degree, in the establishment of priorities. The following projects are separated into those whose primary purpose is the achievement of terminal area or airport capacity and those which have an important, but lesser, capacity impact.

The listing offers an idea of the timeframe in which benefits might be expected, categorized into near-term, medium-term, or longer-term efforts.

NEAR-TERM (1-5 YEARS)

IFR Approaches to Converging Runways. FAA has adapted an interim criterion for conducting converging runway operations that will permit converging IFR operations at a limited number of airports. The only major disadvantage of the interim solution is that the conversatism built into the airspace requirements restricts its applicability and prevents its use when ceilings are much below 500 feet. Work continues on methods for achieving lower decision heights.

Independent Closely-Spaced Parallel Approaches. An effort to develop and demonstrate safe simultaneous operations to parallel runways separated by at least 3,000 feet is underway. If successful, many airports can achieve capacity gains during IFR operations. Efforts are continuing on the identification of a surveillance sensor (or some alternative means) which can provide sufficient accuracy, and displays to allow aircraft to respond to deviations on approach and landing.

Separate Short Runways. The goal is to increase the IFR capacity of major airports by developing procedures and equipment (if necessary) to allow smaller aircraft to use shorter runways (4,000 to 6,000 feet) without interfering with other operations. The benefits fall into two categories. First, more aircraft will be able to use the airport during IFR. The increase in the number of smaller aircraft capable of using shorter runways would free the longer runways for larger aircraft. Second, by segregating the traffic between long and short runways, the smaller aircraft will be grouped together; the average in-trail separations will be smaller because wake vortices will not be a factor on the shorter runway. Implementation of these procedures could have a substantial impact on capacity.

Triple IFR Approaches. Because of the increased use of the hub and spoke concept, arrivals come in bunches requiring brief, occasional needs for arrival capacities which are much higher than the average arrival rate. The use of three simultaneous arrival streams to an airport implies that about 75 aircraft per hour could land. If used during IMC weather conditions where triple runway combinations are available, that much capacity would eliminate current delays caused by insufficient airside capacity; ground-side capacity would become the constraining factor, even at an airport as large as Chicago O'Hare.

The development of procedures to support triple IFR approaches is underway. Acceptable missed approach procedures and adequate surveillance systems must be developed prior to implementation.

LONG-TERM (11-20 YEARS)

4D Navigation in the Terminal Area. The use of time as a method for ensuring separation while increasing efficiency will be a major part of the terminal ATC automation program. The current time variability of aircraft following a trajectory requires that actual separations be increased above the minimum in order to account for early and late arrivals at congestion points (fixes, runways, taxiways). Because of the variability in arrival times in today's environment, it is too difficult for the controllers and pilots to coordinate alternating approaches (except in the special case of dependent parallel aproaches). One major advantage of 4D navigation is that it may allow coordinated, alternating approaches to several runways (parallel or non-parallel) at airports where runway spacing is less than the minimum for independent operations.

Terminal ATC Automation. Through the use of computer-aided decision-making to assist the controller and pilots in sequencing and scheduling arrivals and departures, the variability in arrival/departure times can be reduced. The reduced variability may allow a safe reduction in certain separation standards leading to capacity gains but, even if no reduction is possible, the reduction in variability increases the use of resources and simplifies the pilot's and controller's jobs. Terminal automation programs require careful planning and airspace coordination among the industry/users, FAA offices, aircraft manufacturers, avionics manufacturers, and others. Consequently, the immediate goal is to generate a system description and requirements document that provides a logical basis for future development and program coordination.

PROJECTS WITH MODERATE TO SIGNIFICANT CAPACITY IMPACT

NEAR-TERM (1-5 YEARS)

Microwave Landing System (MLS). The implementation of the new common civil/military approach and landing system to meet current and anticipated user operational requirements will produce capacity gains based on the greater flexibility afforded by MLS coverage.

Runway Configuration Management System. Implementation and evaluation of an aid to the Traffic Management Unit that will assist in the selection of the runway configuration yielding the greatest capacity.

Terminal Radar Enhancements. This project will provide development and support for the Automation Radar Terminal System (ARTS) to ensure that its availability, reliability, and capacity remain acceptable as demand increases, thus reducing delays to airspace users.

Wind Measuring Equipment/LLWAS. Installation of LLWAS to monitor winds and alert the controller to the existence of wind shear conditions will allow the controller to smooth the transition between different runway configurations. Improvement of the detection probability and reduction of the false alarm rate of the LLWAS will improve flight planning and reduce disruptions at LLWAS-equipped airports.

Rotorcraft ATC Procedures. Providing technical methodologies, tools, and a data base to support improvements to the ATC system for fuller integration of rotorcraft into the NAS may relieve congestion in dense traffic areas for both rotorcraft and fixed-wing aircraft.

Rotorcraft Landing and Navigation. The development and evaluation of navigation and landing capabilities for future implementation of systems that will provide basic IFR services for rotorcraft operations is necessary for providing primary system capacity.

Approach Lighting. Improved approach and runway lighting and visual aids will support landings under reduced-minimum weather conditions.

Establish Visual NAVAIDS. The goal of this project is to provide visual navigation aids (e.g., runway end identification lights) that allow operations during adverse weather conditions.

RVR Establish/Upgrade. The upgrading of existing RVR systems and establishment of new systems will allow operations to lower weather minimums.

Airport Design and Configuration Improvements. Development of improved airport designs and configurations that will provide greater airport capacity, as well as increased safety and efficiency of ground movement for current and future aircraft.

MEDIUM-TERM (6-10 YEARS)

Airport Surface Surveillance, Guidance and Control Systems. Several projects fall in this category: Airport Surface Surveillance, All-Weather Taxiway Surface Guidance, and Airport Surface Traffic Automation. The completion of these projects will allow efficient separation assurance during low visibility operations on the airfield. They will improve safety by allowing more careful monitoring of runway taxiway intersections to prevent runway incursions. The management of ground movements will reduce congestion by providing precise gate release times and sequencing of departures.

Next Generation Weather Radars. Development of a new generation of Doppler weather radars will improve hazardous weather detection, improve flight planning and reduce delays.

Upgrade Arrivals/Demand Algorithms. Modification of the Central Flow Control Estimated Departure Clearance Time algorithm to account for prediction uncertainties will enable more efficient use of an airport's capacity.

Departure Flow Metering. The goal of this project is to refine the coordination process between airport, terminal, and en route controllers so that departure slots and times can be determined more precisely to minimize delays for departing aircraft. Prototype systems are being developed and field-tested.

Traffic Management With Arrival Time Commitments. This includes the development of operational procedures and associated processing to enable the traffic management system to plan for, negotiate, and honor airport landing time commitments.

Wake Vortex Operational Solutions. This project focuses on the development of procedures that use the increased precision and flexibility of MLS to provide multiple approach paths that avoid each other's wake vortices. This will allow a reduction in the separation requirements, thus increasing airport capacity.

Methods of Reducing Runway Occupancy Time. This project will investigate technologies to reduce both the average runway occupancy time and its variability. With the introduction of automation in the terminal area, runway occupancy time will be one of the limiting factors on runway capacity; a decrease will allow runways to be used more efficiently, thus increasing capacity.

LONG-TERM (11-20 YEARS)

Wake Vortex Avoidance, Forecasting, and Alleviation. This project aims to improve current methods of avoiding hazardous wake vortex encounters by adopting general separation standards and procedures that more accurately reflect the actual hazard, and by adapting the separations to the real-time duration of the hazard.

Low Altitude Surveillance for Rotorcraft and G.A. Aircraft. This project is to provide surveillance for rotorcraft and fixed wing aircraft at low altitudes not covered by existing surveillance systems through the use of LORAN-C and other dependent surveillance schemes. This project will be particularly useful in certain high-density urban areas and off-shore operations where rotorcraft play a predominant role.

Mode S Data Link Program. The Mode S data link system offers benefits for on projects including 4D navigation, terminal automation, and automated weather reporting. This project will develop, test, and validate operational concepts for data link applications.

Computer-Aided Decision-making Assisted Air Traffic Management Techniques. This project will develop, test, and validate techniques for using expert systems to aid controller decision-making.

Advanced Wind Shear Sensor Development. This project involves research on the measurement of wind fields using advanced technology sensors to determine their effectiveness in an operational airport environment and, if cost and performance warrant, development for airport deployment.

Weather Sensor Development. The evaluation of new systems for weather detection and assessment will provide better forecasting and planning, which will result in improved system efficiency and throughput.

The airport capacity improvement effort will continue as a joint effort. FAA will continue to develop new airspace procedures, new NAVAIDS, and other systems, and will support and encourage airport growth and development while maximizing safety, efficiency, and environmental compatibility. Airlines and other users must encourage aircraft development and airport development to maximize and expand capacity. Aircraft operators should continue efforts to divert demand to off-peak periods and less-congested airports.

Airport operators, local governments and states should continue to assume the initiative in airport expansion and new airport development to accommodate anticipated future demand.

The great success of aviation also presents the greatest challenge of aviation: providing sufficient future capacity to match expected future growth. The ACPO will lead the FAA's efforts to meet this challenge.

5.0 PROJECT DESCRIPTIONS

The project descriptions included in this program have been organized into the following categories:

Category 1: Projects with Near-Term Gains
- 1.1 Procedures
- 1.2 Equipment

Category 2: Terminal Airspace System Projects with Longer-Term Gains
- 2.1 Management/Automation
- 2.2 Equipment

Category 3: Airport Surface Traffic Management System Projects with Longer-Term Gains
- 3.1 Management/Automation
- 3.2 Equipment

Category 4: General Capacity-Enhancement Research and Development with Longer-Term Gains.

The projects in Category 1 do not require extensive research and development to be completed before they can be implemented. All of these projects can be expected to have an impact within the next five years, given either continued or increased funding or, in some cases, acceptance by aviation system users.

Categories 2, 3, and 4 include projects related to equipment and procedures with longer-term expected benefits. Significant R&D is required before the capacity-enhancing effects of these projects can be realized. Category 2 focuses on projects dealing with the terminal airspace. Category 3 projects focus on moving airport surface traffic more efficiently. The projects in Category 4 represent a wide range of research efforts aimed at developing a fuller understanding of factors that affect airport capacity, and at using that knowledge to enhance the overall capacity of the nations's air transport system.

TABLE 5-1 CAPACITY ENHANCEMENT PROJECTS

TABLE 5-1 CAPACITY ENHANCEMENT PROJECTS (CONT'D)

TABLE 5-2
CATEGORY 1: EQUIPMENT AND PROCEDURES WITH POTENTIAL NEAR-TERM GAINS

NUMBER	POTENTIAL	IMPLEMENTATION	
	1.1 PROCEDURES		
1.1.1	AIRPORT CAPACITY ENHANCEMENT TASK FORCES	HI/MED	ONGOING
1.1.2	IFR APPROACHES TO CONVERGING RUNWAYS	HIGH	SHORT
1.1.3	SEPARATE SHORT RUNWAYS	HIGH	SHORT
1.1.4	TRIPLE APPROACHES	HIGH	SHORT
1.1.5	SIMULTANEOUS OPERATIONS ON INTERSECTING WET RUNWAYS	HIGH	SHORT
1.1.6	INDEPENDENT CLOSELY-SPACED PARALLEL IFR	HIGH	SHORT
1.1.7	AIRPORT CAPACITY AND DELAY MODELS	MEDIUM	SHORT
1.1.8	MLS TERPS/PROCEDURES	MEDIUM	SHORT
1.1.9	ROTORCRAFT LANDING AND NAVIGATION	MEDIUM	SHORT
1.1.10	ROTORCRAFT ATC PROCEDURES	MEDIUM	SHORT
1.1.11	AIRPORT DESIGN AND CONFIGURATION IMPROVEMENTS	MEDIUM	ONGOING
1.1.12	REDUCED LONGITUDINAL SEPARATION STANDARDS/ SPACING	LOW	SHORT
	1.2 EQUIPMENT/FACILITIES		
1.2.1	AIRPORT IMPROVEMENT PROGRAM	HIGH	ONGOING
1.2.2	MICROWAVE LANDING SYSTEM (MLS) F&E	HI/MED	SHORT
1.2.3	MLS SERVICE TEST AND EVALUATION PROGRAM (STEP)	MEDIUM	SHORT
1.2.4	INSTRUMENT LANDING SYSTEM (LIS)	MEDIUM	SHORT
1.2.5	EQUIPMENT TO SUPPORT SURFACE TRAFFIC CONTROL SYSTEMS		
1.2.5a	AIRPORT LIGHTING AND VISUAL AIDS	MEDIUM	ONGOING
1.2.5b	APPROACH LIGHTING	MEDIUM	ONGOING
1.2.5c	ESTABLISH VISUAL NAVAIDS	MEDIUM	ONGOING
1.2.5d	RVR ESTABLISH/UPGRADE	MEDIUM	ONGOING
1.2.6	WIND MEASURING EQUIPMENT/LLWAS	MEDIUM	SHORT
1.2.7	RUNWAY CONFIGURATION MANAGEMENT SYSTEM	MEDIUM	SHORT
1.2.8	TERMINAL RADAR ENHANCEMENTS	LOW	SHORT
1.2.9	MODE S DATA LINK TECHNICAL ENHANCEMENT	LOW	SHORT
1.2.10	LLWAS ENHANCEMENTS	LOW	SHORT

1.1.1 AIRPORT CAPACITY ENHANCEMENT TASK FORCES

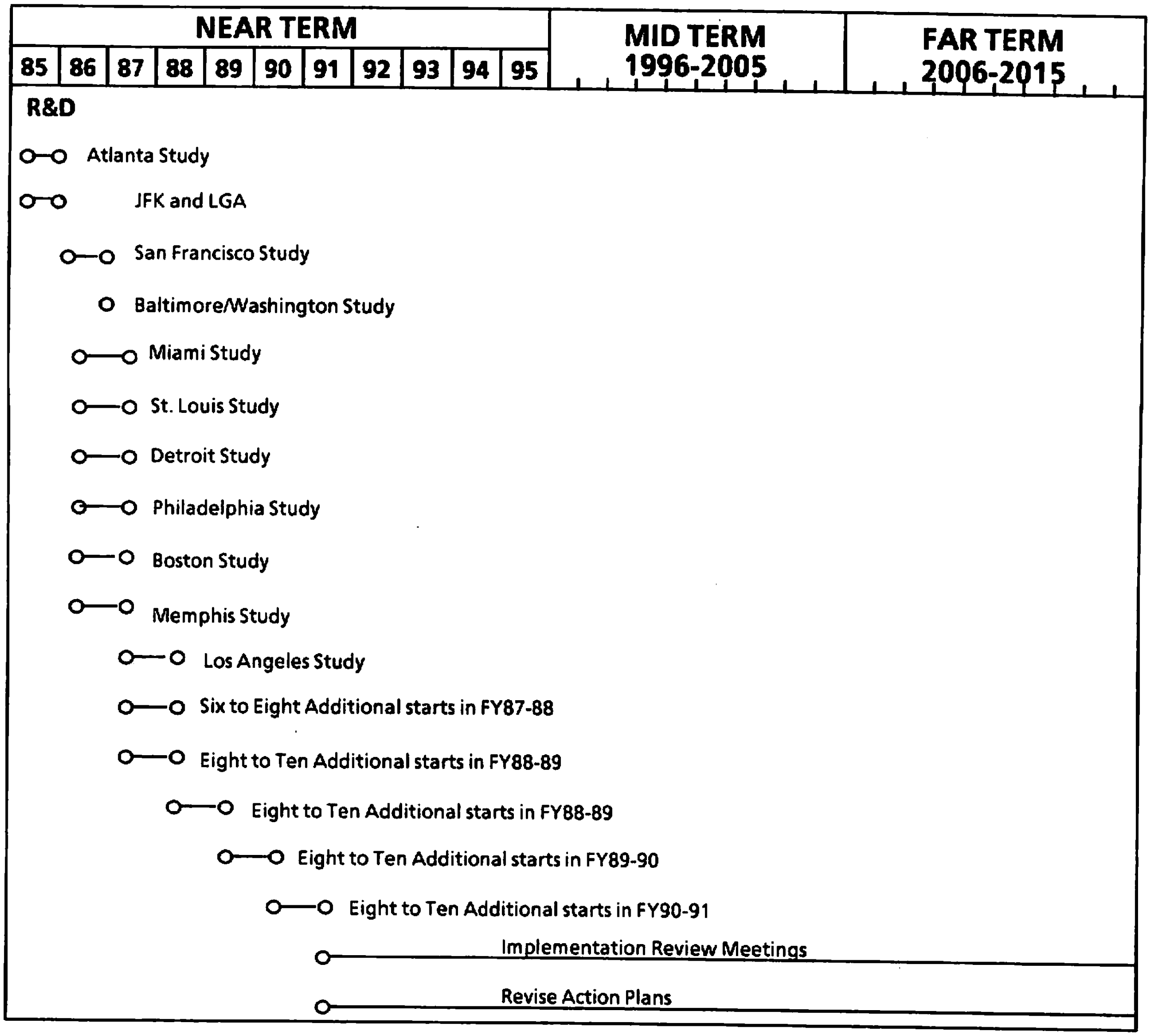
AIRPORT CAPACITY IMPROVEMENT IMPACT:	**IMPROVE PLANNING FOR MEETING FUTURE CAPACITY NEEDS AT THE NATION'S BUSIEST AIRPORTS THROUGH JOINT LOCAL/FAA EFFORTS**

The Federal Aviation Administration is sponsoring airport-specific task forces at congested and soon-to-be-congested airports. The objective of the airport task force program is to establish a forum, sponsored and supported by the FAA or local airport operators, in which local representatives of the aviation community - airport management, the FAA, system users, industry groups, and airport master planning authorities - work together to develop a plan for improving airport capacity by identifying and evaluating options leading to better airport-use strategies and facility investments. Each task force will prepare a report recommending a comprehensive program of capacity improvement measures to reduce the level and cost of delay at a particular airport. The impact of the proposed improvements can be simulated using an airport capacity model. An objective of this program is to provide a mechanism for getting input from local representatives on improving capacity. At sites where capacity studies have been completed, an implementation analysis of any prior studies will serve as the point of departure for the current study.

Airport task forces investigate the application of new airspace procedures, new NAVAIDS, other systems installation, airport development, and other prospective capacity improvements. Computer model simulation estimates the gains from each project that is considered. An action plan incorporates the programs deemed viable by the Task Force.

The FAA proposes to participate in Airport Capacity Enhancement Task Forces at 40 to 50 of the United States' busiest airports. It is the FAA's intent that the Task Forces become quasi-permanent bodies which develop capacity enhancement action plans over a six-to-nine month period and hold periodic implementation review meetings; this entire process is to be repeated on a multi-year cycle.

1.1.1 AIRPORT CAPACITY ENHANCEMENT TASK FORCES



SCHEDULED IMPLEMENTATION: ONGOING

CAPACITY IMPROVEMENT POTENTIAL: HIGH TO MEDIUM

REFERENCES: N/A

1.1.2 IFR APPROACHES TO CONVERGING RUNWAYS

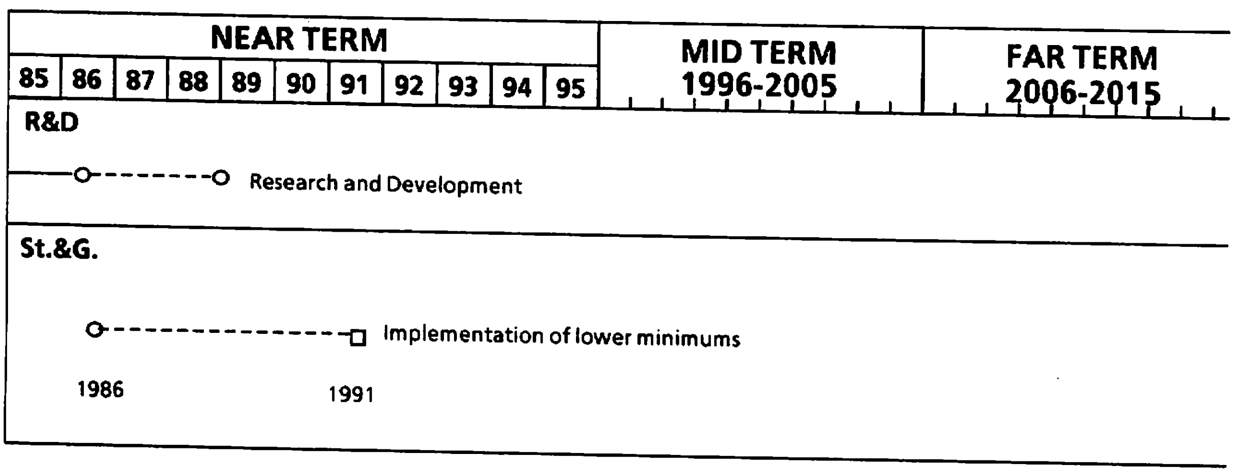
AIRPORT CAPACITY IMPROVEMENT IMPACT: **INCREASE CAPACITY BY ENABLING CONVERGING APPROACHES THAT DO NOT RELY ON VISUAL SEPARATION TECHNIQUES AND CAN BE USED DURING PERIODS OF LOWER CEILINGS AND VISIBILITY.**

Simultaneous instrument approaches to converging runways have been practical during VFR weather conditions at many airports for many years. A few locations conduct these approaches in IFR weather, but only through the application of visual separation. To increase IFR capacity, criteria are needed to define procedures that will permit these operations with lower weather minimums, and that do not rely on visual separation techniques.

The goal of this program is to increase the applicability of converging runway procedures. If successful, converging approach operations may be implemented at an additional 74 airports within our system. This will significantly improve capacity at these airports during IFR weather conditions. Suggested procedures have been developed and are being reviewed by the appropriate FAA offices and industry groups prior to implementation. Assuming favorable comments to the Notice of Proposed Rulemaking regarding one of the procedures, implementation is scheduled for 1986.

Continuing research under this program will investigate methods for permitting converging approaches during periods of lower ceilings and visibility. This will involve an investigation of the use of advanced cockpit avionics, improved surveillance sensors, and electronic means for navigating during missed approaches.

1.1.2 IFR APPROACHES TO CONVERGING RUNWAYS



SCHEDULED IMPLEMENTATION: SHORT-TERM

CAPACITY IMPROVEMENT POTENTIAL: HIGH

REFERENCE: RE&D 3.17, Airport Capacity Improvements.

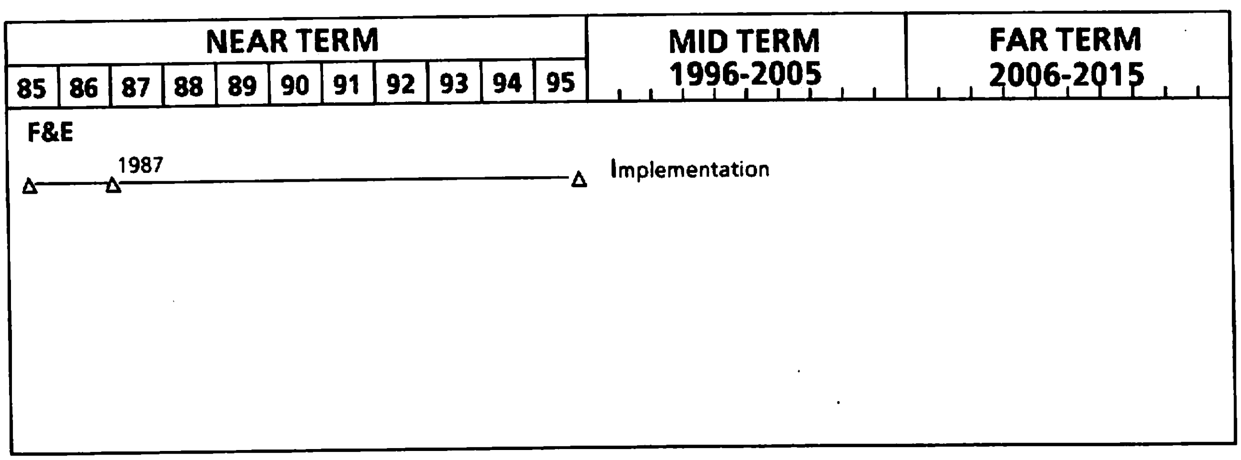
1.1.3 SEPARATE SHORT RUNWAYS

AIRPORT CAPACITY IMPROVEMENT IMPACT: **INCREASE IFR CAPACITY BY PERMITTING MORE EFFICIENT USE OF ALL RUNWAYS THROUGH THE SEGREGATION OF NON-AIR CARRIER TRAFFIC ONTO SEPARATE SHORT RUNWAYS.**

The goal of this project is to develop IFR procedures that will allow independent streams of aircraft to land on separate short runways. The segregation of general aviation, commuter, and air taxi aircraft onto separate short runways (runways that have a length of between 4,000 and 6,000 feet) can yield capacity increases because the required longitudinal spacing between aircraft making approaches to each runway is more uniform, and because it reduces the need for large wake vortex separations. The simultaneous use of short runways currently is limited to VFR operations during daylight hours, resulting in a significant loss of potential IFR capacity.

A separate short runway may or may not be parallel with the main arrival runway. If the separate short runway converges with the main arrival runway, the use of separate short runways during IFR depends on the general acceptance of IFR converging approaches. If the separate short runway is parallel to the main runway and separated from it by less than 2,500 feet, the problem of hazardous wake vortices must be resolved. For the case in which the separate short runway is a closely-spaced parallel runway, wake vortex avoidance procedures may be possible through the use of the higher glide slopes that are possible with the microwave landing system. If there are more than 2,500 feet between a main arrival runway and a separate short runway, then independent or dependent parallel operations may be used.

1.1.3 SEPARATE SHORT RUNWAYS



SCHEDULED IMPLEMENTATION: SHORT-TERM

CAPACITY IMPROVEMENT POTENTIAL: HIGH

REFERENCE: RE&D 3.17, Airport Capacity Improvements.

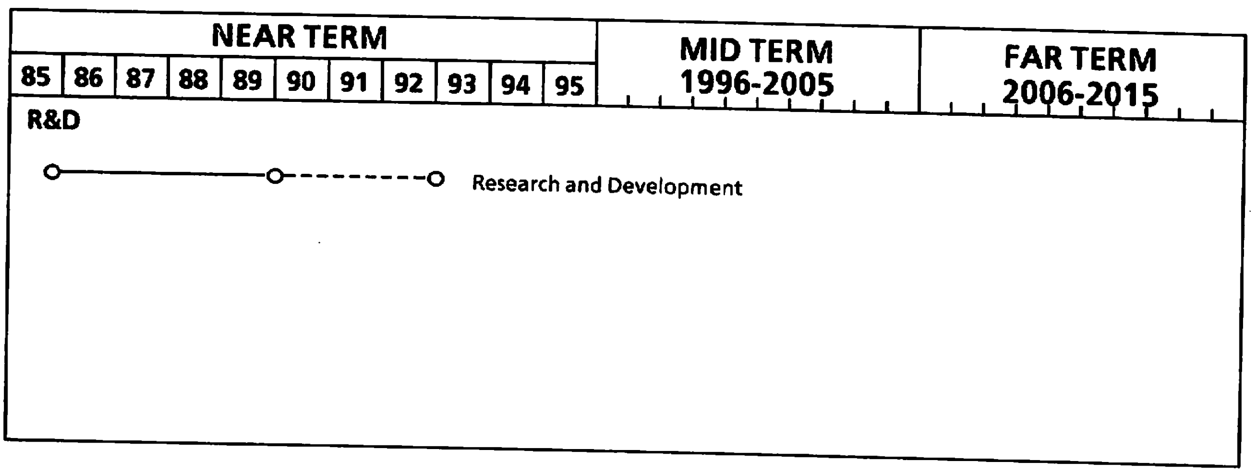
1.1.4 TRIPLE APPROACHES

AIRPORT CAPACITY IMPROVEMENT IMPACT: **INCREASE CAPACITY BY ENABLING TRIPLE ARRIVAL STREAMS UNDER IFR CONDITIONS.**

Triple approaches currently are used at some airports when visibility conditions are at least three miles. The goal of this project is to develop IFR procedures that will permit triple arrival streams during periods of reduced visibility. The effort will involve an investigation of appropriate surveillance and navigation systems that will ensure separation during the approach and missed approach phases of flight. This program depends, in part, on the proposed reduction of the minimum separation requirements between independent parallel runways from 4,300 feet to 3,000 feet, and on the acceptance of IFR approaches to converging runways.

The principal benefit from triple approaches will be with the use of separate short runways. This will permit separate access to major airports which currently have dual main runways. In addition, airport planners require information on the minimum allowable runway spacings so that future airports can take advantage of these procedures.

1.1.4 TRIPLE APPROACHES



SCHEDULED IMPLEMENTATION: SHORT-TERM

CAPACITY IMPROVEMENT POTENTIAL: HIGH

REFERENCE: RE&D 3.17, Airport Capacity Improvements.

1.1.5 SIMULTANEOUS OPERATIONS ON INTERSECTING WET RUNWAYS

AIRPORT CAPACITY IMPROVEMENT IMPACT: **INCREASE CAPACITY BY ALLOWING SIMULTANEOUS OPERATIONS THAT ARE NOT CURRENTLY PERMISSIBLE.**

The goal is to develop specific operating criteria that enable simultaneous operations on intersecting wet runways. Simultaneous arrival procedures on intersecting runways have been used for many years. The Air Traffic Service has determined that there is no appreciable difference in the stopping distance of an aircraft on wet and dry runways as long as the runway surfaces are grooved and free of snow or ice. Thus, it should be possible to formulate criteria for simultaneous operations on intersecting wet runways.

The acceptance of simultaneous IFR approaches to and landings on intersecting runways will offer significant increases in IFR capacity at approximately 70 percent of the nation's airports. Procedural criteria for the use of intersecting wet runways have been developed and are being circulated for comment. Based on a positive response from all interested parties, this procedure will be implemented nationwide at those airports with intersecting runways that have sufficient distance between the runways' thresholds and their intersection point. Acceptance of these procedures will allow wider application of the IFR converging approach concept.

1.1.5 SIMULTANEOUS OPERATIONS ON INTERSECTING WET RUNWAYS

NEAR TERM											MID TERM	FAR TERM
85	86	87	88	89	90	91	92	93	94	95	1996-2005	2006-2015

St.&G.

1986

□ Procedural Implementation

SCHEDULED IMPLEMENTATION: SHORT-TERM

CAPACITY IMPROVEMENT POTENTIAL: HIGH

REFERENCE: N/A

1.1.6 INDEPENDENT CLOSELY-SPACED PARALLEL IFR APPROACHES

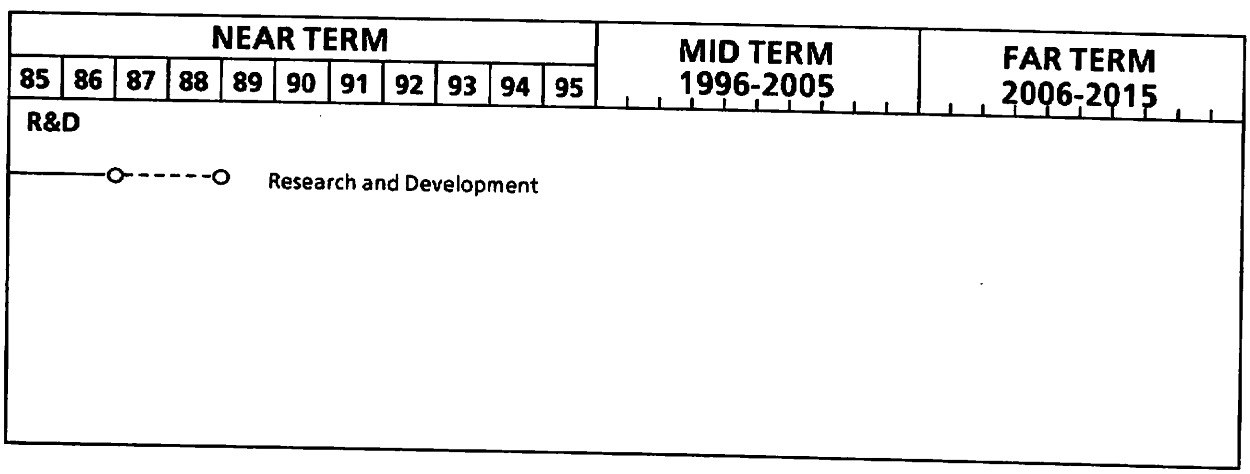
AIRPORT CAPACITY IMPROVEMENT IMPACT: **IMPROVE CAPACITY AT QUALIFYING AIRPORTS BY ALLOWING SIMULTANEOUS INDEPENDENT CLOSELY-SPACED PARALLEL APPROACHES DURING INSTRUMENT WEATHER CONDITIONS.**

The goal of this project is to develop IFR procedures that will enable independent streams of aircraft to land on parallel runways which are separated by less than 4,300 feet but more than 2,500 feet.

Independent parallel approaches have been used successfully since 1963. The original requirement that runways used for independent parallel approaches be separated by 5,000 feet was reduced in 1974 to 4,300 feet. The Industry Task Force on Airport Capacity Improvement and Delay Reduction proposed that the minimum runway separation requirement be reduced to 3,000 feet (subject to specific conditions). This will significantly improve airport capacity at qualifying airports by enabling simultaneous independent closely-spaced parallel operations during instrument weather conditions.

A successful simulation of the proposed procedure was completed at the FAA Technical Center in September, 1984. Demonstrations are being conducted at Memphis, Tennessee during 1985 and 1986. Contingent upon successful completion of the Memphis demonstration, a sensor will be developed to allow independent simultaneous operations to parallel runways between 1990 and 1991 at airports that have runways separated by at least 3,000 feet.

1.1.6 INDEPENDENTLY CLOSELY-SPACED PARALLEL IFR APPROACHES



SCHEDULED IMPLEMENTATION: SHORT-TERM

CAPACITY IMPROVEMENT POTENTIAL: HIGH

REFERENCE: RE&D 3.17, Airport Capacity Improvements.

1.1.7 AIRPORT CAPACITY AND DELAY MODELS

AIRPORT CAPACITY IMPROVEMENT IMPACT: **IMPROVE PLANNING THROUGH THE USE OF COMPUTERIZED MODELS TO SIMULATE AIRPORT SURFACE AND TERMINAL AIRSPACE TRAFFIC FLOWS.**

The goal of this project is to improve the ability of the FAA and airport operators to analyze surface and airborne traffic congestion through the use of computer simulation techniques. The FAA has identified a need for improved models to study airspace congestion near airport and multi-airport terminal areas. This project will seek to enhance existing simulation models and to conduct studies to validate the results of those models. The FAA hopes to have models available at the Technical Center, FAA regional offices, and sponsor airports for capacity-enhancement modeling and benefit analysis. Although the models themselves cannot improve airport capacity, they are used in the selection and application of capacity enhancement options.

Currently, there are three simulation models available to the FAA that could be enhanced to satisfy the needs of airport/terminal modeling. These are the SIMMOD model, used by the Office of Environment and Energy to measure fuel consumption; the ADSIM model, used by the FAA Technical Center to measure delay; and the "Airport Machine," used to model surface traffic.

The ADSIM model currently is used at the FAA Technical Center for evaluating airport capacity and delay problems. It has been used successfully for many years in solving problems at specific airports, and by specialized task forces formed to study capacity/delay problems. The model requires certain modifications to reduce the effort required to analyze a single airport, and to reduce the computer time required to run the model. These enhancements would include automated data entry and graphic displays of the output. Making the model easier to use will allow more offices within the FAA to utilize this proven analytical tool.

A program is underway to validate the SIMMOD model using the New York terminal area airspace. Once the model is tested and validated using the New York example, it will be made available to FAA analysts to study other complex terminal areas such as San Francisco, Chicago, and Dallas. Under the direction of the Office of Environment and Energy, this model is being improved to simplify the entry of the complex data required for each site, and to allow the model to operate on a desktop computer. SIMMOD is expected to be useful in determining the effects of air traffic control procedures on delay times and fuel burn. The output of the SIMMOD model would be compared to that of the ADSIM model as part of the validation process, because the ADSIM model has been used and accepted within the FAA for many years.

The "Airport Machine" was developed as a color-graphics interactive simulation of airport runway and taxiway operations. The interactive capability of the model allows it to be used as a controller training aid, as well as an analytical tool for studying runway and taxiway design. The model currently is being used at New York-area airports, where its results are being evaluated and compared to those of other surface traffic models, such as ADSIM. When the validation process is completed, the model will be made available to regional FAA offices.

1.1.7 AIRPORT CAPACITY AND DELAY MODELS

NEAR TERM											MID TERM 1996-2005	FAR TERM 2006-2015
85	86	87	88	89	90	91	92	93	94	95		

R&D

- Δ Evaluate Airport Machine at LGA
- Δ Validate Airport Machine
- Δ Airport Machine Available in FAA Regions
- Δ SIMMOD Enhancements Complete
- Δ Calibrate SIMMOD on NY Airports
- Δ Validate SIMMOD on NY Airports
- Δ SIMMOD Available to FAA Regions
- Δ ADSIM Enhancements
- Δ ADSIM Available to FAA Regions

SCHEDULED IMPLEMENTATION: SHORT-TERM

CAPACITY IMPROVEMENT POTENTIAL: MEDIUM

1.1.8 MLS TERPS/PROCEDURES

AIRPORT CAPACITY IMPROVEMENT IMPACT: INCREASE IFR CAPACITY AT MANY AIRPORTS BY REDUCING THE AMOUNT OF RESERVED AIRSPACE AND LOWERING APPROACH MINIMUMS, THUS ENABLING WIDER APPLICATION OF INSTRUMENT APPROACH PROCEDURES.

The terminal instrument procedures (TERPS) handbook specifies the minimum altitudes at which aircraft can operate during instrument approach procedures. It also specifies the dimensions of reserved airspace required to provide separation from obstacles during such procedures. With the increased precision available from the microwave landing system, it will be possible to reduce the amount of reserved airspace and to lower approach minimums during IFR operations. The goal of this project is to analyze test data from simulators and flight tests to determine the extent to which these modifications can be safely made.

Multiple instrument approaches (e.g., converging and closely-spaced parallel approaches) have somewhat limited applicability because they are based on the current TERPS separation requirements. The reduction in approach minimums and in the size of the reserved airspace will allow wider application of instrument approach procedures, thereby increasing IFR capacity at many major airports.

1.1.8 MLS TERPS/PROCEDURES

NEAR TERM											MID TERM 1996-2005	FAR TERM 2006-2015
85	86	87	88	89	90	91	92	93	94	95		

R&D

- o Complete TERPS Data Extrapolation for Category D&E Aircraft
- o Complete wide-body aircraft program

For more information on the MLS, see Project 1.2.2.

SCHEDULED IMPLEMENTATION: SHORT-TERM

CAPACITY IMPROVEMENT POTENTIAL: MEDIUM

REFERENCE: NAS Resume 8031, MLS Service, Test, and Evaluation Program (STEP), and NAS Plan Project IV-7, Microwave Landing System.

1.1.9 ROTORCRAFT LANDING AND NAVIGATION

AIRPORT CAPACITY IMPROVEMENT IMPACT: **IMPROVE PLANNING FOR INTEGRATION OF ROTORCRAFT INTO THE NAS BY DEVELOPING AND EVALUATING IFR LANDING AND NAVIGATION CAPABILITIES THAT WILL IMPROVE PRIMARY SYSTEM CAPACITY.**

The goal of this project is to develop and evaluate promising navigation/landing capabilities and consider future implementation of those selected systems that will facilitate the integration of rotorcraft into the National Airspace System. The project will provide support for approval of the new capabilities, for the enhancement of navigation at low altitudes and in remote areas, and for the approach/landing phases of rotorcraft flight. Implementation options for the navigation systems and system enhancements intended to aid rotorcraft navigation will be developed.

A number of reports will be produced, including an assessment of the navigation capabilities needed to meet system-specific rotorcraft navigation requirements, evaluations of various integrated navigation systems in rotorcraft, an evaluation of MLS use in rotorcraft in the STEP program, and evaluations of MLS curved approaches and RNAV/MLS approaches with rotorcraft. In addition, MLS TERPS criteria will be developed for rotorcraft. This project provides basic IFR services for rotorcraft operations and is necessary for providing primary system capacity.

1.1.9 ROTORCRAFT LANDING AND NAVIGATION

NEAR TERM											MID TERM	FAR TERM
85	86	87	88	89	90	91	92	93	94	95	1996-2005	2006-2015

R&D

--O LORAN-C Non-precision Report

--O Gulf LORAN-C Signal Stability Report

--O Helicopter/Heliport FI Data Collection Complete

--O Heliport MLS Pamphlet Completed

---O 3-D LORAN-C Navigation Testing Completed - Report

----O Helicopter Analog 2-Cue Flight Director Evaluation Complete

-----O Helicopter Decelerating Approach - Phase I Complete

----------O Helicopter Digital AFCS/EFIS Evaluation Complete

----------O Helicopter Infrared IFR System

SCHEDULED IMPLEMENTATION: SHORT-TERM

CAPACITY IMPROVEMENT POTENTIAL: MEDIUM

REFERENCE: NAS Resume 7150, Rotorcraft Navigation/Landing.

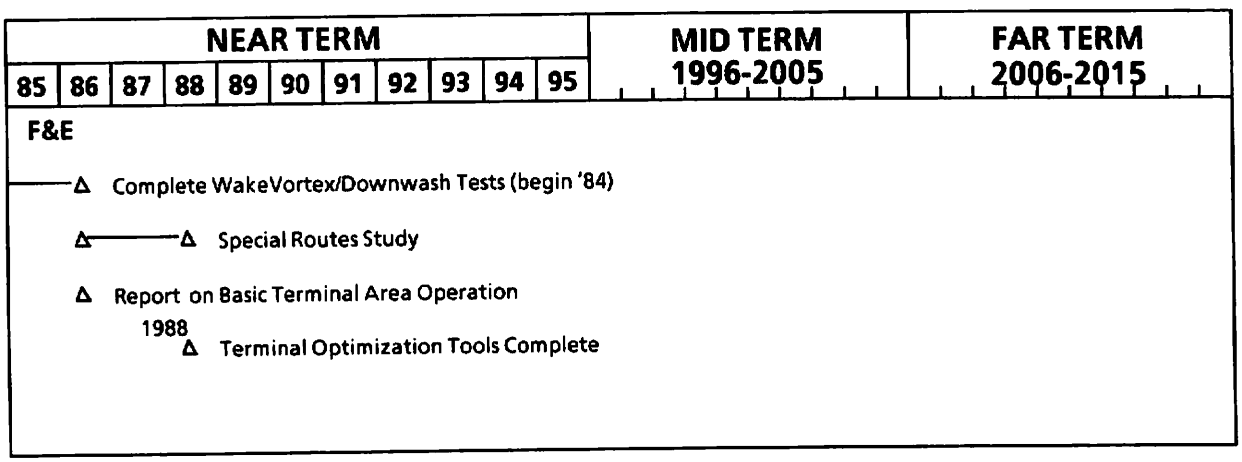
1.1.10 ROTORCRAFT ATC PROCEDURES

AIRPORT CAPACITY IMPROVEMENT IMPACT: **IMPROVE ATC PLANNING FOR BETTER INTEGRATION OF ROTOR-CRAFT INTO THE NAS, THUS RELIEVING OVERALL CONGESTION AND IMPROVING EFFICIENCY.**

The goal of this project is to provide technical methodologies, tools, and a data base to support improvements to the ATC system for fuller integration of rotorcraft into the NAS. The products of this effort will help to relieve overall congestion in dense traffic areas and improve efficiency for fixed-wing users as well as rotorcraft.

This program is focused on three areas: terminal area design, special routings, and wake vortex/downwash separation standards. Primary rotorcraft ATC needs are centered around operation in terminal areas. Dense, mixed traffic dictates the need for optimizing route structures and procedures. A simulation capability for modeling and optimizing terminal area airspace design (including systems, route structures, and procedures) for helicopters and other system users will be developed. Similarly, a general purpose methodology and a set of analytical tools will be developed for planning city-center to city-center operations. Wake vortex and downwash separation criteria will be developed for both helicopter-only and mixed traffic to maintain safe and efficient operations as terminal instrument traffic increases.

1.1.10 ROTORCRAFT ATC TERMINAL



SCHEDULED IMPLEMENTATION: SHORT-TERM

CAPACITY IMPROVEMENT POTENTIAL: MEDIUM

REFERENCE: NAS Resume 8012, Rotorcraft ATC-Terminal.

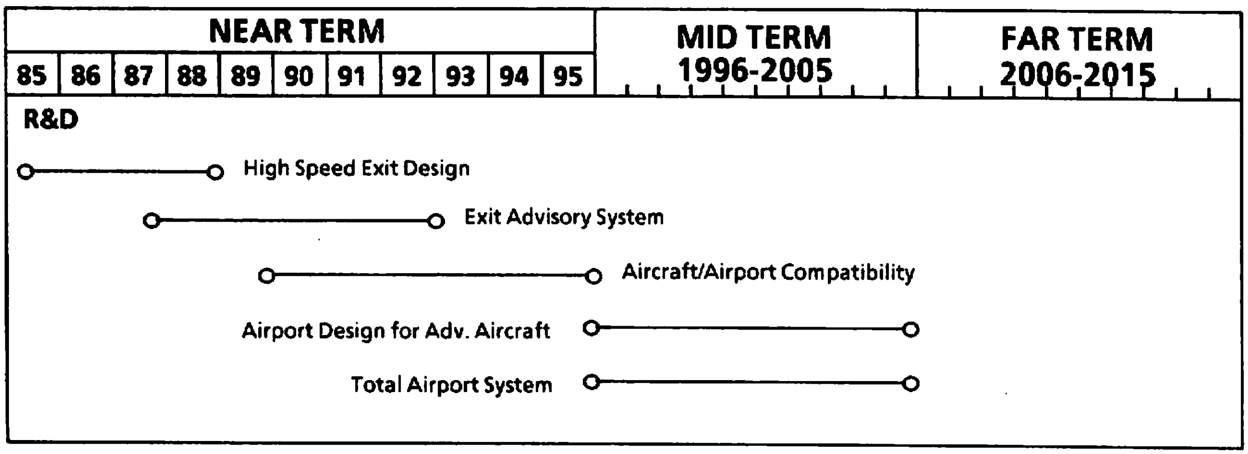
1.1.11 AIRPORT DESIGN AND CONFIGURATION IMPROVEMENTS

AIRPORT CAPACITY IMPROVEMENT IMPACT: **DEVELOP ANALYTICAL TOOLS TO IMPROVE PLANNING FOR MORE EFFICIENT RUNWAY, TAXIWAY, AND RAMP DESIGN.**

The goal of this project is to develop analytical tools such as computer programs and engineering handbooks that will aid in the cost-effective design of runways, taxiways, and ramps that meet current needs and yet are adaptable to future requirements. The variations in aircraft operating characteristics require different operating services, runway lights, taxiway and exit requirements, and apron/gate designs. Because the new operating characteristics of future aircraft may impose different design constraints, improved airport design standards will be required to integrate new aircraft into the airport system.

Design guidelines will be developed or updated for runway exit design and runway, taxiway, and apron configurations. Computer-based airport capacity and delay models will be used to develop and implement those guidelines and standards which show the greatest potential for capacity improvement or delay reduction.

1.1.11 AIRPORT DESIGN AND CONFIGURATION IMPROVEMENTS



SCHEDULED IMPLEMENTATION: ONGOING

CAPACITY IMPROVEMENT POTENTIAL: MEDIUM

REFERENCE: RE&D 10.2, Airport Design and Configuration.

1.1.12 REDUCED LONGITUDINAL SEPARATION STANDARDS/SPACING

AIRPORT CAPACITY IMPROVEMENT IMPACT: **INCREASE CAPACITY BY REDUCING THE REQUIRED LONGITUDINAL SEPARATION BETWEEN AIRCRAFT, ENABLING RUNWAYS TO BE USED MORE EFFICIENTLY.**

The capacity of a single runway is constrained by longitudinal separation standards, which are the requirements for separation between successive aircraft on approach. The current separation standard is three nautical miles (except for heavy jets, which require more separation). The Industry Task Force on Airport Capacity Improvement and Delay Reduction proposed reducing this standard from 3.0 miles to 2.5 miles (subject to specific conditions). The goal of this project is to verify previous analyses which determined that this procedure could be done safely and without increasing the number of "go-arounds" necessary to prevent simultaneous runway occupancy.

Previous analysis has shown that if an airport's average runway occupancy time is less than 50 seconds, then a 2.5 nautical mile separation will not result in an excessive go-around rate. Therefore, for an airport to qualify as a demonstration site, its current runway occupancy times were required to average fifty seconds or less. Dallas-Fort Worth, Atlanta, Newark, and Los Angeles met this requirement and were selected as the demonstration sites.

The first phase of the demonstration program, which permitted 2.5 nautical mile separation only when the runways were dry, began in March, 1985. The second phase, involving operations on wet grooved runways, began in April, 1985. Assuming successful results from these demonstrations, a procedural change allowing operations with the reduced standard is scheduled for 1986.

1.1.12 REDUCED LONGITUDINAL SEPARATION STANDARDS/SPACING

NEAR TERM											MID TERM	FAR TERM
85	86	87	88	89	90	91	92	93	94	95	1996-2005	2006-2015
R&D												
—O--O Procedural Change, Research and Development												

SCHEDULED IMPLEMENTATION: SHORT-TERM

CAPACITY IMPROVEMENT POTENTIAL: LOW

REFERENCE: RE&D 3.17, Airport Capacity Improvements.

1.2.1 AIRPORT IMPROVEMENT PROGRAM (AIP)

AIRPORT CAPACITY IMPROVEMENT IMPACT:	**INCREASE CAPACITY THROUGH THE PROVISION OF FUNDS FOR PLANNING, DEVELOPMENT, NOISE COMPATIBILITY, AND LAND BANKING PROJECTS THAT HAVE A DIRECT BEARING ON CAPACITY.**

The goal of this program is to promote the development of a system of airports to meet the nation's needs by making grants available to public agencies and certain private airport operators for the planning and development of public-use airports included in the FAA-prepared National Plan of Integrated Airport Systems (NPIAS). AIP grants to individual public-use airports for planning, development, or noise compatibility projects often have a direct bearing on airport capacity. Examples of capacity-related projects include the construction of new runways and airports, improved taxiways, new or expanded apron areas and the acquisition of land.

The current AIP program is authorized by by the Airport and Airway Improvement Act of 1982. It provides assistance for airport planning and development through funding from the Airport and Airway Trust Fund. The 1982 Act also authorizes funds for noise compatibility planning and for carrying out noise compatibility programs. The 1982 Act authorized the following amounts for the AIP:

1982:	$450.0 million
1983:	$800.0 million
1984:	$993.5 million
1985:	$987.0 million
1986:	$1,017.0 million
1987:	$1,017.2 million

AIP funds are distributed in accordance with provisions contained in the 1982 Act. Some of the funds are designated for use at a specific airport or in a specific state or insular area; the remaining funds are for disbursement at the discretion of the Secretary of Transportation. Figure 5-1 shows the distribution of AIP funds.

Of the approximately 3,600 airports in the NPIAS, 87 percent are existing airports, while the remaining 13 percent are proposed new sites. New airport construction that may be funded by the AIP program includes new primary airports; additional reliever, general aviation, or commercial service airports that supplement existing congested airports; and new general aviation sites that are the sole NPIAS airports serving the community.

In all cases, new airport construction can capitalize on the experience gained in resolving existing capacity problems. Landside terminal development will employ more efficient passenger flow theories, multiple aircraft gate design, and improved airport access road systems. Contemporary airside runway, taxiway, and apron orientation techniques should increase aircraft flows, thereby reducing runway occupancy times. Installing modern navigational equipment will facilitate operations under adverse weather conditions.

The ACPO is recommending that the legislative proposal to continue the AIP beyond its scheduled expiration in 1987 contain language that reflects the need to give a higher priority to capacity-related projects and to establish a revolving loan program for land banking.

SCHEDULED IMPLEMENTATION: ONGOING

CAPACITY IMPROVEMENT POTENTIAL: HIGH

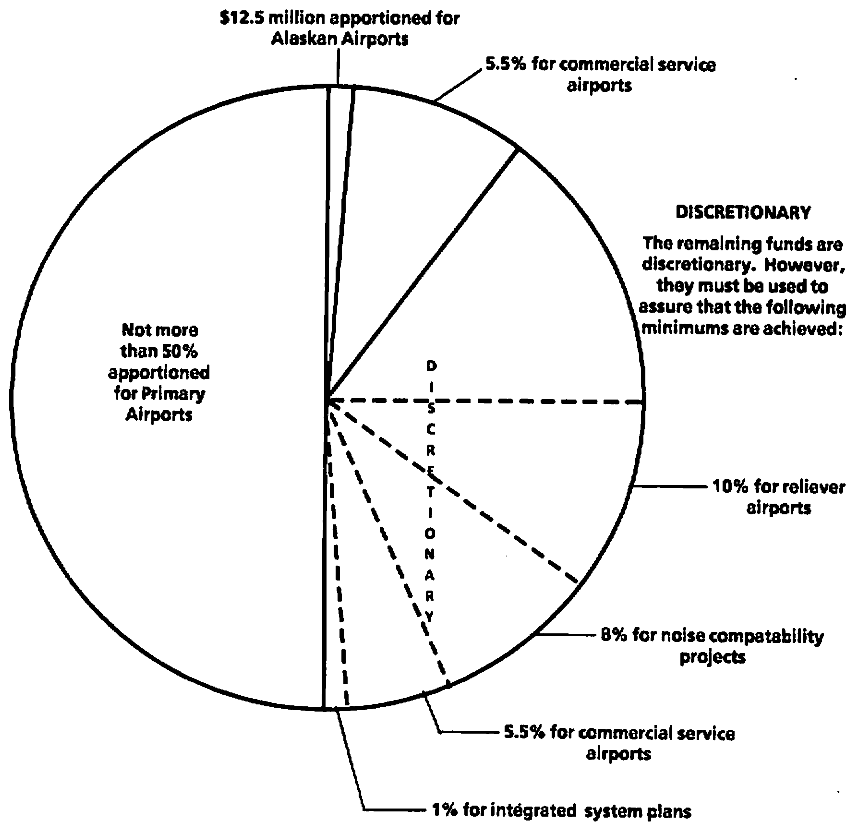


FIGURE 5-1 DISTRIBUTION OF AIRPORT IMPROVEMENT PROGRAM FUNDS

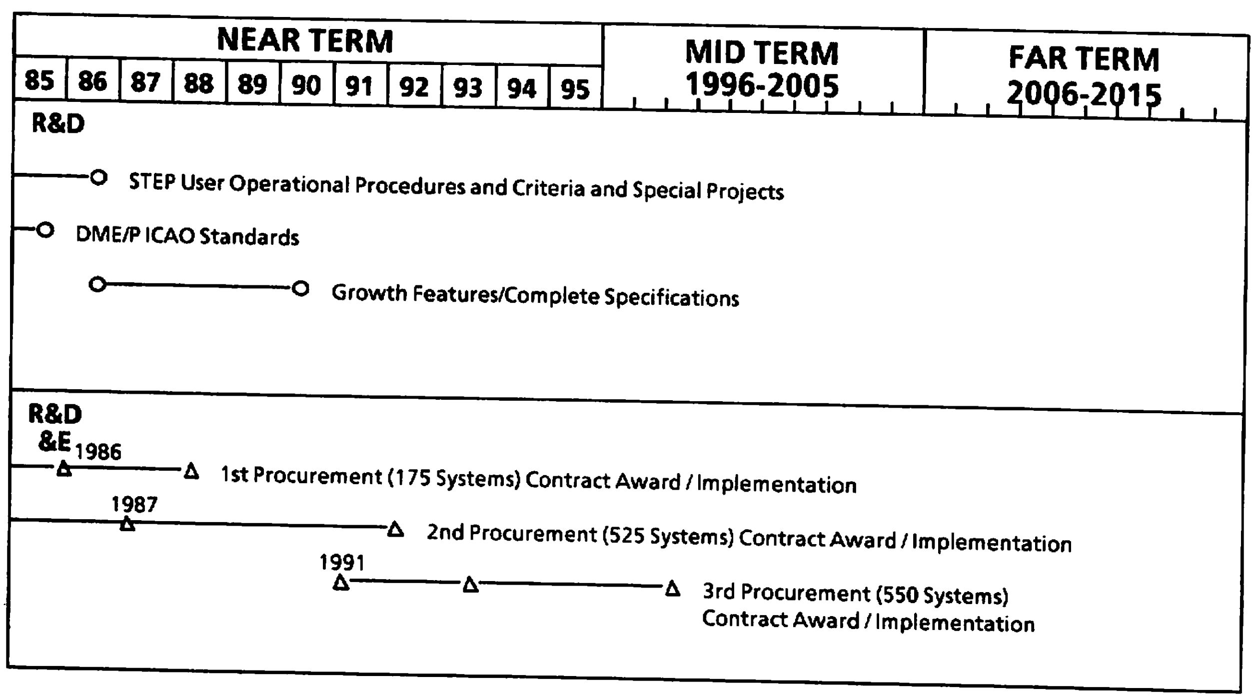
1.2.2 MICROWAVE LANDING SYSTEM (MLS) F&E

AIRPORT CAPACITY IMPROVEMENT IMPACT: **INCREASE CAPACITY BY PROVIDING AN IMPROVED PRECISION APPROACH AND LANDING SYSTEM.**

The Instrument Landing System (ILS) has served as the standard precision approach and landing aid for more than 30 years. Although it has undergone a number of improvements to increase its performance and reliability, the ILS has a number of basic limitations with respect to future aviation requirements. The MLS is designed to overcome these limitations and afford the air traffic environment new operating capabilities. The initial capacity gains from MLS will occur where installations on secondary runways at hub airports allow for more separation of aircraft types. Initial gains also will occur on runways with no current instrumentation at both hub and feeder airports. Longer-term MLS gains include new procedures for multiple approaches and curved approaches.

The goal of this project is to install and develop a new common civil/military approach and landing system that will meet the full range of current and anticipated user operational requirements. The FAA is in the early stages of Phase I of a three-phase implementation program. The first phase provides for the installation of up to 178 MLS ground systems over a two-year period beginning in mid-1987. Phase II includes the procurement of approximately 500 systems. Installation priority will be given to networks of airports that link major city airports or hubs. Phase III provides for the installation of an additional 500 systems to complete the FAA implementation. The overall program includes the implementation of 1,250 systems to meet the system requirements. This project is a prerequisite for Capacity Project 2.2.8, which will develop procedures that will produce capacity gains using the flexibility provided by MLS.

1.2.2 MLS F&E PROCUREMENT



SCHEDULED IMPLEMENTATION: SHORT-TERM

CAPACITY IMPROVEMENT POTENTIAL: HIGH TO MEDIUM

REFERENCE: NAS Plan Project IV-7, Microwave Landing System (MLS).

1.2.3 MLS SERVICE TEST AND EVALUATION PROGRAM (STEP)

AIRPORT CAPACITY IMPROVEMENT IMPACT: **INCREASE THE SPEED WITH WHICH THE CAPACITY-ENHANCING BENEFITS OF MLS BECOME AVAILABLE.**

The goal of this project is to ease the transition from research and development to implementation of the MLS approach system by developing and evaluating operational criteria and procedures and by demonstrating the capabilities of MLS. The STEP program began in 1979 and is expected to be completed during 1986. Operational requirements for the MLS were developed by Radio Technical Commission of America Special Committee 117 during the period 1969-1970; the same requirements have been confirmed during the STEP project. The broad coverage and signal quality of MLS will provide the necessary operational flexibility to permit improvements in airport utilization and runway capacity, to reduce noise, and to enhance safety. The development of additional approach procedures is underway, and will continue as more operational data becomes available. This project supports related capacity improvement and delay reduction projects such as MLS TERPS/Procedures.

For more information on the MLS, see Project 1.2.2.

1.2.3 MLS STEP

NEAR TERM											MID TERM	FAR TERM
85	86	87	88	89	90	91	92	93	94	95	1996-2005	2006-2015

R&D

- O Complete STEP evaluations and reports
- O Complete Terminal Instrument Procedures Data Extrapolation
- O Complete wide-body aircraft program

SCHEDULED IMPLEMENTATION: SHORT-TERM

CAPACITY IMPROVEMENT POTENTIAL: MEDIUM

REFERENCE: NAS Resume 8031, MLS Service, Test, and Evaluation Program (STEP), and NAS Plan Project IV-7, Microwave Landing System.

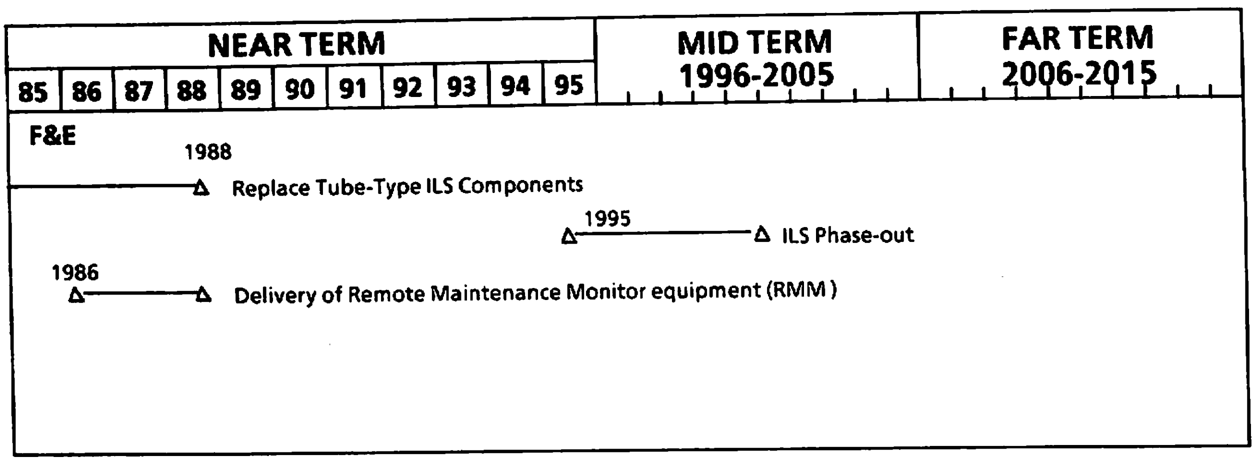
1.2.4 INSTRUMENT LANDING SYSTEM (ILS)

AIRPORT CAPACITY IMPROVEMENT IMPACT: **PREVENT ANY LOSSES IN IFR CAPACITY DURING THE TRANSITION FROM ILS TO MLS.**

The Instrument Landing System (ILS) has been the backbone of IFR weather operations for more than 30 years. During the transition from the ILS to the new microwave landing system (MLS), which is to be completed during the 1990s, some of the older ILS systems will require replacement. The goal of this project is to maintain the ILS system so that there will be no loss in IFR capacity throughout the system during the transition from ILS to MLS.

Several new sites will receive ILS systems as a result of earlier commitments. In addition, some of the solid state ILS systems will be retrofitted with remote maintenance monitoring (RMM) capability, resulting in greater reliability and, consequently, a slight increase in capacity.

1.2.4 INSTRUMENT LANDING SYSTEM (ILS) SCHEDULE



SCHEDULED IMPLEMENTATION: SHORT-TERM

CAPACITY IMPROVEMENT POTENTIAL: MEDIUM

REFERENCE: NAS Resume 4060 and NAS Plan Project IV-6, Instrument Landing System.

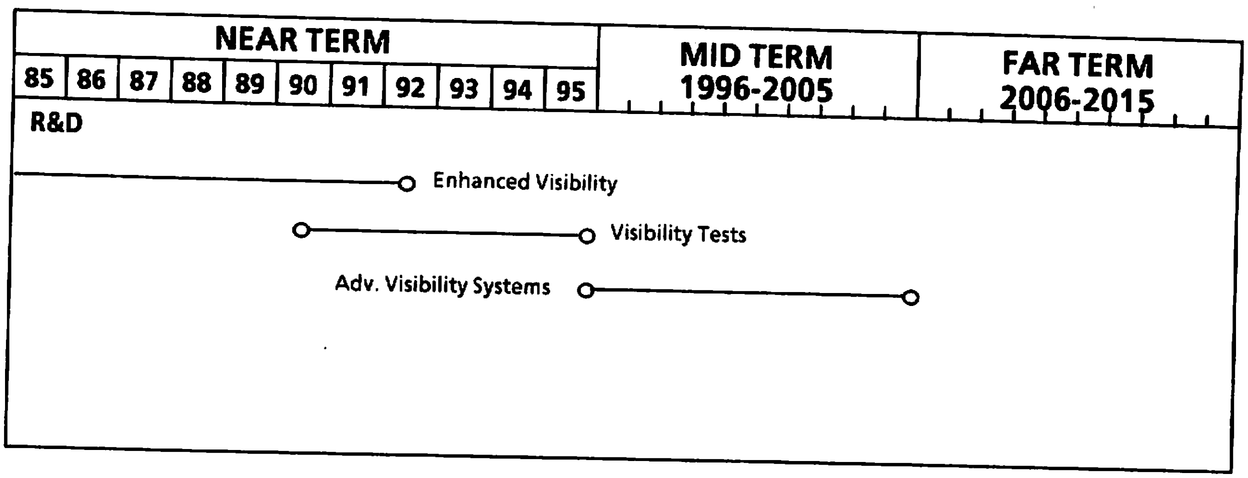
1.2.5 EQUIPMENT TO SUPPORT SURFACE TRAFFIC CONTROL SYSTEMS

1.2.5a AIRPORT LIGHTING AND VISUAL AIDS RESEARCH AND DEVELOPMENT

AIRPORT CAPACITY IMPROVEMENT IMPACT — **REDUCE DELAYS BY DEVELOPING LIGHTING SYSTEMS THAT FACILITATE MORE EFFECTIVE MOVEMENT OF AIRCRAFT WHILE TAXIING.**

The goal of this project is to test and evaluate lighting, marking, and signing systems for their effectiveness under day, night, and low-visibility conditions. These lighting systems will improve guidance while taxiing and the identification of holding and clearance points. Improvements in lighting systems are necessary to support the proposed all-weather taxiway guidance and control system (see Project 3.2.3c). The result will be an increase in efficiency and safety during IFR operations, thus providing some capacity improvement and delay reduction.

1.2.5a AIRPORT LIGHTING AND VISUAL AIDS



SCHEDULED IMPLEMENTATION: ONGOING

CAPACITY IMPROVEMENT POTENTIAL: MEDIUM

REFERENCE: RE&D 10.4, Airport Safety.

1.2.5 EQUIPMENT TO SUPPORT SURFACE TRAFFIC CONTROL SYSTEM

1.2.5b APPROACH LIGHTING

AIRPORT CAPACITY IMPROVEMENT IMPACT: **PROVIDE LIGHTING AND VISUAL AIDS TO SUPPORT LANDINGS UNDER REDUCED VISIBILITY CONDITIONS, THUS INCREASING IFR CAPACITY.**

The goal of this project is to provide improved approach and runway lighting and visual aids to support landings in zero visibility weather conditions. These aids will include approach lights, improved runway visual signs and markings, runway distance-to-go markers, and other advanced systems for guiding aircraft between the airport apron and the runway. Lighting and visual aids unique to heliports also will be developed. Even with advances in navigation such as Category III ILS systems and MLS, it is often the case that the lighting systems determine the minimum weather conditions under which IFR operations can be conducted. It is therefore important to the capacity program to continue research in developing new lighting systems to support all-weather operations.

1.2.5b APPROACH LIGHTING

NEAR TERM											MID TERM	FAR TERM
85	86	87	88	89	90	91	92	93	94	95	1996-2005	2006-2015

F&E

Δ–Δ Semi-Flush Fixtures Implementation

Δ——Δ ALSF-2 Implementation (Approach Lighting System with a sequenced flasher)

1986
Δ–Δ MALSR Implementation (Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights)

SCHEDULED IMPLEMENTATION: ONGOING

CAPACITY IMPROVEMENT POTENTIAL: MEDIUM

REFERENCE: NAS Resume 4100, Approach Lighting System Improvements.
NAS Plan Project IV-10, Approach Lighting System Improvement Program (ALSIP).

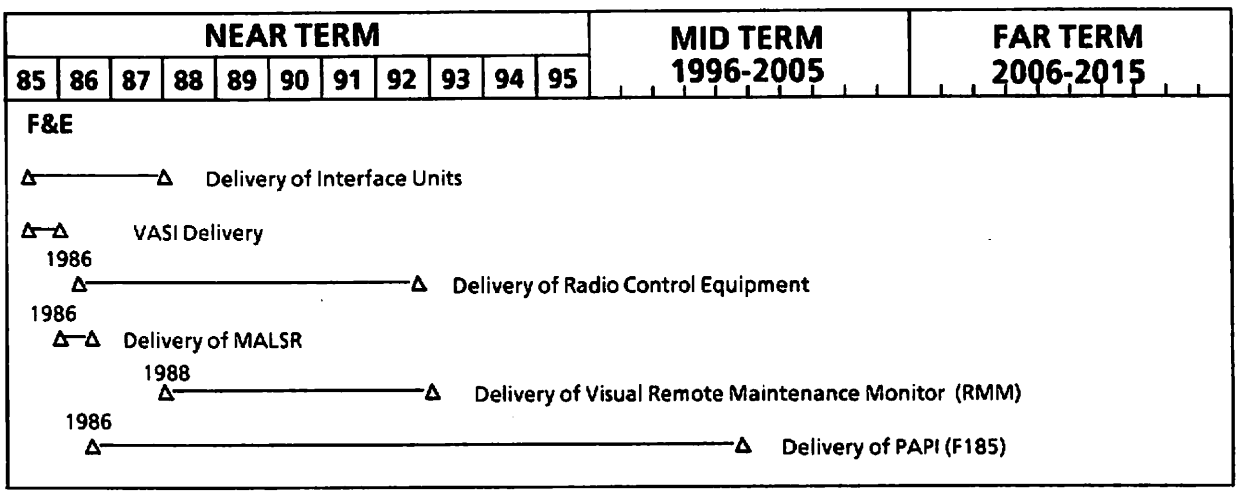
1.2.5 EQUIPMENT TO SUPPORT SURFACE TRAFFIC CONTROL SYSTEM

1.2.5c ESTABLISH VISUAL NAVAIDS

AIRPORT CAPACITY IMPROVEMENT IMPACT: **INCREASE CAPACITY DURING ADVERSE WEATHER CONDITIONS BY PROVIDING IMPROVED VISUAL NAVIGATION AIDS.**

The goal of this project is to provide visual navigation aids (NAVAIDS), such as medium intensity approach lighting systems with runway alignment indicator lights (MALSR), runway end identification lights (REIL), visual approach slope indicator (VASI) or precision approach path indicator (PAPI), and omnidirectional airport lighting systems (ODALS). Such systems are useful in maintaining operational capabilities during VFR operations and during marginal VFR weather conditions. They are especially useful at smaller airports served by air taxi and commuter airline operators. The availability of approach lights may allow operations to continue in adverse weather, increasing the reliability of service.

1.2.5c ESTABLISH VISUAL NAVAIDS



SCHEDULED IMPLEMENTATION: ONGOING

CAPACITY IMPROVEMENT POTENTIAL: MEDIUM

REFERENCE: NAS Resume 4090 and NAS Plan Project IV-9, Visual NAVAIDS.

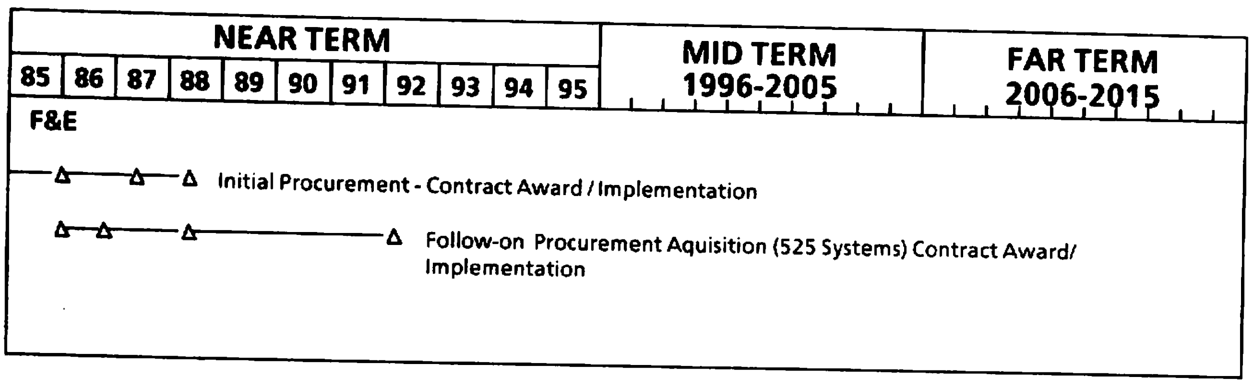
1.2.5 EQUIPMENT TO SUPPORT SURFACE TRAFFIC CONTROL SYSTEM

1.2.5d RVR ESTABLISH/UPGRADE

AIRPORT CAPACITY IMPROVEMENT IMPACT: **REDUCE DELAYS DURING REDUCED AND ZERO VISIBILITY OPERATIONS BY ALLOWING AIRCRAFT TO OPERATE AT LOWER MINIMUM APPROACHES.**

Runway Visual Range (RVR) equipment provides a real-time method of measuring representative visibility along the runway through a light-sensing system. This information is transmitted to the controller and pilot, who in turn determine whether a landing is allowed. RVR information, therefore, is critical to instrument operations, and its existence directly affects airport capacity. The goal of this project is to upgrade existing RVR systems, and to establish new systems to support reduced and zero visibility operations. The existence of RVR on a particular approach allows aircraft to operate at lower minimums because of the more precise knowledge about visibility conditions on the runway. Over the next eight years, 732 additional systems are planned for installation. In addition to providing the equipment, this project will determine the minimum operating conditions allowable at a given site.

1.2.5d RVR ESTABLISH/UPGRADE



SCHEDULED IMPLEMENTATION: ONGOING

CAPACITY IMPROVEMENT POTENTIAL: MEDIUM

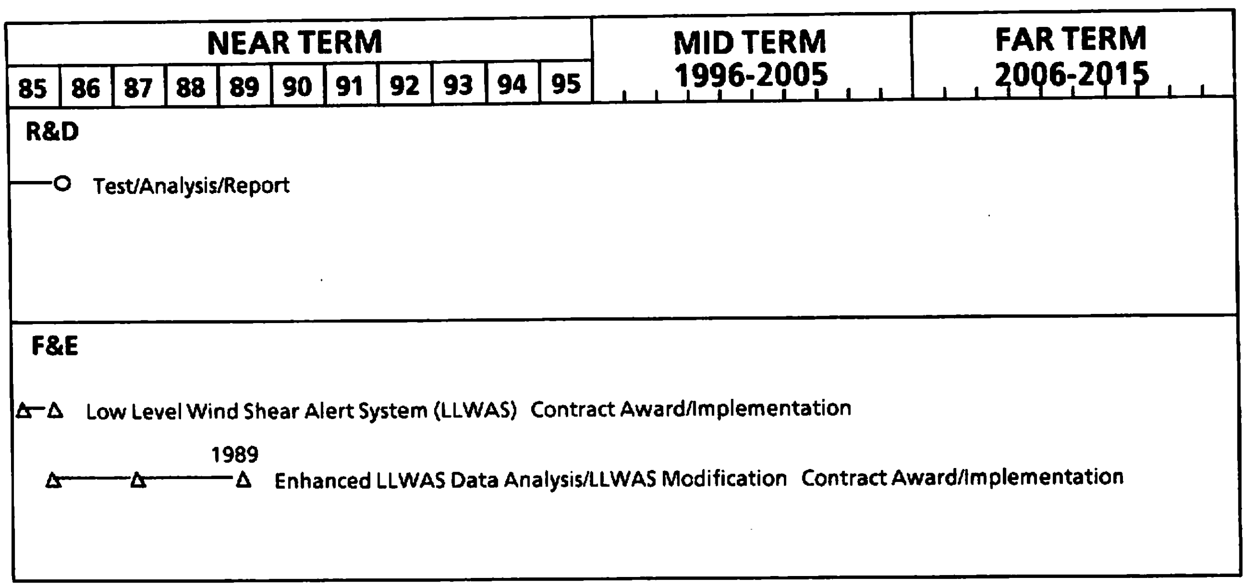
REFERENCE: NAS Resume 4080, RVR Establish/Upgrade, and NAS Plan Project IV-8, Runway Visual Range.

1.2.6 WIND MEASURING EQUIPMENT/EFFORTS (LLWAS)

AIRPORT CAPACITY IMPROVEMENT IMPACT: **REDUCE DELAYS BY SMOOTHING THE TRANSITION BETWEEN THE USE OF DIFFERENT RUNWAY CONFIGURATIONS AS REQUIRED BY WIND SHEAR DETECTION.**

Severe wind shear conditions occurring at low altitude near the airport are hazardous to aircraft during takeoff or final approach. The goal of this project is to install the Low Level Wind Shear Alert System (LLWAS) to monitor the winds near the airport and to alert the pilot, through the air traffic controller, when hazardous wind shear conditions are detected. The LLWAS originally was intended to be an interim system that would be replaced when a more advanced technology, such as Doppler radar, evolved to production status. However, it is evident that the cost of Doppler radar will not permit it to replace all LLWAS, so the LLWAS is expected to remain a vital part of the weather system. In addition, recent studies suggest that when LLWAS is used with Doppler radar it provides better coverage than Doppler radar alone. More accurate detection of wind shear can enhance capacity by smoothing the transition between the use of different runway configurations.

1.2.6 WIND MEASURING EQUIPMENT



SCHEDULED IMPLEMENTATION: SHORT-TERM

CAPACITY IMPROVEMENT POTENTIAL: MEDIUM

REFERENCE: NAS Resume 3120 and NAS Plan Project III-12, Wind Measuring Equipment/Efforts (LLWAS).

1.2.7 RUNWAY CONFIGURATION MANAGEMENT SYSTEM

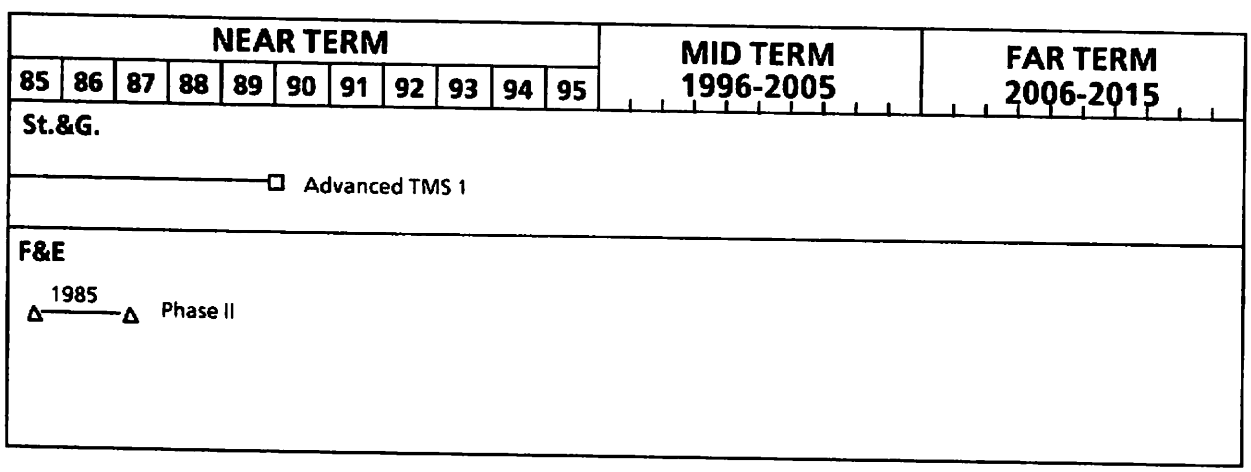
AIRPORT CAPACITY IMPROVEMENT IMPACT: **REDUCE DELAYS BY PROVIDING IMPROVED INFORMATION ON THE CAPACITY OF VARIOUS RUNWAY CONFIGURATIONS, WEATHER CONDITIONS, OPERATIONAL STATUS OF FACILITIES AND EQUIPMENT, AND THE AIRPORT'S DEMAND PROFILE.**

The objective of the Runway Configuration Management System (RCMS) is to serve as an aid to the traffic management unit (TMU) and tower controllers in selecting the runway configuration that will yield the greatest capacity. In addition to selecting the appropriate runway configuration, the RCMS also provides the controller with detailed data on the status of the runway and its associated navigation systems. The RCMS will increase airport capacity by displaying to the operational supervisor the most effective runway configuration given the status of all system-evaluated variables.

The first system is being installed at Chicago O'Hare airport, which has 14 runways. Because of the complexity of the O'Hare ATC system, access to the operational information necessary to make strategic operational decisions is extremely cumbersome and difficult. Centralizing this information enables supervisors to make operational decisions more quickly.

The RCMS will display an ordered list of runway configurations ranked by their capacity. In addition, the system will provide current and forecast weather conditions, operational status of facilities and equipment, and the arrival and departure demand profile of the airport. Field tests will be conducted to determine the impact of the RCMS on the TMU and its relation to the national flow control strategy.

1.2.7 RUNWAY CONFIGURATION MANAGEMENT SYSTEM



SCHEDULED IMPLEMENTATION: SHORT-TERM

CAPACITY IMPROVEMENT POTENTIAL: MEDIUM

REFERENCE: RE&D 3.1, Traffic Management System.

1.2.8 TERMINAL RADAR ENHANCEMENTS

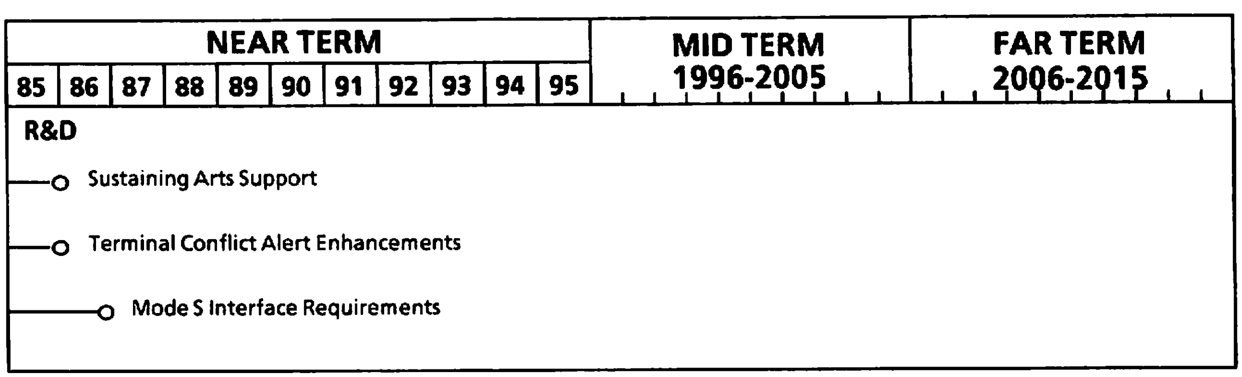
AIRPORT CAPACITY IMPROVEMENT IMPACT: **REDUCE DELAYS THROUGH INCREASING AUTOMATION AND MODIFYING SYSTEM HARDWARE AND SOFTWARE TO IMPROVE CONTROLLER EFFICIENCY AND INCREASE AIRSPACE UTILIZATION.**

The goal of this program is to provide development and support for the Automated Radar Terminal System (ARTS) to insure that its availability, reliability, and capacity remain acceptable as demand increases. The ARTS will continue to provide the computer resources for the terminal area ATC until it is replaced by the Advanced Automation System (AAS) and the consolidated Area Control Facilities (ACF). Increased demands for airspace use and requirements for additional automation functions in the terminal area will require a large sustaining effort to keep the ARTS in use.

Hardware and software modifications will be developed for enhanced automation functions and for interfaces to new ATC systems such as the Mode S data link. Improvements in terminal automation systems will refine terminal conflict alert algorithms and logic to reduce the nuisance alarm rate, and to extend coverage to terminal airspace areas which are not included within the current conflict alert function. In particular, the refinements will optimize processing algorithms to minimize computer resource requirements and will reduce radar position uncertainties due to radar registration error, alignment inaccuracy, and position coordinate conversions.

New sensor data will be available to the ARTS when Mode S is implemented in the terminal environment. Appropriate interfaces and software modifications will be developed to utilize the Mode S sensor data. Products will include specifications for hardware improvements to sustain ARTS, an implementation package for Terminal Conflict Alert enhancements, and Mode S sensor interface requirements. The benefits of this project include improved controller efficiency and increased airspace utilization, leading to reduced delays.

1.2.8 TERMINAL RADAR ENHANCEMENTS



SCHEDULED IMPLEMENTATION: SHORT-TERM

CAPACITY IMPROVEMENT POTENTIAL: MEDIUM

REFERENCE: RE&D 3.15, Terminal Enhancements.

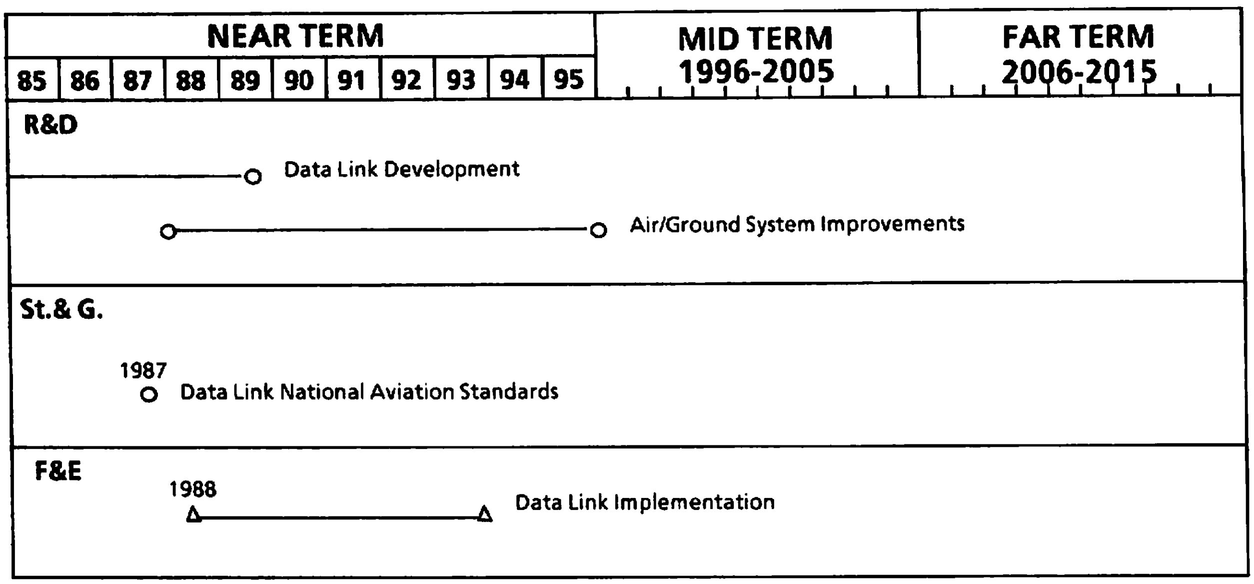
1.2.9 MODE S DATA LINK TECHNICAL ENHANCEMENTS

AIRPORT CAPACITY IMPROVEMENT IMPACT: **INCREASE CAPACITY THROUGH INCREASED USE OF AUTOMATION INCLUDING SATELLITES, GROUND-BASED COMPUTERS, AND AIRBORNE COMPUTERS.**

"Mode S" refers to an aircraft transponder's capability to transmit general data in digital form from the aircraft to the ground. The role of the Mode S data link is to provide basic support to the communications, surveillance, and navigation systems of the future. By improving these systems, there is a general benefit to the capacity and delay program. Throughput will be enhanced by the increasing use of automation as a controller aid in the terminal and en route environment. Mode S provides the means by which the automated system will communicate among its components, which in the future may include satellites, ground-based computers, and airborne computers.

The goal of this project is to pursue Mode S research and development in support of the various automated functions planned for future implementation. One of the main projects will be to develop a Mode S engineering test bed to evaluate various system alternatives.

1.2.9 MODE S DATA LINK TECHNICAL ENHANCEMENTS



SCHEDULED IMPLEMENTATION: SHORT-TERM

CAPACITY IMPROVEMENT POTENTIAL: LOW

REFERENCE: RE&D 4.7, Mode S Data Link Technical Enhancements.

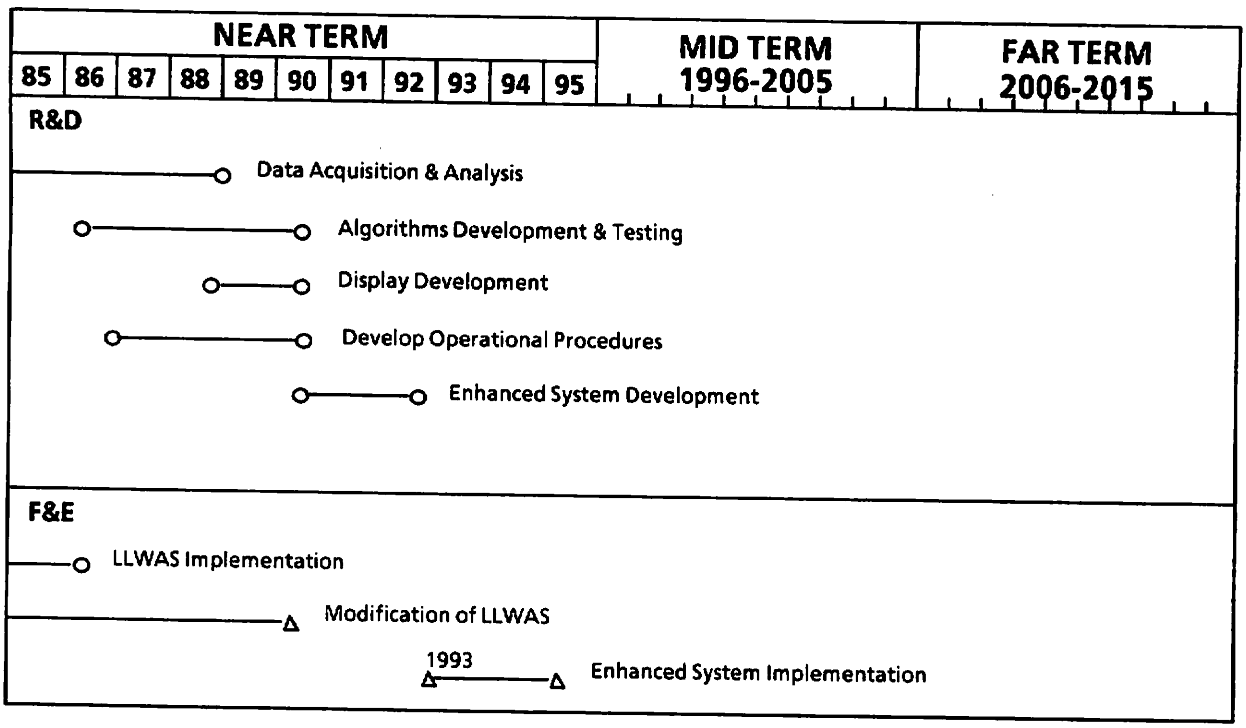
1.2.10 LOW LEVEL WIND SHEAR ALERT SYSTEM (LLWAS) ENHANCEMENTS

AIRPORT CAPACITY IMPROVEMENT IMPACT: **REDUCE DELAYS BY FACILITATING THE DESIGNATION OF ARRIVAL AND DEPARTURE ROUTES WHICH AVOID WIND SHEAR WITHOUT REDUCING OPERATIONS.**

The goal of this project is to improve the wind shear identification performance of the low level wind shear alert system (LLWAS) with respect to increased detection probability, reduced false alarm rate, and improved interpretability. Although the major purpose of this system is to improve safety by detecting wind shears so they can be avoided, this system also enhances capacity by locating the position of wind shears and allowing the designation of alternative arrival and departure routes which avoid the wind shear without reducing operations.

The LLWAS system uses ground-based wind velocity sensors (anemometers) located at many sites around the airport to detect the differences in wind velocity that indicate the presence of wind shear. Improvements to this system involve developing better algorithms for interpreting the data produced by the individual sensors.

1.2.10 LOW LEVEL WIND SHEAR ALERT SYSTEM ENHANCEMENTS



SCHEDULED IMPLEMENTATION: SHORT-TERM

CAPACITY IMPROVEMENT POTENTIAL: LOW

REFERENCE: RE&D 7.4, Low Level Wind Shear Alert System Enhancements.

TABLE 5-3
CATEGORY 2: TERMINAL AIRSPACE SYSTEMS PROJECTS WITH LONGER-TERM GAINS

NUMBER		POTENTIAL	IMPLEMENTATION
	2.1 MANAGEMENT/AUTOMATION		
2.1.1	ALGORITHMIC PROCEDURES/ALGORITHM DEVELOPMENT		
2.1.1a	TERMINAL ATC AUTOMATION	HIGH	LONG
2.1.1b	CADM-ASSISTED AIR TRAFFIC CONTROL TECHNIQUES	MEDIUM	LONG
2.1.1c	DEPARTURE FLOW METERING	MEDIUM	INTERM
2.1.1d	TRAFFIC MANAGEMENT WITH ARRIVAL TIME ACCOMMODATION	MEDIUM	INTERM
2.1.2	MODE S DATA LINK APPLICATIONS DEVELOPMENT	MEDIUM	LONG
2.1.3	WAKE VORTEX OPERATIONAL SOLUTIONS	MEDIUM	INTERM
2.1.4	UPGRADE ARRIVALS/DEMAND ALGORITHM	MEDIUM	INTERM
2.1.5	WAKE VORTEX AVOIDANCE AND FORECASTING, AND ROTORCRAFT WAKE VORTEX AVOIDANCE	MEDIUM	LONG
2.1.6	AUTOMATED AIRPORT CAPACITY CALCULATIONS	LOW	INTERM
	2.2 EQUIPMENT		
2.2.1	4D NAVIGATION IN THE TERMINAL AREA	HIGH	LONG
2.2.2	LANDING MONITOR FOR CLOSELY-SPACED RUNWAYS	MEDIUM	INTERM
2.2.3	NEXT GENERATION WEATHER RADARS	MEDIUM	INTERM
2.2.4	ADVANCED MLS APPLICATIONS	MEDIUM	LONG
2.2.5	SENSOR IMPROVEMENTS	MEDIUM	LONG
2.2.6	WEATHER SENSOR DEVELOPMENT	MEDIUM	LONG
2.2.7	WIND SHEAR DETECTION		
2.2.7a	ADVANCED WIND SHEAR SENSOR DEVELOPMENT	MEDIUM	LONG
2.2.7b	TERMINAL DOPPLER WEATHER RADAR	LOW	LONG
2.2.8	PRECISION APPROACH AND LANDING	LOW	LONG

2.1.1 ALGORITHMIC PROCEDURES/ALGORITHM DEVELOPMENT

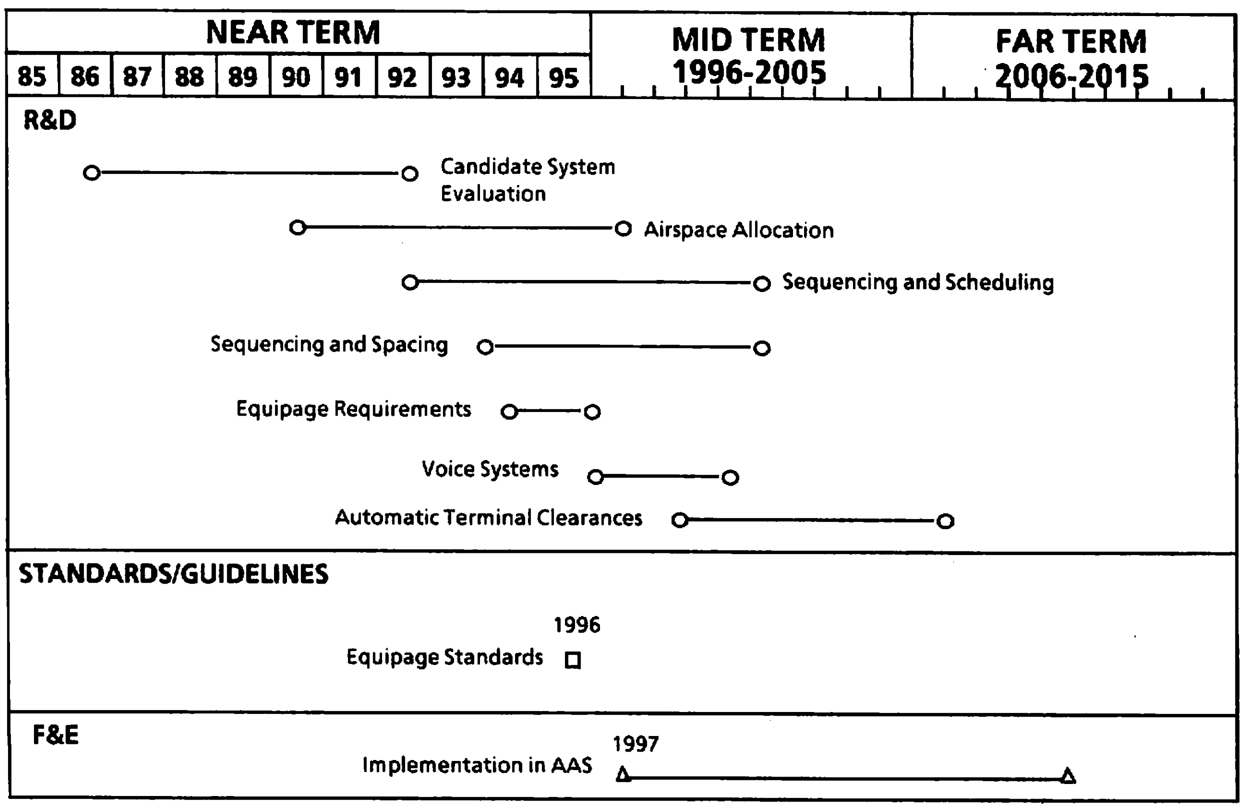
2.1.1a TERMINAL ATC AUTOMATION

AIRPORT CAPACITY IMPROVEMENT IMPACT: **REDUCE DELAYS THROUGH AUTOMATION OF AIRCRAFT SEQUENCING AND THROUGH SCHEDULING OF FLEXIBLE ARRIVAL AND DEPARTURE ROUTES.**

The goal of this project is to develop a terminal planning and advisory aid for controllers so that available terminal capacity can be maximized by sequencing and scheduling aircraft on flexible arrival and departure routes. The automation of aircraft sequencing and scheduling in the terminal airspace was found to be difficult in the past because of inadequate controller interface with automation, lack of accurate data on winds aloft, and lack of accurate demand predictions. These critical technical problems are expected to be alleviated in the near-term.

This project will reexamine the status of weather prediction, avionics, and other related technologies, and will identify operational, functional, and technical requirements for terminal ATC automation. Such automation will represent a major development effort and will be accomplished by developing the following specific functions: dynamic arrival/departure planning, airspace allocation, sequencing and scheduling, automated speed advisories and limited vectoring advisories, and (in the far-term) generation of clearances at high-density airports.

2.1.1a TERMINAL ATC AUTOMATION



SCHEDULED IMPLEMENTATION: LONG-TERM

CAPACITY IMPROVEMENT POTENTIAL: HIGH

REFERENCE: RE&D 3.16, Terminal ATC Automation.

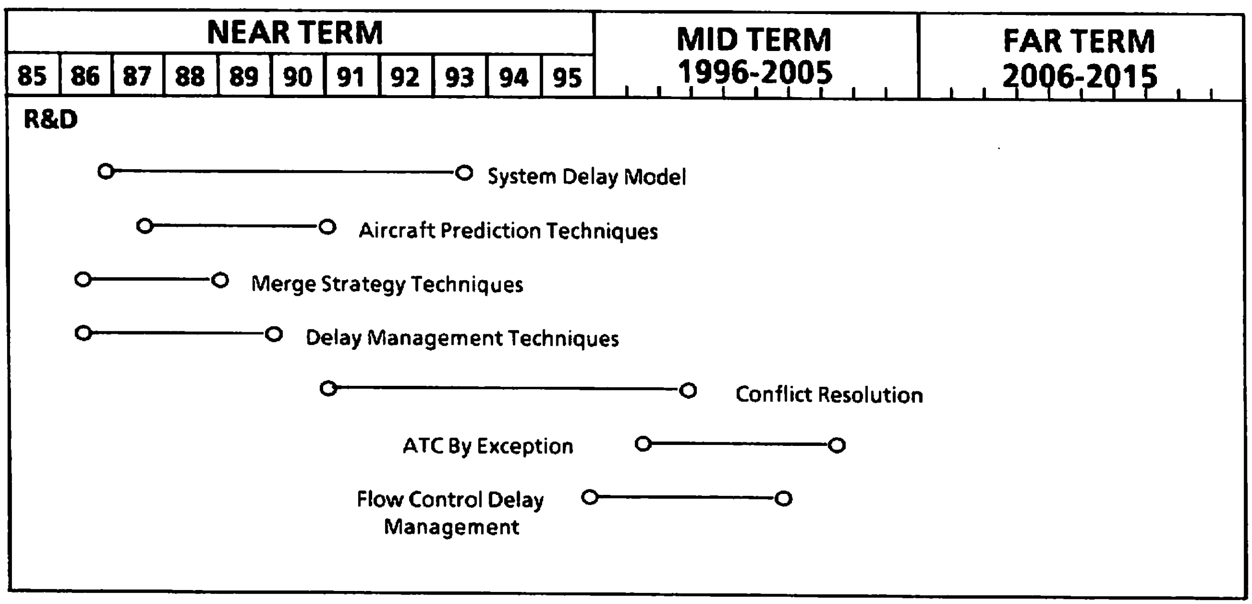
2.1.1 ALGORITHMIC PROCEDURES/ALGORITHM DEVELOPMENT

2.1.1b COMPUTER-AIDED DECISION-MAKING ASSISTED (CADM-ASSISTED) AIR TRAFFIC CONTROL TECHNIQUES

AIRPORT CAPACITY IMPROVEMENT IMPACT: **INCREASE CAPACITY BY APPLYING AUTOMATED TECHNIQUES TO IMPROVING AIR TRAFFIC MANAGEMENT, ESPECIALLY DURING PEAK TRAFFIC PERIODS.**

The goal of this project is to increase air safety, controller productivity, and airport capacity by applying automated techniques to air traffic management that will assist the controllers' decision-making and reduce their workload. The activities of the air traffic controllers that may be improved through the application of expert system and knowledge-based system techniques will be identified, and knowledge bases that will provide the controller with sound recommended actions during high workload conditions will be developed. The products of this project will include knowledge-based specifications of position prediction, merge strategy, delay management, conflict resolution, advanced ATC management, and flow control delay management. This project will increase capacity during peak traffic periods.'

2.1.1b CADM-ASSISTED AIR TRAFFIC CONTROL TECHNIQUES



SCHEDULED IMPLEMENTATION: LONG-TERM

CAPACITY IMPROVEMENT POTENTIAL: MEDIUM

REFERENCE: RE&D 14.19, CADM-Assisted Air Traffic Control Techniques.

2.1.1 ALGORITHMIC PROCEDURES/ALGORITHM DEVELOPMENT

2.1.1c DEPARTURE FLOW METERING

AIRPORT CAPACITY IMPROVEMENT IMPACT: **REDUCE DEPARTURE DELAYS THROUGH THE USE OF AN AUTOMATED DEPARTURE METERING SYSTEM.**

Increased air traffic congestion will result in higher levels of delay. ATC procedures have been implemented to reduce the economic impact of delays on aircraft operators by restricting departures so that delays can be absorbed on the ground. These procedures have significantly increased the complexity of the departure control function, thus warranting the consideration of advanced departure metering automation to ensure efficient ATC operations.

The goal of this project is to implement a departure metering automation support system that will reduce departure delays. The new system will utilize data on proposed flight plans and current departure schedules to generate a set of departure slots which satisfy all applicable local and national flow restrictions. The traffic management coordinators and the tower controllers will be able to use this system while performing tasks such as scheduling departures from multiple airports when departure demand exceeds the capacity of common departure routes. This project will develop and test an engineering model for departure flow metering at an air route traffic control center (ARTCC) that supports a major metroplex terminal area. The results will be used to develop a functional design specification for the advanced automation system.

Potential ATC system benefits include better utilization of the available airport capacity by more orderly processing of departures into the en route airspace through a departure metering automation support system. This is likely to decrease the need for drastic tactical control actions, to reduce controller work load, and to increase safety.

2.1.1c DEPARTURE FLOW METERING

NEAR TERM											MID TERM	FAR TERM
85	86	87	88	89	90	91	92	93	94	95	1996-2005	2006-2015
R&D												
——O Departure Flow Meeting												

SCHEDULED IMPLEMENTATION: INTERMEDIATE

CAPACITY IMPROVEMENT POTENTIAL: MEDIUM

REFERENCE: RE&D 3.1, Traffic Management System.

2.1.1 ALGORITHMIC PROCEDURES/ALGORITHM DEVELOPMENT

2.1.1d TRAFFIC MANAGEMENT WITH ARRIVAL TIME ACCOMMODATION

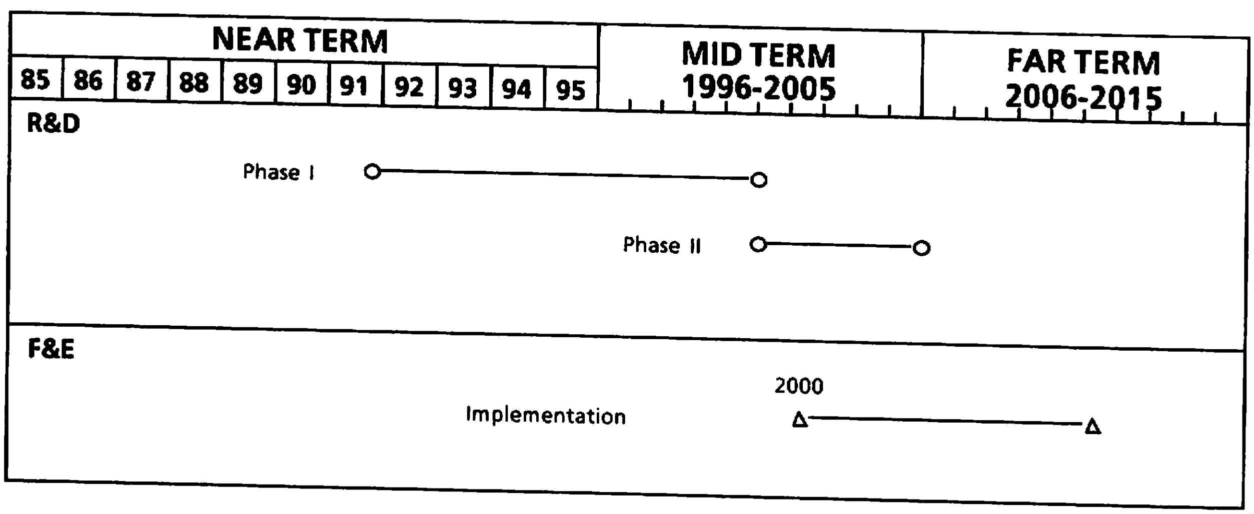
AIRPORT CAPACITY IMPROVEMENT IMPACT: **REDUCE DELAYS BY IMPROVING THE ABILITY OF THE TRAFFIC MANAGEMENT SYSTEM TO ACCOMMODATE USER REQUESTS FOR AIRPORT LANDING TIMES.**

The goal of this project is to develop operational procedures and associated processing capabilities to enable the traffic management system (TMS) to accommodate user requests for airport landing times. This will increase an airport's ability to meet demand, thus significantly reducing delay.

An air traffic model will be developed to simulate operating with a mix of aircraft, with and without 4D navigation, and with varying requests for time-based clearances over some or all phases of their flights. These simulations will utilize the more accurate demand information that will be available due to aircraft capabilities of negotiating time commitments, and the more accurate capacity estimates resulting from better algorithms and weather predictions. The simulations will be used to develop operational procedures and requirements for TMS algorithms, displays, and other aids.

The TMS improvements will be implemented in two phases. Phase I will allow the TMS to make arrival time commitments on a limited scale. For example, it may use a certain portion of available capacity at major airports for negotiating arrival commitments with users before a flight (or, if necessary, in-flight). Phase II will extend these capabilities to permit routine arrival time commitments.

2.1.1d TRAFFIC MANAGEMENT WITH ARRIVAL TIME ACCOMMODATION



SCHEDULED IMPLEMENTATION: INTERMEDIATE

CAPACITY IMPROVEMENT POTENTIAL: MEDIUM

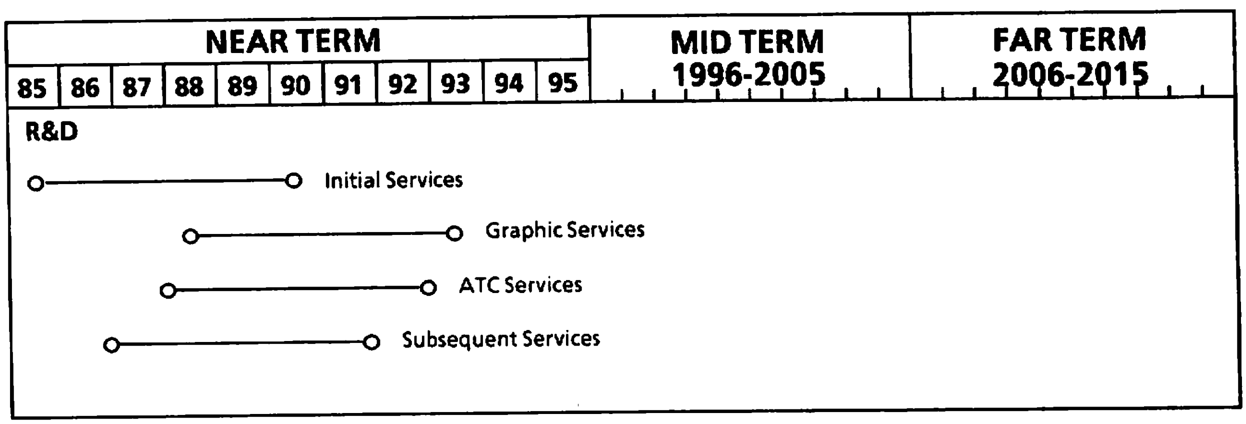
REFERENCE: RE&D 3.2, Traffic Management with Arrival Time Accommodation.

2.1.2 MODE S DATA LINK APPLICATIONS DEVELOPMENT

AIRPORT CAPACITY IMPROVEMENT IMPACT: **INCREASE THROUGHPUT BY IMPROVING GROUND-COCKPIT COMMUNICATIONS, THUS ENABLING MORE EFFICIENT AND PRECISE CONTROL OF AIRCRAFT TRAJECTORIES.**

The Mode S data link is designed to provide data communications between the aircraft and the ground. The goal of this project is to explore ways in which the Mode S data link can contribute to the NAS plan goals of higher productivity, increased efficiency, and enhanced safety. The project will develop, test, and validate operational concepts for several data link applications by defining message flows, content, format, message processing algorithms, and specific human interfaces for each application. The Mode S system offers benefits to the capacity program on many specific projects, including 4D navigation, surface traffic management aids, and automated weather reporting systems. The system's overall contribution is to provide the capability to transfer more data between the ground and the cockpit, allowing more efficient and precise control of aircraft. This project provides the communications component of many future systems that will result in terminal capacity gains. As part of Project 4.4, system studies will be conducted to identify capacity benefits achievable with Mode S data link capability.

2.1.2 MODE S DATA LINK APPLICATIONS DEVELOPMENT



SCHEDULED IMPLEMENTATION: LONG-TERM

CAPACITY IMPROVEMENT POTENTIAL: MEDIUM

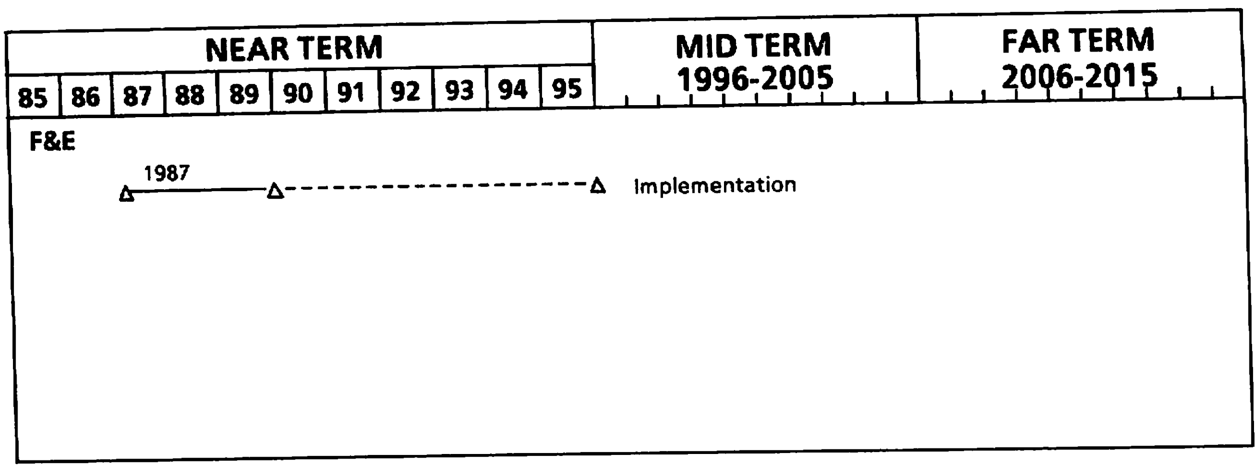
REFERENCE: RE&D 4.8, Mode S Data Link Applications Development.

2.1.3 WAKE VORTEX OPERATIONAL SOLUTIONS

AIRPORT CAPACITY IMPROVEMENT IMPACT: INCREASE CAPACITY BY REDUCING SEPARATION REQUIREMENTS THROUGH THE DEVELOPMENT OF OPERATIONAL SOLUTIONS TO AVOIDING WAKE VORTEX HAZARDS.

The goal of this project is to increase the capacity of runways and airports by developing operational solutions to avoiding wake vortex hazards. The hazards of wake vortices are major inhibitors to increasing runway capacity. Greater separation requirements result from the need to protect aircraft from these hazards on approach. This project will develop appropriate procedures for resolving the wake vortex problem and define the avionics requirements for implementing these procedures. These procedures will exploit the increased flexibility of MLS, which will allow the creation of multiple approach paths to the same runway that avoid wake vortex problems.

2.1.3 WAKE VORTEX OPERATIONAL SOLUTIONS



SCHEDULED IMPLEMENTATION: INTERMEDIATE

CAPACITY IMPROVEMENT POTENTIAL: MEDIUM

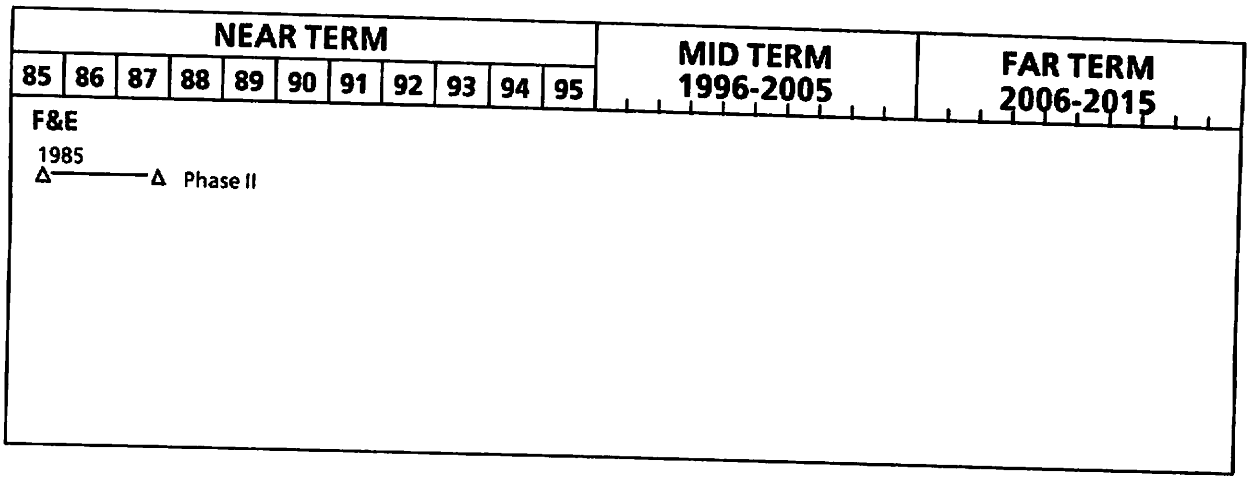
REFERENCE: RE&D 3.17, Airport Capacity Improvements.

2.1.4 UPGRADE ARRIVALS/DEMAND ALGORITHMS

AIRPORT CAPACITY IMPROVEMENT IMPACT: **REDUCE DELAYS BY IMPROVING CENTRAL FLOW CONTROL PREDICTION ALGORITHIMS**

The goal of this project is to modify the Central Flow Control Function Estimated Departure Clearance Time (EDCT) algorithms to allow account for prediction uncertainties, thus making more efficient use of an airport's capacity. Operational data on arrival, departure, and en route flying times will be analyzed as a first step in defining and implementing specific modification to Central Flow Control Function EDCT algorithms . The modified algorithms then will be evaluated by traffic simulations and by conducting appropriate field tests.

2.1.4 UPGRADE ARRIVALS/DEMAND ALGORITHMS



SCHEDULED IMPLEMENTATION: INTERMEDIATE

CAPACITY IMPROVEMENT POTENTIAL: MEDIUM

REFERENCE: RE&D 3.1, Traffic Management System.

2.1.5 WAKE VORTEX AVOIDANCE AND FORECASTING, AND ROTORCRAFT WAKE VORTEX AVOIDANCE

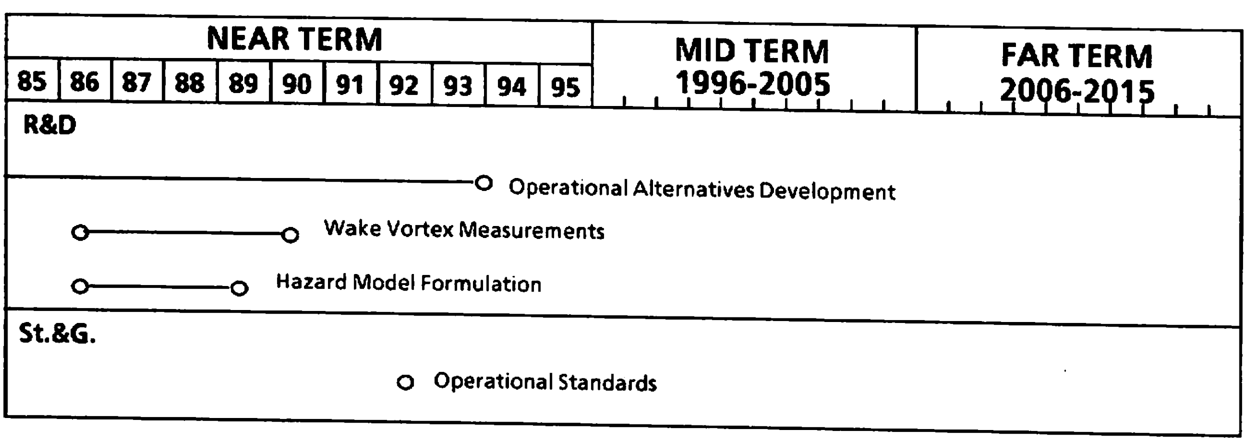
AIRPORT CAPACITY IMPROVEMENT IMPACT: **INCREASE CAPACITY BY IMPROVING THE PREDICTION, DETECTION, AND AVOIDANCE OF WAKE VORTICES, THUS ENABLING REDUCED SEPARATION STANDARDS.**

A serious impediment to improving the capacity at major airports is the need for each aircraft to avoid the wake vortex generated by the preceding aircraft. Considerable research has been performed to develop both technological and operational solutions to this problem. It has been possible to identify surface wind parameters which allow reduced separations, but it has proved difficult to translate this knowledge into an operational procedure which enables controllers to reduce separations for a significant period of time. In addition, pilots have been reluctant to trust a system that does not directly detect the vortices. Furthermore, the costs are borne by one aircraft while the benefits accrue to another; this reduces the incentive for implementing such techniques.

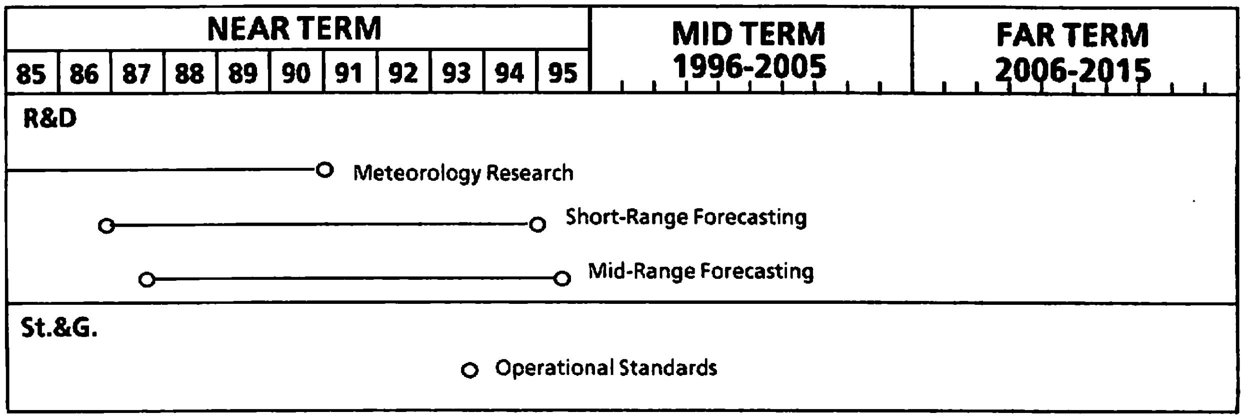
This group of projects is aimed at improving current methods of predicting and avoiding the hazardous effects of wake vortices. The goals of these projects are:

- To improve current methods of avoiding hazardous wake vortex encounters by adopting general separation standards and procedures that more accurately reflect the actual hazard, and by adapting the separations to the real-time duration of the hazard;
- To forecast changes in the duration of the wake vortex hazard so that aircraft separation changes and airport capacity can be known in advance; and
- To support rotorcraft separation standards by obtaining information on rotorcraft wakes and rotorcraft upset criteria, and by developing a rotorcraft vortex avoidance system.

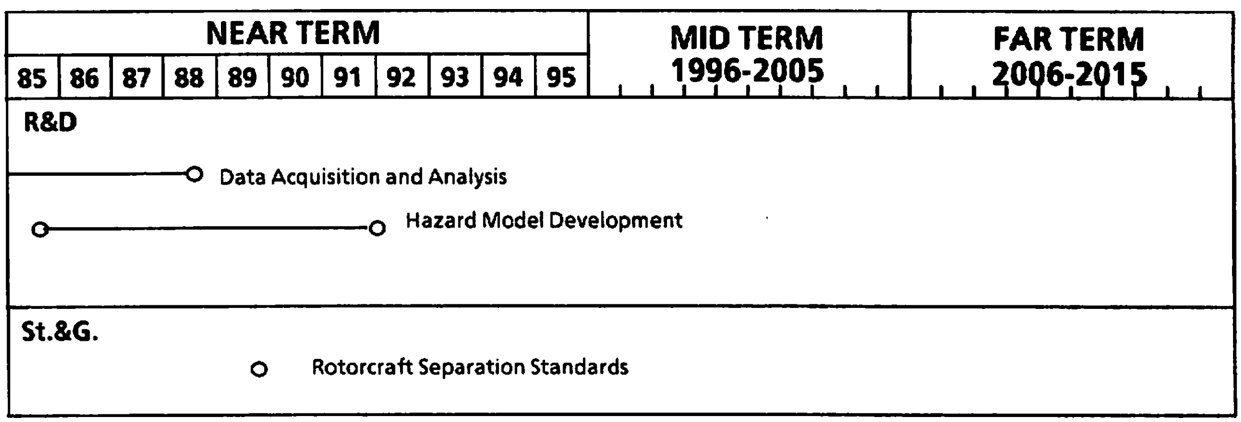
2.1.5 MILESTONES: WAKE VORTEX AVOIDANCE



WAKE VORTEX FORECASTING



ROTORCRAFT WAKE VORTEX AVOIDANCE



SCHEDULED IMPLEMENTATION: LONG-TERM

CAPACITY IMPROVEMENT POTENTIAL: MEDIUM

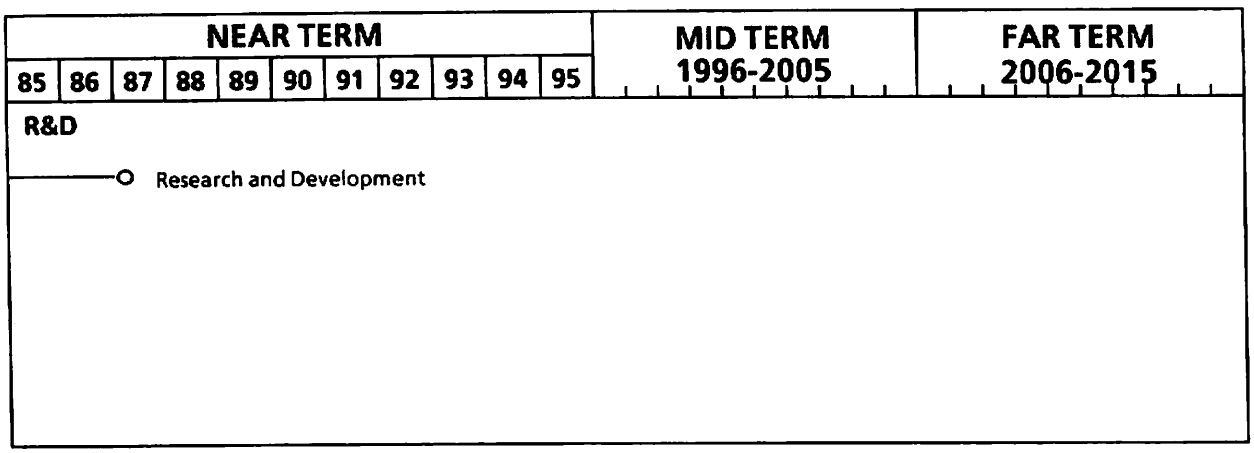
REFERENCE: RE&D 14.1, Wake Vortex Avoidance.
RE&D 14.2, Wake Vortex Forecasting.
RE&D 14.3, Rotorcraft Wake Vortex Avoidance.

2.1.6 AUTOMATED AIRPORT CAPACITY CALCULATIONS

AIRPORT CAPACITY IMPROVEMENT IMPACT: **IMPROVE IDENTIFICATION AND PREDICTION OF IMBALANCES BETWEEN DEMAND AND CAPACITY, AND PROVIDE CONTROLLERS WITH TOOLS TO MATCH DEMAND TO MAXIMUM AVAILABLE CAPACITY.**

The goal of this project is to predict airport acceptance rates as a function of planned runway configurations, predicted weather, predicted mix of aircraft types and their capabilities, and predicted arrival and departure demand characteristics. The automated airport acceptance rate calculations will be developed as a function of the Traffic Management System (TMS). The purpose of the TMS is to enhance the ATC system capabilities to monitor air traffic demand on saturable resources such as airports, fixes, and sector airspaces; to predict and identify imbalances between demand and capacity, and to provide traffic management specialists with tools to evaluate and select flow management alternatives such as ground delays and alternate routes for efficiently matching the traffic demand to the maximum available capacity. The automated airport acceptance rate calculations model will be evaluated by conducting appropriate field tests and modified as necessary.

2.1.6 AUTOMATED AIRPORT CALCULATIONS



SCHEDULED IMPLEMENTATION: INTERMEDIATE

CAPACITY IMPROVEMENT POTENTIAL: LOW

REFERENCE: RE&D 3.1, Traffic Management System.

2.2.1 4D NAVIGATION IN THE TERMINAL AREA

AIRPORT CAPACITY IMPROVEMENT IMPACT: **INCREASE THROUGHPUT IN THE TERMINAL AREA BY REDUCING THE AMOUNT OF AIRSPACE RESERVED FOR EACH FLIGHT.**

The goal of this project is to investigate the use of time as a basic parameter in controlling aircraft within the terminal area, thus allowing aircraft equipped with four-dimensional (4D) navigation capability to fully utilize that equipment. The use of time as an independent parameter in the ATC system may allow properly equipped aircraft to navigate and meet arrival time commitments at airports and arrival fixes to minimize fuel consumption and delays.

With this type of navigational system, an aircraft can be given a specific time to arrive at an airport or at a certain point in the terminal airspace. Given a reasonable expectation that an aircraft can comply with such an instruction by arriving at the designated point within a few seconds of the specified time, the amount of airspace reserved for each flight can be reduced, thereby increasing the throughput in the terminal area. This is one of the concepts to be developed under NAS Development Studies, Project 4.4.

SCHEDULED IMPLEMENTATION: LONG-TERM

CAPACITY IMPROVEMENT POTENTIAL: HIGH

REFERENCE: N/A

Milestones not currently available.

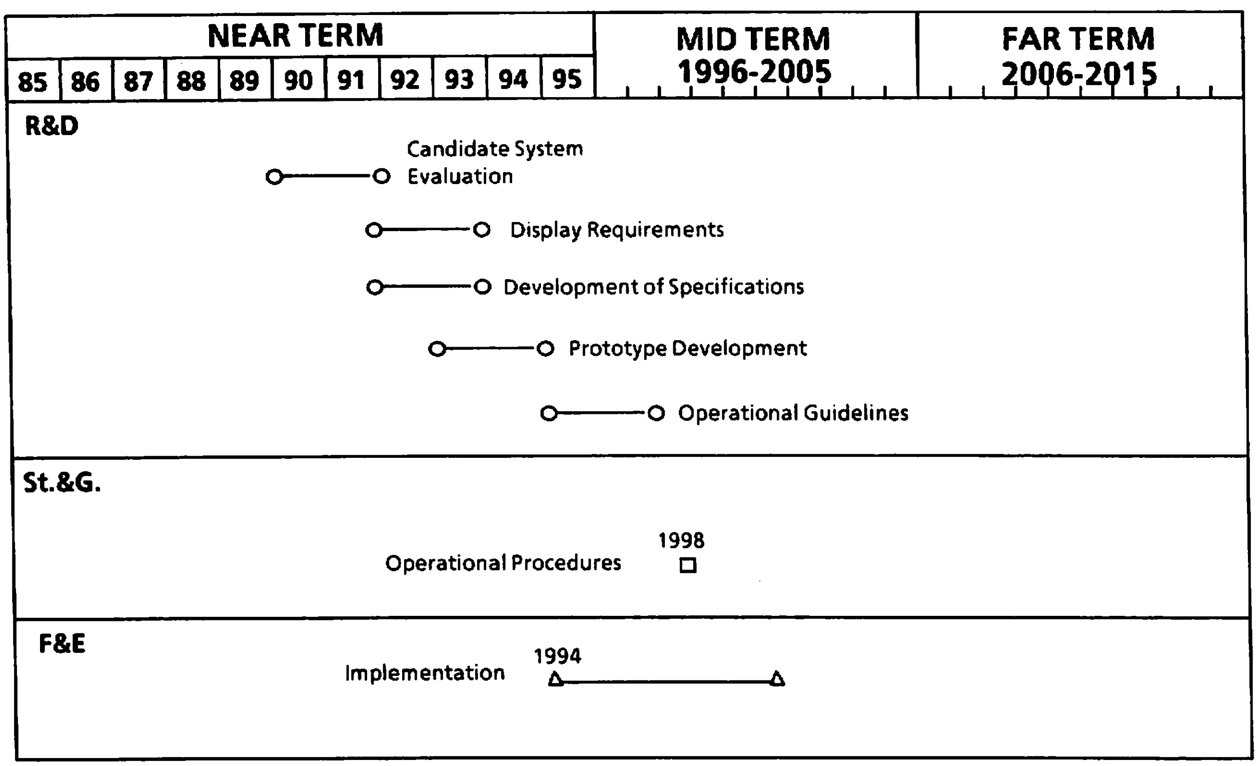
2.2.2 LANDING MONITOR FOR CLOSELY-SPACED RUNWAYS

AIRPORT CAPACITY IMPROVEMENT IMPACT: **INCREASE CAPACITY BY ENABLING BETTER USE OF CLOSELY-SPACED PARALLEL RUNWAYS, TRIPLE RUNWAYS, AND CONVERGING RUNWAYS DURING IFR WEATHER CONDITIONS.**

The goal of this project is to develop independent surveillance coverage of aircraft approaches and landings to support IFR operations on closely-spaced parallel runways, triple runways, and converging runways. Increased use of these instrument procedures will improve airport capacity. The landing monitor developed by this project must provide the controller with sufficient accuracy, update rate, and display tools to respond to aircraft deviations and complex MLS approaches. The accuracy and update rate needed for airport-based monitors and tower displays at candidate sites will be determined. Alternative concepts will be developed and evaluated, including the application of existing systems, such as ILS and ASDE, and new systems, such as MLS and Mode S.

Specifications for a prototype radar surveillance system for monitoring independent operation of closely-spaced parallel runways will be developed, and a prototype will be procured for testing and evaluation at sites to be selected. Technical feasibility and cost/benefit studies will be performed as part of the selection process. There will be a study of alternative, low-cost monitoring systems that could be used instead of radar to support airport capacity improvement programs. Operational procedures and guidelines will be established based on test results. It is estimated that the development of a prototype will be concluded by 1995.

2.2.2 LANDING MONITOR FOR CLOSELY-SPACED RUNWAYS



SCHEDULED IMPLEMENTATION: INTERMEDIATE

CAPACITY IMPROVEMENT POTENTIAL: MEDIUM

REFERENCE: RE&D 6.3, Landing Monitor for Closely-Spaced Runways.

2.2.3 NEXT GENERATION WEATHER RADARS

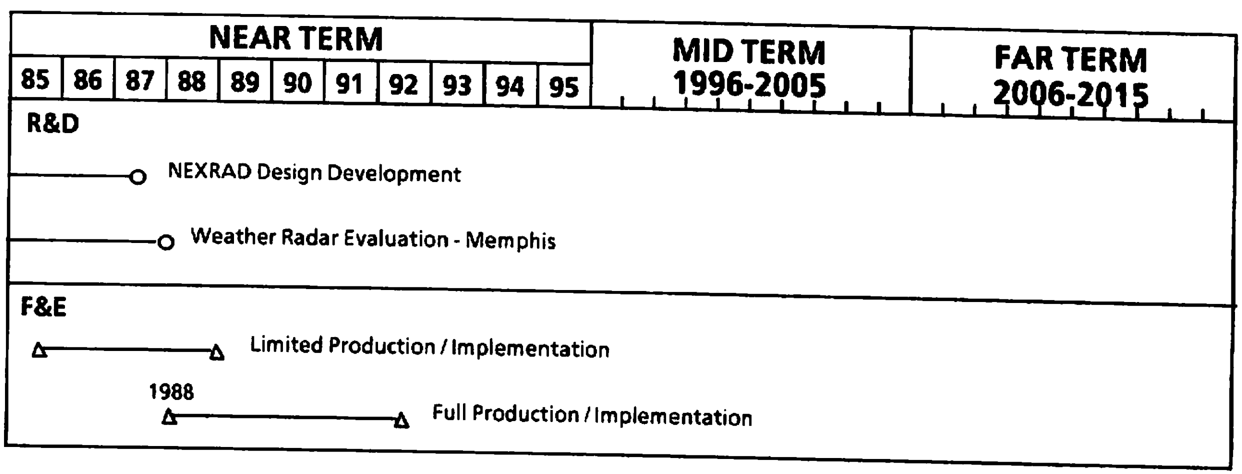
AIRPORT CAPACITY IMPROVEMENT IMPACT: **REDUCTION IN WEATHER- RELATED DELAYS DUE TO USE OF MORE EFFICIENT ALTERNATIVE ROUTES MADE POSSIBLE BY IMPROVED WEATHER RADARS.**

The goal of this project is to develop a new generation of Doppler weather radars (NEXRAD) that will provide accurate information on precipitation, wind velocity, and turbulence, and to furnish software algorithms that take advantage of the improved radar presentation of weather data. The ability to detect areas of hazardous weather results in more efficient alternate routes which reduce weather-related delay.

To improve hazardous weather detection, reduce flight delays, and improve flight planning, the FAA has joined with the National Weather Service and the U.S. Air Force's Air Weather Service in a program to develop and deploy the NEXRAD system. The FAA also is developing a central weather processor for the distribution and display of NEXRAD data. The FAA intends to use NEXRAD to provide data on hazardous and routine weather for all altitudes above 6,000 feet throughout the continental United States.

Terminal Doppler Weather Radar (TDWR) also will be developed for weather detection at airports. This will be similar to, and possibly a derivative of, NEXRAD. Such a system would be useful in identifying localized areas of hazardous weather that result in traffic delays in a terminal area. This project is described separately as Project 2.2.7b.

2.2.3 NEXT GENERATION WEATHER RADARS



SCHEDULED IMPLEMENTATION: INTERMEDIATE

CAPACITY IMPROVEMENT POTENTIAL: MEDIUM

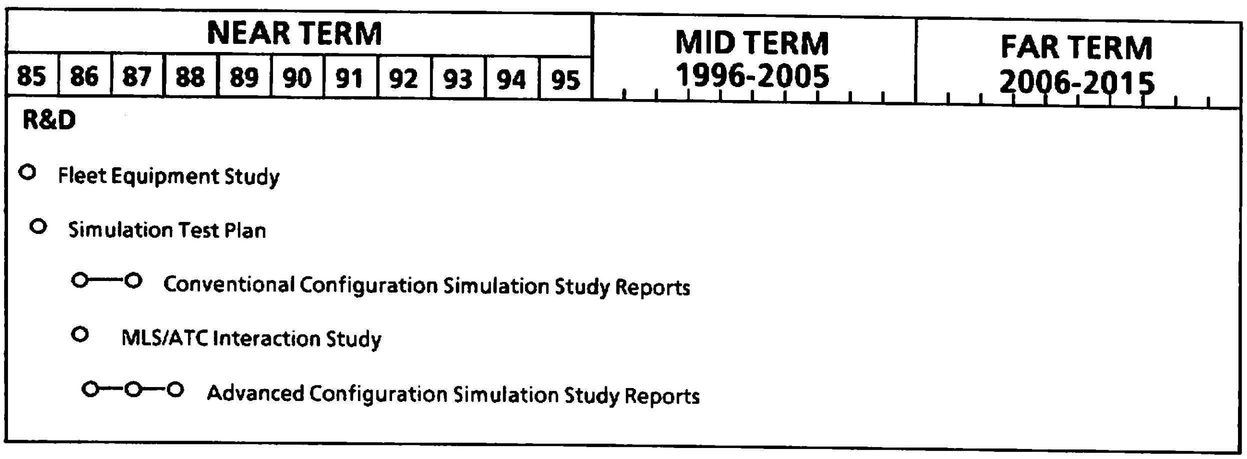
REFERENCE: RE&D 7.2, Next Generation Weather Radars. RE&D 7.3, Terminal Doppler Weather Radar.

2.2.4 ADVANCED MLS APPLICATIONS

AIRPORT CAPACITY IMPROVEMENT IMPACT: **INCREASE IFR CAPACITY THROUGH DEVELOPMENT OF MLS REQUIREMENTS TO SUPPORT NEW CAPACITY-ENHANCING PROCEDURES AND TO PERMIT PRECISION APPROACHES AT MORE LOCATIONS.**

The goal of this project is to develop capacity-enhancing procedures for IFR approaches and departures that take advantage of the microwave landing system's ability to provide 3D precision guidance in the terminal area. The development of navigation technology follows the establishment of operational requirements for new capabilities. The purpose of this study is to specify the operational requirements for capacity-enhancing procedures (such as reduced separations, missed approach guidance, and variable glide path angles) so that the navigation equipment can be designed or modified to support them. This project will include the development of MLS requirements to support new procedures and to permit precision approaches at more locations.

2.2.4 ADVANCED MLS APPLICATIONS



SCHEDULED IMPLEMENTATION: LONG-TERM

CAPACITY IMPROVEMENT POTENTIAL: MEDIUM

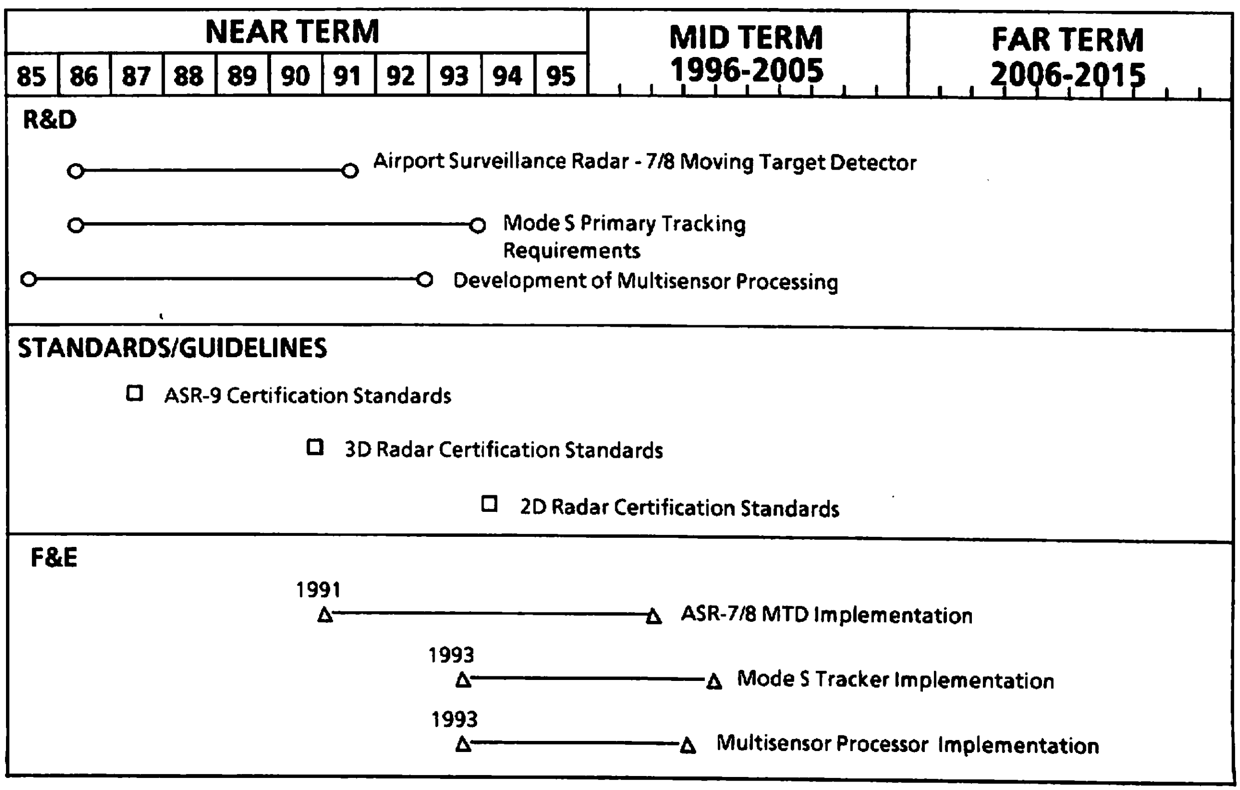
REFERENCE: NAS Resume 8032, MLS Advanced Approaches, and NAS Plan Project IV-7, Microwave Landing System.

2.2.5 SENSOR IMPROVEMENTS

AIRPORT CAPACITY IMPROVEMENT IMPACT: **INCREASE CAPACITY BY ENABLING SEPARATIONS BETWEEN AIRCRAFT TO BE REDUCED TO RADAR MINIMUMS DUE TO MORE EFFICIENT POSITION, IDENTIFICATION, AND TRACKING INFORMATION.**

The goal of this project is to improve the detection, accuracy, and resolution of current FAA radar sensors, to develop new processing algorithms for different types of radars, and to establish certification standards and procedures for new radars used in the terminal and en route ATC system. The improvements included in this project will enable the radar system to provide aircraft position, identification, and tracking information more quickly and more accurately. The broader coverage provided by the new sensors will enable radar separations between aircraft to be reduced to radar minimums, thus increasing capacity in the terminal area. Radar coverage over the airport may enable the use of converging IFR runways where radar separation is required in the event of simultaneous missed approaches.

2.2.5 SENSOR IMPROVEMENTS



SCHEDULED IMPLEMENTATION: LONG-TERM

CAPACITY IMPROVEMENT POTENTIAL: MEDIUM

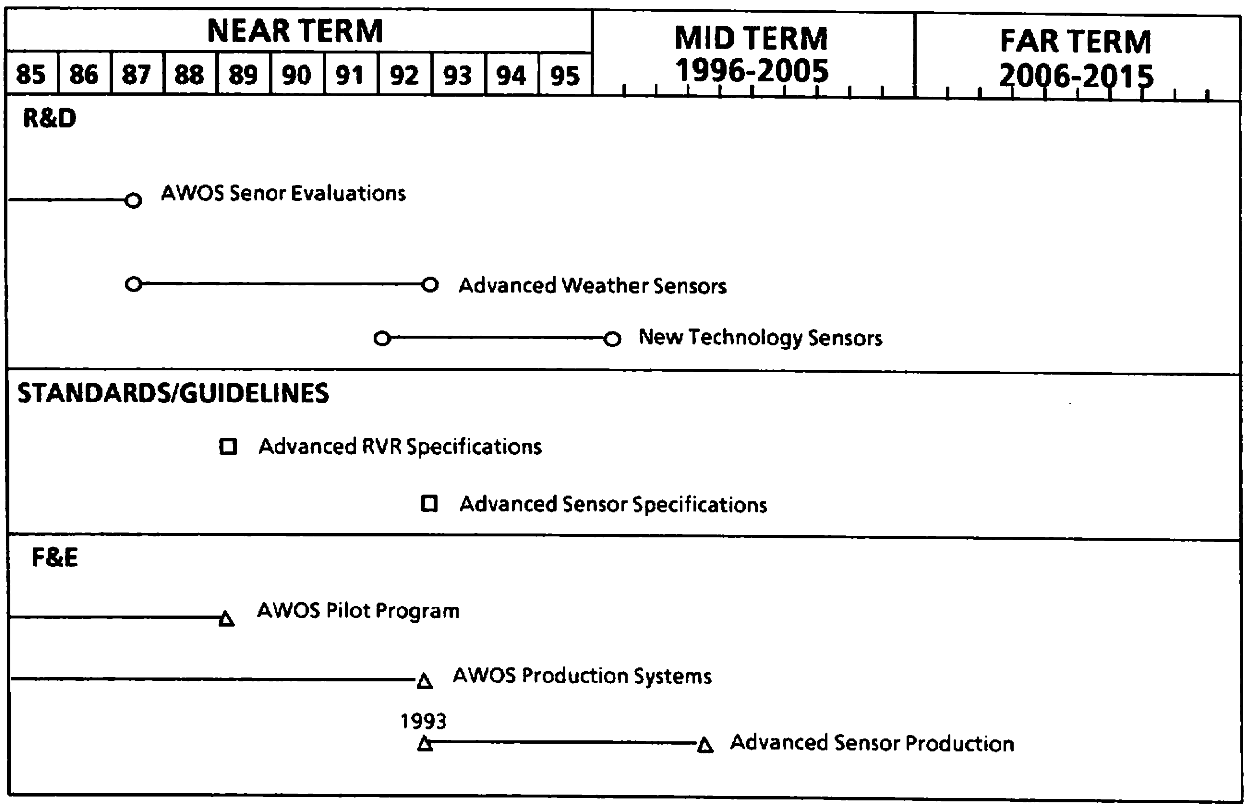
REFERENCE: RE&D 6.1, Sensor Improvements.

2.2.6 WEATHER SENSOR DEVELOPMENT

AIRPORT CAPACITY IMPROVEMENT IMPACT: **REDUCE DELAYS THROUGH BETTER FORECASTING AND FLIGHT PLANNING BY IMPROVING THE DETECTION OF HAZARDOUS WEATHER PHENOMENA.**

The goal of this project is to evaluate new systems for weather detection and assessment. Advanced weather sensor development, which is conducted primarily by the National Oceanic and Atmospheric Administration laboratories and the National Weather Service, and is supported by the FAA. This research will continue to develop sensors and technologies using lasers, infrared systems, and Doppler radars for detecting meterological phenomena such as wind shear and other forms of turbulence, cloud height, precipitation rates, and icing. Improving the detection of hazardous weather phenomena results in increased system throughput and efficiency through better forecasting and flight planning.

2.2.6 WEATHER SENSOR DEVELOPMENT



SCHEDULED IMPLEMENTATION: LONG-TERM

CAPACITY IMPROVEMENT POTENTIAL: MEDIUM

REFERENCE: RE&D 7.1, Weather Sensor Development.

2.2.7 WIND SHEAR DETECTION

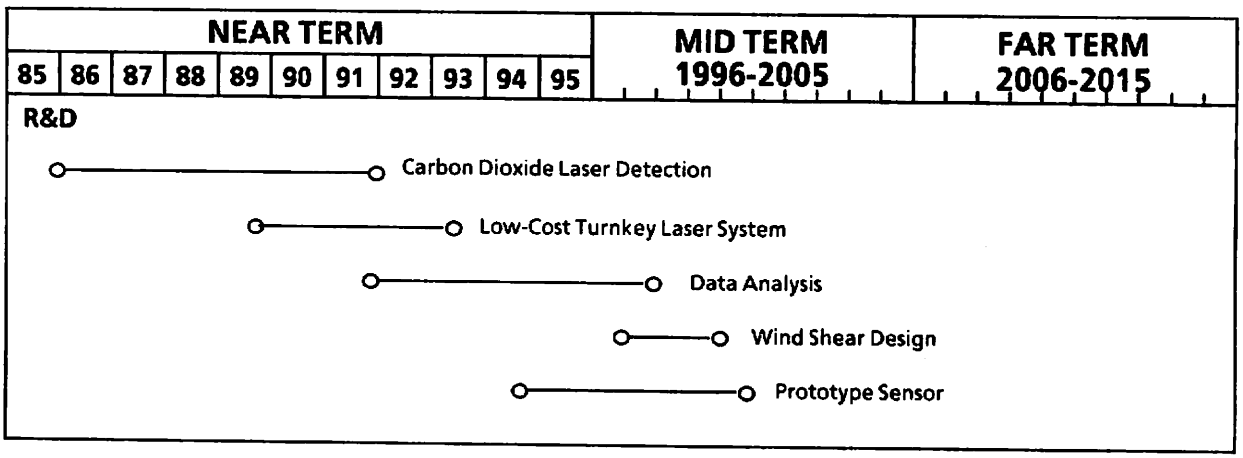
2.2.7a ADVANCED WIND SHEAR SENSOR DEVELOPMENT

AIRPORT CAPACITY IMPROVEMENT IMPACT: **REDUCE DELAY THROUGH USE OF ARRIVAL AND DEPARTURE ROUTINGS THAT MINIMIZE EXPOSURE TO HAZARDOUS WIND SHEARS.**

The goal of this project is to investigate techniques for detecting hazardous wind shears in the airport terminal area. The presence of such hazards results in traffic delays, and the ability to detect them would reduce delay through the use of alternate arrival and departure routings.

Effort in this area is concentrated on carbon dioxide laser Doppler clear-air wind returns leading to the development of an experimental sensor. Based on an analysis of field tests, a prototype advanced technology wind shear sensor will be developed for eventual deployment at airports.

2.2.7a ADVANCED WIND SHEAR SENSOR DEVELOPMENT



SCHEDULED IMPLEMENTATION: LONG-TERM

CAPACITY IMPROVEMENT POTENTIAL: MEDIUM

REFERENCE: RE&D 14.4, Advanced Wind Shear Sensor Development.

2.2.7 WIND SHEAR DETECTION

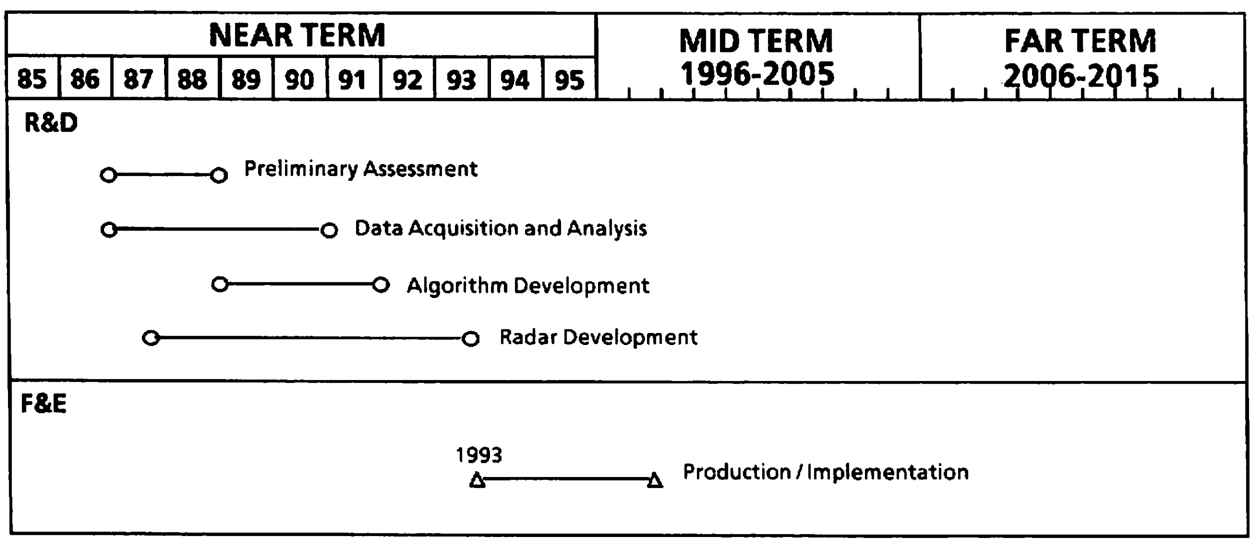
2.2.7b TERMINAL DOPPLER WEATHER RADAR

AIRPORT CAPACITY IMPROVEMENT IMPACT: **REDUCE DELAYS BY PERMITTING MORE EFFICIENT TRANSITIONS BETWEEN THE USE OF DIFFERENT RUNWAY CONFIGURATIONS AS REQUIRED WHEN WIND SHEAR OCCURS.**

The goal of this project is to improve the detection and identification of dangerous wind shear events by measuring wind fields above and around the airport using Doppler weather radar techniques. In addition to providing information on the location of hazardous wind shears, this equipment provides information on wind velocity within its area of coverage. This information is useful in determining which runway configuration to use, and since it is provided in advance of a shift in wind direction, it allows the controller to plan for a change of runway configuration.

Although the Doppler weather radar is designed primarily to enhance safety, it does have an impact on the capacity enhancement program by permitting efficient transitions between the use of different runway configurations. Without advance warning of a change in wind direction, the controller often has several airplanes in line for takeoff that are headed in the "wrong" direction; these aircraft must taxi to the other end of the runway when wind shift occurs.

2.2.7b TERMINAL DOPPLER WEATHER RADAR



SCHEDULED IMPLEMENTATION: LONG-TERM

CAPACITY IMPROVEMENT POTENTIAL: LOW

REFERENCE: RE&D 7.3, Terminal Doppler Weather Radar.

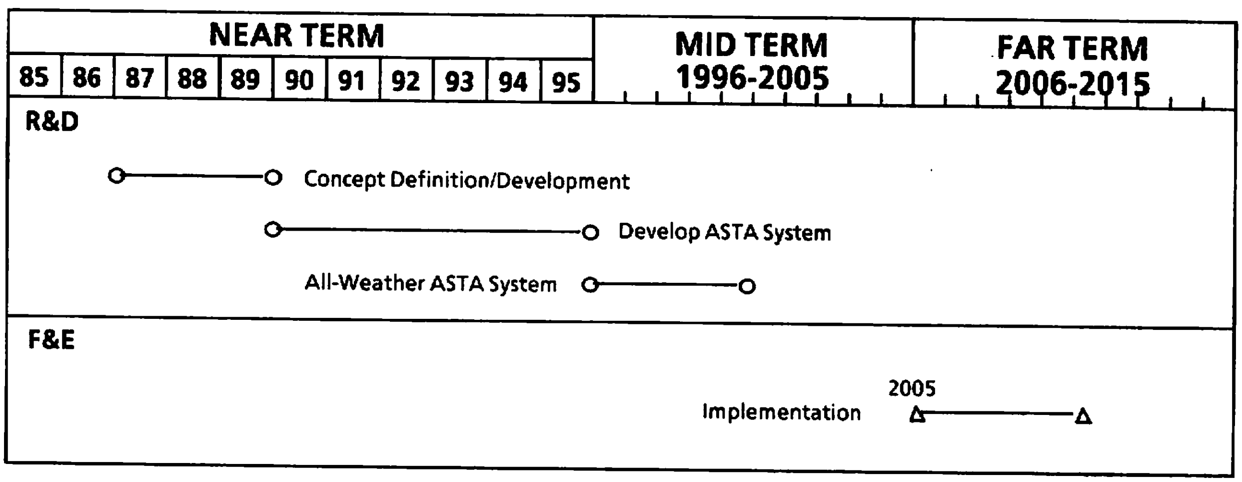
3.1.1 AIRPORT SURFACE TRAFFIC AUTOMATION

AIRPORT CAPACITY IMPROVEMENT IMPACT: **TO INCREASE RUNWAY, TAXIWAY, APRON, AND GATE EFFICIENCY, AND TO INCREASE OVERALL CAPACITY IN ALL WEATHER CONDITIONS, BY PROVIDING AUTOMATION ASSISTANCE TO CONTROLLERS.**

The goal of this project is to provide automation assistance to the controller to increase runway, taxiway, apron and gate efficiency, and overall airport capacity in all weather conditions. During low visibility conditions, the system will improve surface separation techniques by providing automated taxiway and runway intersection control functions based on the use of improved airport surface surveillance and communication systems.

Airport Surface Traffic Automation (ASTA) will be developed as a tower controller's automation aid for organizing and routing aircraft between gates and runways to increase airport capacity. A ground surveillance system, such as ASDE radar, will be utilized by ASTA to aid controllers in monitoring the movements of aircraft and other ground vehicles. The project will identify the functional requirements for utilizing airport surface surveillance data and controller-defined routings to safely and efficiently control surface traffic movements. In addition, surveillance and communication requirements will be defined for the eventual evolution of ASTA into a system that will provide completely automatic ground traffic management under all weather conditions.

3.1.1 AIRPORT SURFACE TRAFFIC AUTOMATION



SCHEDULED IMPLEMENTATION: INTERMEDIATE

CAPACITY IMPROVEMENT POTENTIAL: MEDIUM

REFERENCE: RE&D 3.18, Airport Surface Traffic Automation.

3.1.2 METHODS OF REDUCING RUNWAY OCCUPANCY TIME (ROT)

AIRPORT CAPACITY IMPROVEMENT IMPACT: **IMPROVE CAPACITY BY MAKING IT POSSIBLE FOR MORE AIRCRAFT TO USE A GIVEN RUNWAY BY REDUCING RUNWAY OCCUPANCY TIME.**

Air Traffic Control rules currently require that not more than one arriving aircraft occupy a runway at any time. The goal of this project is to investigate methods for reducing runway occupancy time so that runways can be used more efficiently, thus increasing capacity. With the introduction of automation in the terminal area, runway occupancy time will be one of the limiting factors on runway capacity. Not only does the average ROT determine the number of aircraft that can use the runway, but the high variability of ROT also forces increased separations during final approach to avoid simultaneous runway occupancies.

This project will investigate the application of current technologies to reduce the average ROT and its variability. Ideas to be examined include drift-off runways, elongated exits, dual-landing runways, and multiple runway occupancy (safety permitting). In addition, an investigation of new procedures for allowing simultaneous runway occupancy will survey technological and procedural methods for controlling such operations. A systems analysis will recommend ways to reduce runway occupancy times, their variability, and possible ways to permit simultaneous runway use.

3.1.2 METHODS OF REDUCING RUNAWAY OCCUPANCY TIME (ROT)

NEAR TERM											MID TERM 1996-2005	FAR TERM 2006-2015
85	86	87	88	89	90	91	92	93	94	95		
R&D												
		o——	——	——o	Research & Development							

SCHEDULE IMPLEMENTATION: IMTERMEDIATE

CAPACITY IMPROVEMENT POTENTIONAL: MEDIUM

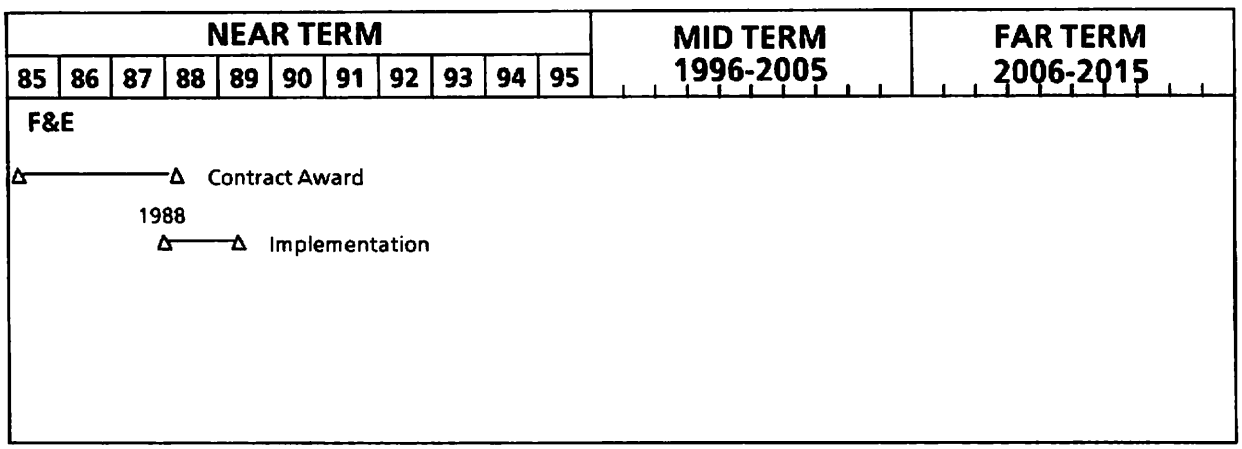
REFERENCE: RE&D 3.17, Airport Capacity Improvements.

3.2.1 AIRPORT SURFACE DETECTION EQUIPMENT (ASDE-3)

AIRPORT CAPACITY IMPROVEMENT IMPACT: **REDUCE DELAY BY SPEEDING UP THE ISSUANCE OF RUNWAY CLEARANCES FOR ARRIVALS AND DEPARTURES.**

The goal of this project is to improve the monitoring of aircraft and surface vehicle movement on airport surfaces during inclement weather conditions. The new ASDE-3 radar systems are expected to resolve some of the basic radar performance limitations of the existing ASDE-2 system, which has been in operation for 25 years. The ASDE radar reduces the time necessary to issue a runway clearance for an aircraft to land or depart by verifying that a runway is clear. This both reduces delay and increases safety. The radar operating frequency of ASDE-2 is characteristically absorbed and deflected by precipitation. The resulting cluttered plan view display makes the detection of surface vehicle movement more difficult. Improving the monitoring of such vehicle movement may result in an improvement in capacity under IFR conditions.

3.2.1 AIRPORT SURFACE DETECTION EQUIPMENT (ASDE-3)



SCHEDULED IMPLEMENTATION: INTERMEDIATE

CAPACITY IMPROVEMENT POTENTIAL: MEDIUM

REFERENCE: NAS Resume 4140 and NAS Plan Project IV-14, Airport Surface Detection Equipment (ASDE) - 3.

3.2.2 AIRPORT SURFACE SURVEILLANCE

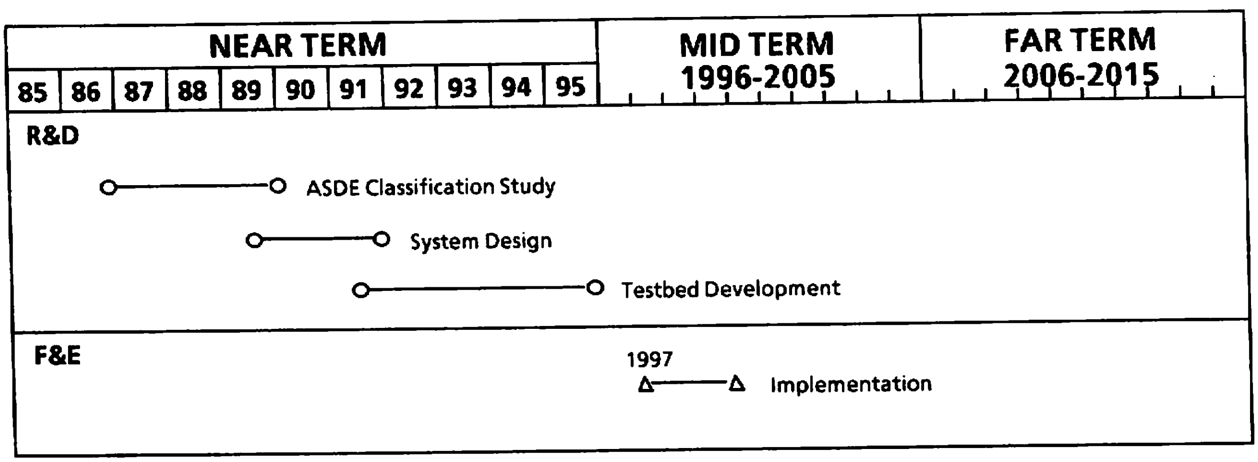
AIRPORT CAPACITY IMPROVEMENT IMPACT: **REDUCE DELAYS BY IMPROVING IDENTIFICATION OF AIRCRAFT ON TAXIWAYS AND RUNWAYS, ENABLING THEIR MOVEMENTS TO BE COORDINATED MORE EFFICIENTLY.**

During periods of low visibility, it is not always possible for the ground controller to see all of the runways and taxiways at major airports. Therefore, it is necessary to use a surveillance system which will detect an aircraft on a taxiway or runway and determine the identity of that aircraft. Current Airport Surface Detection Equipment (ASDE) radars have the capability to detect aircraft, but do not provide information on the identity of aircraft.

The goal of this project is to enhance the current ASDE system by providing identification tags on the controller's display panel, and to improve the overall reliability of ASDE radar. The project will involve integrating ASDE radar information with data received from the Mode S data link to improve both accuracy and reliability. At high-density airports, these improvements will reduce the heavy workload of air traffic controllers responsible for the movements of aircraft and ground vehicles.

This project will provide the surveillance component of the surface traffic automation system described in Project 3.1.1.

3.2.2 AIRPORT SURFACE SURVEILLANCE



SCHEDULED IMPLEMENTATION: INTERMEDIATE

CAPACITY IMPROVEMENT POTENTIAL: MEDIUM

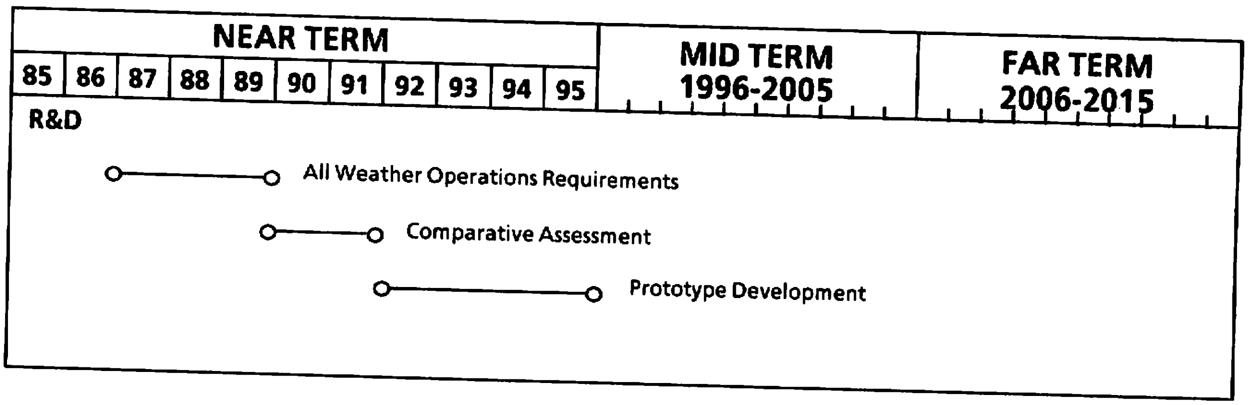
REFERENCE: RE&D 6.5, Airport Surface Surveillance

3.2.3 ALL-WEATHER TAXIWAY GUIDANCE

AIRPORT CAPACITY IMPROVEMENT IMPACT: **REDUCE DELAYS BY FACILITATING MORE EFFICIENT MOVEMENT OF AIRCRAFT ON AIRPORT SURFACES DURING PERIODS OF LOW VISIBILITY.**

The goal of this project is to provide surface guidance to support ground movements of aircraft and other vehicles in reduced or zero visibility. Alternate system concepts will be developed for guiding the aircraft during landing, taxiing, and takeoff in reduced or zero visibility conditions. Prototype equipment will be developed for limited operational evaluation of promising concepts. Based on the results of this testing and evaluation, operational guidelines and equipment design specifications will be published. This project offers capacity improvement and delay reduction benefits by supporting the airport surface traffic automation (ASTA) program. This project also is a component of the surface traffic management system described in Project 3.1.1.

3.2.3 ALL-WEATHER SURFACE GUIDANCE



SCHEDULED IMPLEMENTATION: LONG

CAPACITY IMPROVEMENT POTENTIAL: MEDIUM

REFERENCE: RE&D 10.3, All-Weather Taxiway Guidance.

3.2.4 PAVEMENT STRENGTH, DURABILITY, AND REPAIR

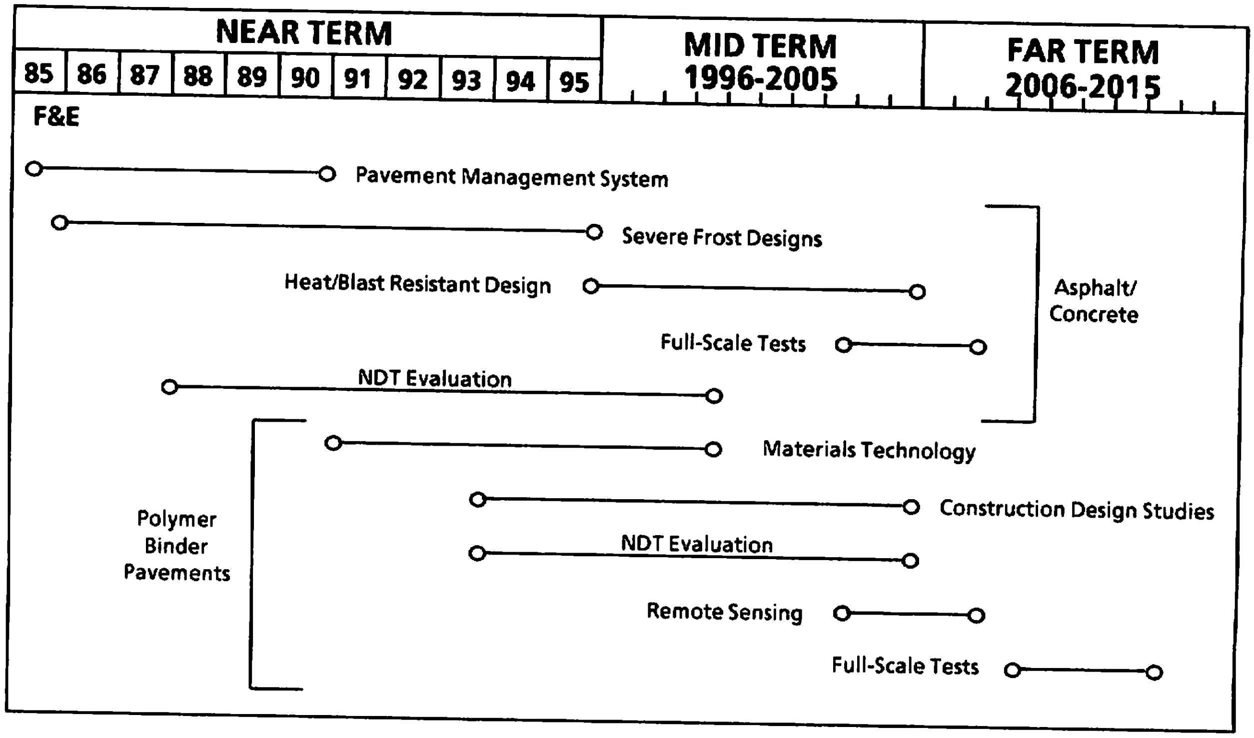
AIRPORT CAPACITY IMPROVEMENT IMPACT: **INCREASE CAPACITY BY DEVELOPING MORE DURABLE AIRPORT PAVEMENT MATERIALS, THUS INCREASING RUNWAY AVAILABILITY.**

The goal of this project is to develop new and cost-effective techniques to enhance the strength and durability of materials used as airport pavement components. These components must be strong enough to sustain repeated landings, insensitive to changes in temperature and moisture, and free from frost damage and thaw weakening. At major airports, runway repair activities may have a significant impact on capacity; therefore, methods to increase the durability of concrete and to reduce its susceptibility to damage from the environment and from traffic will increase runway availability. In parallel with the development of better pavement materials, improved analytical techniques for pavement design and evaluation will be formulated.

The characteristics of airport pavement materials are not well quantified, and the existing specifications and design criteria are only partially successful in assuring maximum pavement life. Design techniques that can accommodate various mixes of aircraft, climatic conditions, and subgrade conditions are needed. The FAA's participation in airport pavement construction has been confined to new construction, major reconstruction, and construction required for safety purposes, since the terms of AIP grants required the owner to maintain the pavement. Proper pavement management guidance is needed to better maintain the pavement and to delay the need for major reconstruction.

This project will pursue the development of advanced airport pavement designs and evaluations. New pavement design criteria for severe frost areas and runways with high traffic volumes (up to 200,000 departures) are needed. Advanced computer-based uniform design methods also will be developed to give pavement designers the option of selecting the design based on costs, pavement construction time, delays caused by the construction, and the functional requirements. The pavement evaluations for frost areas, high traffic volumes, and advanced computer-based design methods will rely on nondestructive testing involving dynamic or vibratory loadings.

3.2.4 PAVEMENT STRENGTH, DURABILITY, AND REPAIR



SCHEDULED IMPLEMENTATION: LONG

CAPACITY IMPROVEMENT POTENTIAL: UNDETERMINED

REFERENCE: RE&D 10.1, Pavement Strength, Durability, and Repair.

TABLE 5-5
CATEGORY 4: GENERAL CAPACITY - ENHANCEMENT RESEARCH AND DEVELOPMENT WITH LONGER-TERM GAINS

NUMBER		POTENTIAL	IMPLEMENTATION
4.1	LOW ALTITUDE SURVEILLANCE	MEDIUM	LONG
4.2	ENVIRONMENTAL PROGRAMS	LOW	ONGOING
4.3	ADVANCED CONCEPTS STUDIES	UNDET	ONGOING
4.4	NAS DEVELOPMENT STUDIES	UNDET	ONGOING

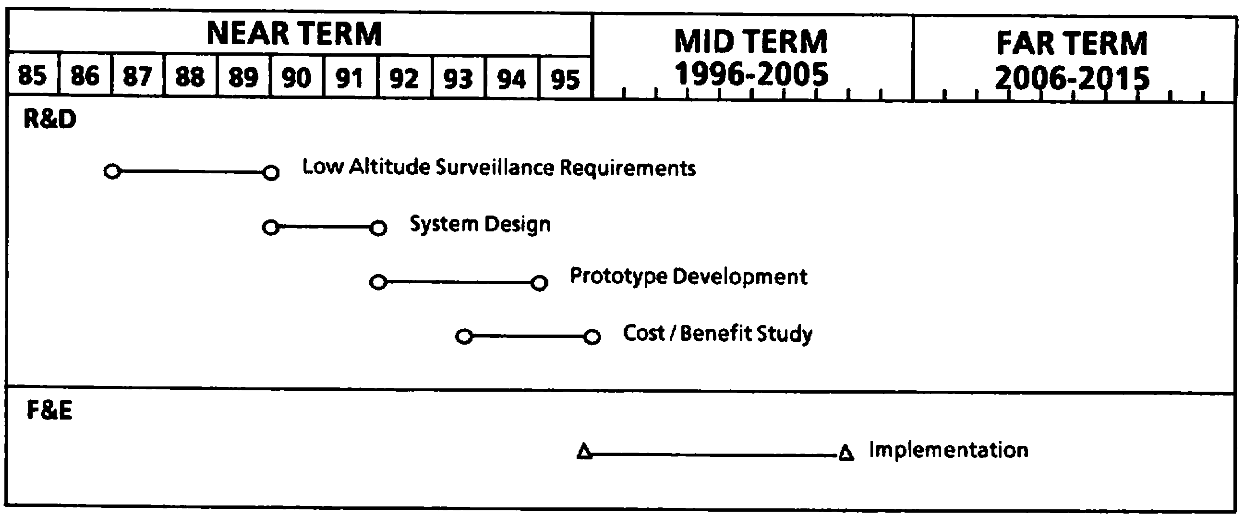
4.1 LOW ALTITUDE SURVEILLANCE

AIRPORT CAPACITY IMPROVEMENT IMPACT: **ENHANCE CAPACITY BY PROVIDING IMPROVED SEPARATION SERVICES FOR THE LOW ALTITUDE SYSTEM.**

The goal of this project is to provide surveillance of rotorcraft and fixed-wing aircraft at low altitudes in airspace that is not adequately covered by existing en route surveillance systems. Low altitude coverage is needed especially for heliports in high-density urban areas, off-shore operations, and certain remote areas. The ability to provide separation services will greatly increase the capacity of the low altitude system, which serves these aircraft.

The project will evaluate candidate systems to provide this coverage. Among the alternatives are LORAN-C Flight Following (LOFF) and Mode S- dependent surveillance techniques using on-board navigation equipment. Items which must be considered include the choice of frequencies, maximum range and altitude, type of aircraft, update rate, accuracy, and tracking accuracy needed to support the specific operations.

4.1 LOW ALTITUDE SURVEILLANCE



SCHEDULED IMPLEMENTATION: LONG

CAPACITY IMPROVEMENT POTENTIAL: MEDIUM

REFERENCE: RE&D 6.2, Low Altitude Surveillance.

4.2 ENVIRONMENTAL PROGRAMS

AIRPORT CAPACITY IMPROVEMENT IMPACT

IMPROVE PLANNING FOR INCREASING CAPACITY BY REDUCING ENVIRONMENT-RELATED CONSTRAINTS ON THE GROWTH OF THE NATIONAL AIR TRANSPORTATION SYSTEM

The goal of this project is to reduce environment-related constraints on the growth of the national air transportation system, especially on airport capacity, by developing the methods, technology and expertise to mitigate or control the environmental impacts of such growth. There is a continuing requirement to provide the aviation community and the general public with the most cost-effective and health-effective mix of aircraft/rotorcraft and airports/heliports. Efforts have focused on reducing the noise and pollution produced by air traffic. Aircraft noise has been reduced at the source through certification standards; the noisest aircraft (Stage I) were prohibited from operating at U.S. airports after December 31, 1985 (except by special time-limited exemption). Consideration is being given to further restricting the certification and operation of the next tier of aircraft in terms of noise emission (Stage II). Noise abatement operating procedures undertaken by air traffic control towers in cooperation with airport operators have further reduced aircraft noise in the vicinity of airports. Emission controls have been placed on aircraft engines in an effort to control pollution.

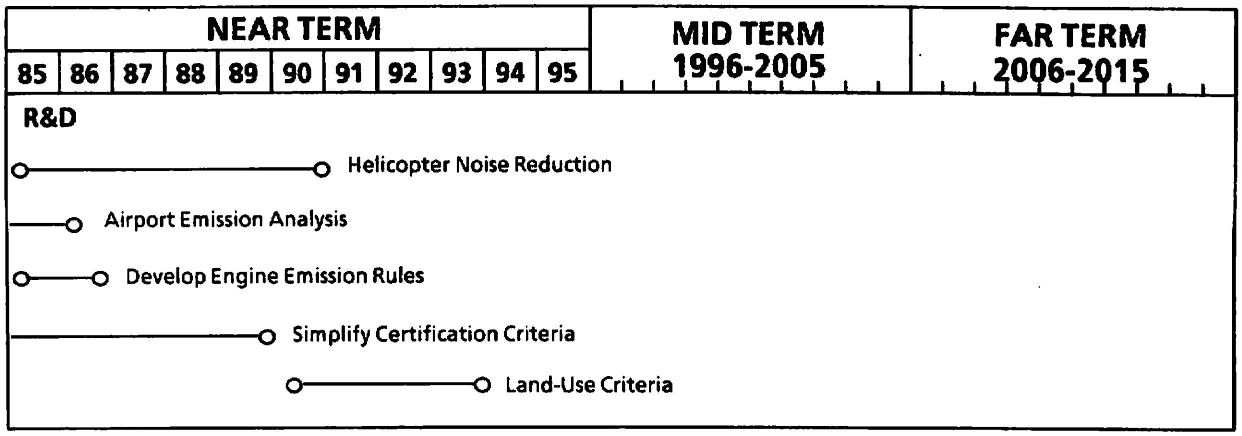
Rotorcraft noise and heliport compatibility efforts will include assessing the need for civil helicopter and heliport noise standards, and developing standards which are economically reasonable and technologically practicable. Airport noise and land-use compatibility efforts will include encouraging airport operators to undertake airport noise compatibility planning studies (as detailed in FAR Part 150). Airport noise exposure maps and noise compatability programs submitted by airport sponsors will be evaluated by the FAA. Further streamlining of the Part 150 process to expedite noise compatibility planning is under consideration.

Aircraft noise and sonic boom efforts will include developing and maintaining accurate information that defines the noise characteristics of current and projected aircraft, and determining the need for control of noise and sonic boom from these sources; developing and validating methods for predicting the noise generated by various aircraft components; working closely with NASA and industry to understand the current and projected state-of-the-art technology in aviation noise control and the costs associated with technology; and assessing the benefits and costs of simpler certification criteria.

In accordance with the Administrator's Airport Capacity Action Plan, the FAA produced a Notice of Proposed Policy on Airport Access and Capacity to solicit comments from the aviation industry on the Federal policy on airport access and airport capacity. The major goals are to ensure the provision of sufficient airport capacity to meet demand and to minimize *ad hoc* Federal involvement in local airport capacity issues.

Efforts also are underway to develop improved methods for predicting and assessing the impact of aircraft and helicopter noise, to improve the compatibility criteria for land users near noise-affected airports, to provide simpler aircraft noise certification procedures, to improve aircraft engine emission certification procedures, and to provide a model for analyzing pollution dispersion around airports.

4.2 ENVIRONMENTAL PROGRAMS



SCHEDULED IMPLEMENTATION: ONGOING

CAPACITY IMPROVEMENT POTENTIAL: LOW

REFERENCE: RE&D 11.6, Environmental Impact Studies.

4.3 ADVANCED CONCEPTS STUDIES

AIRPORT CAPACITY IMPROVEMENT IMPACT: **IMPROVE PLANNING FOR ACCOMMODATING ANTICIPATED FUTURE AIRCRAFT DEMAND AND TECHNOLOGIES.**

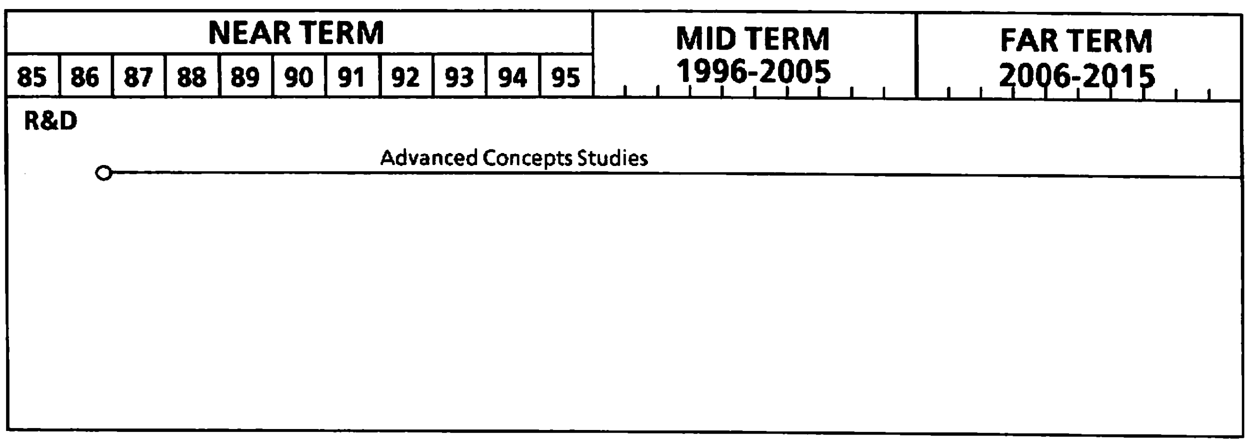
The goal of this project is to identify and explore advanced concepts for providing air traffic services and system capacity 25 years from now, when technologically-advanced vehicles will be operating in the National Airspace System (NAS), when the magnitude and nature of demand for aircraft operations may be dramatically different, and when a significant restructuring of services provided in the NAS may be necessary to adjust to the new requirements and new technologies available.

Requirements analyses will include consideration of changing demands for transportation as a result of population shifts, the evolving use of other modes of transportation, the extent to which other technologies (especially communications) may reduce the demand for some types of air travel, and the emergence of new vehicles in the NAS, including the supersonic and hypersonic (trans-atmospheric) aircraft.

New technologies to be considered for application in the NAS will include advanced cockpit traffic situation displays that may permit flight crews to better monitor and assure separation, advanced artificial intelligence applications, and opportunities to fully automate aircraft control for improved safety and increased airport capacity.

The products of this effort will include an assessment of requirements that can be expected in the year 2010, an assessment of the technologies applicable to these requirements, descriptions of advanced concepts for air traffic services, and recommendations for new research, engineering, and development projects to develop promising technologies and concepts.

4.3 ADVANCED CONCEPTS STUDIES



SCHEDULED IMPLEMENTATION: ONGOING

CAPACITY IMPROVEMENT POTENTIAL: UNDETERMINED

REFERENCE: RE&D 2.2, Advanced Concept Studies.

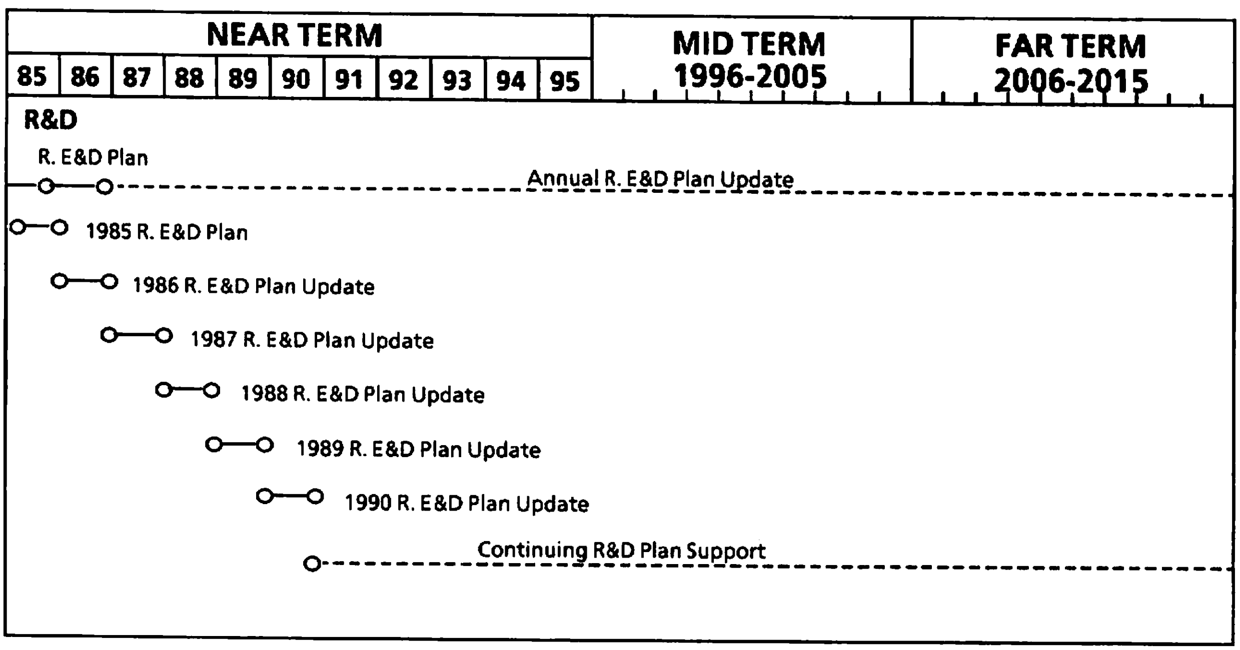
4.4 NAS DEVELOPMENT STUDIES

AIRPORT CAPACITY IMPROVEMENT IMPACT: **IMPROVE PLANNING FOR COPING WITH FUTURE DEMANDS ON THE NAS.**

The goal of this project is to develop and maintain a current plan for the evolution of the National Airspace System (NAS) over the next 25 years, including plans for the research, engineering, and development efforts that will support this evolution. Long-term change in the NAS will be determined by the demands placed on the system, by the technological and operational alternatives available for meeting these demands, and by the decision-making process that selects alternatives for development and implementation. So that a viable NAS can be provided in the future, a formal methodology will be established that includes the following activities:

- NAS performance assessment;
- Demand analysis;
- Requirements definition;
- Assessment of NAS development plans;
- Technological and operational assessment of development alternatives;
- Cost/benefit analysis;
- Anticipated impacts of proposed NAS evolution;
- Current research, engineering, and development plan;
- Research, engineering, and development facility requirements; and
- Aviation community consultation.

4.4 NAS DEVELOPMENT STUDIES



SCHEDULED IMPLEMENTATION: ONGOING

CAPACITY IMPROVEMENT POTENTIAL: UNDETERMINED

REFERENCE: RE&D 2.1, NAS Development Studies.

APPENDIX A: TABLES FOR SECTION 1.0

TABLE A-1 AIRPORT AND HUB CLASSIFICATIONS

Airport Classifications:

The Federal Aviation Administration classifies airports for Federal purposes as:

1. Primary -- Public-use commercial service airports enplaning at least 0.01 percent of all passengers enplaned annually at U.S. airports or approximately 34,000 enplanements in 1984. 280 airports are included in this category.

2. Commercial Service -- Other non-primary public-use airports receiving scheduled passenger service and enplaning at least 2,500 passengers annually. There are 280 airports in this category.

3. General Aviation -- Those airports with fewer than 2,500 annual enplaned passengers and those used exclusively by private and business aircraft not providing common-carrier passenger service. More than 2,400 airports fall into this category.

4. Reliever -- Airports that relieve congestion at primary airports and provide more access for general aviation traffic. This category includes 227 airports.

Hub Classifications:

The FAA classifies Standard Metropolitan Statistical Areas by the level of passenger traffic. Metropolitan areas are referred to as hubs and are divided into four classes according to the number of passengers enplaned in the hub:

1. Large -- Enplaning one percent or more of total annual U.S. enplaned passengers. (Approximately 3,400,000 enplanements in 1984.)

2. Medium -- Enplaning 0.25 to 0.99 percent of total annual U.S. enplaned passengers.

3. Small -- Enplaning 0.05 to 0.24 percent of total annual U.S. enplaned passengers.

4. Non-hub -- Enplaning less than 0.05 percent of total annual U.S. enplaned passengers.

TABLE A-2 TOP 50 AIRPORTS RANKED BY 1983 TOTAL PASSENGER ENPLANEMENTS

Rank	Airport	Total Enplanements[1] (000)	Percent of Total	Cumulative Percent
1.	Chicago O'Hare	19,116	5.8	5.8
2.	Atlanta	18,811	5.7	11.5
3.	Los Angeles Int'l	15,991	4.9	16.4
4.	New York Kennedy	13,240	4.0	20.4
5.	Dallas-Fort Worth	12,861	3.9	24.3
6.	Denver	11,936	3.6	27.9
7.	San Francisco Int'l	10,364	3.2	31.1
8.	Miami	9,153	2.8	33.9
9.	New York LaGuardia	9,076	2.8	36.7
10.	Boston	8,617	2.6	39.3
11.	St. Louis Int'l	7,626	2.3	41.6
12.	Newark	7,584	2.3	43.9
13.	Honolulu	7,193	2.2	46.1
14.	Washington National	6,805	2.1	48.2
15.	Houston Continental	6,402	2.0	50.2
16.	Minneapolis	5,909	1.8	52.0
17.	Pittsburgh	5,644	1.7	53.7
18.	Seattle-Tacoma	5,272	1.6	55.3
19.	Detroit	5,075	1.6	56.9
20.	Las Vegas	4,809	1.5	58.4
21.	Phoenix	4,675	1.4	59.8
22.	Philadelphia	4,544	1.4	61.2
23.	Tampa	3,838	1.2	62.4
24.	Orlando	3,767	1.2	63.6
25.	Charlotte	3,572	1.1	64.7
26.	Salt Lake City	3,318	1.0	65.7
27.	San Diego	3,113	1.0	66.7
28.	New Orleans	3,063	0.9	67.6
29.	Dallas Love Field	2,930	0.9	68.5
30.	Cleveland	2,745	0.8	69.3
31.	Houston Hobby	2,713	0.8	70.1
32.	Ft. Lauderdale	2,632	0.8	70.9
33.	Baltimore	2,606	0.8	71.7
34.	Kansas City	2,428	0.7	72.4
35.	Memphis	2,413	0.7	73.1
36.	San Juan	2,408	0.7	73.8
37.	Portland	2,169	0.7	74.5
38.	San Antonio	1,867	0.6	75.1
39.	Cincinnati	1,838	0.6	75.7
40.	Palm Beach	1,793	0.5	76.2
41.	San Jose	1,710	0.5	76.7
42.	Buffalo	1,692	0.5	77.2
43.	Kahului	1,668	0.5	77.7
44.	Milwaukee	1,506	0.5	78.2
45.	Oakland	1,467	0.4	78.6
46.	Columbus	1,461	0.4	79.0
47.	Albuquerque	1,445	0.4	79.4
48.	Windsor Locks	1,440	0.4	79.8
49.	Burbank	1,425	0.4	80.2
50.	Indianapolis	1,423	0.4	80.6

[1]Includes U.S. certificated route air carriers, foreign flag carriers, supplementals, air commuters, and air taxis.
[2]Based on 339 million passenger enplanements at 60 airports with 2,500 or more enplanements in FY 1983.

Source: FAA Terminal Area Forecasts FY 84-95.

TABLE A-3 TOP 50 TOWERED AIRPORTS RANKED BY 1983 TOTAL AIRCRAFT OPERATIONS

Rank	Airport	Total Operations[1] (000)	Percent of Total	Cumulative Percent
1.	Chicago O'Hare	650.3	1.2	1.2
2.	Atlanta	599.5	1.1	2.3
3.	Los Angeles Int'l	498.1	0.9	3.2
4.	Van Nuys	485.7	0.9	4.1
5.	Denver Stapleton	466.8	0.9	5.0
6.	Santa Ana	453.4	0.9	5.9
7.	Dallas-Fort Worth	426.8	0.8	6.7
8.	Long Beach	417.3	0.8	7.5
9.	Seattle Boeing Field	390.9	0.7	8.2
10.	Oakland	360.6	0.7	8.9
11.	Denver Arapahoe	355.6	0.7	9.6
12.	San Francisco	349.0	0.7	10.3
13.	St. Louis Lambert	343.3	0.6	10.9
14.	New York Kennedy	342.1	0.6	11.5
15.	Phoenix Sky Harbor	341.2	0.6	12.1
16.	Miami Int'l	341.2	0.6	12.7
17.	New York LaGuardia	340.4	0.6	13.3
18.	Boston	340.3	0.6	13.9
19.	Anchorage Merrill Field	331.3	0.6	14.5
20.	Houston Intercontinental	330.9	0.6	15.1
21.	Washington National	327.4	0.6	15.7
22.	Honolulu	326.7	0.6	16.3
23.	Philadelphia	321.4	0.6	16.9
24.	San Jose	316.9	0.6	17.5
25.	Pittsburgh	315.0	0.6	18.1
26.	Ft. Worth Meachan	312.8	0.6	18.7
27.	Houston Hobby	309.8	0.6	19.3
28.	Miami Tamiami	305.2	0.6	19.9
29.	Dallas Love Field	302.1	0.6	20.5
30.	Minneapolis	300.3	0.6	21.1
31.	Las Vegas	297.2	0.6	21.7
32.	Memphis	292.5	0.5	22.2
33.	Teterboro	286.2	0.5	22.7
34.	Oakland	285.9	0.5	23.2
35.	Charlotte	280.7	0.5	23.7
36.	Salt Lake City	273.1	0.5	24.2
37.	Tampa	272.1	0.5	24.7
38.	Detroit Metropolitan	271.4	0.5	25.2
39.	Torrance	270.1	0.5	26.7
40.	Newark	263.9	0.5	26.2
41.	Caldwell	263.6	0.5	26.7
42.	Hayward	249.1	0.5	27.2
43.	Phoenix Deer Valley	243.8	0.5	27.7
44.	Baltimore	239.1	0.4	28.1
45.	Miami Opa Locka	239.0	0.4	28.5
46.	Ft. Lauderdale Hollywood	236.4	0.4	28.9
47.	Tucson	234.0	0.4	29.3
48.	Columbus	230.7	0.4	29.7
49.	Islip MacArthur	220.5	0.4	30.1
50.	West Palm Beach	220.5	0.4	30.5

[1] Based on 53 million aircraft operations recorded at 392 FAA-operated airport traffic control towers in FY 1983.

Source: FAA Terminal Area Forecasts FY 84-95.

TABLE B-1 SDRS: MAJOR AIRPORTS AND AIRLINES

	Airports	Airlines Reporting
1.	Atlanta, Hartsfield Intl.	EAL
2.	Boston, Logan Intl.	EAL, (UAL), AAL
3.	Baltimore/Washington Intl.	EAL, (UAL), (AAL)
4.	Charleston, S.C. Intl.	(EAL)
5.	Cleveland, Hopkins Intl.	(EAL), UAL, (AAL)
6.	Covington/Cincinnati Intl.	(AAL)
7.	Washington National	EAL, (UAL), AAL
8.	Denver, Stapleton Intl.	(EAL), UAL
9.	Dallas/Ft. Worth Regional	(EAL), AAL
10.	Detroit/Wayne County	(EAL), UAL, AAL
11.	Newark Intl.	EAL, (UAL), (AAL)
12.	Honolulu Intl.	(UAL)
13.	Washington, Dulles Intl.	(EAL), (UAL), (AAL)
14.	Houston Intercontinental	(EAL), (AAL)
15.	Indianapolis Intl.	(EAL), (AAL)
16.	Jacksonville Intl.	(EAL)
17.	New York Kennedy Intl.	EAL, UAL, AAL
18.	Los Angeles Intl.	(EAL), UAL, AAL
19.	New York, LaGuardia	EAL, (UAL), AAL
20.	Memphis Intl.	(UAL), (AAL)
21.	Miami Intl.	EAL, (UAL), (AAL)
22.	Minneapolis-St. Paul Intl.	(EAL), (UAL)
23.	New Orleans, Moisant Intl.	(EAL), (AAL)
24.	Chicago, O'Hare Intl.	(EAL), UAL, AAL
25.	Philadelphia Intl.	EAL, (UAL), (AAL)
26.	Phoenix Sky Harbor Intl.	(EAL), (UAL), AAL
27.	Greater Pittsburgh Intl.	(EAL), UAL, (AAL)
28.	Raleigh/Durham	(EAL), (UAL)
29.	Seattle-Tacoma Intl.	(EAL), UAL, AAL
30.	San Francisco Intl.	(EAL), UAL, AAL
31.	St. Louis, Lambert Intl.	(EAL) AAL
32.	Tampa Intl.	EAL, (UAL), (AAL)
33.	Total System	EAL, UAL, AAL

Note:

- o Parentheses indicate less than 35 operations per day.
- o Information on other, smaller airports served by one or more of the three carriers is aggregated and reported in a category designated "Other."
- o Detail for the carriers entire system also is provided.
- o Delays are measured against standard ground times and computer-projected flight times.

TABLE B-2 DETAIL ON CONSTRUCTION OF DELAY COST ESTIMATE

Costs of Delay to Aircraft

The cost of delay varies according to the phase of flight in which it occurs, with airborne delays being considerably more costly than delays taken on the ground. SDRS carriers regularly report their ground and airborne operating costs, and the average cost per hour of delay is derived by weighting the two delay cost categories according to the proportions in which they occur. In 1984, 75 percent of all SDRS delay was taken on the ground and the average hourly cost of delay was $1,642. Multiplying this by the number of delay hours encountered in 1984 results in a total annual cost of $2,023 billion. Table 2-9 presents comparable figures for 1982 and 1983. From 1982 to 1984, the total cost of delay to aircraft has risen more than $500 million, despite a decline in aircraft hourly operating costs.

Cost of Delay to Passengers

Based on the average plane size and load factor, the FAA estimates that passengers lost more than 117 million hours as a result of airport delay in 1984, a 62 percent increase from 1982. The dollar cost of passenger delay can be calculated using FAA estimates of the value of passenger time. Table 2-9 gives figures on passenger delay costs and on the total cost of delay for 1982 and 1984.

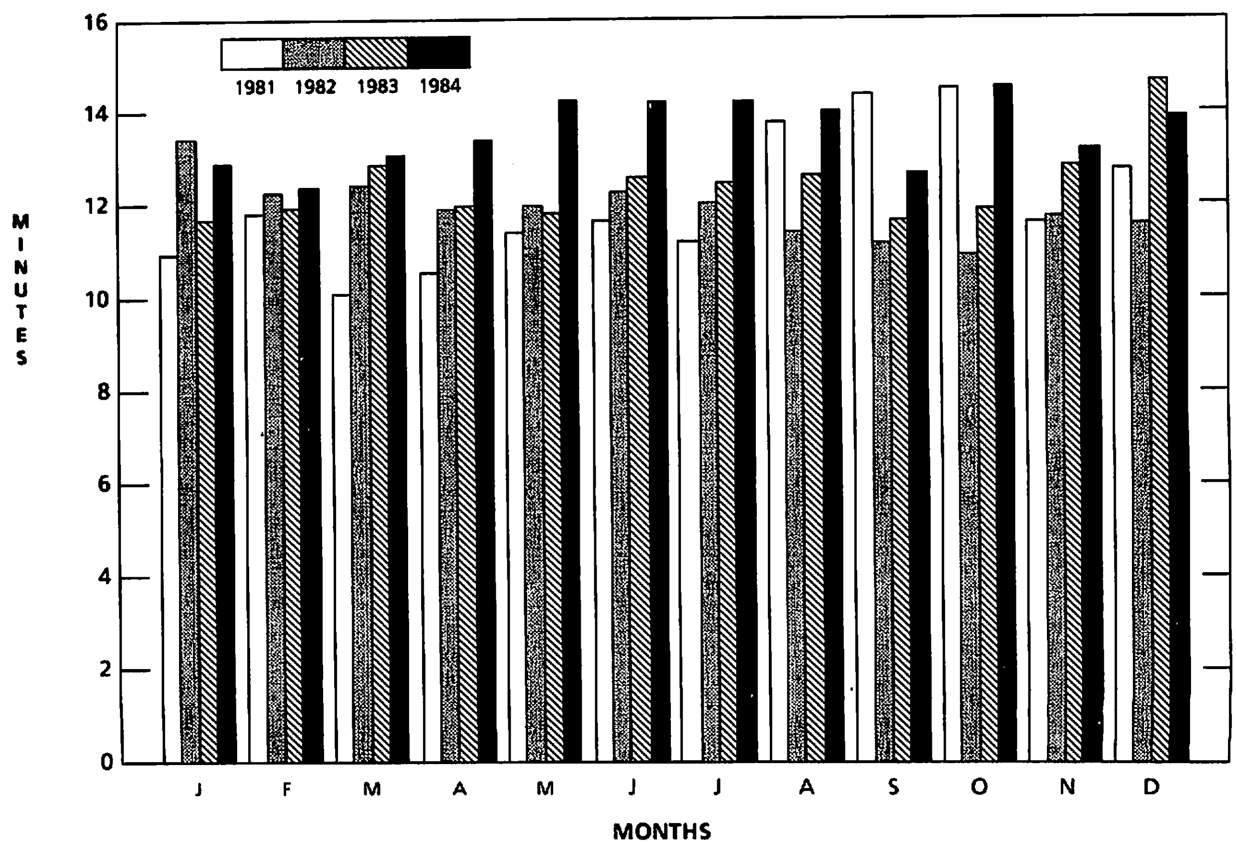


FIGURE B-1 SDRS REPORTED AVERAGE DELAY PER FLIGHT

APPENDIX C: EXAMPLES OF AIR TRAFFIC SYSTEM CAPACITY IMPROVEMENTS

AIR TRAFFIC SYSTEM CAPACITY IMPROVEMENTS

Traffic management is the balancing of air traffic demand with system capacity, to ensure maximum efficiency in utilization of total airspace, thereby producing a safe, orderly, and expeditious flow of traffic while minimizing delays.

The primary method of traffic management at the beginning of fiscal year 1985 was Expanded Quota Flow (EQF). EQF is a computerized program designed to limit the number of arrivals into a specific airport by assigning ground delays to flights destined to the affected airport. In addition, the original landing sequence, contained in the Central Flow Control data base, was preserved. The program in essence moved aircraft scheduled in one 15 minute block to a less busy 15 minute block. This reduced the controller workload, but did not ensure equitable delays to system users. This program was generally used to manage traffic at airports with reduced capacities due to constraints caused by weather, airport construction, accidents, or equipment outages.

In May 1985, the EQF program was enhanced and the Controlled Departure Time (CDT) program evolved. The CDT program provided a more accurate traffic flow and reduced inequities in the delays received. The CDT program assigned each flight a specific delay, rather than assigning the same delay to all flights scheduled to arrive within the same 15 minute block. The CDT program is an advanced automation program in which the Central Flow Control Facility (CFCF) specialist also uses the computer to transmit the information to affected air traffic facilities and system users.

To better manage the en route flows of air traffic during the severe thunderstorm season, a program entitled "Cluster Control" was implemented in June 1985. Cluster Control utilizes long range weather forecasts and early weather tracking, which allows for earlier planning and redistribution of traffic flows, resulting in greater system efficiency and reduced delays.

The CDT program was enhanced in November 1985, to allow for further reductions in system delays. The selective CDT program provided more efficiency by assigning delays to flights arriving via a specific route. These flights are moved from a high demand period to a period of lesser demand, but the assigned delays seldom exceed 25 minutes. The selective CDT program provides the flexibility to manage air traffic on a single arrival route, when the situation dictates, without impacting other arrival traffic.

In addition to the national programs administered by CFCF, Traffic Management Units at the 20 domestic ARTCCs administer local traffic management programs. These programs assist controllers in balancing traffic flows within sector/facility capacities, assure the efficient use of airspace, expedite traffic, and reduce user costs by reducing airborne delays. These programs are described as follows:

<u>Arrival Sequencing Program (ASP)</u> -- This program, formerly called En Route Metering (ERM), is a method of time regulating traffic into a terminal area so as not to exceed the airport's capacity. This automated program is in use at 11 ARTCCs. Traffic Management Coordinators (TMC) routinely use the program for volume/delay predictions and fix loading/balancing activities. Timed metering is initiated only when the demand, exceeding the airports capacity, cannot be relieved by fix loading/balancing techniques. Benefits: Airport saturation is avoided, controller workload is reduced, and Airborne delays at low altitudes are reduced (delays are taken at altitude while en route by utilizing speed control and radar vectors).

<u>En Route Spacing Program (ESP)</u> -- This program was initially implemented to enhance safety by reducing the sector controller's preoccupation with miles-in-trail (MIT) restrictions. TMCs monitor designates traffic flows and sectors to determine when peaking and bunching will occur, and applies appropriate spacing. Manipulation of the traffic is accomplished by coordination between TMC's and sector controllers, and adjacent facilities. ESP is operational in 16 centers, and will be expanded

En Route Spacing Program (ESP) -- This program was initially implemented to enhance safety by reducing the sector controller's preoccupation with miles-in-trail (MIT) restrictions. TMCs monitor designates traffic flows and sectors to determine when peaking and bunching will occur, and applies appropriate spacing. Manipulation of the traffic is accomplished by coordination between TMC's and sector controllers, and adjacent facilities. ESP is operational in 16 centers, and will be expanded to include the remaining centers as equipment and operational requirements are met. ESP, as currently practiced, is a manual operation; however, the program will be automated in the first HOST computer update. Benefits: Traffic flows are smoother, controller and pilot workload is reduced, en route delays are reduced, and MIT restrictions have been substantially reduced.

Departure Sequencing Program (DSP) -- DSP, as currently practiced, is a manual operation; however, an automated program is currently undergoing operational testing at Los Angeles Center. Departure volume at selected airports is monitored so that continuous information is available to TMCs. Departing aircraft are sequenced into the en route traffic flows -- DSP is interdependent with ESP. Benefits: TMCs can plan traffic flows and take alternative actions to reduce both controller workload and departure delays.

EXAMPLES OF ESTIMATED MLS CAPACITY IMPROVEMENTS

The MITRE Corporation

1. Airport: John F. Kennedy International - New York (JFK)
   Runway: 13R

   Installing an MLS on runway 13R may allow converging operations to runways 13R and 22L with a decision height of 550 feet. This would result in an IFR arrival capacity increase of approximately 25 aircraft per hour (100% increase).

2. Airport: Newark International - (EWR)
   Runway: 11

   Installing an MLS on runway 11 may allow converging operations to runways 11 and 4R with a decision height of 700 feet. This would result in an IFR arrival capacity increase of approximately 25 aircraft per hour (100% increase).

3. Airport: Kansas City International - (MCI)
   Runway: 27

   Installing an MLS on runway 27 may allow converging operations to runways 27 and 19 with a decision height of 550 feet. This would result in an IFR arrival capacity increase of approximately 27 aircraft per hour (100% increase).

Alternative airports that would benefit from an initial MLS installation are (runways do not have precision guidance, MLS would allow converging operations):

Airport	MLS on Runway	Converging Runways	Decision Height (ft.)
Cleveland (CLE)	10L	10L, 5R	950
New Orleans (MSY)	19	19, 10	750
San Antonio (SAT)	21	21, 12R	800

(PRELIMINARY STATISTICS)

SELECT AIRPORT OPERATIONS
1985 VS 1984

AIRPORT	1984 OPNS	1985 OPNS	PERCENT 1984 OPERATIONS
Atlanta	689483	755426	110
Boston-Logan	387422	408345	105
Chicago-O'Hare	741296	769166	104
Cleveland-Hopkins	241027	225051	93
Dallas/Ft. Worth	524564	561679	107
Denver/Stapleton	517520	492128	95
Detroit Metropolitan	326269	380086	116
Fort Lauderdale	239797	226005	94
Houston Intercntl	328382	314797	96
Kansas City Intl	198275	193257	97
Las Vegas-Mc Carran	296684	316749	107
Los Angeles Intl	550756	545903	99
Miami International	352585	329299	93
Minneapolis Intl	337838	372770	110
LaGuardia	365118	367896	101
John F. Kennedy	356647	338981	95
Newark International	369990	403856	109
Greater Pittsburgh	355632	362621	102
Philadelphia Intl	344769	355183	103
St. Louis-Lambert	395906	427712	108
San Francisco Intl	404900	401877	99
Washington National	340682	328209	96
	8,665,542	8,876,996	102.4

Note: Statistics for 1984 and January through August 1985 were obtained frm AMS official records. Those for September through December 1985 are NAPRS.

FAA REGION PROGRAM - AIRPORT CAPACITY EXAMPLES

Eastern Region

A. Physical Improvements at Eastern Region Airports

Priority of improvements at Eastern Region Airports are currently determined by Airports Division through a revitalized program of Joint Planning Conferences. Joint Planning Conferences (JPC) consider improvements suggested by the airport owner, ATA, individual airlines, Air Traffic Division, Airway Facilities Division, and other interested parties. The product of a Joint Planning Conference is a 3 to 5 year program of improvements to be accomplished with funding from the Airport Improvement Program (AIP) and a revised Airport Layout Plan (ALP). Increased priority has been given to capacity improvements in the Eastern Region by:

- Joint Planning Conferences at the major airports;
- Capacity Task Force efforts (Newark completed, JFK/LGA in progress, Ph1 planned for 1986.

B. Improvements to the Airspace Structure

- The expanded East Coast Plan. A Preliminary Report was issued in November 1985. The plan is currently being reviewed with particular emphasis on the prerequisites for implementation.
- Airspace Simulation Model (SIMMOD). A team has been formed to validate an airspace simulation model intended to be used as a tool for evaluation of potential changes in the New York terminal airspace.

C. Improved Traffic Management

- Traffic Management Units (TMU). The TMUs in the TRACON and NY Center have been equipped with Apollo Computers; the major Towers will be similarily equipped in the Spring of '86.
- Departure Flow Management (DFM). Departure Flow Management is an attempt to assist Air Traffic Control through automation to smooth the flow of Departure Traffic from the three NY Airports and satellites through the Departure fixes by pre-computing takeoff time for each flight.
- Improved Communication with Users.
    - A daily briefing of users to share Traffic Management information and strategies for the day.
    - An Eastern Region FAA/Industry Working Group which looks for the root causes of delay problems and their solutions.

- Other Specific Efforts

  - Newark 2 1/2 Longitudinal Mile Spacing Study. The benefits are being quantified in the LGA/JFK Task Force Study.

  - Simultaneous LGA ILS Runway 22 & JFK ILS Runway 13L. Developed a missed approach at LGA that we believe can permit simultaneous approaches. Proposal is currently being reviewed by Air Traffic and Flight standards.

  - MLS. Potential uses of MLS in the JFK-LGA capacity/delay task force at the New York airports.

D. Demand Management

- The primary effort to manage demand in the Eastern Region is the reliever program which diverts general aviation demand from the air carrier airports.

- Another Eastern Region effort involves the study of the potential of new technology rotortcraft for intercity travel.

E. Other Ancilliary Efforts

- Improved Reporting of Activity and Delay. Working with Air Traffic Division to standardize reporting of activity and delay.

Great Lakes Region

Chicago - O'Hare International Airport

Chicago, Illinois

A. Capacity - Related AIP Projects - placed under grant during the past 2 Fiscal years: — Federal Share

1. -04 Project FY-85:

   a. Relocate glide slope antenna on Runway 9R for construction of future parallel taxiway. — $ 35,000

   b. Relocate localizer antenna, glide slope antenna, RVR, middle marker, approach light system, and RTR for future Runway 32L extension. — 1,207,225

2. -05 Project FY-85:

   a. Relocate localizer antenna, glide slope antenna, RVR, approach light system and middle marker for future extension of Runway 27R. — 656,040

   b. Install touch-down zone lights on Runway 9R and Runway 27L ends. — 375,000

B. Capacity - Related AIP Projects - proposed for funding during the 3 Fiscal years:

1. FY-87: Extend Runway 27R, including taxiway and blast pad — 3,069,129

2. FY-88: Construct second taxiway bridge. — 11,910,878

C. Capacity - Related F&E Projects:

	PROJECT	RUNWAY	REMARKS
1.	Establish MLS	09R	Change request from RW due to equipment Cat III retrofit cost - est. comm. summer 1987
2.	Establish RVR	04R	May be in "gap filler" RVR equip buy
3.	Establish RVR	22R	May be in "gap filler" RVR equip buy
4.	Establish RVR (Cat III)	14L	Equipment not available until 1988

Minneapolis-St. Paul International/Wold Chamberlain Airport

Minneapolis, Minnesota

A. Capacity - Related AIP Projects - placed under grant during the past 2 Fiscal years: — Federal Share

1. -03 Project FY-84:
   Reconstruct 35,000 square yards and construct 85,000 square yards of Pier "A" apron. — $4,137,816

2. -05 Project FY-85:
   Stage construct 74,000 square yards of apron for new international terminal and interim aircraft parking apron. — 2,515,250

3. -06 Project FY-85:
   Construct southern addition to main terminal building. — 2,953,000 (4, 499,165 multi-year potential)

4. -08 Project FY-85:
   Construct partial parallel taxiway for Runway 4-22. — 1,008,750

B. Capacity - Related AIP Projects - proposed for funding during the next 3 Fiscal years:

1. FY-86/87:
   a. Realign Taxiway "E" — 565,000
   b. Pave Pier "D" island — 860,000
   c. Rehabilitate Runway R-22 — 7,500,000

2. FY-87/88:

   Extend Runway 4-22. — 5,250,000

NOTE: $8,424,830 committed to St. Paul Downtown-Holman Field. $3-4 million still needed. Will enhance system capacity.

C. Capacity-Related F&E Projects:

	PROJECT	RUNWAY	REMARKS
1.	Establish MLS	11L	Change requested from RW 29L due to equipment CAT III retrofit cost est comm. 1988
2.	Establish MLS	29L	Opposite of top entry above FY-87 budget (as of 9-85)

NOTE: No FY-86 or FY-88 projects for capacity expansion.

D. Capacity - Related Air Traffic Control Initiatives:

1. Implementation of a Traffic Management Unit.
2. Application of Departure Metering.

Detroit Metropolitan Wayne County Airport

Detroit, Michigan

			Federal Share
A.	Capacity - Related AIP Projects - placed under grant during the past 2 Fiscal years:		
	1.	-03 Project FY-84: Reconstruct terminal apron gate positions for larger aircraft.	$ 230,000
	2.	-04 Project FY-85:	
		a. Reconstruct terminal apron gate positions for larger aircraft	496,000
		b. Widen fillets at a couple of taxiways	13,000
B.	Capacity - Related AIP Projects - proposed for funding during the next 3 Fiscal years:		
	1.	FY-86: Master Plan update and FAR Part 150 study	670,000
	2.	FY-86/87:	
		a. Construct holding apron and taxiway for Runway 21C	5,203,000
		b. Extend partial taxiway (second parallel to Runway 3L-21R)	1,461,000
		c. Reconstruct terminal apron gate positions for larger aircraft	861,000
		d. Construct high-speed taxiway exit on Runway 21R	616,000
		e. Construct taxiway connector from Runway 3R to the southeastern general aviation area	1,147,000
		f. Construct holding apron for Runway 3R	1,651,000
		g. Extend Taxiway "P" connector	588,000
		h. Construct holding apron for Runway 9	1,065,000
	3.	FY-86 through 88 Construct moving sidewalk	not known

4.	FY-87: Construct Terminal Finger "H"	Federal Share not known
5.	FY-87/88:	Federal Share
a.	Construct Terminal Finger "H" apron (adjacent to south end of International Terminal)	4,500,000
b.	Construct Terminal Finger "G" apron (to replace temporary apron installed by Republic in 1985 (Non-AIP)	4,330,000
c.	Construct holding apron for Runway 21L	1,000,000
d.	Reconstruct terminal apron gate positions for larger aircraft	625,000
e.	Improve entrance (and service) roads	1,200,000
f.	Construct Terminal Finger "G" (to replace temporary Terminal Finger "G" installed by Republic)	not known
g.	Expand automobile parking (and improve roads)	not known

C. Capacity - Related F&E Projects:

	PROJECT	RUNWAY	REMARKS
1.	Establish MLS	03R	Change requested from RW 4R due to equipment Cat III retrofit cost - est comm. summer 1987
2.	Establish RVR (CAT III)	03L	Equipment not available until 1988
3.	Establish MLS	21L	FY-87 Budget (as of 9-85)

NOTE: No FY-86 or FY-88 projects for capacity expansion.

D. Capacity - Related Air Traffic Control Initiatives:

1. Additional physical radar positions. (1 feeder + 2 departure positions).
2. Segregations of satellite departure and arrival traffic from Metro traffic.
3. Improved arrival metering.
4. Simultaneous approaches to Runways 3R/L and 21R/L.
5. Implementation of a Traffic Management Unit.
6. Application of Departure Metering.

Cleveland Hopkins International Airport

Cleveland, Ohio

A. Capacity - Related AIP Projects - placed under grant during the past 2 Fiscal years: **Federal Share**

1. -08 Project FY-85:
   Construct Taxiway "Q" — $2,062,000

2. -09 Project FY-85/86:
   Construct ATCT — 3,100,000

B. Capacity - Related AIP Projects - proposed for funding during the next 3 Fiscal years:

FY-87/88:
Relocate Taxiway "L" — 3,705,000

C. Capacity - Related F&E Projects:

	PROJECT	RUNWAY	REMARKS
1.	Establish MLS	05R	Est comm 1988

NOTE: No FY-86, FY-87, or FY-88 projects for capacity expansion.

D. Capacity - Related Air Traffic Control Initiatives:

None

Indianapolis International Airport

Indianapolis, Indiana

A. Capacity - Related AIP Projects - placed under grant during the past 2 Fiscal years: — Federal Share

None

B. Capacity - Related AIP Projects - proposed for funding during the next 3 Fiscal years:

FY-86 through 88:
Construct new Runway 4R-22L with parallel taxiway and connectors. — $24,760,610

C. Capacity - Related F&E Projects:

	PROJECT	RUNWAY	REMARKS
1.	Establish MLS	22R	Change requested from RW 4R due to equipment CAT III retrofit cost - est comm. summer 1987
2.	Establish RVR	13	Equipment not available until 1988
3.	Establish MLS	04L	Opposite of top entry above-FY-87 budget (as of 9-85)

NOTE: No FY-86 or FY-88 projects for capacity expansion.

D. Capacity - Related Air Traffic Control Initiatives:

Reduced coordination procedures for cross runway departures.

Airport	Year	Project No.	Type of Environment
*Anchorage International	1978	ADAP-12	Air Carrier North Parking Apron
*Anchorage International	1984	AIP-01	Remote Air Carrier Refueling Apron
Merrill Field (Anchorage)	1979	ADAP-05	Taxiways and Aprons
Merrill Field (Anchorage)	1982	AIP-01	Taxiways and Aprons
Merrill Field (Anchorage)	1984	AIP-03	Apron
*Merrill Field (Anchorage)	1985	AIP-05	Apron
*Wiley Post/Will Rogers Memorial (Barrow)	1984	AIP-01	Apron
*Bethel	1979	ADAP-07	Apron & Taxiway
*Deadhorse	1984	AIP-01	Parallel Taxiway & Apron
*Dillingham	1980	AIP-03	Air Carrier Apron General Aviation Apron & Taxiway
*Fairbanks International	1981	ADAP-08	Air Carrier Apron General Aviation Apron
Fort Yukon	1980	ADAP-01	Apron
Galena	1982	AIP-01	Apron
*Goose Bay	1985	AIP-01	Reconstruct Airport for Public Use to Relieve Merrill Field Training Operations Congestion
Gulkana	1984	AIP-01	Apron
Harris Harbor Seaplane Float	1983	AIP-01	Seaplane Float Reconstruction and Expansion

AIRPORT DEVELOPMENT

Projects Which Have Improved Capacity - 1978 to Present (Cont'd.)

Airport	Year	Project No.	Type of Environment
Homer	1979	ADAP-04	Apron
*Homer	1983	AIP-01	Apron
*Iliamna Airport	1980	ADAP-02	Apron
Juneau International	1978	ADAP-07	Apron
*Juneau International	1983	AIP-01	Apron
*Kenai Municipal	1983	AIP-01	Apron (Transient GA Apron Relieved Congestion on Terminal Apron)
*King Salmon	1984	AIP-01	Taxiway and Apron
Kodiak	1981	ADAP-03	Taxiway and Apron
Ralph Wien Memorial (Kotzebue)	1982	AIP-01	Land for Apron Expansion
*Ralph Wien Memorial (Kotzebue)	1983	AIP-02	Apron and Taxiway
*Seldovia	1985	AIP-01	Apron
*Sitka	1981	ADAP-03	Air Carrier Apron General Aviation Apron
*Soldotna	1979	ADAP-03	Apron and Partial Parallel/Taxiway
Soldotna	1984	AIP-01	Apron
Talkeetna	1979	ADAP-01	Apron

* These projects significantly improved operational capacity or provided necessary facilities to satisfy scheduled air carrier demand (typically terminal apron space).

Planned Projects Which Will Enhance Airport Capacity

Airport	Development
Anaktuvuk Pass	Apron
Anchorage International	Apron and Seaplane Parking
Angoon Seaplane Base	Seaplane Base Expansion
Aniak	Apron
Wiley Post/Will Rogers Memorial (Barrow)	Apron and Taxiway
Dillingham	GA Crosswind Runway and Apron
Haines	Apron
Homer	Taxiway
Juneau International	Parallel Taxiway
Kenai Municipal	Seaplane Basin and Parallel Taxiway
Ketchikan	Parallel Taxiway
King Salmon	Parallel Taxiway and Apron
Kodiak	Apron and Seaplane Basin
Ralph Wein Memorial (Kotzebue)	Apron
Nome	Taxiway and Apron
Savoonga	Apron
Skagway	Apron
Tok	Apron
Unalaska	Apron
Wasilla (new)	Replacement Airport for Standards and to Satisfy GA Apron Demand

Northwest Mountain Region

Accomplishments

Airport	Project	Benefit Category
All Hub Airports	Reduce Runway Incursion Problems (Regional Notice & Awareness Program)	Reduce Delays
Stapleton Int. Denver, CO	LDA Approach Rwy 35R	Increase IFR Capacity
	Relocate Threshold Rwy 8L	Reduce Delays
	New Reliever Front Range Airport & NDB Facility (Non-Federal)	Increase System Capacity
	Low Level Windshear Alert (LLWAS)	Reduce Delays
	Environmental Work	Improve Planning
	MALSR, Runway 17R	Increase Capacity
	Ext. Runways 16/34 @ Reliever Centennial	Increase System Capacity
	Ext. Runway 11L/29R @ Reliever Jeffco	Increase System Capacity
Sea-Tac Int. Seattle, WA	Part 150 Study	Improve Planning
	Noise Abatement Land	Reduce Delays
	Fund Studies for Two Privately Owned Reliever Airports	Increase System Capacity
	Extend Runway @ Auburn Reliever Airport	Increase System Capacity
	New Runway @ Paine Field Reliever Airport	Increase System Capacity
Portland Int., OR	New Mulino Reliever Airport	Increase System Capacity
	Taxiway, Apron Expansion	Increase Capacity
	VOR for Noise Abatement (Sponsor Funded)	Reduce Delays

Airport	Project	Benefit Category
	Part 150 Study (Sponsor Funded)	Improve Planning
	RVR, Runway 10R	Increase IFR Capacity
Boise Air Terminal Boise, ID	Part 150 Study & Master Plan	Improve Planning
Salt Lake City Int., UT	DMEL, Runway 16L	Increase IFR Capacity
Municipal, Colorado Springs, CO	New N/S Runway (Under Construction)	Increase Capacity
Logan Field, Billings, MT	Part 150 Study	Improve Planning
	Widen Taxiway and Improve Signs	Increase Capacity
Missoula Co., Missoula, MT	Part 150 Study	Improve Planning
	Apron and Taxiway Improvements and Rehab Runway 7/25	Increase Capacity
Great Falls Int., MT	Rehab Runway 7/25	Increase Capacity
McCall, ID	Increase Number of Weather Observations	Reduce Delays
Hailey, ID	Increase Number of Weather Observations	Reduce Delays

Northwest Mountain Region

Regional Listing of Significant Airport Capacity Enhancement Projects

Planned

Airport	Project	Benefit Category
All Airports	Loran "C" Application	Increase System IFR Capacity
Facility @ John Day Airport	Establish Weather Reporting for the State of Oregon	Reduce Delays
Stapleton Int. Denver, CO	Simultaneous Approaches to Runways 17L & 8L	Increase Capacity
	New Runways E/W & Short N/S	IFR Capacity
	MLS& MALSR @ Front Range Airport	Improve System IFR Capacity
	MLS's Runways 17R, 35L	Increase Capacity
	Terminal Expansion	Reduce Delays
	Airport Capacity Task Force & Capacity Models	Improve Planning
	Part 150 Study	Improve Planning
	New E/W Runway @ Reliever Centennial	Increase System Capacity
	ASDE-3 (Was Planned Now Unscheduled)	Reduce Delays
	RVR, Runway 8R	Increase IFR Capacity
	PAPI's Runways 34, 08, & 16	Increase Capacity
Sea-Tac Int. Seattle, WA	Develop Two Privately Owned Reliever Airports	Increase System Capacity
	MLS, Runway 16L	Increase IFR Capacity
	Noise Abatement Assistance	Reduce Delays
Portland Int., OR	New Reliever Airport study	Improve Planning
	RVR Runway 10L	Increase Capacity

Airport	Project	Benefit Category
	MLS Runway 20	Increase IFR Capacity
Spokane Int., WA	New Parallel Runway	Increase Capacity
Salt Lake City Int., UT	ASDE-3	Reduce Delays
	LLWAS	Reduce Delays
	New N/S Runway	Increase Capacity
	New Reliever Airport	Increase System Capacity
Boise Air Terminal Boise, ID	Improve Reliever Airport @ Caldwell, ID	Increase System Capacity
Logan Field, Billings, MT	Terminal Expansion	Increase Groundside Capacity
Missoula Co., Missoula, MT	Extend Runway 7/25	Increase Capacity

Southern Region

A. On October 1, 1984, we published "Airport Programs Strategies for the 80's." One of the major strategies was our plan to assure adequate system capacity.

B. Airport Capacity Task Force. The Atlanta Capacity Enhancement Action Plan is scheduled for completion in May 1986. The initial Task Force meeting for Miami is scheduled for January 1986.

C. State System Plans

Florida - A major update is underway. Major features include identification of new reliever airports, capacity development and airspace problems associated with system capacity enhancement. Estimated completion is August 1986.

South Carolina - A major update involving resolution of capacity problems is underway. Scheduled completion is February 1987.

D. Metro Systems Plans

Florida - Metro Systems Plans for Tampa, Jacksonville, Miami and Orlando are included in the Florida State System Plan currently underway. The first metro plan scheduled for completion is Orlando and the estimated date is March 1986.

Atlanta - The Atlanta regional Commission (ARC) initiated a 7-county system plan study in April 1985 to develop a 5-year capital improvement plan for capacity development.

Since the aviation demand exceeded the capacity available within the 7-county ARC planning jurisdiction, the Southern Region expanded the study to include the area within a 50-mile radius of Atlanta. A total of 26 airports was included in the combined efforts of ARC and FAA. The study was completed September 1985.

The problem of "unsatisified demand within a planning jurisdiction" occurs on a frequent basis in metro and Regional system planning, and the FAA does not have the personnel to supplement these studies except in unusual circumstances.

As a matter of policy, we recommend that metro and Regional planning be accomplished where possible as a part of a state system plan as is presently being done under the Florida state and metro system plans to avoid situations as encountered in the ARC study.

E. Major Capacity Planning and Development Actions

Atlanta - The 4th parallel runway at Hartsfield Atlanta International Airport was opened December 1984.

Anticipate FY-86 tentative allocation for new runway at Gwinnett County Airport (Reliever) in 2nd quarter.

Miami - Runway relocation for capacity enhancement underway. Estimated completion is November 1986.

Fort Lauderdale - Master plan for runway extensions, conversion of general aviation runway to air carrier (as indicated in the Report on 22 Pacing Airports), and other airfield development is underway. Two of three new terminal buildings opened in 1985 providing additional gate and passenger capacity.

Orlando - Grant to develop plans and specifications for 3rd parallel runway has been issued. Construction scheduled to start May 1986. $400-500 million terminal expansion scheduled over next ten years. Environmental action completed.

West Palm Beach - Terminal building construction scheduled to start in near future.

Raleigh - Parallel runway (5L/23R) scheduled to open February 1986.

Nashville - Environmental assessment underway for 3rd parallel runway. Estimated completion is May 1986. Construction to start as soon as possible.

Cincinnati - Environmental assessment underway for parallel runway. Site preparation scheduled for FY-88; paving for FY-89.

Charlotte - Master plan completion scheduled February 1986.

Birmingham - Master plan completion scheduled January 1987.

Memphis - Master plan completion estimated June 1987. Recommended development will probably include a 3rd parallel runway.

F. New Reliever Airports (Public)

Tampa - Land acquisition for Vandenburg Airport under grant. Grant for airfield development scheduled for 2nd quarter FY-86.

Palm Beach County, Florida - Environmental assessment completion scheduled 2nd quarter FY-86. Master Plan grant scheduled 2nd quarter FY-86. Land acquisition with state funds scheduled in 1986.

Broward County, Florida - Environmental action for two new airports in Fort Lauderdale area scheduled for May 1986.

Nashville - New reliever airport scheduled to open October 1986.

G. Private Reliever Airports

Atlanta - Grant issued for master plan for Bear Creek Airport. Grant for taxiway construction and obstruction removal scheduled 2nd or 3rd quarter FY-86.

Grant issued for master plan for Stone Mountain AIrport.

Memphis - Anticipated FY-86 tentative allocation to overlay existing runway, taxiway and apron and to extend runway 1000 feet in 2nd quarter FY-86 for Olive Branch Airport.