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16. Abstract

The Airport Capacity Enhancement Plan plays a major role in the Federal Aviation Administration's (FAA) effort to increase airport capacity and efficiency without compromising the safety of passengers or the environment.

The Plan identifies the causes and extent of capacity and delay problems currently associated with the U.S. air system, projects the effects of increased air traffic on airport capacity over the next decade, and outlines various planned and ongoing FAA projects intended to reduce capacity-related problems. The projects are directed toward one or more of four airport capacity enhancement areas: 1) airport construction and expansion; 2) revised airspace control procedures; 3) additional equipment and systems; and 4) capacity enhancement and planning studies. A description of each project is provided, along with significant milestones and estimates of the resulting capacity-related benefits.

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PREFACE

The Federal Aviation Administration (FAA) has sponsored the 1987 Airport Capacity Enhancement Plan. The Plan was developed by the FAA's Airport Capacity Program Office (ACPO) to ensure that current levels as well as projected increases in demand can be accommodated by the National Airspace System without compromising public safety or the environment.

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EXECUTIVE SUMMARY

The Airport Capacity Enhancement 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.

This document provides an overview of the delay problem and defines the extent and causes of present and projected delays over the coming decade. The FAA's program to enhance capacity is described, and the delay reduction benefits associated with specific ongoing and planned projects are evaluated. Project descriptions and milestones are also included.

Congestion and Delay

During 1987 over 400 million passengers and billions of dollars worth of merchandise will be flown throughout the country. Although there are 3,200 airports available to the public, most aviation activity is concentrated at a relatively small number of airports that serve large urban centers. In 1986 the top 50 primary commercial airports accounted for more than 80 percent of all passenger enplanements and over 30 percent of all aircraft operations.

Commercial air traffic has grown dramatically in recent years, and the FAA predicts that significant air traffic growth will continue. Between 1982 and 1986, total aircraft operations at towered airports increased 16 percent. Recent FAA projections indicate that between 1986 and 1998 operations will grow by 34 percent and passenger enplanements by 70 percent. At many airports the anticipated traffic levels cannot be accommodated without creating or adding to congested conditions.

The high traffic levels, particularly at large hub airports, have often been accompanied by rising numbers of delayed operations. Operations delayed for at least 15 minutes averaged 1,104 per day in FY 1986, up 20 percent from the 921 average daily delays experienced in FY 1985. Average daily delays increased further during the first quarter of FY 1987 to 1,220, an increase of nearly 11 percent.

Although the volume of delays has increased, the distribution of delays by reported cause has not changed significantly over the past few years. In 1986, 67 percent of delays were attributed to weather, up from 62 percent in 1983. The next most significant source of delay was airport volume, which accounted for 16 percent of reported delays in 1986 and 13 percent in 1983. Delays due to center volume dropped from approximately 17 percent in 1983 to 10 percent in 1986. Other sources of delay accounted for only 6 to 7 percent of total delays in each of the two years.

These reported delays include only delays of 15 minutes or more. However, most delays are under 15 minutes in duration. In 1985, 94 percent of flights delayed while airborne were delayed between 1 and 14 minutes, but only 5 percent were delayed from 15 to 29 minutes. Gateholds tended to be somewhat longer, with 48 percent under 15 minutes and another 30 percent under 30 minutes. Just over 85 percent of all taxi-out delays and 98 percent of all taxi-in delays were under 15 minutes in duration.

Congestion and delay vary considerably among airports. In 1986, the percentage of operations that were delayed ranged from a high of 14 percent to practically nil. That same year, 15 of 22 major airports experienced an increase in the number of operations delayed more than 15 minutes. System-wide air carrier delays are expected to grow from 1,139 to 1,582 thousand hours from 1984 to 1994, an increase of 39 percent. As in the past, the distribution of these delays is expected to be uneven, with 58 percent of all delays anticipated at 20 airports.

The FAA Airport Capacity Enhancement Program

The goal of the FAA's Airport Capacity Enhancement Program is to provide sufficient capacity in the National Airspace System to accommodate current and future demand in ways that are safe, effective, and environmentally sound. To meet this goal, the FAA has developed a comprehensive program to attack the problem of airport capacity and aircraft delays. This program consists of four broad areas:

- Airport Construction and Expansion
- Improved Airspace Control Procedures
- Additional Equipment and Systems
- Capacity Planning Studies

Airport Construction and Expansion

The construction of new airports and runways can be a highly effective means to enhance capacity and reduce delay. Some new runways are intended to serve only small general aviation aircraft. Others are independent parallel or converging runways built for all aircraft under all meteorological conditions and can double an airport's capacity. Although the capacity gains may be smaller, construction projects involving runway exits, taxiways, lighting, and terminals also can help in processing aircraft through an airport complex more quickly.

The FAA provides financial support for airport construction through grants made under the Airport Improvement Program (AIP), in which the Aviation Trust Fund is used for airport development. AIP grants to individual public-use airports for planning, development, or noise compatibility projects often can improve airport capacity. Such projects include the construction of runways and airports, improved taxiways, new or expanded apron areas, and the acquisition of land. The 1987 appropriation for the AIP is approximately $1.0 billion.

In the current FAA program the following projects fall into the airport construction and expansion category:

1.1 Airport Improvement Program (AIP)
1.2 Airport Design and Configuration Improvements
1.3 Airport Lighting and Visual Aids Research and Development
1.4 Pavement Strength, Durability, and Repair

Improved Airspace Control Procedures

Improved airspace procedures can make a significant and direct contribution to capacity because the aircraft separation standards and procedures used under Instrument Flight Rules (IFR) conditions reduce airport capacity relative to the standards and procedures used when Visual Flight Rules (VFR) conditions exist. Consequently, the lower IFR capacities can result in more delays even if demand is unchanged. Roughly two-thirds of all delays over 15 minutes are reportedly due to weather problems when visual approaches are likely to be precluded.

Given the disparity between IFR and VFR capacities, the most significant increases in capacity can arise from revised airspace procedures that permit the IFR capacity of an airport to approach its VFR capacity. Clearly, the applicability of any of these revised procedures depends on the runway geometry of an airport. For example, for an airport to implement independent parallel approaches, it has to have parallel runways separated by a specified minimum distance. The capacity enhancement benefits achievable with each of these procedures varies from airport to airport in accordance with specific airport and traffic characteristics.

In the current FAA program the following projects fall into the improved airspace control procedures category (not necessarily listed in order of implementation):

2.1 Simultaneous IFR Approaches to Converging Runways
2.2 Improved Independent Parallel IFR Approaches
2.3 Improved Dependent Parallel IFR Approaches
2.4 Triple IFR Approaches
2.5 Separate Short Runways
2.6 Improved IFR Longitudinal Separation Standards

Additional Equipment and Systems

The FAA capacity enhancement program includes the development and deployment of a wide range of equipment and systems for terminal areas. Individual projects either support and enhance the revisions to airspace control procedures described above, or directly alleviate the airport delay problem. The individual projects vary in their applicability. Some, such as Wind Shear Sensor Development and Mode S Data Link Applications Development, will apply at all airports. Others, such as Wake Vortex Avoidance and Forecasting, mainly affect airports with closely-spaced multiple approach streams.

In the current FAA program the following projects fall into the additional systems and equipment category:

- 3.1 Microwave Landing System (MLS)
- 3.2 Instrument Landing System (ILS)
- 3.3 Next Generation Weather Radars
- 3.4 Wind Measuring Equipment (LLWAS)
- 3.5 Weather Sensor Development
- 3.6 RVR Establish/Upgrade
- 3.7 Wind Shear Detection
- 3.8 Wake Vortex Avoidance and Forecasting
- 3.9 Departure Flow Metering
- 3.10 Upgrade Arrivals/Demand Algorithms
- 3.11 Automated Airport Capacity Calculations
- 3.12 Terminal Radar Enhancements
- 3.13 Airport Surface Detection Equipment (ASDE-3)
- 3.14 Mode S Data Link Applications Development
- 3.15 Runway Configuration Management System
- 3.16 Terminal ATC Automation

Capacity Planning Studies

The FAA has a number of projects and programs that support capacity enhancement by developing analytical tools or serving as catalysts for the adoption of other capacity enhancement actions. One project, the Airport Capacity Enhancement Task Forces, provides a means for the Airport Capacity Program Office (ACPO) to initiate and support planning activities at individual airports. Another involves the development and application of multi-airport traffic flow models for optimum use of existing system capacity. The ACPO has sponsored the use of one of these models, SIMMOD, in the development of revised aircraft control procedures for the east and west coasts.

In the current FAA program the following projects fall into the capacity planning studies category:

- 4.1 Airport Capacity Enhancement Task Forces
- 4.2 Airport Capacity and Delay Models
- 4.3 Environmental Programs

Summary

The lack of sufficient airport capacity has neither a single cause nor a simple solution. The FAA, however, 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. Many of the FAA projects in this plan are expected to increase the effective throughput of airports. Assisted in some cases by AIP grants, airport and aircraft operators can take action to reduce delays. While these projects will help, they cannot be expected to solve all airport capacity problems. At many hubbing airports, where financial incentives underlie an increase in operations, demand for services is expected to increase at a faster rate than capacity.

The projects described in this plan will enhance capacity and alleviate some of the existing and projected congestion and delay. Some projects, such as those funded by the AIP grant program, may yield significant capacity gains by promoting expansion of airport facilities. Other projects will enhance capacity by equipping airports with new equipment and systems, including more precise radar and navigation aids. Many projects, such as those involving revised airspace control procedures, are directed towards making more effective use of existing airport facilities while maintaining or improving safety. Finally, improved planning will provide a coordinated response and ensure that priority is given to projects likely to provide the greatest capacity enhancement benefit.

While the FAA can assist in providing funding for runways, navigation equipment and other projects, it relies on the airport owners and operators to identify those projects that will be most beneficial to a particular airport. This plan suggests ways to increase capacity. However, initiatives are needed from the aviation industry to get these ideas implemented.

1. INTRODUCTION

1.1 OVERVIEW OF THE AIRPORT CAPACITY PROBLEM

The economic impacts of civil aviation are considerable. Total scheduled passenger and cargo traffic generates approximately $44 billion in annual revenues; air carriers and general aviation provide direct employment for approximately 500,000 people. A local airport facilitates interregional trade, attracts new businesses, and promotes tourism. In 1985, for example, the Port Authority of New York and New Jersey estimated that the commercial aviation industry, which represents Kennedy, Newark and LaGuardia airports, contributed almost $19 billion annually to the region's economy and was responsible for approximately 300,000 jobs.

The economic impacts of civil aviation amount to $44 billion in annual revenues and direct employment for approximately 500,000 people

1.2 LEVEL OF AVIATION ACTIVITY

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 that have at least one paved and lighted runway available to the public. Of these, 552 airports enplane more than 2,500 passengers annually, and 263 are primary airports. Primary airports are public-use commercial service airports that enplane at least 0.01 percent of all passengers enplaned annually at U.S. airports. The 263 primary airports handled approximately 402 million enplanements in 1986.

3,200 airports have at least one paved, lighted runway available to the public

The top 50 primary commercial airports accounted for more than 80 percent of all passenger enplanements in 1986

Nonetheless, aviation activity is highly concentrated at a relatively small number of airports serving large urban areas. As illustrated in Figure 1-1, the top 50 primary commercial airports accounted for more than 80 percent of all passenger enplanements in 1986. The top 50 towered commercial and general aviation airports handled over 30 percent of all 1986 aircraft operations.[1]

The top 50 airports handled over 30 percent of all 1986 aircraft operations

[1] Tables A-1 and A-2 in Appendix A list the top 50 airports ranked by total passenger enplanements and total aircraft operations at towered airports, respectively.

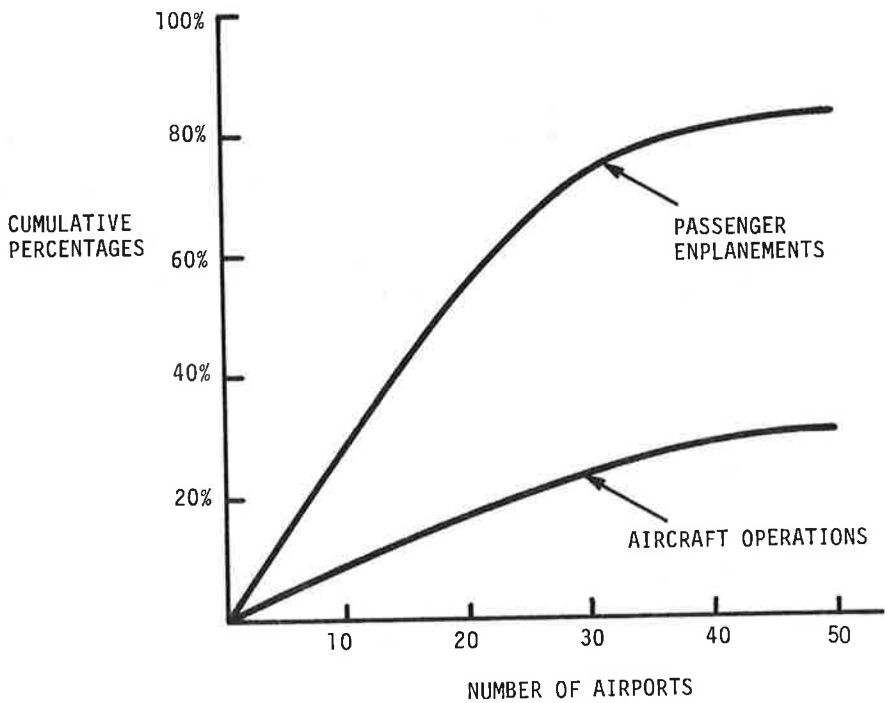


FIGURE 1-1. PASSENGER ENPLANEMENTS AND AIRCRAFT OPERATIONS, 1986

Operations delayed for at least 15 minutes averaged 1,104 per day in FY 1986, up 20 percent from FY 1985

Traffic levels at several of these large hub airports have reached record highs in recent years, and it is anticipated that a healthy economy will further stimulate 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 averaged 1,104 per day in FY 1986, up 20 percent from the 921 average daily delays experienced in FY 1985. Average daily delays increased to 1,220 during the first quarter of FY 1987, an increase of nearly 11 percent.

Figure 1-2 and 1-3 show the average daily operations and average daily delays, respectively, per month from FY 1984 through the first quarter of FY 1987. Average daily operations have increased steadily (on the order of 4 percent per year) since FY 1984. Average daily delays have also increased from year to year, barring a decrease in FY 1985. Both figures indicate a seasonal pattern, with operations and delays generally declining in December-January and gradually rising throughout the rest of the year. This trend is illustrated in Figure 1-4, which shows delays per 1,000 operations and further indicates that delays continue to be a

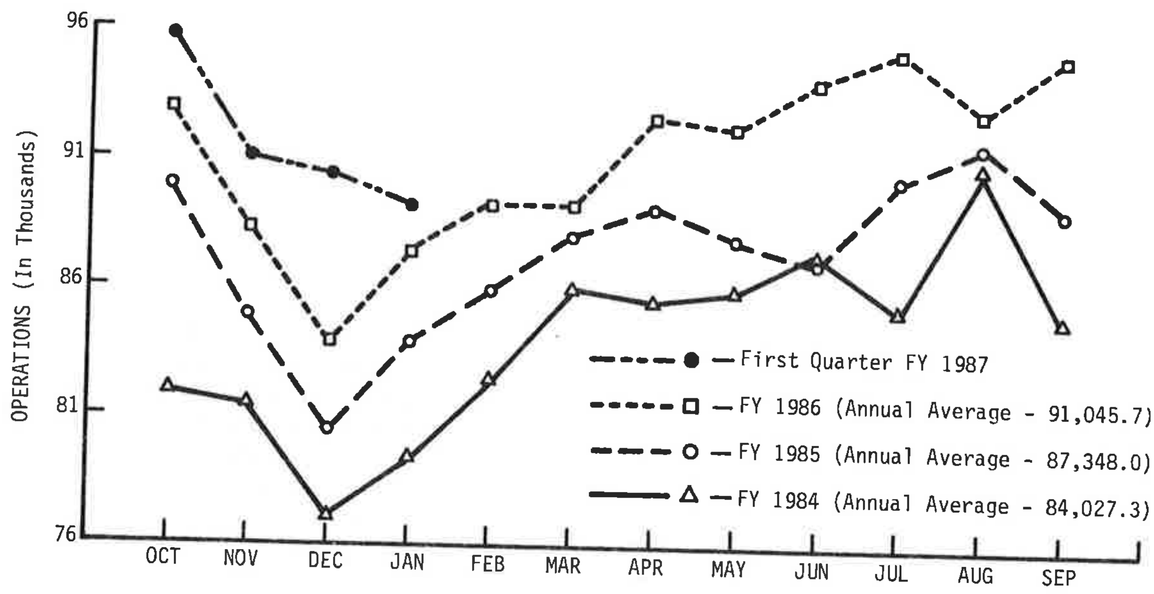


FIGURE 1-2. AVERAGE DAILY OPERATIONS

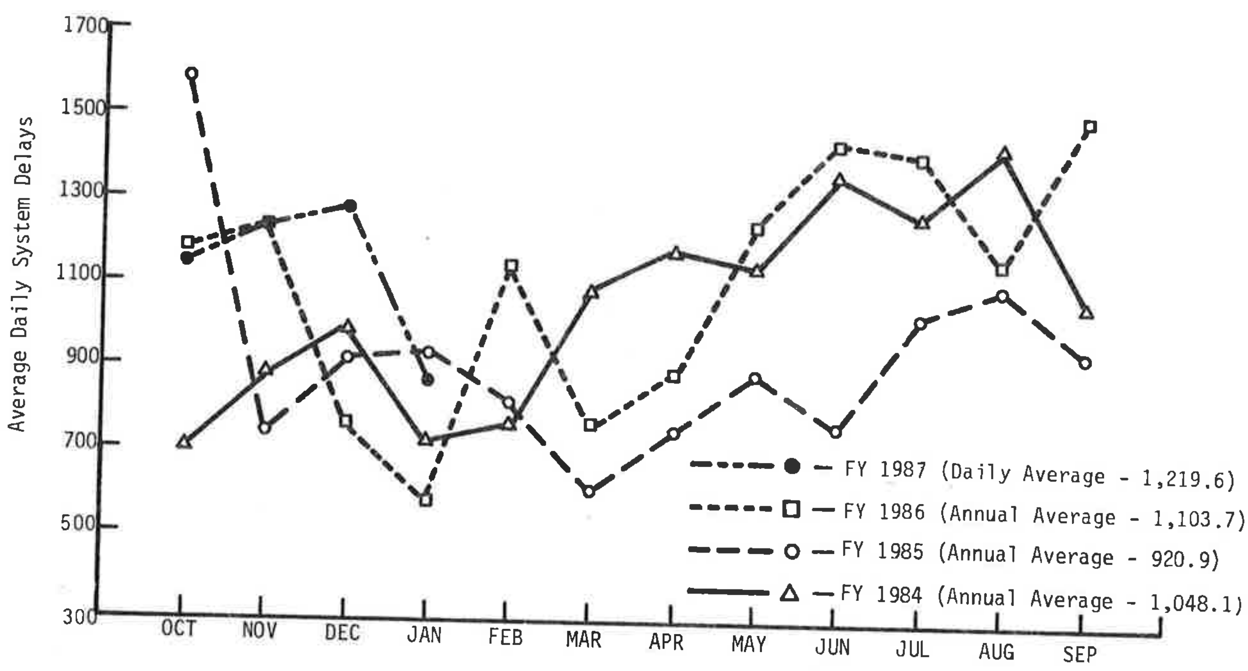


FIGURE 1-3. AVERAGE DAILY DELAYS

serious problem. Although delays per operation started out somewhat lower in FY 1987 than in the previous two years, they continued to rise and in December exceeded the level of the previous three Decembers.

1.3 FAA INVOLVEMENT IN AIRPORT CAPACITY

Grant Programs

From 1971 to 1981, grants totalling $4.5 billion were approved and from 1982 to 1986, $3.5 billion

The improvement of airports' ability to accommodate traffic efficiently is an important FAA goal. There has been significant Federal investment in the United States airport system through the Airport Improvement Program and earlier grant-in-aid programs. These include the Federal Aid Airport Program (FAAP) established by the Federal Airport Act in 1946; the Airport and Airway Development Act of 1970, which created the Planning Grant Program (PGP) for airport planning and the Airport Development Aid Program (ADAP) for airport development; and the current Airport Improvement Program (AIP) established by the Airport and Airways Improvement Act of 1982. The progression of these programs and annual funding levels are shown in Figure 1-5. From 1971 to 1981, grants totalling $4.5 billion were approved for airport planning and development. From 1982 to 1986, under the AIP, $3.5 billion has been placed under grant.

Industry Task Force on Airport Capacity

To facilitate progress, in 1982 the FAA asked the aviation community to study the problem of airport congestion through the Industry Task Force on Airport Capacity Improvement and Delay Reduction (ITF), chaired by the Airport Operators Council International. The ITF developed a number of near-term and long-term recommendations for increasing the capacity of the airport and airway system.

Airport Capacity Task Forces

In 1985 the FAA initiated a renewed program of sponsoring local capacity enhancement task forces at congested airports. Each task force is directed to develop a coordinated government/industry/community airport action plan for reducing airport delay. Currently, six airport task forces are under way. Since they have detailed knowledge of specific airports, these task forces are able to provide useful planning, as well as a realistic assessment of alternative projects to enhance capacity.

Airport Capacity Models

The FAA also has sponsored the development and use of the ***Airport Machine***, an analytical model that measures and predicts the changes in airport capacity and delay associated with changes in an airport's layout and demand profile (types and quantities of aircraft), or changes in ATC procedures. The FAA plans to place

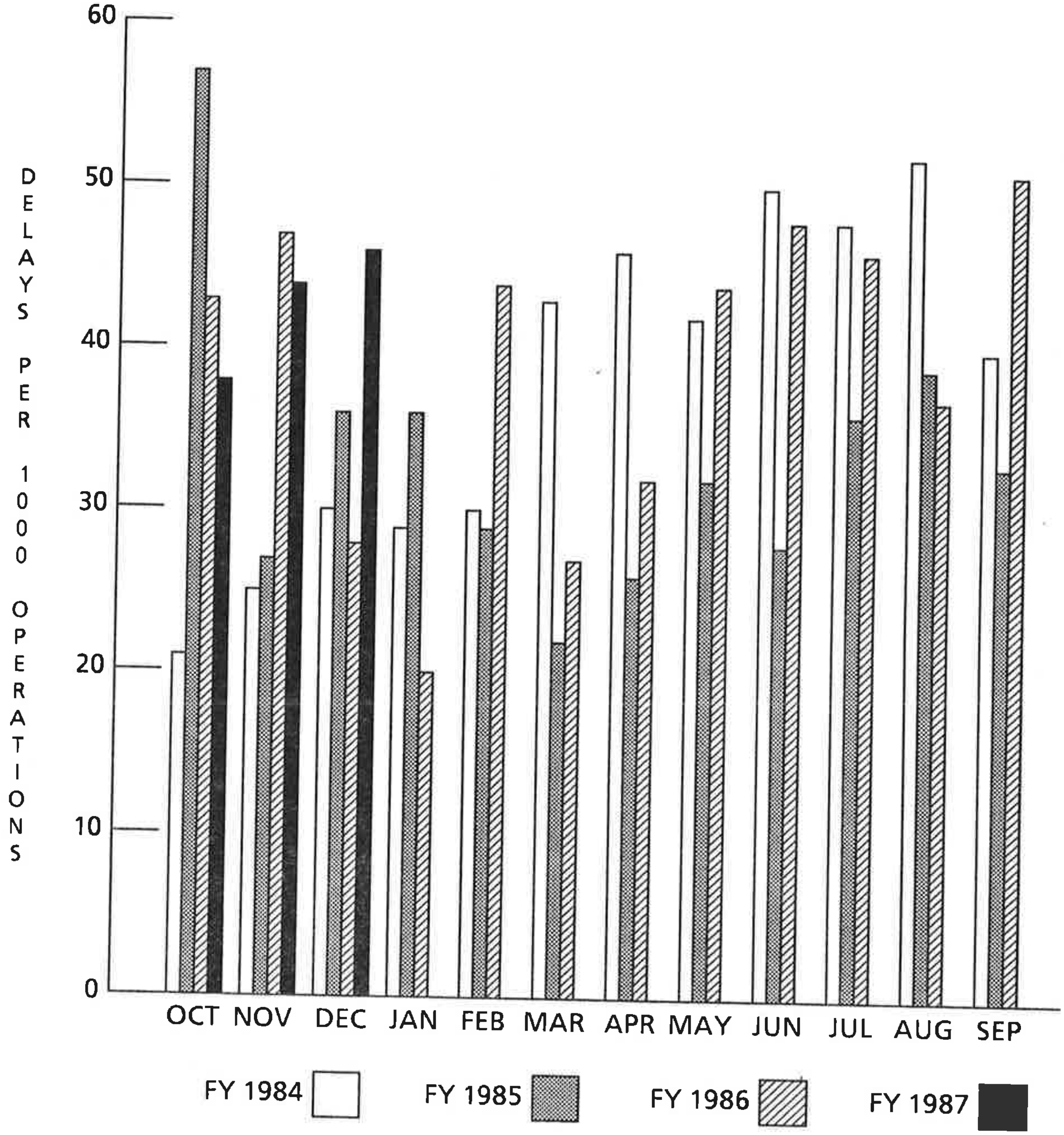


FIGURE 1-4. AIR TRAFFIC SYSTEM DELAYS PER 1,000 OPERATIONS

Note: Includes delays of 15 minutes or more at 22 airports.

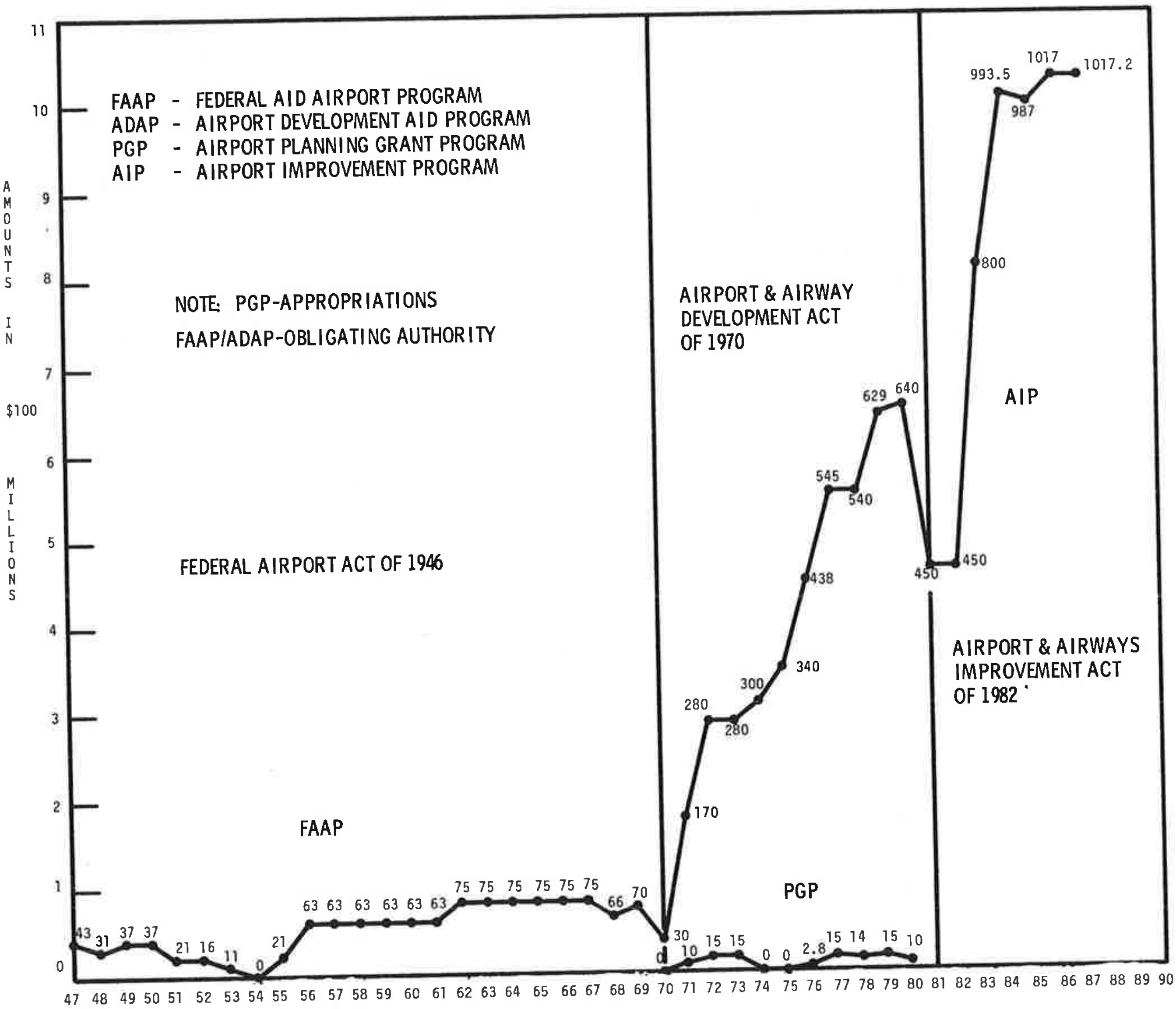


FIGURE 1-5. AIRPORTS PROGRAMS: PLANNING AND DEVELOPMENT GRANT-IN-AID PROGRAMS
FY 1947 - FY 1987

the model in four FAA regions in 1987 and, ultimately, in all FAA regions.

A more complex model, the ***Airport and Airspace Delay and Fuel Consumption Simulation Model*** (SIMMOD), is currently being applied in east and west coast airspace studies. SIMMOD simulates the real-world processes by which aircraft fly through ATC-controlled en route and terminal airspace, and arrive and depart through airport gate/taxiway/runway complexes. This effort will study changing departure and arrival routes, and other procedures to reduce delay.

New Pavements

Efforts to enhance airport capacity and relieve congestion must continue to involve airport operators and users as well as the FAA. Ultimately, decisions regarding the construction, development, and maintenance of local airports must be made by local airport authorities. Clearly, the largest gains in airport capacity are made through the construction of new airports or new pavements at existing airports.

Airport Capacity Program Office

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 Program Office (ACPO) to 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 ACPO's responsibilities is to prepare an Airport Capacity Enhancement Plan that provides a framework for capacity enhancement actions. The office is also responsible for updating the Plan annually. The Plan's focus is on projects and activities that will increase airport and air system capacity ranging from policy and planning activities to new airspace procedures and equipment, airport construction and development, and new and replacement equipment and systems. The Plan does not address the management of existing capacity to reduce delay.

The Airport Capacity Enhancement Plan consists of four chapters and appendices:

- Chapter 1 provides a general overview of the delay problem.

- Chapter 2 defines the extent and causes of present delay problems and discusses the impact of projected traffic growth on airports over the coming decade.

- Chapter 3 evaluates specific ongoing and planned FAA projects designed to reduce delay and increase capacity.

- Chapter 4 presents descriptions and milestones for the entire range of specific projects and programs in the FAA program.

- Appendices include more detailed information on the activity levels and characteristics of airports; the estimation procedures used in the Plan, including the cost of delay, delay projections and delay reduction benefits associated with specific types of projects; and a list of abbreviations.

2. CAPACITY AND DELAY: PROBLEM DEFINITION

Historically, the most serious congestion problems were limited to a small number of airports serving the nation's largest metropolitan areas. However, with the general growth in air traffic, the competitive operating environment engendered by airline deregulation, and the consequential adoption of ***hub-and-spoke*** systems by airlines, lengthy and frequent delays are being experienced at a growing number of airports. Delay problems are especially acute at several of the large hub airports. Hubbing increases the concentration of flights at particular airports at certain times of day, and in so doing contributes to peaking problems at those airports.

Commercial air traffic has grown dramatically in recent years. Airline industry deregulation, population growth, and a strong economy have all contributed to significant growth in air traffic. Between 1982 and 1986, total aircraft operations at towered airports increased 16 percent. Expanded air carrier and commuter operations accounted for the bulk of this increase, rising 37 and 35 percent, respectively, over the five-year period. During this period, general aviation traffic increased 8 percent.

Between 1982 and 1986 total aircraft operations at towered airports increased 16 percent

General aviation traffic increased by 8 percent

The effects of greater demand by air carriers and of hubbing are compounded by the growth in short-haul commuter, business and general aviation operations. Often using small aircraft, commuter airlines need major airports to connect to long-haul carriers. This contributes to congestion since small aircraft require greater between-aircraft spacing when operating behind large aircraft, and heavy aircraft in particular disrupt spacing because of wake vortices. Business aviation, which often needs to use major terminals, has grown significantly. General aviation also requires its share of capacity at major airports, although reliever airports close to major cities can provide alternatives for the general and business aviation community.

FAA forecasts of aviation activity predict continued air traffic growth over the coming years. The FAA projects that operations will grow by 34 percent and passenger enplanements by 70 percent between 1986 and 1988. At many airports the anticipated traffic levels cannot be accommodated without creating or adding to congested conditions. As air traffic expands over the next decade, it is inevitable that airport users will experience longer and more costly delays unless capacity improvements are made.

The FAA projects that operations will grow by 34 percent and passenger enplanements by 70 percent between 1986 and 1998

Users will experience longer and more costly delays unless capacity improvements are made

2.1 CAPACITY, DELAY AND CONGESTION

Capacity

Airport capacity is the maximum number of aircraft operations (either a takeoff or landing) that can be processed during a specified interval of time and under specific conditions at an airport when there is a continuous demand for service. This definition has been referred to as theoretical capacity, maximum throughput, ultimate capacity, or saturation capacity. Since capacity varies with airport conditions, the capacity of an airport is not a single value. Rather it is a set of values, each associated with a particular combination of active runways (runway configuration), airport operating conditions, including ceiling and visibility, the mix of aircraft types using the airport, and the proportions of arrivals and departures.

Capacity and Delay

Capacity cannot be observed directly. Instead, throughput and delay are observed and, taken together, may be used to measure capacity. Throughput is simply the number of aircraft operations that are processed by a runway configuration under a combination of specific demand and operating conditions. Delay is the difference between the time it would take an aircraft to travel unconstrained over a specific portion of the system and the actual time it would take under specific conditions of airspace constraints, e.g., ATC procedures, ceiling and visibility, winds, the runway layout and configuration in use, aircraft mix, ratio of arrivals to departures, exit taxiway locations, and other sources of system variability.

As demand approaches capacity, delays increase at an increasing rate

As demand approaches capacity, delays increase at an increasing rate. This relationship among capacity, demand and delay is depicted in Figure 2-1. For a given capacity, there is a tradeoff between demand and delay, with increases in demand accommodated only at the cost of longer and more frequent delays. Even when demand is quite low with respect to capacity, a change in an airport's operating conditions may reduce capacity and thereby increase the delay associated with a given level of demand.

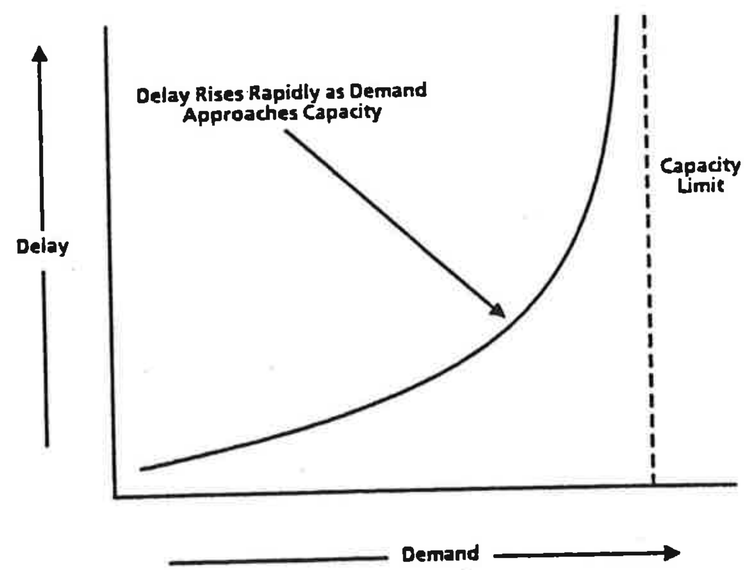


FIGURE 2-1. DELAY, DEMAND AND CAPACITY

For planning purposes, the FAA calculates several measures of capacity that take delay into consideration. Three commonly used measures are: practical hourly capacity; practical annual capacity; and annual service volume. They are actually levels of demand that result in a particular level of delay at a specific airport.

Congestion

Variability in capacity and in the pattern of demand results in airport congestion. Congestion refers to 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, it becomes increasingly difficult to eliminate backlogs. Any unexpected increase in demand or disruption that reduces capacity, even if relatively short-lived, can result in rising levels of delay that may persist throughout the day.

2.2 FACTORS AFFECTING AIRPORT CAPACITY

The primary determinant of an airport's capacity is its physical design i.e., the number, length, and location of runways, intersections, taxiways, and gates. A variety of factors affect decisions regarding the appropriate runway configurations to be used in particular circumstances, the type of aircraft the airport can accommodate, and the rate at which operations can be processed. These include constraints imposed by airport resources, meteorological conditions, and air traffic control procedures. Noise considerations and the pattern of aircraft demand have also become more important.

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

Noise Considerations

Noise abatement procedures adopted by the FAA and local airport authorities can reduce available capacity. Strategies most likely to reduce capacity entail restrictions on the use of departure and approach paths over residential areas, limitations on airport operations at certain times of the day, and preferential use of particular runways or a rotational runway system. The impact of such restrictions may be severe when restrictions are placed on those runway configurations with the highest capacity. A listing of airports that employ some type of use restriction is shown in Appendix A-3.

Aircraft Demand and Peak Hour Scheduling Practices

The pattern of aircraft demand, including the number of aircraft seeking access, their size, weight, performance characteristics, and desired access time, is an important determinant of capacity and delay. For a given level of demand, the performance characteristics of aircraft affect the rate at which operations can be processed. Such characteristics include the in-trail separation

The pattern of aircraft demand is an important determinant of capacity and delay

required between different sizes of aircraft and differences in the runway occupancy times of different types of aircraft. Table 2-1 provides the arrival and departure separations required by aircraft of different sizes. Because the different requirements are most significant between heavy and small aircraft, the mixture of aircraft types at large hubs contributes to a decrease in capacity.

The distribution of arrivals and departures also affects available capacity. In the current competitive environment, airlines have an incentive to offer flights during peak travel times when passengers most want to travel. This, combined with the concentration of flights due to hubbing and passenger exchanges among closely spaced flights, is likely to cause peaks in demand each day. Such peaks may be compounded by seasonal variation in demand. Not only does the total demand increase significantly at certain hours of the day, but also aircraft demand is split unevenly between departures and arrivals. This means that procedures are required to manage traffic that is either mostly arrivals or mostly departures.

Table 2-1. ARRIVAL AND DEPARTURE SEPARATIONS

Minimum Arrival Separations (nautical miles)

Visual Flight Rules*

Lead \ Trail	S	L	H
S	1.9	1.9	1.9
L	2.7	1.9	1.9
H	4.5	3.6	2.7

Instrument Flight Rules

Lead \ Trail	S	L	H
S	3	3	3
L	4	3	3
H	6	5	4

Minimum Departure Separations (seconds)

Visual Flight Rules*

Lead \ Trail	S	L	H
S	35	45	50
L	50	60	60
H	120	120	90

Instrument Flight Rules

Lead \ Trail	S	L	H
S	60	60	60
L	60	60	60
H	120	120	90

* VFR separations are not operational minima but rather reflect what field data show under saturated conditions.

S = Small, L = Large, H = Heavy

Source: Office of Technology Assessment, Airport System Development, August, 1984.

This pattern of demand may result in many simultaneously scheduled departures and arrivals. Table 2-2 identifies a total of 30 instances in which 15 or more aircraft were scheduled to arrive at or depart from their gate in the same minute. These include departures and arrivals scheduled at eight airports on Friday, December 19, 1986. Since not all of these flights can depart or arrive at the same time, some delay is inevitable.

TABLE 2-2. FLIGHT SCHEDULE PEAKS

		NUMBER OF FLIGHTS SCHEDULED		
AIRPORT	TIME	DEPARTURES	ARRIVALS	TOTAL
Atlanta (ATL)	9:25	16	0	16
	12:20	17	3	20
	15:55	15	2	17
Cincinnati (CVG)	14:05	0	17	17
Dallas/Fort Worth (DFW)	7:00	16	0	16
	8:40	21	3	24
Los Angeles (LAX)	7:00	23	5	28
	8:00	20	5	25
	10:00	17	3	20
	12:00	15	7	22
	15:00	16	2	18
Miami (MIA)	7:30	15	0	15
	13:30	15	5	20
Chicago (ORD)	7:00	17	1	18
	8:15	10	19	29
	9:00	18	1	19
	9:15	8	32	40
	10:42	7	26	33
	17:44	1	19	20
	18:44	16	4	20
	19:15	7	28	35
	20:15	24	3	27
	21:15	3	19	22
	21:40	16	0	16
	21:45	15	1	16
Pittsburgh	13:00	15	1	16
St. Louis (STL)	8:35	15	0	15
	8:40	16	1	17
	13:00	15	0	15
	20:10	18	0	18

Source: **Official Airline Guide schedule for December 19, 1986 (Friday). Prepared by FAA, Office of Policy and Plans (APO-130).**

2.3 DELAY TRENDS

Delay is difficult to measure and there is no industry-wide agreement on an appropriate definition of delay. However, because one of the main uses for a measure of delay is to determine trends (i.e., is delay increasing or decreasing), any consistent measure of relative changes in delay is useful. The FAA maintains two types of data on delay: delay by cause; and delay by phase 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.[1] Using NAPRS data, Table 2-3 identifies the percentage and total number of delayed operations by cause for the years 1983-1986. Between 1983 and 1984, total delays rose 66 percent. The pattern changed dramatically in 1984-1985, as total delays dropped 17 percent. However, in 1986, the number of delayed flights exceeded the previously high level of 1984.

TABLE 2-3. PERCENTAGE OF AIRCRAFT DELAY BY CAUSE, 1983-1986

CAUSE	1983	1984	1985	1986
Weather	62	60	68	67
Airport Volume	13	18	12	16
Center Volume	17	16	11	10
Runway Construction	2	3	6	3
Equipment	2	2	2	3
Weather/Equipment	3			
Other	1	1	1	1
Total Delays (000s)	243	404	334	418
Percent of Change from Previous Year		+66	-17	+25

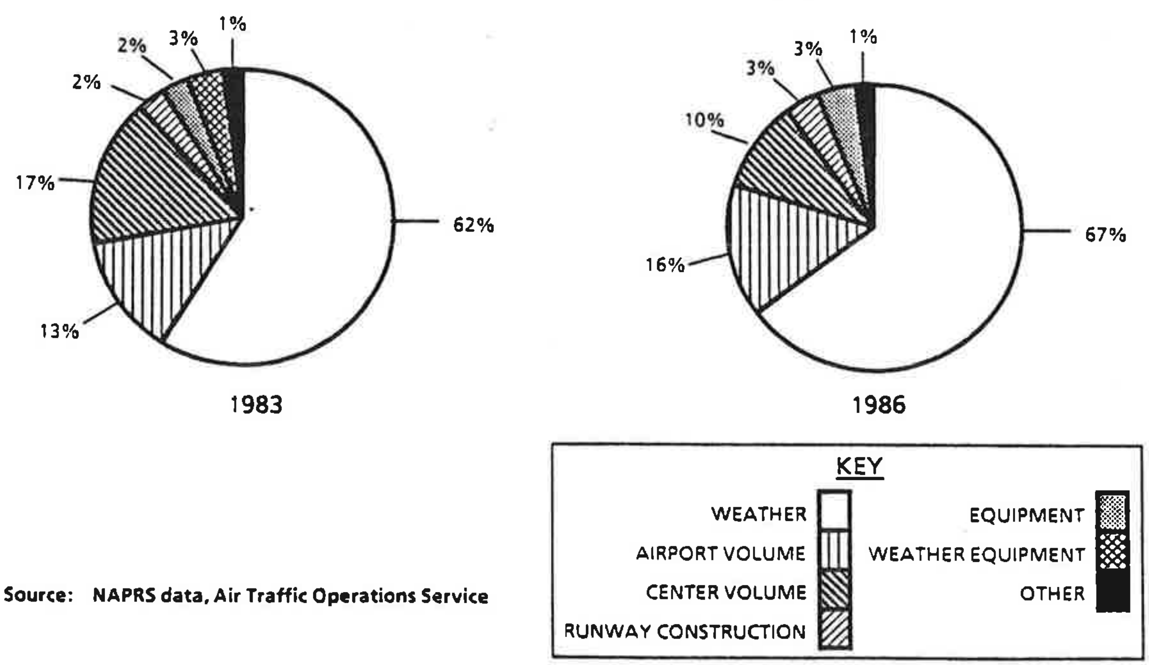
Source: NAPRS.

[1] Detailed information on delayed operations is provided for 22 airports. However, because NAPRS excludes delays of fewer than 15 consecutive minutes, it does not measure all delay in the system. In years prior to 1982, when NAPRS only tracked delays of 30 or more minutes, weather was judged responsible for about 80 percent of delays. A reduction in 1982 of the reporting threshold to 15 minutes not only increased the number of reported delays but also changed the distribution of those delays by cause. The percentage of reported delays attributed to weather dropped to approximately 60 to 70 percent after the threshold change.

The distribution of delays by cause has not changed significantly over the past four years. As illustrated in Figure 2-2, the primary cause of delay continues to be weather, with 67 percent of delays in 1986 attributed to weather, up from 62 percent in 1983. The next most significant source of delay was airport volume, which accounted for 13 and 16 percent of reported delays in 1983 and 1986, respectively. Delays related to center volume have declined from 17 percent in 1983 to 10 percent in 1986. Delays due to other causes continue to comprise a very small percentage of the total delays.

67 percent of delays in 1986 were attributed to weather, up from 62 percent in 1983

Airport volume accounted for 13 and 16 percent of reported delays in 1983 and 1986



Source: NAPRS data, Air Traffic Operations Service

FIGURE 2-2. DELAY BY CAUSE 1983 VS 1986

Delay by Phase of Flight

The Standardized Delay Reporting System (SDRS) compiles data on flight delay by phase of flight as follows:[2]

- ATC gatehold delay - when a departing aircraft is held at the gate while awaiting permission to move onto the taxiway and prepare for takeoff;

- Taxi-out delay - when a departing aircraft is made to wait on the taxiway between gate departure and takeoff;

- Airborne delay - when an aircraft is delayed between takeoff and landing; and

- Taxi-in delay - when an aircraft is delayed between landing and arrival at the gate.

The average total delay in 1985 was approximately 3 percent higher than in 1983, but 6 percent lower than in 1984

Table 2-4 shows the average delay per flight experienced by SDRS carriers at 32 major airports from 1983 to 1985.[3] The average total delay in 1985 was approximately 3 percent higher than in 1983, but 6 percent lower than in 1984.[4] Most of the improvement in 1985 occurred in the air, although ATC gateholds improved as well.[5] Taxi-in and taxi-out delays remained about the same.

TABLE 2-4. DELAY BY PHASE OF FLIGHT, 1983-1985*

FLIGHT PHASE	1983	1984 (average minutes)	1985
ATC Gatehold	0.78	1.01	0.97
Taxi	5.46	6.32	6.35
Airborne	4.54	4.81	4.01
Taxi-in	2.10	2.11	2.50
Total Per Flight	12.88	14.25	13.83

*Based on sub-sample of consistent SDRS records for 2 carriers for their systems.

Source: SDRS, 1983-1985.

[2] The SDRS contains data on flight delays (to the closest minute) experienced by three airlines: Eastern, American and United. From 1976-1984, the data cover all airports served by the three carriers, with detailed data provided for 32 major commercial airports. In 1985, data for United were unavailable, but a fourth carrier, Republic, was added. However, Republic's data cannot be substituted for United's for two reasons: 1) Republic's flight schedules, including airports used, are significantly different from those of United and 2) Republic used a different method to compute airborne delay.

[3] The SDRS carriers perform approximately one-fourth of all air carrier operations. While these data provide a useful indication of the extent of delays and general trends in delays over time, they may not be representative of all carrier delays. It may be that the SDRS carriers' system-wide delays are slightly higher than the average for all carriers because the SDRS carriers fly a higher percentage of flights into congested airports. Conversely, delays may be underestimated at airports where no SDRS carrier has a significant presence.

[4] This is consistent with the general trend of the NAPRS data, which show a subsequent increase in delay in 1986.

[5] To adjust for the change in carriers represented in the SDRS beginning in 1985, Table 2-4 presents delay data for the two carriers that reported in each of the three years.

While average delay has been used to show trends in the amount of delays over time, an average obscures much of the underlying variation in delay. Table 2-5 shows the distribution of the length of delays in increments of 15 and then 30 minutes. Most delays in each phase of flight were under 15 minutes in duration. For example, 94.4 percent of flights delayed while airborne were delayed between 1 and 14 minutes, but only 4.5 percent were delayed 15 to 29 minutes. Gateholds tended to be somewhat longer with 47.5 percent under 15 minutes and another 30 percent under half an hour.

Most delays in each phase of flight were under 15 minutes

94.4 percent of flights delayed while airborne were delayed between 1 and 14 minutes; only 4.5 percent were delayed 15 to 29 minutes

TABLE 2-5. PERCENTAGE OF FLIGHTS DELAYED, BY LENGTH OF DELAY

LENGTH OF DELAY (minutes)	**GATE HOLD**	**TAXI-OUT**	**AIRBORNE**	**TAXI-IN**
1-14	47.5	85.9	94.4	98.1
15-29	30.0	11.4	4.5	1.7
30-59	15.2	2.3	1.0	0.2
60 +	7.3	0.4	0.1	--
Total	100.0	100.0	100.0	100.0

Source: Distribution based on SDRS data for July, 1985. FAA Office of Aviation Policy and Plans.

Delay by Airport

Congestion and delay vary considerably from airport to airport. In Table 2-6, based on NAPRS data, the percentage of operations delayed more than 15 minutes at 22 major air carrier airports in 1986 ranges from approximately 13.8 percent at Newark International to virtually no delay at Las Vegas McCarran. For 15 of the 22 airports the percentage of operations delayed in 1986 was greater than 1985. However, 1985 was a significantly better year than 1984. In 1986, the percentage of total flights delayed approached the 1984 level.

TABLE 2-6. PERCENTAGE OF OPERATIONS DELAYED 15 MINUTES OR MORE

AIRPORT	1984	1985	1986
Newark International	10.6	9.2	13.8
New York LaGuardia	14.5	9.2	8.9
Boston Logan International	5.1	6.1	7.3
New York Kennedy	12.3	6.1	7.0
Atlanta Hartsfield International	5.3	6.2	6.5
Chicago O'Hare International	5.7	4.1	5.6
San Francisco International	4.4	3.4	5.3
St. Louis-Lambert International	5.4	4.6	4.4
Minneapolis International	1.5	2.2	3.9
Denver Stapleton International	7.1	4.6	3.2
Washington National	2.5	2.0	3.2
Dallas/Ft. Worth International	1.5	1.7	2.6
Philadelphia International	1.1	0.9	2.0
Detroit Metropolitan	1.2	2.1	1.3
Los Angeles International	1.0	0.8	1.1
Kansas City International	0.8	0.3	1.0
Miami International	1.7	0.3	0.7
Greater Pittsburgh International	2.1	1.7	0.6
Cleveland Hopkins International	0.4	0.1	0.3
Fort Lauderdale-Hollywood International	0.2	0.1	0.3
Houston Intercontinental	0.4	0.3	0.2
Las Vegas McCarran International	0.1	0.0	0.0
Average	4.2	3.4	4.0

Source: NAPRS - 22 Major airports.

2.4 COST OF DELAY

Delay represents a significant cost to the aviation community in terms of increased airline operating costs and passenger inconvenience. It is estimated that delays in 1985 cost the scheduled air carriers up to $1.8 billion system-wide.[6] This constitutes approximately 7 percent of the scheduled air carriers' total direct operating costs. These delays cost passengers on the order of $1.1 billion system-wide. Taken together, estimated delays in 1985 cost $2.9 billion.

delays in 1985 cost $2.9 billion

These costs pertain only to delays encountered by scheduled air carriers and their passengers. Data on delays to general aviation and commuter traffic are not available. As this traffic also encounters airport congestion and delay, the estimate of cost of delay underestimates the total cost.

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

2.5 PROJECTIONS

There is little doubt that airport congestion is a growing problem. Each year the FAA issues forecasts of national aviation activity and of activity at the nation's 3,200 public-use airports. Current forecasts indicate that aviation activity will continue to grow significantly over the next decade.

With steady economic growth and stable aviation fuel costs, domestic passenger enplanements are expected to grow an average of 4.5 percent annually between 1986 and 1998. Enplanements in 1998 are projected to be 70 percent above the 1986 level. While a 70 percent increase over 12 years may seem high, this estimate is conservative when compared with historical growth patterns. Since 1975 air carrier passenger enplanements have grown by 90 percent. Between 1986 and 1998, total aircraft operations at towered airports are expected to increase by 34 percent, an annual growth rate of 2.5 percent. This includes 33 percent growth in air carrier operations, 58 percent growth in commuter operations, and negligible growth in general aviation operations.

Domestic passenger enplanements are expected to grow an average of 4.5 percent annually between 1986 and 1998

Between 1986 and 1998, total aircraft operations at towered airports are expected to increase by 34 percent

[6] The estimation procedure used to calculate the cost of delay is described in Appendix B-1.

Table 2-7 lists the projected growth in operations from 1986 through 2000 at 35 primary commercial airports. At some of the most active and congested airports, such as Atlanta, Newark and New York LaGuardia, only modest growth is projected. Currently these airports are used intensively and cannot accommodate significant traffic growth given current facilities and technologies. Conversely, sizeable increases in operations are anticipated at several growing airports, such as Dulles and Baltimore-Washington, which serve metropolitan areas with heavily used primary airports. Airports that serve smaller metropolitan areas, such as Charlotte, Memphis, Raleigh-Durham, Kansas City and Salt Lake City, also expect substantial growth as airlines establish hubbing operations in these cities.

An indication of the impact of air traffic growth on airport congestion can be obtained by comparing current and projected levels of delay.[7] Table 2-8 presents estimates of present and future hours of delay for the 35 primary airports, assuming no enhancement or expansion of capacity.

System-wide air carrier delays are expected to grow from 1,139 to 1,582 thousand hours by 1994 with no changes in capacity

In 1994, 58 percent of all delays are expected to occur at the top 20 airports

System-wide air carrier delays are expected to grow from 1139 to 1582 thousand hours, an increase of 39 percent by 1994 with no changes in capacity. As indicated in Table 2-8, the distribution of these delays among airports is uneven, with certain congested airports experiencing delays considerably in excess of the average. Table 2-9 gives the distribution of 1994 delays for all airports ranked by the number of air carrier operations. The cumulative distribution of these delays is illustrated in Figure 2-3. In 1994, 58 percent of all delays are expected to occur at the top 20 airports; another 18 percent are projected for the next group of 20 airports.

[7] **Delays were estimated using a delay equation (see Appendix B-2) identifying the relationship between air carrier delay and both the ratio of air carrier operations to capacity and the ratio of general aviation operations to capacity at the airport.**

TABLE 2-7. ACTUAL AND PROJECTED GROWTH IN OPERATIONS, 35 PRIMARY AIRPORTS, 1986-2000*

AIRPORT	TOTAL OPERATIONS FY 1986	FORECAST OPERATIONS FY 2000	PERCENT CHANGE 1986-2000
	(thousands of operations)		
Chicago O'Hare International	795	934	17.5
Atlanta Hartsfield International	775	816	5.3
Denver Stapleton International	521	692	32.9
Dallas/Ft. Worth International	575	672	16.8
St. Louis-Lambert International	461	645	40.1
Los Angeles International	565	634	12.2
Phoenix Sky Harbor International	412	582	41.2
Dallas Love Field	259	577	122.7
Boston Logan International	420	549	30.7
Charlotte Douglas Municipal	361	537	48.7
Memphis International	380	525	38.0
Philadelphia International	368	524	42.3
Houston Intercontinental	298	521	74.7
Las Vegas McCarran International	352	509	44.5
Honolulu International	364	505	38.8
Miami International	345	494	43.1
Salt Lake City International	270	480	77.6
Greater Pittsburgh International	366	478	30.7
Minneapolis-St. Paul International	402	476	18.5
San Francisco International	423	461	9.1
Newark International	414	454	9.7
Washington Dulles International	271	433	59.6
Baltimore-Washington International	283	425	50.1
Raleigh-Durham	209	424	103.1
Tampa International	261	403	54.2
Washington National	326	400	22.8
Houston Hobby	280	397	42.0
New York Kennedy International	327	379	16.0
New York LaGuardia	365	370	1.3
Ft. Lauderdale-Hollywood International	224	341	52.4
Seattle Tacoma International	254	325	28.2
Kansas City International	206	303	46.8
Indianapolis International	207	274	32.7
Cleveland Hopkins International	230	267	16.1
Nashville Metropolitan	239	260	8.8

*Source: FAA Terminal Area Forecasts, FY 1986-2000, May 1987.

TABLE 2-8. PRESENT AND FUTURE DELAY AT 35 PRIMARY AIRPORTS

FLIGHT PHASE	TOTAL HOURS OF DELAY* 1984	1994
Chicago O'Hare International	93,548	132,378
Atlanta Hartsfield International	79,642	103,570
Dallas/Ft. Worth International	44,646	64,750
Denver Stapleton International	38,078	62,060
Los Angeles International	38,479	56,174
Newark International	32,995	45,647
Minneapolis St. Paul International	19,803	35,273
St. Louis-Lambert International	37,342	43,493
San Francisco International	42,718	41,778
New York LaGuardia	41,518	44,783
Greater Pittsburgh International	21,951	30,409
Phoenix Sky Harbor International	14,915	22,429
Charlotte Douglas Municipal	18,435	39,979
Boston Logan International	23,858	32,272
Miami International	24,814	26,727
New York Kennedy International	28,873	30,563
Houston Intercontinental	19,247	29,623
Washington National	25,762	29,202
Honolulu International	15,023	22,036
Philadelphia International	12,795	20,209
Seattle Tacoma International	13,692	20,560
Memphis International	11,274	16,643
Tampa International	12,697	15,357
Baltimore-Washington International	10,129	14,392
Cleveland Hopkins International	12,979	12,999
Las Vegas McCarran International	10,300	14,966
Raleigh-Durham	4,662	13,516
Kansas City International	10,626	14,247
Salt Lake City International	7,373	12,539
Houston Hobby	9,905	11,754
Washington Dulles International	3,352	10,224
Dallas Love Field	9,901	12,488
Ft. Lauderdale-Hollywood International	4,875	6,630
Indianapolis International	5,138	6,504
Nashville Metropolitan	4,119	5,433

*** Total hours of delay are based on 1984 data and 1994 forecasts, the latest available data for all airports and the delay equation described in Appendix B-2. Later forecasts are available for the larger primary airports, but have not been used here to maintain consistency with system-wide estimates.**

TABLE 2-9. ESTIMATED 1994 DELAY

GROUP	AIRPORTS (AC* ops)	AC DELAY (000 hr)	AC DELAY (percent)
1.	Top 20	923	58.2
2.	Next 20	286	18.2
3.	Next 20	136	8.6
4.	Next 20	80	5.1
5.	Next 20	32	2.1
6.	Next 20	14	0.9
7.	121-240	1	0.1
8.	All others	108	6.8
	Totals	1582	100.0

* AC = Air Carrier.
Source: Delays calculated using the delay equation described in Appendix B-2.

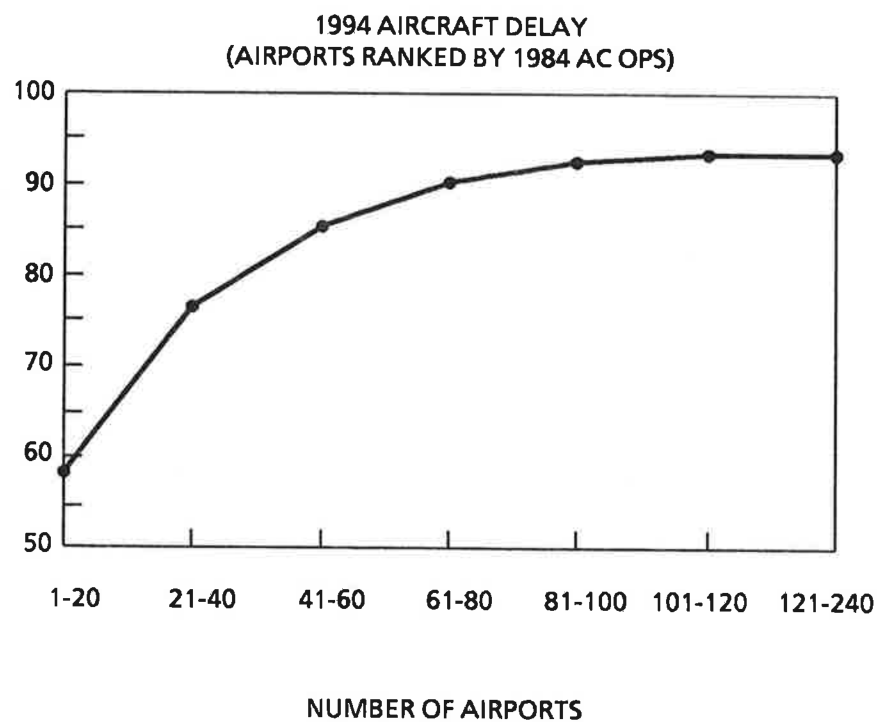


FIGURE 2-3. 1994 AIR CARRIER DELAY: CUMULATIVE DISTRIBUTION

3. FAA CAPACITY ENHANCEMENT PROGRAM

The goal of the FAA's Airport Capacity Enhancement Program is to provide for capacity enhancements so that current and projected levels of demand can be accommodated by the National Airspace System with a minimum of delays and without compromising safety or the environment. To meet this goal, the FAA has developed a comprehensive program to attack the problem of airport capacity and aircraft delays, consisting of four broad areas:

The FAA has developed a comprehensive program to attack the problem of airport capacity and aircraft delays

1. airport construction and expansion;
2. improved airspace control procedures;
3. additional equipment and systems; and
4. capacity planning studies.

Airport construction and expansion represents the most beneficial and direct approach to increasing capacity at many airports. Thus a priority of the capacity enhancement program is to study the feasibility of and to promote new construction, particularly new runways. Improved airspace control procedures can also contribute directly and significantly to capacity. The installation of new and replacement equipment and systems frequently supports capacity enhancement by facilitating the effective use of existing airport facilities. Finally, capacity planning studies provide for the analysis and assessment of capacity enhancement options and the development of capacity enhancement plans at specific airports.

Currently, a number of FAA projects are underway that will result in increased airport capacity and reduced delays. These projects are grouped into the four categories in Table 3-1. This chapter describes the projects in each area and presents information regarding their expected capacity enhancement benefits.[1] Detailed project descriptions, including milestone charts and the responsible office within the FAA, are included in Chapter 4.

A number of FAA projects are underway that will result in increased airport capacity and reduced delays

[1] For some projects, numerical estimates of potential delay reductions are given. The source of these estimates is an airport database covering 240 busy airports that is described in Appendix B-2. A listing of the airports, including an indication of possible capacity enhancement project applications, is shown in Table B-2-2. The database includes, for each airport, the IFR and VFR hourly capacities taken from the FAA's National Plan of Integrated Airport Systems (NPIAS). A delay equation, developed by TSC, relates average delay per air carrier operation to the level of operations and to the two capacities. The delay reduction benefit numbers in this chapter are calculated from that equation.

TABLE 3-1. CLASSIFICATION OF AIRPORT CAPACITY ENHANCEMENT PROJECTS

NO.	PROJECT TITLE
1.	AIRPORT CONSTRUCTION AND EXPANSION
1.1	Airport Improvement Program (AIP)
1.2	Airport Design and Configuration Improvements
1.3	Airport Lighting and Visual Aids Research and Development
1.4	Pavement Strength, Durability, and Repair
2.	IMPROVED AIRSPACE CONTROL PROCEDURES
2.1	IFR Approaches to Converging Runways
2.2	Improved Independent Parallel IFR Approaches
2.3	Improved Dependent Parallel IFR Approaches
2.4	Triple IFR Approaches
2.5	Separate Short Runways
2.6	Improved IFR Longitudinal Separation Standards
3.	ADDITIONAL EQUIPMENT AND SYSTEMS
3.1	Microwave Landing System (MLS) F&E
3.2	Instrument Landing System (ILS)
3.3	Next Generation Weather Radars
3.4	Wind Measuring Equipment (LLWAS)
3.5	Weather Sensor Development
3.6	RVR Establish/Upgrade
3.7	Wind Shear Detection
3.8	Wake Vortex Avoidance and Forecasting
3.9	Departure Flow Metering
3.10	Upgrade Arrivals/Demand Algorithms
3.11	Automated Airport Capacity Calculations
3.12	Terminal Radar Enhancements
3.13	Airport Surface Detection Equipment (ASDE-3)
3.14	Mode S DataLink Applications Development
3.15	Runway Configuration Management System
3.16	Terminal ATC Automation
4.	CAPACITY PLANNING STUDIES
4.1	Airport Capacity Enhancement Task Forces
4.2	Airport Capacity and Delay Models
4.3	Environmental Programs

3.1 AIRPORT CONSTRUCTION AND EXPANSION PROJECTS

The construction of new airports and runways can be an effective means of enhancing capacity and reducing delay. A new runway can change the airport's capacity in several ways depending on its length and location. In some cases the new runway may be designed to serve only small GA aircraft. In others, the new runway may be an independent parallel or converging runway for use by all aircraft under all meteorological conditions. The latter type of construction can double capacity at an airport. Although the capacity gains may be smaller, construction projects involving runway exits, taxiways, lighting, and terminals can also help in processing aircraft through an airport complex more quickly.

The FAA provides financial support for airport construction through grants made under the Airport Improvement Program (AIP). This is the mechanism whereby the Aviation Trust Fund is used for airport development. The 1987 appropriation for the AIP is about $1.0 billion and much of that money is for projects that will directly enhance airport capacity. The FAA also works with airport operators to plan and fund these construction efforts, and the ACPO oversees the creation of Airport Capacity Enhancement Task Forces at specific airports.[2]

Runway construction projects illustrate the benefits of the AIP

The additional capacity and reduced delays that result from runway construction projects illustrate the benefits of the AIP. To show the range of benefits, Tables 3-2 and 3-3 identify nine representative airports with recently built or planned new runways. The increase in the VFR and IFR capacities at the nine representative airports is estimated to result in a total delay reduction of 35,000 hours in 1994. The distribution of benefits among the affected airports is shown in Table 3-3; a concentration of benefits among the five most affected is apparent.

The increase in the VFR and IFR capacities due to construction projects at the nine representative airports is estimated to result in a total delay reduction of 35,000 hours in 1994

The approximate airport capacity gain associated with each new runway is given in Table 3-4. For example, a new parallel runway which is 3,500 feet from an existing runway was recently completed at Raleigh-Durham airport. The projected capacity increase for this runway is 20 operations per hour during IFR and 42 operations per hour during VFR. There are airports beyond the nine studied here at which substantial capacity gains can be achieved via construction. The FAA is working with airport operators and the airlines to identify and encourage these projects, especially at airports where the delay problem is severe.

Despite the large capacity gains , the construction of new runways is not feasible at all airports, especially those where expansion is limited by land availability. This poses a significant problem, since many congested airports are surrounded by populated areas.

[2] Task forces are described in Section 3.4

TABLE 3-2. PLANNED OR POSSIBLE NEW RUNWAYS

STATE	CITY	AIRPORT	NEW RUNWAY (ft. sep.)
Airports ranked 1 through 5*			
AZ	PHOENIX	PHOENIX SKY HARBOR INT.	**PAR. 2000
CO	DENVER	STAPLETON INTERNATIONAL	PAR. 4300
NV	LAS VEGAS	MCCARRAN INTERNATIONAL	PAR. 1000
TX	DALLAS/FT. WORTH	DALLAS/FT. WORTH INTERNATIONAL	SEP. SHORT
TX	HOUSTON	HOUSTON INTERCONTINENTAL	PAR. 3520
Airports ranked 6 through 9*			
LA	NEW ORLEANS	NEW ORLEANS INT. (MOISSANT)	PAR. 9000
MD	BALTIMORE	BALTIMORE-WASHINGTON INT.	PAR. 3500
NC	RALEIGH	RALEIGH-DURHAM	PAR. 3500
UT	SALT LAKE CITY	SALT LAKE CITY INTERNATIONAL	PAR. 6000

***Ranked by hours of reduced delay in 1994 from new runways, alphabetically by state and city.**

****PAR: parallel runway**

TABLE 3-3. NEW RUNWAYS, ESTIMATED 1994 DELAY REDUCTION

NO. AIRPORTS BENEFITING		AIRCRAFT (hours)	PASSENGER (hours)
LARGEST	5 *	25,008	1,324,195
	6-9	10,791	464,654
TOTAL		35,799	1,788,849

*** Ranked by number of hours of reduced delay.**

Note: The benefit due to the construction of the GA runway at DFW is estimated by assuming that a portion of the airport's GA traffic shifts to the new runway. This is accomplished by using 50 percent of the baseline GA operations in the delay equation. The benefits presented in Table 3-4 do not include the possible effects of other capacity enhancement projects such as triple approaches or closely spaced independent IFR parallels even though these concepts would further enhance the benefits of the new runways.

TABLE 3-4. ESTIMATED NEW RUNWAY BENEFITS FOR SAMPLE AIRPORTS

		IFR (operations per hour)			VFR (operations per hour)		
STATE	CITY	OLD	NEW	INCREASE	OLD	NEW	INCREASE
AZ	PHOENIX	70	70	0	186	279	43
CO	DENVER	58	88	36	150	150	0
LA	NEW ORLEANS	51	91	40	64	93	29
MD	BALTIMORE-WASHINGTON	70	98	28	125	188	63
NC	RALEIGH-DURHAM	52	72	20	90	33	42
NV	LAS VEGAS	50	50	0	108	210	102
TX	DALLAS/FT. WORTH	117	126	8	153	153	0
TX	HOUSTON	52	72	20	100	141	41
UT	SALT LAKE CITY	65	111	71	126	184	46

Note: **The capacities shown were obtained from the NPIAS database and may, in some cases, differ from capacities estimated using computer models. VFR capacity changes are based on information obtained from the FAA's Advisory Circular Airport Capacity. IFR capacity changes are estimates derived by analyzing the multiple approach options available given the new airport layout and current operating standards. For example, the proposed parallel runway for Baltimore-Washington is 3,500 ft. from an existing runway. The assumed 39 percent IFR capacity gain is thus predicated on a shift to dependent parallel operations (see Section 3.2.3). Reduced spacing for independent parallel operations would result in additional benefits at BWI, but are not included in this table's estimates.**

Funding and environmental constraints may further prevent or complicate the building of new runways.

A 9,000-foot runway, 150 feet wide, covers 31 acres of land. It has been estimated that over 30,000 additional acres of land will be needed by the year 2000 to expand facilities at existing airports. Federal grant assistance, under the AIP and its predecessor grant programs, is available for the purchase of land to meet short-term needs (within five years). Federal grant assistance is also available for land acquisition for longer-term capacity needs. Because of funding limitations, however, only projects for which an immediate need can be demonstrated are normally programmed. In addition, airport operators generally have not applied for grant funds for advance land acquisition, or land banking.

It has been estimated that over 30,000 additional acres of land will be needed by the year 2000 to expand facilities at existing airports

3.2 IMPROVED AIRSPACE CONTROL PROCEDURES

The aircraft separation standards and procedures used under IFR reduce airport capacity relative to VFR, particularly with respect to arrivals. The lower IFR capacities result in more delays even if demand is unchanged. Thus it is not surprising that roughly two-thirds of all delays over 15 minutes can be attributed to weather problems. Given this disparity, significant increases in capacity can arise from new airspace procedures that permit the IFR capacity of an airport to approach its VFR capacity. The FAA is working to increase IFR capacities by revising aircraft separation standards and procedures while still maintaining safety margins.

One way in which IFR capacities can be increased is to allow Independent (simultaneous) IFR approaches to more than one runway under a wider set of weather conditions. Several concepts at various stages of planning or implementation fall under this heading. These include multiple approaches to pairs of converging or closely-spaced parallel runways, triple approaches, and use of separate short runways. Reducing IFR longitudinal (in-trail) separation standards is another procedural method for increasing arrival capacity.

The application of any multiple approach concept depends on the runway geometry of an airport. For example, independent IFR parallel approaches require a pair of parallel runways that meet minimum separation standards. The reduction in IFR longitudinal separations can apply at most airports; the FAA has recently adopted this procedure and it will gradually be applied at individual airports. These concepts are described in the following sections; benefits will vary among airports depending on specific runway geometries and traffic characteristics.

3.2.1 IFR Approaches to Converging Runways

Description of Concept

Under VFR it is common to use non-intersecting converging runways for independent streams of arriving aircraft. Because of reduced visibility and ceilings associated with IFR operations, the simultaneous independent use of such runways is currently permitted for aircraft arrivals only during relatively high weather minimums. The purpose of this project is to establish improved procedures for the independent use of converging runways under IFR. Figure 3-1 illustrates a procedure for IFR converging approaches that was recently approved for limited application. Sites currently under review for IFR converging approaches are: St. Louis, Kansas City, Chicago, Milwaukee, Boston, Dallas/Ft. Worth, and Denver. Table 3-5 compares the current best configuration with potential converging approach IFR capacities at eighteen airports.

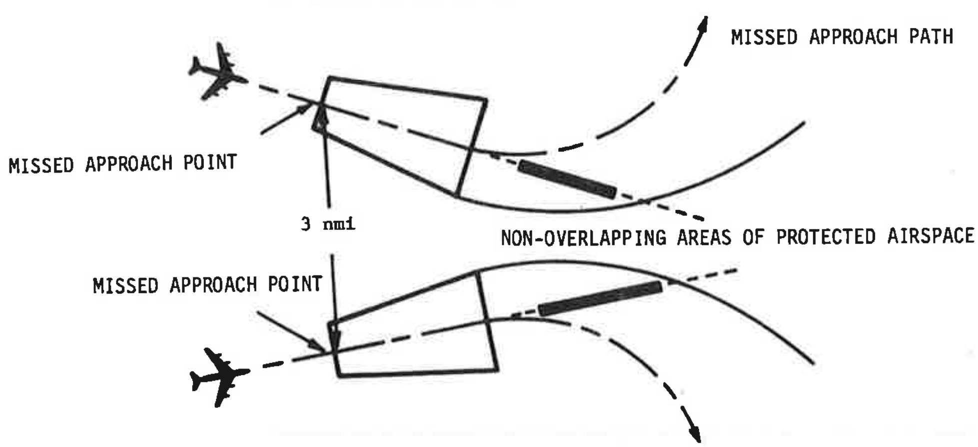


FIGURE 3-1. IFR APPROACHES TO CONVERGING RUNWAYS

TABLE 3-5. SAMPLE OF IFR CAPACITIES FOR CONVERGING APPROACHES (Arrivals/Hour)

AIRPORT	RUNWAYS	IFR CAPACITY CONVERGING	IFR CAPACITY CURRENT BEST
Boston Logan International	22R/27[1]	52	26[3]
Baltimore-Washington International	28/33L[2]	46	26[3]
Washington National	36/33[2]	46	26[3]
Denver Stapleton International	17L/26L[1]	51	26[3]
Newark International	11/4R[1]	51	25[3]
Houston Hobby	17/22[2]	44	25[3]
Houston Intercontinental	26/32R[1]	51	25[3]
New York Kennedy International	13R/22L[1]	49	37[5]
Las Vegas McCarran International	19/25[1]	48	24[3]
New York LaGuardia	4/31[2]	46	27[3]
Kansas City International	19/27[1]	55	28[3]
Memphis International	36L/27[1]	49	35[5]
Minneapolis-St. Paul International	22/29L[2]	44	36[5]
Philadelphia International	17/9R[1]	50	25[3]
Greater Pittsburgh International	14/10C[2]	45	53[4]
San Francisco International	10L/1R[2]	45	25[3]
Salt Lake City International	14/16L[1]	51	36[5]
St. Louis-Lambert International	24/30R[1]	52	26[6]

[1] Independent converging approaches
[2] Dependent converging approaches
[3] Single runway approaches
[4] Independent parallel approaches
[5] Dependent parallel approaches
[6] Single runway; does not consider *sidestep* procedure used at STL

Note: **Capacities of independent IFR converging approaches have been assumed to be twice those of single IFR approaches. Capacities of dependent IFR converging approaches have been estimated by assuming appropriate procedures. Those procedures are currently under development.**

Source: **FAA Airfield Capacity Model**

The estimate of benefits assumes that all airports with VFR converging runways are candidates for this concept. There are 75 such airports, and the 30 airports expected to receive the greatest benefit from this concept are listed in Table 3-6. It is likely that restrictions to IFR runway usage may preclude the application of this concept at some of the identified airports. Restrictions can occur because of obstructions in the flight path, noise problems, or the lack of suitable sites for approach lights and other navigation aids.

TABLE 3-6. THIRTY CANDIDATE AIRPORTS FOR IFR CONVERGING APPROACHES

STATE	CITY	AIRPORT
Airports ranked 1 through 5*		
CA	OAKLAND	METRO OAKLAND INTERNATIONAL
CO	DENVER	STAPLETON INTERNATIONAL
MO	ST. LOUIS	LAMBERT-ST. LOUIS INTERNATIONAL
NJ	NEWARK	NEWARK INTERNATIONAL AIRPORT
TX	HOUSTON	HOUSTON INTERCONTINENTAL
Airports ranked 6 through 10*		
MA	BOSTON	GEN. EDW. L. LOGAN INTERNATIONAL
NC	RALEIGH	RALEIGH-DURHAM
OH	CLEVELAND	CLEVELAND-HOPKINS INTERNATIONAL
TN	MEMPHIS	MEMPHIS INTERNATIONAL
TX	HOUSTON	WILLIAM P. HOBBY
Airports ranked 11 through 20*		
AK	ANCHORAGE	ANCHORAGE INTERNATIONAL
CA	BURBANK	BURBANK-GLENDALE-PASADENA
CA	SAN DIEGO	SAN DIEGO INTERNATIONAL LINDBERGH FIELD
LA	NEW ORLEANS	NEW ORLEANS INTERNATIONAL (MOISSANT)
MA	HYANNIS	BARNSTABLE MUNICIPAL
MO	KANSAS CITY	KANSAS CITY INTERNATIONAL
NE	OMAHA	EPPLEY AIRFIELD
NY	ISLIP	LONG ISLAND-MAC ARTHUR
NY	ROCHESTER	ROCHESTER MONROE COUNTY
TX	SAN ANTONIO	SAN ANTONIO INTERNATIONAL
Airports ranked 21 through 30*		
AR	LITTLE ROCK	ADAMS FIELD
CT	WINDSOR LOCKS	BRADLEY INTERNATIONAL
FL	JACKSONVILLE	JACKSONVILLE INTERNATIONAL
IN	INDIANAPOLIS	INDIANAPOLIS INTERNATIONAL
NC	GREENSBORO	GREENSBORO-HIGH POINT-WINSTON
NJ	ATLANTIC CITY	ATLANTIC CITY
NY	SYRACUSE	SYRACUSE-HANCOCK INTERNATIONAL
VA	RICHMOND	RICHARD EVELYN BIRD INTERNATIONAL
WA	SPOKANE	SPOKANE INTERNATIONAL
WI	MADISON	DANE COUNTY REGIONAL

*** Ranked by hours of reduced delay in 1994 from simultaneous IFR converging approaches, alphabetically by state and city.**

Delay Reductions

IFR approaches to converging runways result in an estimated 1994 air carrier delay reduction of 26,000 hours

The use of two arrival streams under this concept is assumed to double each airport's IFR arrival capacity given in the NPIAS database. Increasing the IFR capacities at these airports and recalculating 1994 air carrier delays using the delay equation results in a total aircraft delay reduction of 26,000 hours. With an average hourly delay cost approaching $2,000, this represents $52 million in potential savings.

The improvements total over 16,000 hours at the five airports most affected and fall to 156 hours at the 35 airports least affected. Table 3-7 gives the distribution of potential benefits among airports. There is a concentration of benefits among the 30 most affected. The reduced passenger delays at these airports also indicate that the implementation of this concept at even a few airports can result in sizeable improvements for airline passengers.

TABLE 3-7. SIMULTANEOUS IFR APPROACHES TO CONVERGING RUNWAYS, ESTIMATED 1994 DELAY REDUCTION

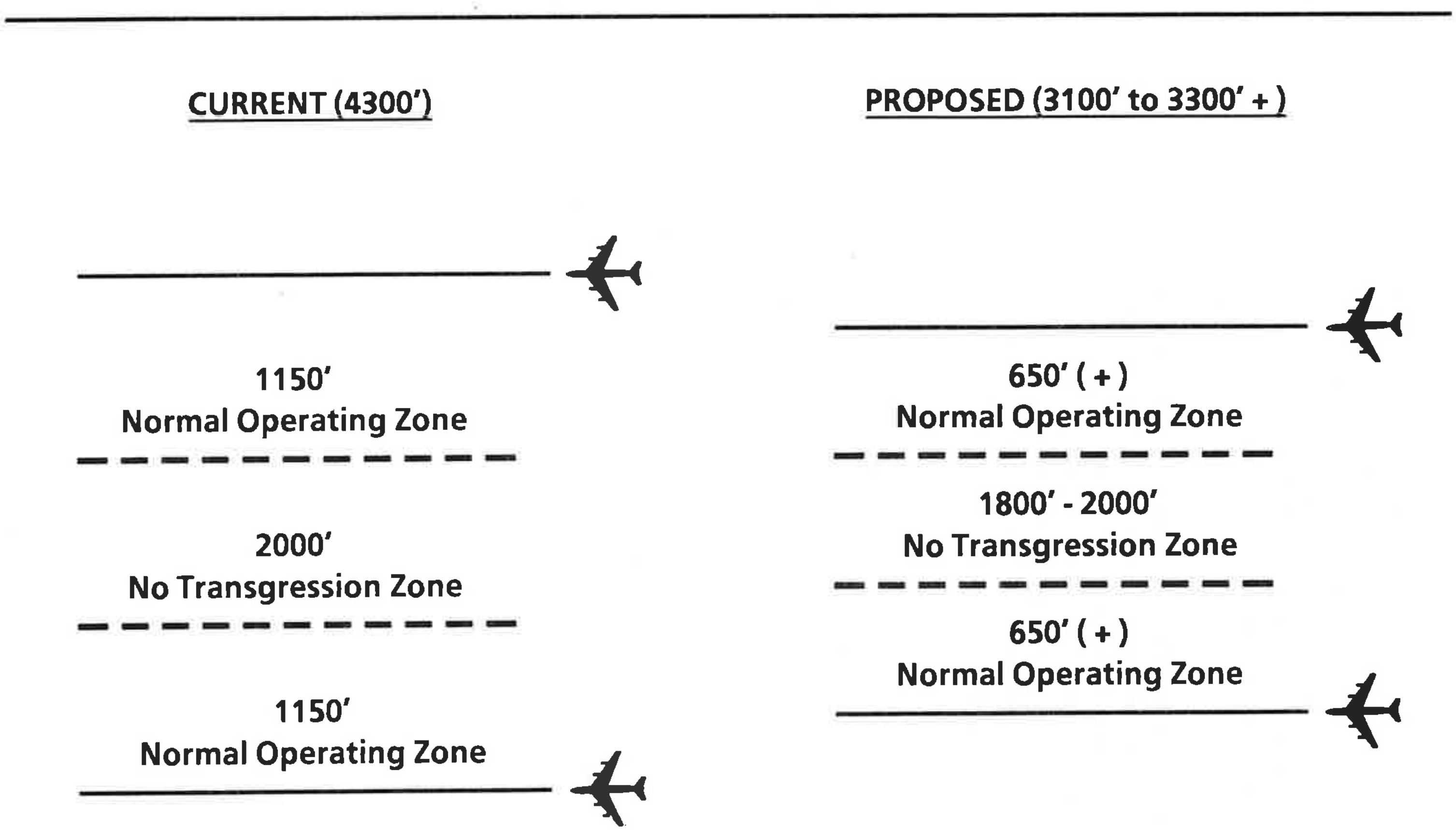
NO. AIRPORTS BENEFITING		AIRCRAFT (hours)	PASSENGER (hours)
LARGEST	5 *	16,422	838,202
	6-10	4,622	200,635
	11-20	3,312	137,192
	21-30	1,475	47,059
	31-40	453	20,188
	41-75	156	5,663
TOTAL		26,439	1,248,939

*** Ranked by number of hours of reduced delay.**

3.2.2 Improved Independent Parallel IFR Approaches

Description of Concept

Currently, the separation between parallel runways must be at least 4,300 feet for independent IFR operations. This project involves a reduction in this separation standard to a goal of around 3,000 feet. Since dependent IFR parallel operations are currently permitted with runway spacings between 3,000 and 4,300 feet, the aim of this project is to permit a shift to independent operations in this spacing range. Figure 3-2 shows the proposed reductions. The flexibility inherent in having two independent arrival streams is a significant advantage relative to the dependent case in which diagonal separations must be maintained. In the dependent case, aircraft on one approach cannot pass the aircraft on the other.



- DISTANCES ARE ROUNDED TO NEAREST 50 FT.

3100 = 650 + 1800 + 650
3300 = 650 + 2000 + 650

FIGURE 3-2. PARALLEL RUNWAY SPACING, PROPOSED REDUCTIONS

Of the 76 airports with parallel runways, 13 have maximum spacings between runway pairs in the 3,000 to 4,300-foot range. These airports are listed in Table 3-8. It is assumed that all of these airports would implement independent IFR operations if the spacing standard were reduced to 3,000 feet.

TABLE 3-8. THIRTEEN CANDIDATE AIRPORTS FOR INDEPENDENT PARALLEL IFR APPROACHES

STATE	CITY	AIRPORT
Airports ranked I through 5*		
MN	MINNEAPOLIS	MINNEAPOLIS-ST. PAUL INTERNATIONAL
NC	RALEIGH	RALEIGH-DURHAM
OH	CLEVELAND	CLEVELAND-HOPKINS INTERNATIONAL
TN	MEMPHIS	MEMPHIS INTERNATIONAL
TX	DALLAS	DALLAS LOVE FIELD
Airports ranked 6 through 10*		
AZ	PHOENIX	PHOENIX SKY HARBOR INT
CA	LONG BEACH	LONG BEACH-DAUGHERTY FIELD
FL	FORT LAUDERDALE	FORT LAUDERDALE-HOLLYWOOD INT
NE	LINCOLN	LINCOLN MUNICIPAL
OR	PORTLAND	PORTLAND INTERNATIONAL
Airports ranked 11 through 13*		
FL	MIAMI	TAMIAMI
ND	GRAND FORKS	GRAND FORKS INTERNATIONAL
TX	LUBBOCK	LUBBOCK INTERNATIONAL

* **Ranked by hours of reduced delay in 1994 from improved independent parallel IFR approaches, alphabetically by state and city.**

Note: New York's Kenedy Airport (JFK) has not been included in this list because it has parallel runways separated by more than 4,300 feet. However, site-specific restrictions do not allow them to be used independently (simultaneously). Thus, JFK could also benefit from this project because it has another set of parallel runways which are 3,000 feet apart.

Improved independent parallel IFR approaches result in an estimated 1994 air carrier delay reduction of 3,000 hours

Delay Reductions

Increasing the IFR capacities at affected airports and recalculating 1994 air carrier delays using the delay equation results in a total delay reduction of 3,000 hours. The improvements range from over 2,500 hours at the five airports most affected to less than 50 hours at the three airports least affected. Table 3-9 gives the distribution of benefits among airports. There is a concentration of benefits among the 10 most affected. Table 3-10 presents the potential IFR capacity improvements at ten airports where independent parallel approaches may be implemented.

TABLE 3-9. IMPROVED INDEPENDENT PARALLEL IFR APPROACHES, ESTIMATED 1994 DELAY REDUCTION

NO. AIRPORTS BENEFITING		**AIRCRAFT (hours)**	**PASSENGER (hours)**
LARGEST	5 *	2,533	84,109
	6-10	764	60,711
	11-13	49	1,452
TOTAL		3,346	146,272

*** Ranked by number of hours reduced delay.**

TABLE 3-10. POTENTIAL CAPACITY IMPROVEMENTS USING EXISTING PAVEMENTS

			IFR CAPACITY[1] (Arrivals/hour)	
AIRPORT	**RUNWAYS[2]**	**CENTERLINE SPACING**	**DEPENDENT PARALLEL**	**INDEPENDENT PARALLEL**
NEW YORK KENNEDY	4R,4L	3000′	37	49
PHOENIX SKY HARBOR	8R,8L	3400′	35	48
MINNEAPOLIS-ST. PAUL	11R,11L	3380′	36	49
SALT LAKE CITY	16R,16L	3500′	36	51
DETROIT METRO	3L,3C	3800′	37	50
FT. LAUDERDALE	27R, 27L	4000′	35	48
PORTLAND	28R,28L	3100′	36	53
RALEIGH-DURHAM	5R,5L	3500′	35	49
MEMPHIS	36R,36L	3400′	35	49
DALLAS LOVE	31R,31L	2975′	36	53
AVERAGE CAPACITY			36	50

Note: Capacities were calculated using the FAA Airfield Capacity Model.

[1] Capacity numbers assume 50-50 mix for arrivals and departures
[2] Opposite ends of runways may also be candidates

3.2.3 Improved Dependent Parallel IFR Approaches

Description of Concept

The separation between parallel runways must be currently at least 2,500 feet for dependent IFR operations with 2.0 nautical miles diagonal separation between landing aircraft on adjacent approaches. The diagonal separation standard prevents a faster aircraft on one approach from passing a slower aircraft on the other approach and thus limits the capacity increase associated with using the two arrival streams. Two separate projects involve changes in the runway separation standard to less than 2,500 feet and a reduction in the 2.0 nautical mile diagonal separation between aircraft.

Of 76 airports with existing parallel runways, 24 have maximum spacings between runway pairs in the 1,000- to 2,500-foot range. These airports are listed in Table 3-11. It is assumed that all of these airports would implement reduced diagonal spacings under IFR if the runway spacing standard were reduced.

Delay Reductions

Increasing the IFR capacities at affected airports and recalculating 1994 air carrier delays using the delay equation results in a total delay reduction of 9,000 hours. The improvements range from nearly 8,000 hours at the five airports most affected to no measured benefit at the eight airports least affected. Table 3-12 gives the distribution of benefits among airports. There is a concentration of benefits among the 10 most affected.

Improved dependent parallel IFR approaches result in an estimated 1994 air carrier delay reduction of 9,000 hours

TABLE 3-11. TWENTY-FOUR CANDIDATE AIRPORTS FOR IMPROVED DEPENDENT PARALLEL IFR APPROACHES

STATE	CITY	AIRPORT
Airports ranked 1 through 5*		
CA	OAKLAND	METRO OAKLAND INTERNATIONAL
FL	ORLANDO	ORLANDO INTERNATIONAL
MA	BOSTON	GEN. EDW. L. LOGAN INTERNATIONAL
MO	ST. LOUIS	LAMBERT-ST. LOUIS INTERNATIONAL
TX	HOUSTON	HOUSTON INTERCONTINENTAL
Airports ranked 6 through 10*		
NE	OMAHA	EPPLEY AIRFIELD
PA	PHILADELPHIA	PHILADELPHIA INTERNATIONAL
RI	PROVIDENCE	THEODORE F. GREEN STATE
TN	NASHVILLE	NASHVILLE METROPOLITAN
TX	SAN ANTONIO	SAN ANTONIO INTERNATIONAL
Airports ranked 11 through 20*		
FL	DAYTONA BEACH	DAYTONA BEACH REGIONAL
FL	MELBOURNE	MELBOURNE REGIONAL AIRPORT
FL	VERO BEACH	VERO BEACH MUNICIPAL
IL	CHICAGO	PALWAUKEE
MI	LANSING	CAPITAL CITY
MT	BILLINGS	BILLINGS-LOGAN INTERNATIONAL
OH	CINCINNATI	CINCINNATI MUNI.-LUNKEN
TN	KNOXVILLE	MCGHEE-TYSON
TX	EL PASO	EL PASO INTERNATIONAL
TX	MIDLAND	MIDLAND REGIONAL AIRPORT
Airports ranked 21 through 24*		
OH	COLUMBUS	OHIO STATE UNIVERSITY
OK	OKLAHOMA CITY	WILEY POST
TX	FORT WORTH	MEACHAM FIELD
WA	MOSES LAKE	GRANT COUNTY

* **Ranked by hours of reduced delay in 1994 from dependent improved parallel IFR approaches, alphabetically by state and city.**

TABLE 3-12. DEPENDENT PARALLEL IFR APPROACHES, ESTIMATED 1994 DELAY REDUCTION

NO. AIRPORTS BENEFITING		AIRCRAFT (hours)	PASSENGER (hours)
LARGEST	5 *	7,837	345,281
	6-10	990	37,814
	11-20	120	4,161
	21-24	0	0
TOTAL		8,947	387,256

*** Ranked by number of hours of reduced delay.**

3.2.4 Triple IFR Approaches

Description of Concept

At some airports various combinations of independent IFR parallel operations, dependent IFR parallel operations, and independent IFR converging runways could be used to implement a system involving triple IFR arrival streams. The primary applications of this concept involve airports that have independent IFR arrival streams to parallel runways (using either the 4,300-foot runway separation standard or the proposed 3,000-foot standard). For such airports a third (dependent) parallel runway or a favorably located converging runway may be used for a third arrival stream. Ten airports that meet these criteria are listed in Table 3-13.

TABLE 3-13. TEN CANDIDATE AIRPORTS FOR TRIPLE IFR APPROACHES

STATE	CITY	AIRPORT
Airports ranked I through 5*		
GA	ATLANTA	WILLIAM B. HARTSFIELD
IL	CHICAGO	CHICAGO O'HARE
NC	RALEIGH	RALEIGH-DURHAM
NY	NEW YORK	JOHN F KENNEDY
TX	DALLAS.FT WORTH	DALLAS/FT. WORTH
Airports ranked 6 through 10*		
DC	WASHINGTON	DULLES
MI	DETROIT	DETROIT
PA	PITTSBURGH	GREATER PITTSBURGH
TN	MEMPHIS	MEMPHIS
TX	LUBBOCK	LUBBOCK

* **Ranked by hours of reduced delay in 1994 from triple IFR approaches, alphabetically by state and city.**

Delay Reductions

Triple IFR approaches result in an estimated 1994 air carrier delay reduction of 14,000 hours

Increasing the IFR capacities at affected airports and recalculating 1994 air carrier delays using the delay equation results in a total delay reduction of 14,000 hours. The improvements range from over 12,000 hours at the five airports most affected to 2,000 hours at the five airports least affected. Table 3-14 gives the distribution of benefits among the sample airports.

TABLE 3-14. TRIPLE IFR APPROACHES, ESTIMATED 1994 DELAY REDUCTIONS

NO. AIRPORTS BENEFITING		AIRCRAFT (hours)	PASSENGER (hours)
LARGEST	5 *	12,270	720,073
	6-10	2,007	74,034
TOTAL		14,276	794,107

*** Ranked by number of hours reduced delay.**

Note: The IFR capacity gains associated with triple approaches are 20 percent when a third dependent parallel stream is added, and 50 percent when the third stream is independently converging.

3.2.5 Separate Short IFR Runways

Description of Concept

Airports sometimes have runways that are suitable for use by slower aircraft but too short for regular use by faster air carrier jets. These runways are used under VFR but not IFR because of the restrictions placed on multiple approach operations when visibility is limited. Nonetheless, the multiple approach options covered in sections 3.2.1 through 3.2.4 can be applied to short runways, adding to an airport's IFR capacity for slower planes. Generally the benefits of this approach are included as part of the relevant multiple approach concept covered in the previous sections. However, benefits from use of short runways were not included for some larger airports. These are included in this section.

The use of separate short IFR runways for slower aircraft can benefit large airports that satisfy two conditions: an appropriate runway must exist; and use of the short runway as an IFR multiple approach option must be in addition to the use of existing longer runways. Seven airports that meet these criteria are identified in Table 3-15.

TABLE 3-15. SEVEN CANDIDATE AIRPORTS FOR SEPARATE SHORT RUNWAYS

STATE	CITY	AIRPORT
Airports ranked 1 through 5*		
KY	COVINGTON	GREATER CINCINNATI INT.
MD	BALTIMORE	BALTIMORE-WASHINGTON INT.
OH	COLUMBUS	PORT COLUMBUS INTERNATIONAL
PA	PHILADELPHIA	PHILADELPHIA INTERNATIONAL
WI	MILWAUKEE	GENERAL MITCHELL FIELD
Airports ranked 6 through 7*		
IN	INDIANAPOLIS	INDIANAPOLIS INTERNATIONAL
NY	NEW YORK	LAGUARDIA

* Ranked by hours of reduced delay in 1994 from separate short runways, alphabetically by state and city.

Delay Reductions

Separate short runways result in an estimated 1994 air carrier delay reduction of 2,000 hours

Delay reductions attributable to the IFR use of separate short runways at the seven candidate airports were estimated by assuming that GA operations (up to a maximum of one-half of total airport operations) are shifted to the short runway. An increased IFR capacity level related to runway geometry was estimated and used in the delay equation to compute delay reductions for each airport. The resulting 2,000 hour delay reduction is an estimated benefit of this concept, as indicated in Table 3-16.

TABLE 3-16. SEPARATE SHORT RUNWAYS, ESTIMATED 1994 DELAY REDUCTION

NO. AIRPORTS BENEFITING		AIRCRAFT (hours)	PASSENGER (hours)
LARGEST	5 *	1,805	63,189
	6-7	410	18,024
TOTAL		2,215	81,213

*** Ranked by number of hours of reduced delay.**

Note: The benefits of short runways quantified in this section do not overlap with the benefits reported elsewhere. For 43 large air carrier airports, runways less than 6,000 feet in length were omitted from consideration in analyses of multiple approach concepts. This is because any extra capacity they create would not be available to the majority of aircraft using the airport. If separate short runways were available to the smaller aircraft using these large airports, there would be less congestion and delay on runways serving larger aircraft. This delay reduction cannot be estimated in the same manner used in the other sections because the extra capacity affects only a portion of the aircraft using the airport. Instead, an alternate benefits estimation procedure is used involving an adjustment to IFR capacity that depends on the percentage of GA operations.

3.2.6 Improved IFR Longitudinal Separations

Description of Concept

Air traffic control procedures include minimum longitudinal separation standards for aircraft in IFR approach streams. The separation distances vary depending on the relative sizes of the leading and trailing aircraft. The minimum separations are intended to protect the trailing aircraft from leading aircraft wake vortices and to avoid situations in which the trailing aircraft lands on the runway before the leading aircraft has exited it. A reduction in the separation standard from 3.0 to 2.5 nautical miles between certain classes of aircraft has been approved and included in the FAA's terminal ATC procedures. FAA approval of applications to reduce standards at individual airports will lead to implementation of this procedure.

All airports will benefit from the reduced separations except those where diagonal separations between aircraft landing on parallel runways require greater longitudinal spacings. Reductions in air carrier delays are estimated for 165 airports that have air carrier operations and non-zero IFR capacity. The 30 airports expected to receive the greatest benefit from this concept are listed in Table 3-17.

TABLE 3-17. THIRTY CANDIDATE AIRPORTS FOR IMPROVED IFR LONGITUDINAL SEPARATION

STATE	CITY	AIRPORT
Airports ranked 1 through 5*		
CA	LOS ANGELES	LOS ANGELES INTERNATIONAL
CO	DENVER	STAPLETON INTERNATIONAL
GA	ATLANTA	WILLIAM B. HARTSFIELD
IL	CHICAGO	CHICAGO O'HARE
MO	ST. LOUIS	LAMBERT-ST. LOUIS INTERNATIONAL
Airports ranked 6 through 10*		
CA	SAN FRANCISCO	SAN FRANCISCO INTERNATIONAL
NC	CHARLOTTE	CHARLOTTE/DOUGLAS INTERNATIONAL
NJ	NEWARK	NEWARK INTERNATIONAL AIRPORT
NY	NEW YORK	LAGUARDIA
TX	HOUSTON	HOUSTON INTERCONTINENTAL
Airports ranked 11 through 20*		
CA	OAKLAND	METRO OAKLAND INTERNATIONAL
CA	SAN JOSE	SAN JOSE MUNICIPAL
CA	SANTA ANA	JOHN WAYNE AIRPORT-ORANGE COUNTY
DC	WASHINGTON	WASHINGTON NATIONAL
KY	COVINGTON	GREATER CINCINNATI INTERNATIONAL
MA	BOSTON	GEN. EDW. L. LOGAN INTERNATIONAL
NY	NEW YORK	JOHN F. KENNEDY INTERNATIONAL
PA	PITTSBURGH	GREATER PITTSBURGH INTERNATIONAL
TX	DALLAS/FT. WORTH	DALLAS/FT. WORTH INTERNATIONAL
WA	SEATTLE	SEATTLE-TACOMA INTERNATIONAL
Airports ranked 21 through 30*		
AK	ANCHORAGE	ANCHORAGE INTERNATIONAL
CA	ONTARIO	ONTARIO INTERNATIONAL
FL	ORLANDO	ORLANDO INTERNATIONAL
MD	BALTIMORE	BALTIMORE-WASHINGTON INTERNATIONAL
MO	KANSAS CITY	KANSAS CITY INTERNATIONAL
OH	CLEVELAND	CLEVELAND-HOPKINS INTERNATIONAL
PA	PHILADELPHIA	PHILADELPHIA INTERNATIONAL
TX	AUSTIN	ROBERT MUELLER
TX	HOUSTON	WILLIAM P. HOBBY
TX	SAN ANTONIO	SAN ANTONIO INTERNATIONAL

*** Ranked by hours of reduced delay in 1994 from improved IFR longitudinal separation, alphabetically by state and city.**

Delay Reductions

Increasing the IFR capacities at the affected airports and recalculating 1994 air carrier delays using the delay equation results in a total delay reduction of 6,500 hours. The improvements range from over 2,700 hours at the five airports most affected to no benefit at a few airports. Table 3-18 gives the distribution of benefits among airports. There is a concentration of benefits among the 20 most affected.

Improved IFR longitudinal separations result in an estimated 1994 air carrier delay reduction of 6,500 hours

TABLE 3-18. IMPROVED IFR LONGITUDINAL SEPARATION, ESTIMATED 1994 DELAY REDUCTION

NO. AIRPORTS BENEFITING		AIRCRAFT (hours)	PASSENGER (hours)
LARGEST	5 *	2,706	142,518
	6-10	1,126	60,094
	11-20	1,378	72,129
	21-30	526	22,021
	31-40	278	9,947
	41-105	496	17,785
TOTAL		6,511	324,504

* Ranked by number of hours of reduced delay.

3.3 ADDITIONAL EQUIPMENT AND SYSTEMS

The FAA capacity enhancement program includes the development and deployment of a wide range of equipment and systems for terminal areas. Individual projects either support and enhance the revisions to airspace control procedures described in the previous section, or they directly alleviate some aspect of the airport delay problem. The individual projects vary in their applicability. Some such as Wind Shear Sensor Development and Mode S Data Link Applications Development will apply at most airports, while others such as Wake Vortex Avoidance and Forecasting have their main impact at airports where there are closely-spaced multiple approach streams.

The Microwave Landing System (MLS) can provide major long-term capacity gains due to its capability to provide high flexibility with precision in both approach and departure operations. The initial installations of MLS will be on secondary runways at hub airports. Capacity gains also will be achieved with installation on runways that are currently using restricted instrument landing systems (ILS).

Ultimately the use of MLS offers potential capacity benefits at many major airports by enabling 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. It also would eliminate airspace conflicts between LaGuardia and Kennedy airports, which under certain conditions, would enable the use of an additional runway at LaGuardia. By using the curved approach capability of MLS, properly equipped aircraft also could avoid noise-sensitive areas. This would allow the airports to operate with higher capacity configurations than may be possible given current noise abatement procedures.

This group of projects also includes Terminal ATC Automation (TATCA) and many other projects that complement its application. The effect of TATCA is to improve the performance of air traffic controllers and pilots and thereby increase the effective rate at which airport operations can occur, especially under IFR. This improved performance consists of reductions in the size and variability of aircraft separations from the metering fix to the runway threshhold.

The FAA and NASA are working jointly on a proposal for the dynamic control of arrival aircraft. The concept is to sequence, meter, and control aircraft along fuel-efficient flight profiles. Aircraft would be sequenced on a first-come, first-serve basis using travel times on a minimum flight path with a clean configuration and idle thrust. Aircraft would be provided with a 4-D flight profile, including airspeed, route, time across a metering fix, and assigned altitude. This information would be provided to the controller to relay to the pilot. Eventually, datalink could be used to update a 4-D RNAV-capable aircraft automatically. The aircraft's conformance with its profile would be monitored and adjustments made as necessary due to fix time errors. On final approach, computer-aided fine-tuning maneuvers could be made to reduce the delivery error.

All airports with control towers could benefit from TATCA. Benefits are estimated in terms of reduced delay to IFR air carrier operations at 180 airports by assuming that IFR operations more closely resemble operations under VFR. The 30 airports expected to receive the greatest benefit from this concept are listed in Table 3-19.

TABLE 3-19. THIRTY CANDIDATE AIRPORTS FOR TERMINAL AIR TRAFFIC CONTROL AUTOMATION

STATE	CITY	AIRPORT
Airports ranked I through 5*		
CA	LOS ANGELES	LOS ANGELES INTERNATIONAL
CO	DENVER	STAPLETON INTERNATIONAL
GA	ATLANTA	WILLIAM B. HARTSFIELD
IL	CHICAGO	CHICAGO O'HARE
MO	ST. LOUIS	LAMBERT-ST. LOUIS INTERNATIONAL
Airports ranked 6 through 10*		
CA	OAKLAND	METRO OAKLAND INTERNATIONAL
CA	SAN FRANCISCO	SAN FRANCISCO INTERNATIONAL
NC	CHARLOTTE	CHARLOTTE/DOUGLAS INTERNATIONAL
NJ	NEWARK	NEWARK INTERNATIONAL AIRPORT
TX	HOUSTON	HOUSTON INTERCONTINENTAL
Airports ranked 11 through 20*		
CA	SANTA ANA	JOHN WAYNE ARPT.-ORANGE CO.
DC	WASHINGTON	WASHINGTON NATIONAL
MA	BOSTON	GEN. EDW. L. LOGAN
MI	DETROIT	DETROIT METROPOLITAN-WAYNE
MN	MINNEAPOLIS	MINNEAPOLIS-ST. PAUL INT./WOLD
NY	NEW YORK	JOHN F. KENNEDY
NY	NEW YORK	LAGUARDIA
PA	PITTSBURGH	GREATER PITTSBURGH INTERNATIONAL
TX	DALLAS/FT. WORTH	DALLAS/FT. WORTH INTERNATIONAL
WA	SEATTLE	SEATTLE-TACOMA INTERNATIONAL
Airports ranked 21 through 30*		
CA	ONTARIO	ONTARIO INTERNATIONAL
CA	SAN JOSE	SAN JOSE MUNICIPAL
FL	ORLANDO	ORLANDO INTERNATIONAL
KY	COVINGTON	GREATER CINCINNATI INTERNATIONAL
MD	BALTIMORE	BALTIMORE-WASHINGTON INTERNATIONAL
NC	RALEIGH	RALEIGH-DURHAM
OH	CLEVELAND	CLEVELAND-HOPKINS INTERNATIONAL
PA	PHILADELPHIA	PHILADELPHIA INTERNATIONAL
TN	MEMPHIS	MEMPHIS INTERNATIONAL
TX	HOUSTON	WILLIAM P. HOBBY

* Ranked hours of reduced delay in 1994 from Terminal ATC Automation, alphabetically by state and city.

Delay Reductions

Terminal air traffic control automation results in an estimated 1994 air carrier delay reduction of 17,000 hours

Increasing the IFR capacities at affected airports and recalculating 1994 air carrier delays using the delay equation results in a total delay reduction of 17,000 hours. The improvements range from 6,700 hours at the five airports most affected to little benefit at some airports. Table 3-20 gives the distribution of benefits among airports. There is a concentration of benefits among the 20 most affected.

TABLE 3-20. TERMINAL AIR TRAFFIC CONTROL AUTOMATION, ESTIMATED 1994 DELAY REDUCTION

NO. AIRPORTS BENEFITING		AIRCRAFT (hours)	PASSENGER (hours)
LARGEST	5 *	6,740	354,824
	6-10	2,768	136,478
	11-20	3,395	182,886
	21-30	1,618	57,348
	31-40	931	50,846
	41-180	1,741	61,300
TOTAL		17,193	843,682

*** Ranked by number of hours of reduced delay.**

Note: There are several ways to estimate the effects of TATCA. This analysis used as an approximation a reference point of VFR input values for several parameters in the Airfield Capacity Model. The IFR values for these parameters were adjusted for the effects of TATCA by moving them closer to the VFR values. It was arbitrarily assumed that TATCA would have the effect of reducing the VFR-IFR parameter differences by 60 percent.

3.4 CAPACITY PLANNING STUDIES

Airport Capacity Task Forces

The FAA has a number of projects and programs that support capacity enhancement by developing analytical tools for serving as catalysts for the adoption of other capacity enhancement actions. Foremost among these projects are the Airport Capacity Enhancement Task Forces, which provide a means for the ACPO to initiate and support planning activities at individual airports. These Task Forces include representatives from the airport operator, involved airlines, the airport control tower, the FAA Technical Center and regional office, and others.

Foremost among these projects are the Airport Capacity Enhancement Task Forces

Each Task Force performs an in-depth study of an airport's current and anticipated capacity problems; it identifies the causes of delay and then evaluates the delay reduction potential of alternative air traffic control procedures, facilities and equipment, and AIP improvement options. The result is an action plan that serves as a guide for improvements at the particular airport. For example, an action plan for Atlanta and tentative action plans for Kennedy, LaGuardia, and San Francisco airports are shown in Tables 3-21 and 3-22. Each year Task Forces are begun at some airports and completed at others. However, even when completed, the intent is to provide for periodic review to update the plans.

TABLE 3-21. ACTION PLAN FOR WILLIAM B. HARTSFIELD ATLANTA INTERNATIONAL AIRPORT

Improvements	Type of Action[1]	Time Frame[2]	Responsible Agency
Airfield			
(1) International concourse	Achievable	Near	City
(2) Fifth concourse	Master Plan	Intermediate	City
(3) Commuter/GA terminal and runway complex south of R/W 9R/27L	Master Plan	Intermediate	City
(4) Three hold pads at end of departure runways	Achievable	Near	City
(5) Taxiway C parallel to and west of taxiway D	Achievable	Near	City
(6) Angled exits for commuter aircraft; widened fillets at exits to facilitate use in either direction	Achievable	Near	City
Facilities and Equipment			
(7) Expedite development and installation of wake vortex forecasting and avoidance systems	Systems Policy Change	Long	FAA
(8) Upgrade NAVAIDS and approach lights on R/W 26R and 27L to Category II	Achievable	Intermediate	FAA
(9) Update terminal approach radar	Achievable	Near	FAA
(10) Upgrade RVR system to CAT IIIB and ICAO standards	Achievable	Near	FAA
(11) Install ASDE III with tracking	Achievable	Near	FAA
(12) Install touchdown zone lights on R/W 27L	Achievable	Intermediate	City
Operational Improvements			
(13) Reduce arrival separations to 2.5 nm	Achievable	Near	FAA
(14) Enhance traffic management procedures	Achievable	Near	FAA
User Improvements			
(15) De-peak airline schedules within the hour	Major Policy Change	Near	Airlines

[1] Types of Action: Achievable - Changes or improvements with benefits that have been clearly identified; for which action may already be underway; and that do not require a major policy change by any of the Task Force organizations. Major Policy Change - A change in procedure or operational regulation that requires a major policy revision by one of the Task Force organizations. Master Plan Study - A physical change for which the benefits in delay reduction must be evaluated for its economic and environmental consequences by groups outside the Task Force. Systems Policy Change - A change that must be implemented concurrently system-wide due to its wide scope and that requires detailed research and evaluation by the Federal Aviation Administration.

[2] Time Frame: Near - Improvement available and producing benefits by 1991; Intermediate - by 1996; Far - beyond 1996.

TABLE 3-22. TENTATIVE ACTION PLANS[1]

	DELAY REDUCTION (hours per year)
KENNEDY INTERNATIONAL AIRPORT[2]	
Allow Class 3 and 4 aircraft departures on Runway 31R	3,967
Allow Class 2 quiet jet departures on Runway 31R	6,933
Develop independent converging IFR approaches to Runways 13R and 22L	1,800
Relocate Runway 4L glide slope and develop staggered approaches to Runways 4L/4R	9,233 (1991)
Short Runway 4/22E for GA aircraft	11,200 (1991)
Short (shoreline) Runway 13/31S for GA aircraft	8,350 (1991)
Full length (shoreline) Runway 13/31S for all aircraft departures.	18,717 (1996)
LaGUARDIA AIRPORT[3]	
Reduce longitudinal separation to 2.5 nmi for IFR arrivals	4,717
Install state-of-the-art ASDE radar	5,100
Eliminate noise restrictions on Runway 13 departures	497
Relieve airspace interaction between LGA Runway 22 and JFK Runway 13L	567
SAN FRANCISCO INTERNATIONAL AIRPORT[4]	
Expanded visual approach procedure, Runways 28R and 28L	2,271
Offset instruments approach, Runways 28R	56,740
Simultaneous IFR departures, Runways 10L and 10R	6,775
Extend Runways 19L and 19R	12,181
Extend Runways 28L and 28R	32,716

[1] This table includes only recommendations that were computer simulated.

[2] Hours per year based on 1986 activity unless noted.

[3] Hours per year based on 1986 activity unless noted.

[4] Hours per year based on forecast activity of 443,000 operations per year; current level is approximately 389,000 per year.

Multi-Airport Traffic Flow Analysis

Another project in this area involves the development, enhancement, and application of multi-airport traffic flow models to facilitate better use of available system capacity. The ACPO has sponsored the use of one of these models, the Airport/Airspace Delay and Fuel Consumption Simulation Model (SIMMOD), in the development of revised aircraft control procedures for the east and west coasts. These planning efforts are expected to reduce delays by creating more departure routes from areas served by multiple airports.

For example, the FAA Western-Pacific Region will identify the West Coast Plan problems and issues to be addressed using SIMMOD. These problems and issues will include, but are not limited to, the following:

1. development of a San Francisco Bay Area to Los Angeles Basin offshore route;
2. realignment of traffic flows into and out of Los Angeles Area airports including multi-facility resectorization;
3. redesign of inland air traffic routes between the San Francisco Bay Area and Los Angeles Basin;
4. expansion of tower en route control in various areas of California and Arizona;
5. movement of several Military Operating Areas to free up airways and affected airspace; and
6. realignment of Center boundaries and airspace.

Implementation of the East Coast Plan in the New York area has begun, and there has been a 48 percent reduction in delays at New York Airports during February - March 1987 as opposed to the same months in 1986. Analysis in support of an extension of the East Coast Plan into the New England Region and the West Coast Plan are underway.

3.5 SUMMARY

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 in this plan are expected to increase the effective throughput of airports. Assisted in some cases by AIP grants, airport and aircraft operators can take action to reduce delays. However, while these projects will help, they are not in themselves a complete solution to all airport capacity problems. It is likely that the demand for travel at a number of busy airports will increase faster than the airports' ability to accommodate the growth. Each component of the industry must do its part to solve the congestion problem.

FAA's Contribution

The projects described in this plan will enhance capacity and alleviate some of the existing and projected congestion and delay. Some projects, such as those funded by the AIP grant program, may yield significant capacity gains by promoting expansion of airport facilities. Other projects will enhance capacity by equipping airports with new equipment and systems, including more precise radar and navigational aids. Many projects, such as those involving revised airspace control procedures, are directed toward optimum usage of existing airport facilities while maintaining or improving safety. Finally, improved planning will provide a coordinated response and ensure that priority is given to projects likely to provide the greatest capacity enhancement benefit.

Aircraft Operators' Contribution

There are parts of the airspace system where and times of the day when the amount of congestion is much lower than the average. Aircraft operators who can shift their operations from the more congested areas and times to the less congested ones, while still meeting their operational objectives, can increase the overall utilization of the airspace system and reduce their delay costs. The creation of hubs at previously under-utilized airports such as Washington Dulles and Memphis are examples of this. The overnight package delivery companies have found a profitable way to use the system during off-peak hours, and vacation oriented charter flights also depart and arrive at off-peak hours to their advantage.

Airport Owners' and Operators' Contribution

While the FAA can assist in providing funding for runways, navigation equipment and other projects, it relies on the airport owners or operators to identify those projects that would be most beneficial to a particular airport. This plan suggests ways to increase capacity; however, initiative from the aviation industry is needed to get these ideas implemented.

4. PROJECT DESCRIPTIONS

This chapter presents detailed descriptions of the capacity enhancement projects that currently make up the Airport Capacity Enhancement Program. For consistency with Chapter 3, the project descriptions are grouped into the four broad categories of airport construction and expansion, improved airspace control procedures, additional equipment and systems, and capacity planning studies. Each description is accompanied by a milestone chart*, expected completion dates, and the telephone number of a responsible FAA office. To facilitate locating a particular project description, the projects are listed alphabetically by title and project number in Table 4-1.

***R, E & D (O) Research, Engineering and Development**
St. & G (□) Standards and Guidelines
F&E (Δ) Facilities and Equipment

TABLE 4-1. ALPHABETICAL LISTING OF AIRPORT CAPACITY ENHANCEMENT PROJECTS

PROJECT TITLE	NO.
Airport Capacity and Delay Models	4.2
Airport Capacity Enhancement Task Forces	4.1
Airport Design and Configuration Improvements	1.2
Airport Improvement Program (AIP)	1.1
Airport Lighting and Visual Aids Research and Development	1.3
Airport Surface Detection Equipment (ASDE-#3)	3.13
Automated Airport Capacity Calculations	3.11
Departure Flow Metering	3.9
Environmental Programs	4.3
IFR Approaches to Converging Runways	2.1
Improved Independent Parallel IFR Approaches	2.2
Microwave Landing System (MLS) F&E	3.1
Mode S Data Link Applications Development	3.14
Next Generation Weather Radars	3.3
Pavement Strength, Durability, and Repair	1.4
Improved Longitudinal Separation Standards	2.3
Runway Configuration Management System	3.15
RVR Establish/Upgrade	3.6
Terminal ATC Automation	3.16
Terminal Radar Enhancements	3.12
Triple IFR Approaches	2.4
Upgrade Arrivals/Demand Algorithms	3.10
Wake Vortex Avoidance and Forecasting	3.8
Weather Sensor Development	3.5
Wind Measuring Equipment/Efforts (LLWAS)	3.4
Wind Shear Detection	3.7

Note: This list does not include two projects discussed in Chapter 3: Improved Dependent IFR Parallel Approaches and Separate Short Runways.

1 AIRPORT CONSTRUCTION AND EXPANSION

1.1 AIRPORT IMPROVEMENT PROGRAM (AIP)

AIRPORT CAPACITY IMPROVEMENT IMPACT: **INCREASE CAPACITY THROUGH THE PROVISION OF FUNDS FOR PLANNING, DEVELOPMENT, NOISE COMPATIBILITY, AND LAND BANKING PROJECTS WITH 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 such 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 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:

	AUTHORIZED	APPROPRIATION LIMIT
1982:	$450.0 million	$450.0 million
1983:	$800.0 million	$804.5 million
1984:	$993.5 million	$800.0 million
1985:	$987.0 million	$925.0 million
1986:	$1,017.0 million	$885.2 million
1987:	$1,017.2 million	$1,000.0 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.

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

RESPONSIBLE OFFICE: APP-520, (202) 267-8809
APP-500, (202) 267-3831

REMARKS/NOTES: The House and Senate conferees have reached agreement on FY 1987 appropriations for DOT/FAA and provided an obligation ceiling of $1 billion for the Airport Improvement Program. $5.5 million was also approved for airport capacity research. The transportation funding will be included in the Continuing Resolution (H.J. Res. 738) for FY 1987.

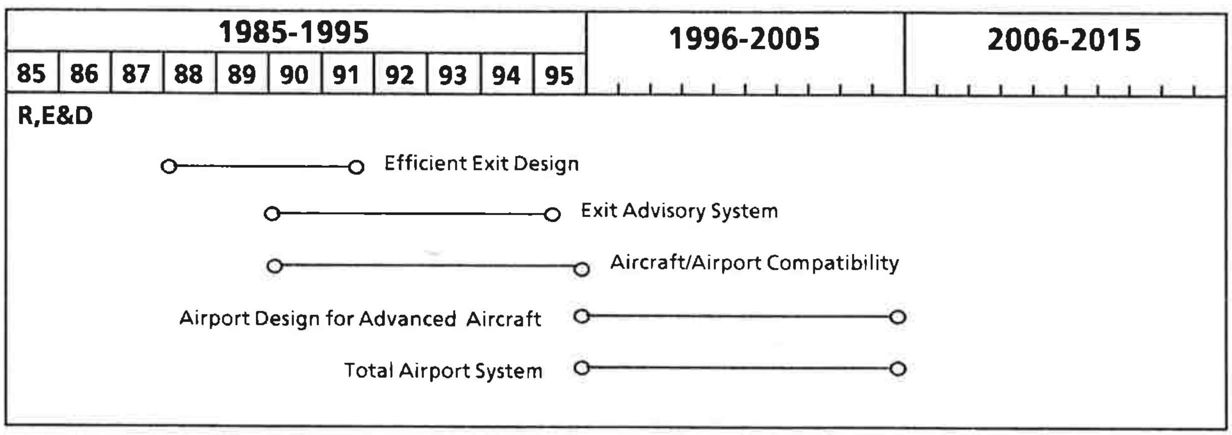
1.2 AIRPORT DESIGN AND CONFIGURATION IMPROVEMENTS

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 to aid in the cost-effective design of runways, taxiways, and ramps that meet current needs and yet are adaptable to future requirements. These tools are needed to maintain current capacity and enhance it in light of future airfield surface and aircraft developments. 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 needed 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 that show the greatest potential for capacity improvement or delay reduction.

MILESTONE SCHEDULE:



RESPONSIBLE OFFICE: APM-740, (202) 267-8679

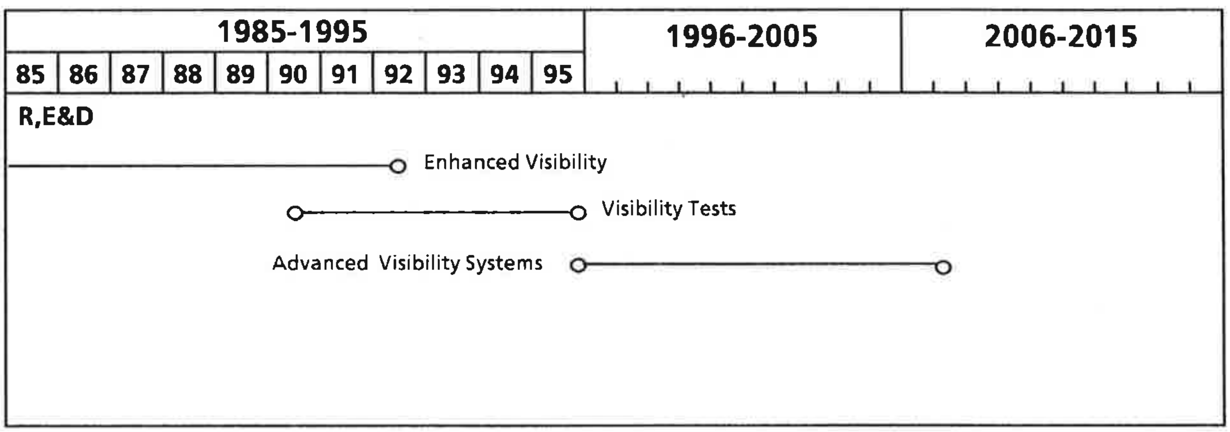
REMARKS/NOTES: Several specific configurations of runways, taxiways, and aprons will be evaluated for distances and times required for ground operations. Facilities for STOL and VTOL aircraft and rotorcraft will then be added to these configurations, and the resulting airport systems will be evaluated for overall operating efficiency.

1.3 AIRPORT LIGHTING AND VISUAL AIDS RESEARCH AND DEVELOPMENT

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

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 provide guidance while taxiing and improve the identification of holding and clearance points. Improvements in lighting systems are necessary to support the proposed all-weather taxiway guidance and control system. The result will be increased efficiency and safety during IFR operations, which will provide capacity improvement and delay reduction.

MILESTONE SCHEDULE:



RESPONSIBLE OFFICE: APM-450, (202) 267-8536

1.4 PAVEMENT STRENGTH, DURABILITY, AND REPAIR

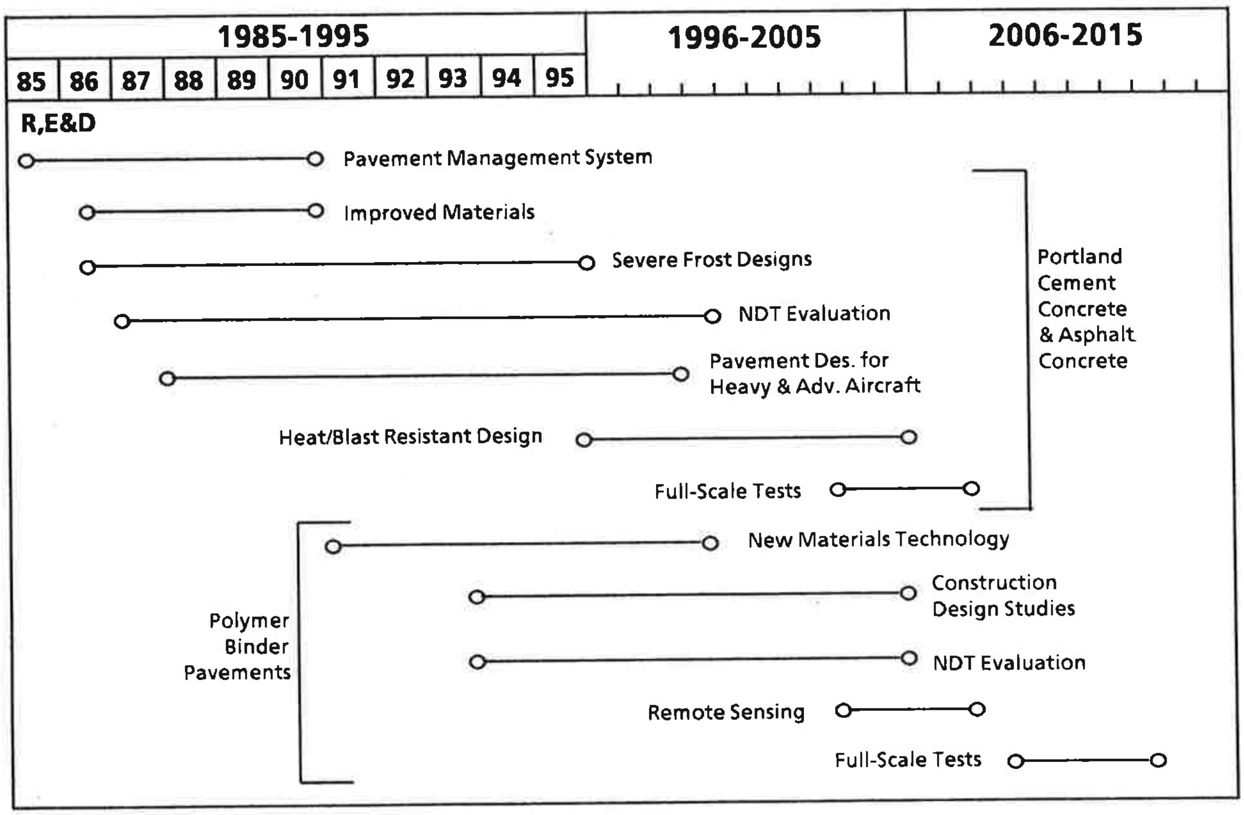
AIRPORT CAPACITY IMPROVEMENT IMPACT:	**INCREASE CAPACITY BY DEVELOPING MORE DURABLE AIRPORT PAVEMENT MATERIALS, THUS INCREASING RUNWAY AVAILABILITY**

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 that increase the durability of concrete and reduce its susceptibility to damage from the environment and traffic will increase runway availability. To parallel 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. Since the terms of AIP grants require the owner to maintain the pavement, the FAA's participation in airport pavement construction has been confined to new construction, major reconstruction, and construction required for safety purposes. Proper pavement management guidance is needed to maintain pavement and delay the need for major reconstruction.

MILESTONE SCHEDULE:

	Scheduled Completion	Revised Scheduled Completion	Actual Completion
• Draft - Pavement Management System Pavement Condition Index (PCI) Computer Software Developed			5/86
• PCI Final Report	9/87		



RESPONSIBLE OFFICE: APM-740, (202) 267-8679

REMARKS/NOTES: FAA has provided airport owners and operators with a system of evaluation from which a pavement condition index (PCI) can be determined. But, utilizing the PCI system, setting priorities, scheduling maintenance operations to avoid conflict with aircraft traffic, and performing cost analyses would be facilitated by computer software compatible with a personal computer. This effort will provide a computer program with documentation to assist airport owners and operators in maintenance management.

2 IMPROVED AIRSPACE CONTROL PROCEDURES

2.1 IFR APPROACHES TO CONVERGING RUNWAYS

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

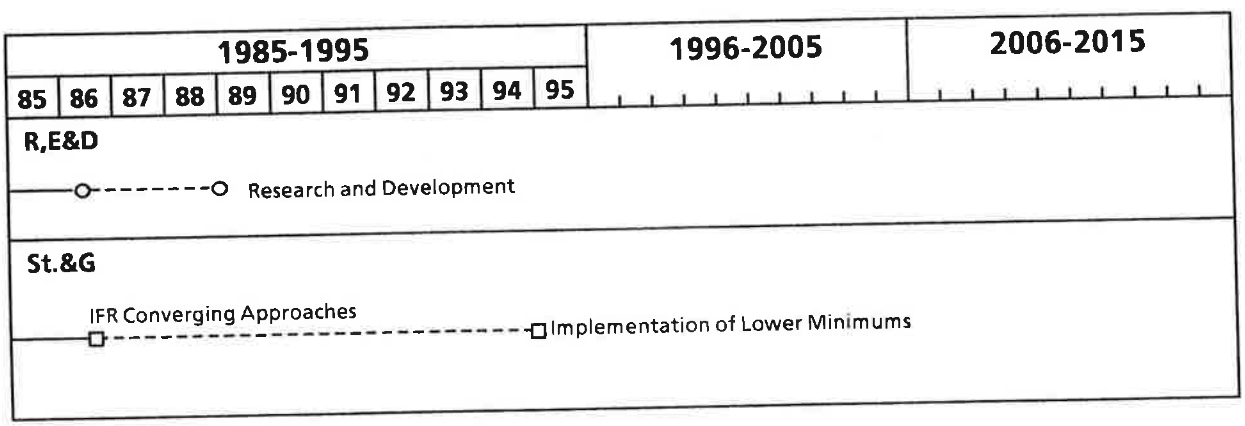
Simultaneous instrument approaches to converging runways have been operated during VFR weather conditions at many airports for many years. A few airports have conducted these approaches in IFR weather, but only through the application of visual separation. To increase IFR capacity, criteria and improved surveillance are needed 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 up to 70 of the busiest airports. This will significantly improve capacity at these airports during IFR weather conditions.

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

MILESTONE SCHEDULE:

	Scheduled Completion	Revised Scheduled Completion	Actual Completion
• FAA Order 7110.98 Simultaneous Converging Instrument Approaches (SCIA)			4/13/86
• Lower Minimums	1994		



RESPONSIBLE OFFICE: ATO-320, (202) 267-9335

2.2 IMPROVED INDEPENDENT PARALLEL IFR APPROACHES

AIRPORT CAPACITY IMPROVEMENT IMPACT: **IMPROVE CAPACITY AT QUALIFYING AIRPORTS BY ALLOWING IMPROVED INDEPENDENT PARALLEL APPROACHES DURING INSTRUMENT WEATHER CONDITIONS**

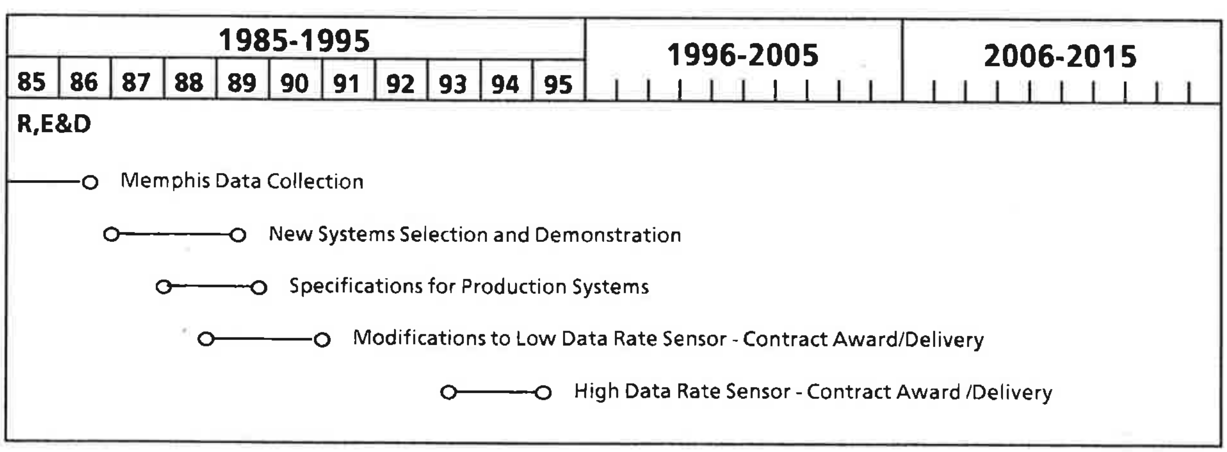
The goal of this project is to develop IFR procedures that will enable independent streams of aircraft to land on parallel runways separated by less than 4,300 feet but more than 2,500 feet.

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 further 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. Data collection was conducted at Memphis, Tennessee during 1985 and 1986. Data were collected using a precision approach radar that was determined not to be cost effective. Additional surveillance systems were reviewed and two systems were selected for demonstration.

MILESTONE SCHEDULE:

	Scheduled Completion	Revised Scheduled Completion	Actual Completion
Memphis Data Collection			3/1/86
• Draft Report			9/30/86
• Data Analysis and Final Report			
• Engineering Requirements for Sensor			
• Prototype Sensors for Demonstration	FY 1989		



RESPONSIBLE OFFICE: ACP-5, (202) 267-8789

2.3 IMPROVED LONGITUDINAL SEPARATION STANDARDS

AIRPORT CAPACITY IMPROVEMENT IMPACT: **INCREASE CAPACITY BY REDUCING THE REQUIRED LONGITUDINAL SEPARATION BETWEEN AIRCRAFT, ENABLING MORE EFFICIENT RUNWAY USE**

The capacity of a single runway is constrained by longitudinal separation standards, which are required separation between successive aircraft on approach. The current separation standard between large aircraft when wake vortices are not a factor, is three nautical miles. The Industry Task Force on Airport Capacity Improvement and Delay Reduction has 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 that determined that this procedure could be done safely and without increasing the number of missed approaches 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 50 seconds or less. Dallas-Fort Worth, Atlanta, Newark, and Los Angeles were selected as 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 demonstrations were successful and a procedural change allowing operations with the reduced standard has been approved for implementation in 1987.

MILESTONE SCHEDULE:

	Scheduled Completion	Revised Scheduled Completion	Actual Completion
• Proposed Revision to FAA Handbook 7110.65, Paragraph 5-72, MINIMA out for comments			8/1/86
• Implement Revision to FAA Handbook 7110.65			5/1/87

1985-1995											1996-2005	2006-2015
85	86	87	88	89	90	91	92	93	94	95		
R,E&D												
O---O Procedural Change												

RESPONSIBLE OFFICE: ATO-320, (202) 267-8460

2.4 TRIPLE APPROACHES

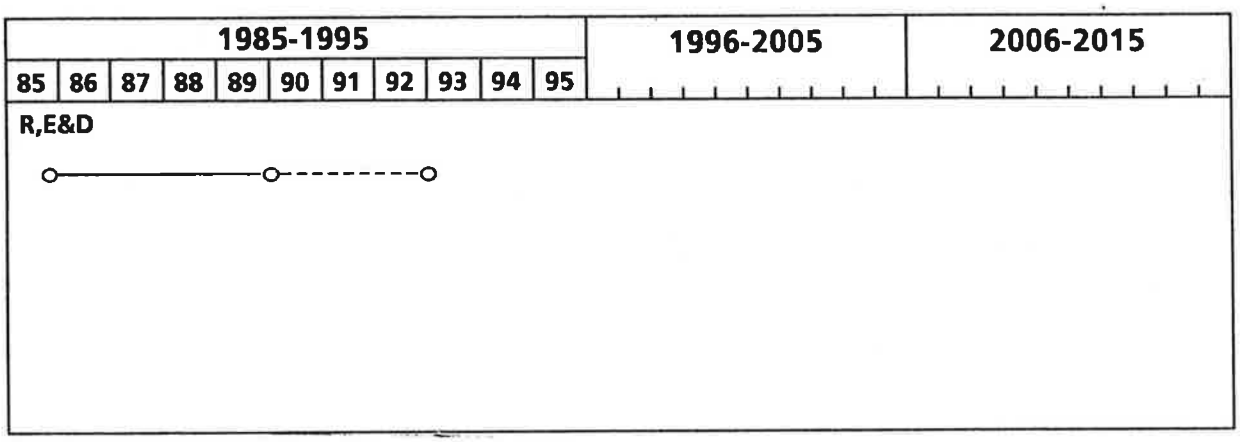
AIRPORT CAPACITY IMPROVEMENT IMPACT: **INCREASE CAPACITY BY ENABLING TRIPLE ARRIVAL STREAMS UNDER IFR CONDITIONS**

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 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 obtained using separate short runways. This will permit separate access to major airports that 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.

MILESTONE SCHEDULE:

	Scheduled Completion	Revised Scheduled Completion	Actual Completion
• Requirement for Instrument Approaches to Triple Parallel Runways			7/81
• Triple Approach Procedures - Existing Separation Standards	Not Scheduled		
• Triple Approach Procedures - New Separation Standards	Not Scheduled		



RESPONSIBLE OFFICE: ATO-320, (202) 267-8460

REMARKS/NOTES: Triple approaches are currently used at some airports when visual conditions are three miles or better. The development of IFR procedures that will permit triple approaches during periods of reduced visibility requires an investigation of surveillance and navigation systems that will ensure separation during the approach and missed approach phases.

3 ADDITIONAL EQUIPMENT AND SYSTEMS

3.1 MICROWAVE LANDING SYSTEM (MLS) F&E

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

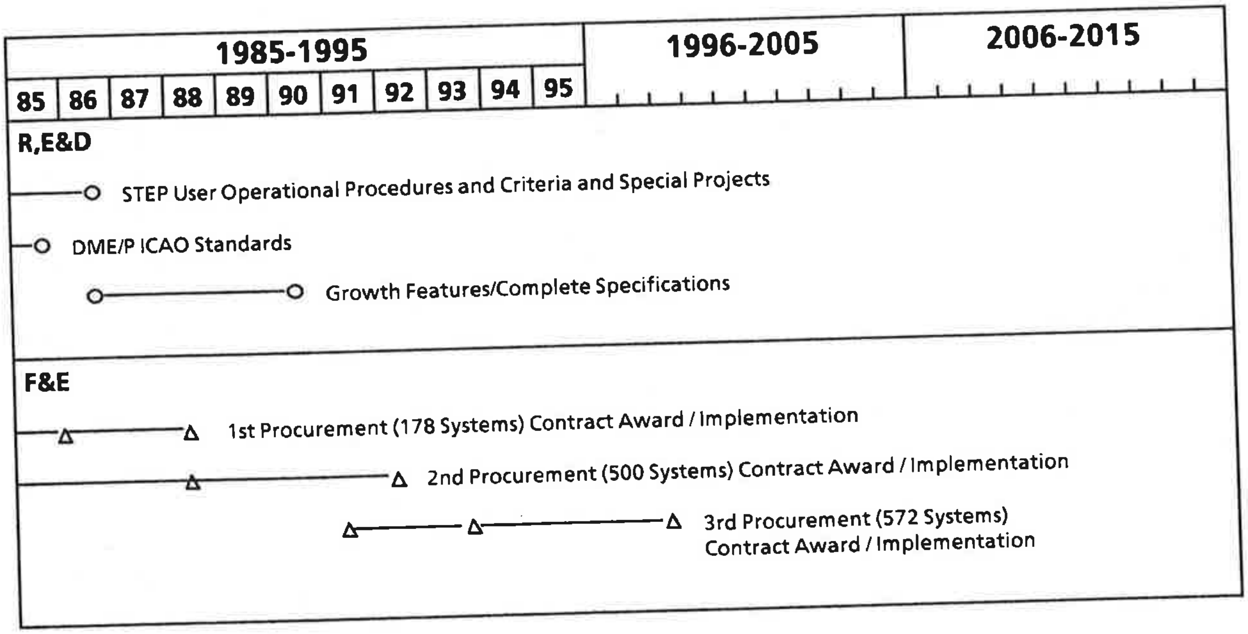
The Instrument Landing System (ILS) has served as the standard precision approach and landing aid for more than 30 years. Although it has undergone a number of improvements to increase its performance and reliability, the ILS has a number of basic limitations with respect to future aviation requirements. 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 greater 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 requirements. The FAA is in the early stages of Phase I of a three-phase implementation program. The first phase provides for installation of up to 178 MLS ground systems over a two-year period beginning in 1988. Phase II includes installation of approximately 500 systems; priority will be given to networks of airports that link major city airports or hubs. Phase III provides for an additional 572 systems to complete the FAA implementation. The overall program includes the implementation of 1,250 systems to meet the system requirements.

MILESTONE SCHEDULE:

	Scheduled Completion	Revised Scheduled Completion	Actual Completion
• 1st Procurement 178 CAT I MLS Ground System Implementation	12/1/85		4/22/86
• Regional Input to MLS Site Selection - 2nd procurement			7/30/86
• 2nd Procurement 500 MLS Ground Systems out for bid		TBD	
• 3rd Procurement 572 MLS Ground Systems Contract Awarded	9/30/87	1988	

MILESTONE SCHEDULE (CONT.)



RESPONSIBLE OFFICE: APM-4A, (202) 267-8663
APR-100, (202) 267-9654
APM-410, (202) 267-8504

REMARKS/NOTES: Congress de-funded MLS in FY 1987.

3.2 INSTRUMENT LANDING SYSTEM (ILS)

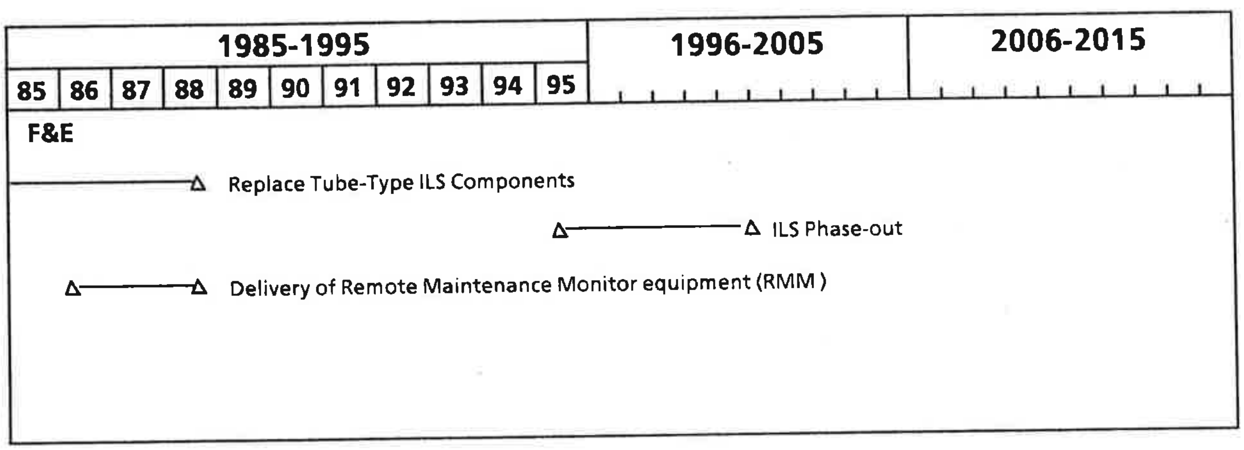
AIRPORT CAPACITY IMPROVEMENT IMPACT: **PREVENT ANY LOSSES IN IFR CAPACITY DURING THE TRANSITION FROM ILS TO MLS**

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), 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 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.

MILESTONE SCHEDULE:

	Scheduled Completion	Revised Scheduled Completion	Actual Completion
• ILS - Replace Tube-Type	10/88		
• ILS Remote Maintenance Monitor Equipment (RMM)	10/88		



RESPONSIBLE OFFICE: APM-410, (202) 267-8507

REMARKS/NOTES: Congress appropriated $5 million for ILS installation under the Airport Improvement Program in FY 1987.

3.3 NEXT GENERATION WEATHER RADARS

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

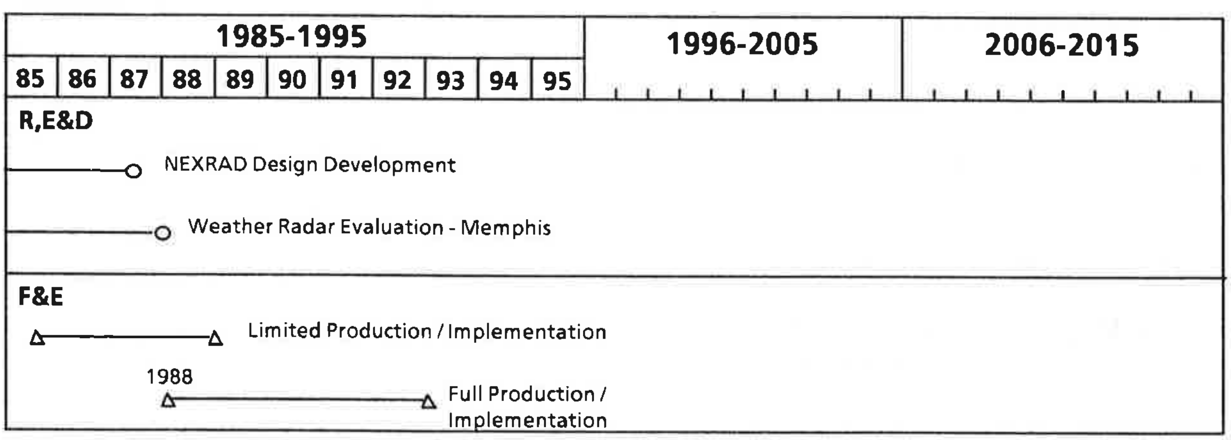
The goal of this project is to develop a new generation of Doppler weather radars (NEXRAD) that provide accurate information on precipitation, wind velocity, and turbulence; and to furnish software algorithms that take advantage of the improved radar presentation of weather data. The ability to detect areas of hazardous weather will enable use of more efficient routes that can 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 to distribute and display 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 contribute to traffic delays in a terminal area.

MILESTONE SCHEDULE:

	Scheduled Completion	Revised Scheduled Completion	Actual Completion
• Weather Radar Evaluation - Memphis			11/85
• Experimental weather radar system at Huntsville, Alabama - low-level windshear, microburst			



RESPONSIBLE OFFICE: APM-310, (202) 267-8573

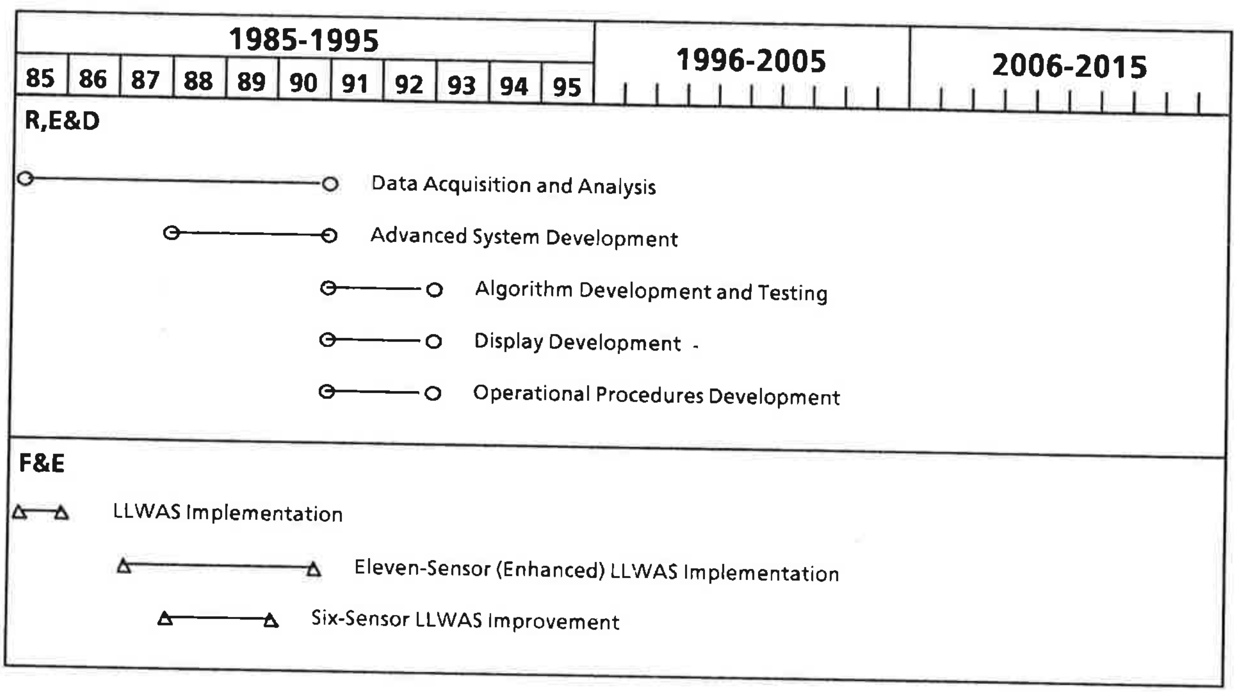
3.4 WIND MEASURING EQUIPMENT/EFFORTS (LLWAS)

AIRPORT CAPACITY IMPROVEMENT IMPACT: **REDUCE DELAYS CAUSED BY WIND SHEAR BY SMOOTHING THE TRANSITION BETWEEN DIFFERENT RUNWAY CONFIGURATIONS**

Severe wind shear conditions at low altitudes 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 pilots, through the air traffic controller, when hazardous wind shear conditions are detected. Recent studies suggest that LLWAS used with Doppler radar 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.

MILESTONE SCHEDULE:

	Scheduled Completion	Revised Scheduled Completion	Actual Completion
• 110 Systems Installation	7/87		



RESPONSIBLE OFFICE: APM-650, (202) 267-8714

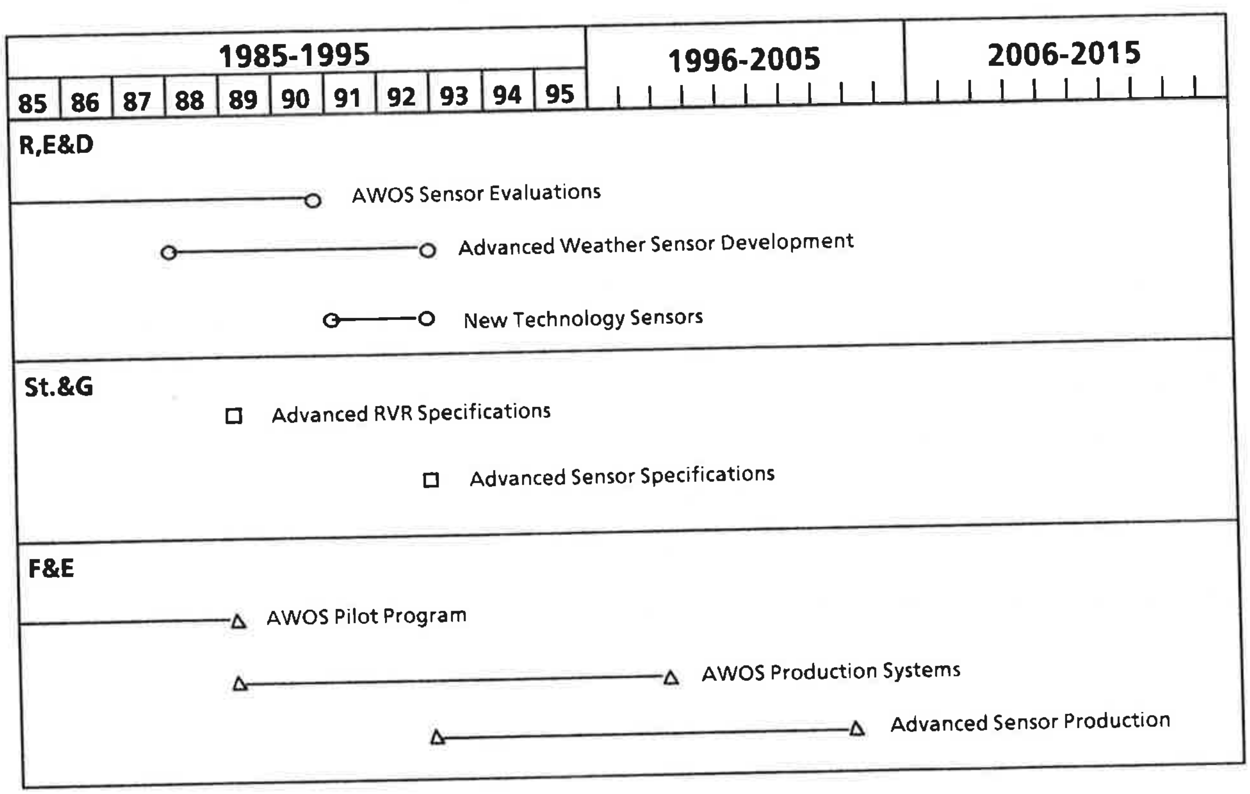
3.5 WEATHER SENSOR DEVELOPMENT

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, conducted primarily by the National Oceanic and Atmospheric Administration laboratories and the National Weather Service, is supported by the FAA. This research will continue to develop sensors and technologies using lasers, infrared systems, and Doppler radars for detecting meteorological 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 throughout and efficiency through better forecasting and flight planning.

MILESTONE SCHEDULE:

	Scheduled Completion	Revised Scheduled Completion	Actual Completion
• Development, Testing and Evaluation of an Automatic Present Weather Observing System			2/12/85



RESPONSIBLE OFFICE: APM-650, (202) 267-8714

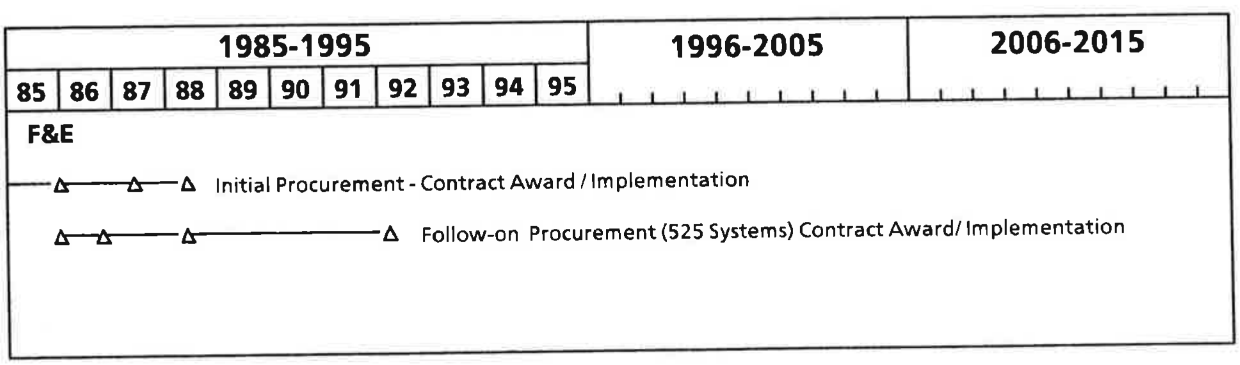
3.6 RVR ESTABLISH/UPGRADE

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 who then informs the pilot, who in turn determines whether a landing is allowed. The existence of RVR on a particular approach allows aircraft to operate at lower minimums because of more precise knowledge about visibility conditions on the runway. RVR information 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. 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.

MILESTONE SCHEDULE:

	Scheduled Completion	Revised Scheduled Completion	Actual Completion
• Acquisition			
Contract Award (715 systems)			
• Production			
System Delivered to Test and Evaluation Site	10/30/87		
System Delivery to First Operational Site	5/31/88		
• Implementation			
First Order	8/31/88		
Last Order	9/30/93		



RESPONSIBLE OFFICE: APM-440, (202) 267-8507

3.7 WIND SHEAR DETECTION

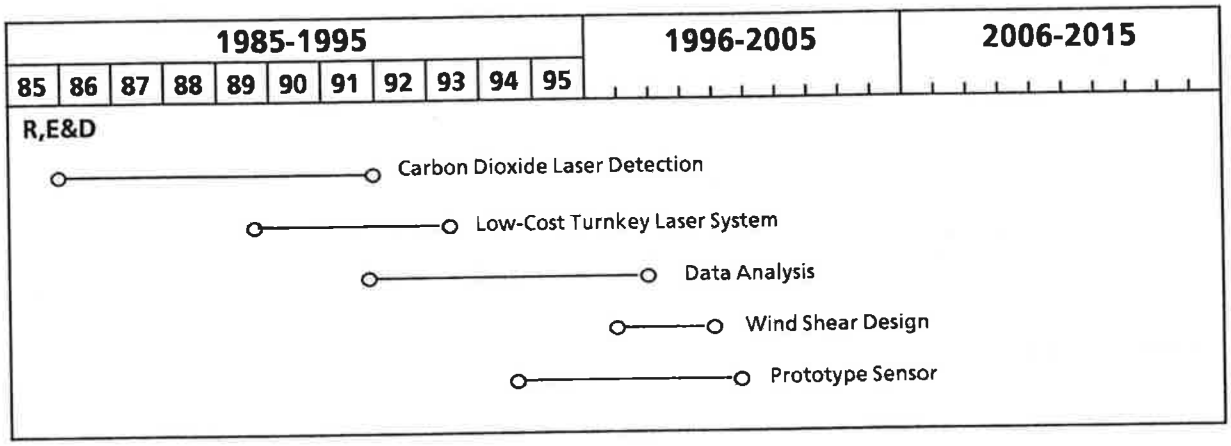
AIRPORT CAPACITY IMPROVEMENT IMPACT: **REDUCE DELAY THROUGH USE OF ARRIVAL AND DEPARTURE ROUTINGS THAT MINIMIZE EXPOSURE TO HAZARDOUS WIND SHEARS**

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; the ability to detect the absence of 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.

MILESTONE SCHEDULE:

	Scheduled Completion	Revised Scheduled Completion	Actual Completion
• Draft FAA Integrated Wind Shear Program Plan			
- out for comments			5/86
- comments due			9/30/86
• Joint NASA/FAA/Industry Task Force Planned			9/30/86
- Report on feasibility of laser detection of wind flow fields	To be determined		
- Report on feasibility of low-cost turnkey laser systems	To be determined		
- Report on experimental sensor design	To be determined		
• Evaluation of Freezing Rain/ Precipitation Sensor - Otis AFB, MA.	Spring 1987		
• Evaluation/Data Collection - Ceilometer (Cloud Height) AWOS Specification change requirement. 5,500 ft. to 12,000 ft. (ATC AWOS Requirement)	Review Process		

MILESTONE SCHEDULE (CONT.)



RESPONSIBLE OFFICE: ADL-15, (202) 267-3083

3.8 WAKE VORTEX AVOIDANCE AND FORECASTING

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

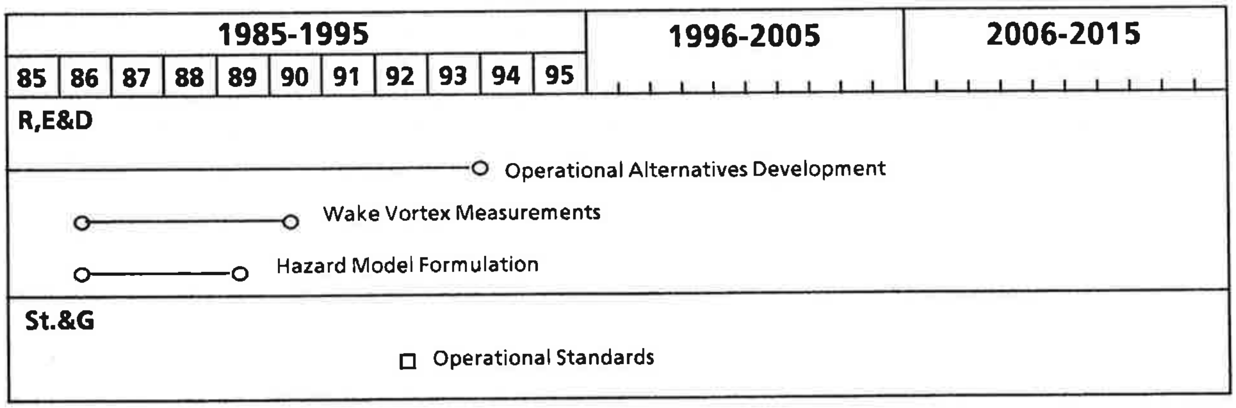
A critical impediment to improving capacity at major airports is the need for each aircraft to avoid the wake vortex generated by the preceding aircraft. Considerable research has been performed to develop both technological and operational solutions to this problem. It has been possible to identify surface wind parameters that allow reduced separations, but it has proved difficult to translate this knowledge into an operational procedure that enables controllers to reduce separations for a significant period of time.

MILESTONE SCHEDULE:

		Scheduled Completion	Revised Scheduled Completion	Actual Completion
1.1	Draft Report: Wake Vortex Classification of Aircraft: Volume I, Aircraft Type and Aircraft Mix Dependence			
1.2	Draft Report: Wake Vortex Classification of Aircraft: Volume II, Validation of Classification Model for New Aircraft Types	9/87		
2.1	Draft Project Memorandum: MLS Approach Procedures			
2.2	Enhanced Computer Model for Wake Vortex Analysis of Approach Procedures			
2.3	Draft Project Memorandum: Feasibility of Model Coordination for Capacity Determination			
3.1	Draft Report: Turbulence Effects on Vortex Delay			11/85
3.2	Draft Report: Feasibility and Utility of Variable Aircraft Spacings Based on the Richardson Number			
4.1	Computer Flight Test Plan for Separation Tests	7/88		

MILESTONE SCHEDULE (CONT.)

	Scheduled Completion	Revised Scheduled Completion	Actual Completion
4.2 Complete Simulator Wake Vortex Hazard Study	11/88		



RESPONSIBLE OFFICE: AES-310, (202) 267-9845

3.9 DEPARTURE FLOW METERING

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

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 use data on proposed flight plans and current departure schedules to generate a set of departure slots that 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 approaches 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 available airport capacity through the more efficient processing of departures into the en route airspace made possible by a departure metering automation support system.

MILESTONE SCHEDULE:

	Scheduled Completion	Revised Scheduled Completion	Actual Completion
• ATC Procedures - Departure Flow Metering			Implemented
• Engineering Model Development and Test - N.Y. Terminal area			
• Design Specification for Advance Automation System	4/87		

MILESTONE SCHEDULE (CONT.)

1985-1995											1996-2005	2006-2015
85	86	87	88	89	90	91	92	93	94	95		
R,E&D												
Departure Flow Metering												

RESPONSIBLE OFFICE: AES-320, (202) 267-9849

REMARKS/NOTES: This project is being transferred to Terminal Automation.

3.10 UPGRADE ARRIVALS/DEMAND ALGORITHMS

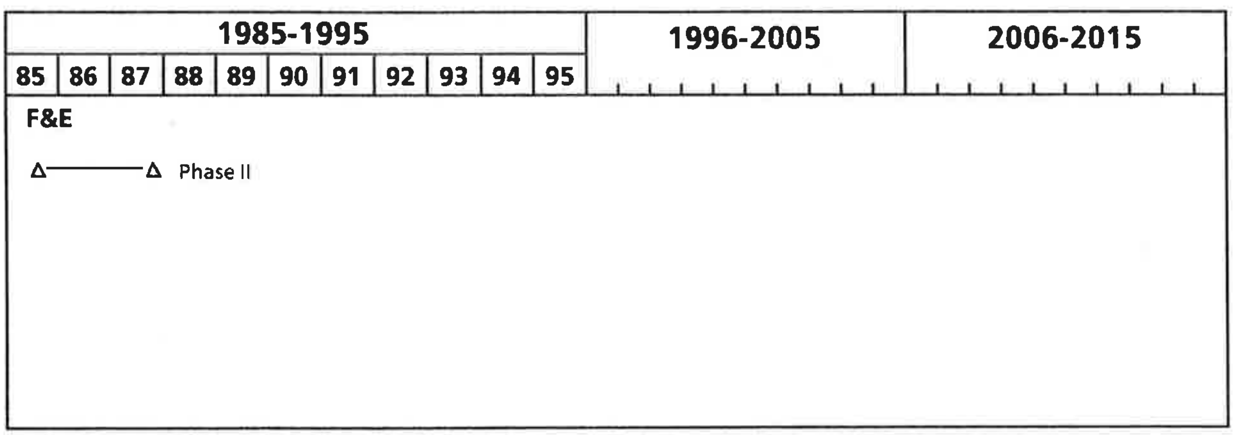
AIRPORT CAPACITY IMPROVEMENT IMPACT: **REDUCE DELAYS BY IMPROVING CENTRAL FLOW CONTROL PREDICTION ALGORITHIMS**

The goal of this project is to modify the Central Flow Control Facility Estimated Departure Clearance Time (EDCT) algorithms to allow 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 modifications to the EDCT algorithms . The modified algorithms then will be evaluated by traffic simulations and appropriate field tests.

MILESTONE SCHEDULE:

	Scheduled Completion	Revised Scheduled Completion	Actual Completion
• Phase I Rewrite Software for Traffic Management System-Update 9020 Computer to 4341 Computers			12/31/84
• Phase II Wide Scale Enhancement Upgrade - Replace 4341 Computers	12/87	12/89	

MILESTONE SCHEDULE:



RESPONSIBLE OFFICE: AES-320, (202) 267-9849

3.11 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 part of the Traffic Management System (TMS). The purpose of the TMS is to enhance the ATC system's capability 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 efficient matching of traffic demand to maximum available capacity. The automated airport acceptance rate calculations model will be evaluated by conducting appropriate field tests and modified as necessary.

MILESTONE SCHEDULE:

1985-1995											1996-2005	2006-2015
85	86	87	88	89	90	91	92	93	94	95		
R,E&D												
Research and Development												

RESPONSIBLE OFFICE: AES-320, (202) 267-9849

3.12 TERMINAL RADAR ENHANCEMENTS

AIRPORT CAPACITY IMPROVEMENT IMPACT: **REDUCE DELAYS BY 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). The increased demand 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.

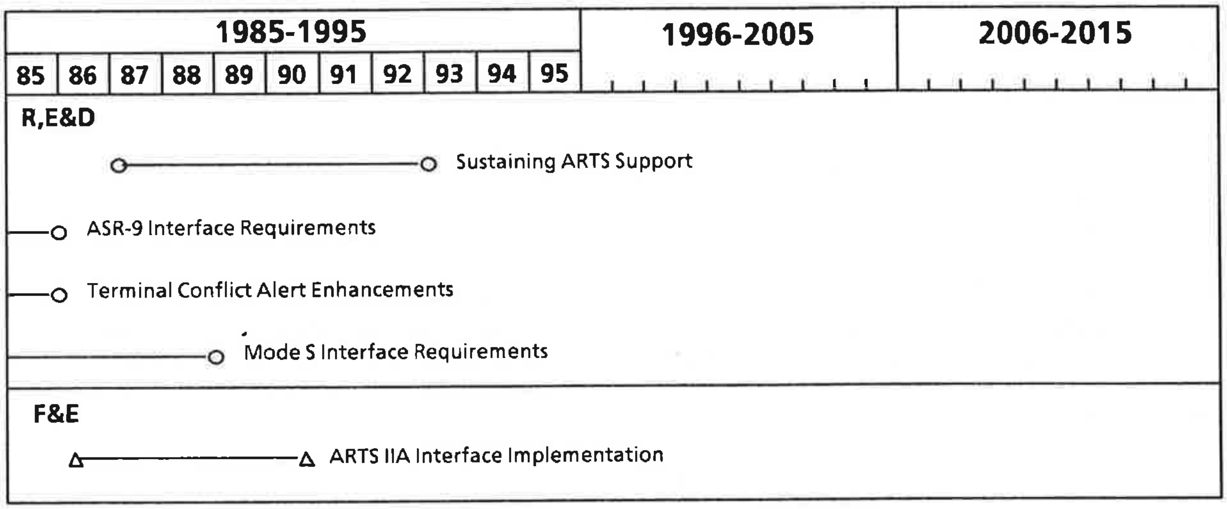
Hardware and software modifications will be developed for enhanced automation functions and for interfaces to new ATC systems such as the Mode S Sensor. Improvements in terminal automation systems will refine terminal conflict alert algorithms to reduce the nuisance alarm rate and extend coverage to terminal airspace areas that 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 use these data. Products will include specifications for hardware improvements to sustain the 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.

MILESTONE SCHEDULE:

	Scheduled Completion	Revised Scheduled Completion	Actual Completion
• Report on the analysis of ARTS III Terminal Conflict Alert Nuisance Alarms published			1/86
• Mode Sensor interface requirements	FY 1987		
ARTS IIA - Factory Acceptance completed	11/19/86		
ARTS IIA - ACT-100 Integration	1/14/87		
ARTS IIA - APM-160 Shakedown Test	1/16/87		
ARTS IIA - First Operational Readiness demonstration	4/1/87		
ARTS IIA - First System delivered	12/4/87		
ARTS IIA - Last System delivered	1/7/88		

MILESTONE SCHEDULE (CONT.)



RESPONSIBLE OFFICE: APM-220, (202) 267-8364

REMARKS/NOTES: Terminal ATC facilities are being upgraded under the current NAS Plan. The Automated Radar Terminal System (ARTS) is being provided with more memory so that it can support additional functions, such as Terminal Conflict Alert and Minimum Safe Altitude Warning (MSAW). Interfaces to Mode S and on-site controller training facilities are also under development.

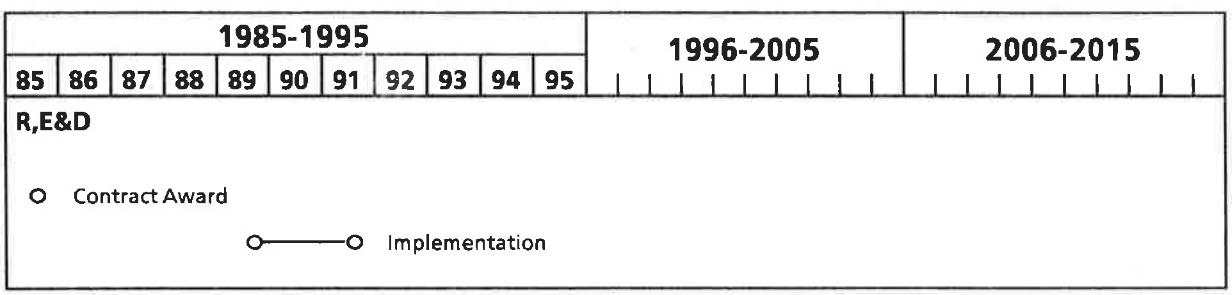
3.13 AIRPORT SURFACE DETECTION EQUIPMENT (ASDE-3)

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 increase in capacity under IFR conditions.

MILESTONE SCHEDULE:*

	Scheduled Completion	Revised Scheduled Completion	Actual Completion
• Contract Award (30 systems)			9/85
• Delivery of 17 Systems (FY 1985)	9/88		
• Delivery of 13 Systems (FY 1986)	3/90		



RESPONSIBLE OFFICE: APM-310, (202) 267-8573

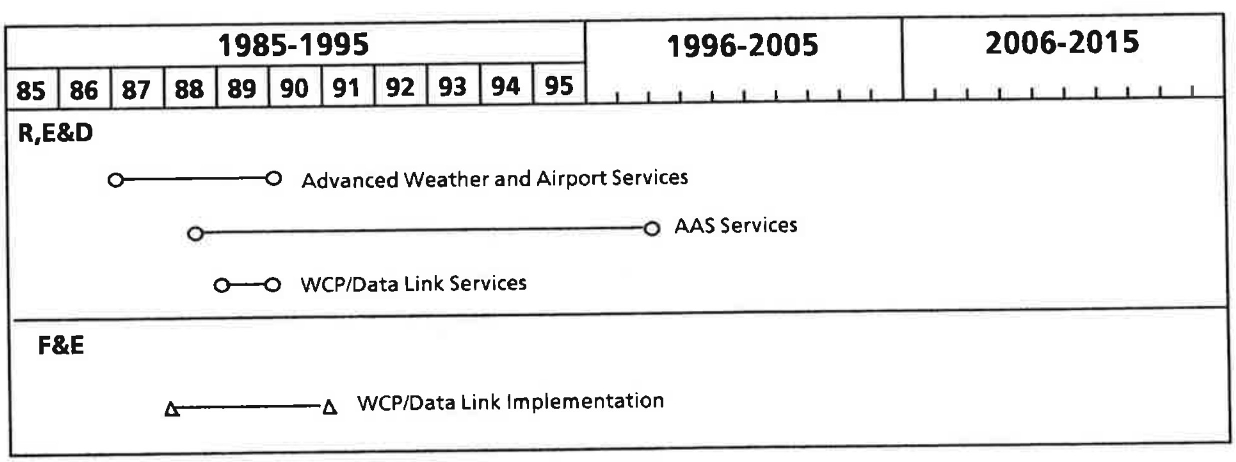
3.14 MODE S DATA LINK APPLICATIONS DEVELOPMENT

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 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.

MILESTONE SCHEDULE:

	Scheduled Completion	Revised Scheduled Completion	Actual Completion
• Contract Award (137 systems) FY 1983, FY 1984, FY 1985)			10/5/84
• RTCA-SC 142 Develop Minimum Operational Performance Specifications (MOPS) for Mode-S	FY 1987		
• Delivery of First System	FY 1989		
• Delivery of Last System	FY 1992		



RESPONSIBLE OFFICE: APM-320, (202) 267-3156

3.15 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 system will increase airport capacity by displaying to the supervisor the most effective runway configuration given the status of all system-evaluated variables.

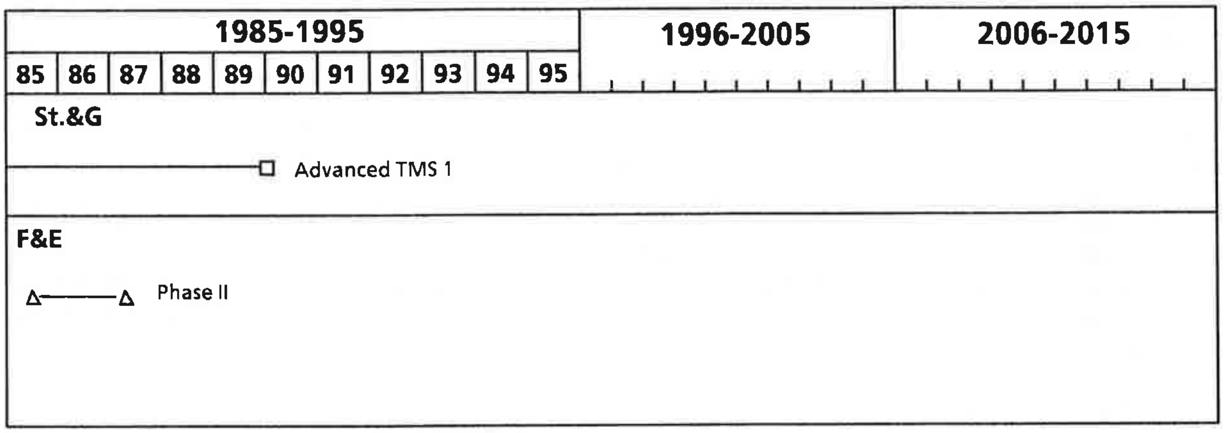
The first system is being installed at Chicago O'Hare airport, which has 14 runway ends that may be used in many combinations. Centralizing this information will enable supervisors to make operational decisions more quickly.

The RCMS will display an ordered list of runway configurations ranked by their capacity. In addition, the system will provide current and forecasted 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 relationship with the national flow control strategy.

MILESTONE SCHEDULE:

	Scheduled Completion	Revised Scheduled Completion	Actual Completion
• St.&G			
Advanced TMS-2 - Redesign System	1995		
Artificial Intelligence Implementation TMS-2	2000		
• F&E			
Phase I - Rewrite Software TMS Update 9020 Computers to 4341 Computers		12/31/84	
Phase II - Widescale Enhancement Upgrade Replace 4341 Computers	12/87	12/89	

MILESTONE SCHEDULE (CONT.)



RESPONSIBLE OFFICE: AES-320, (202) 267-9849

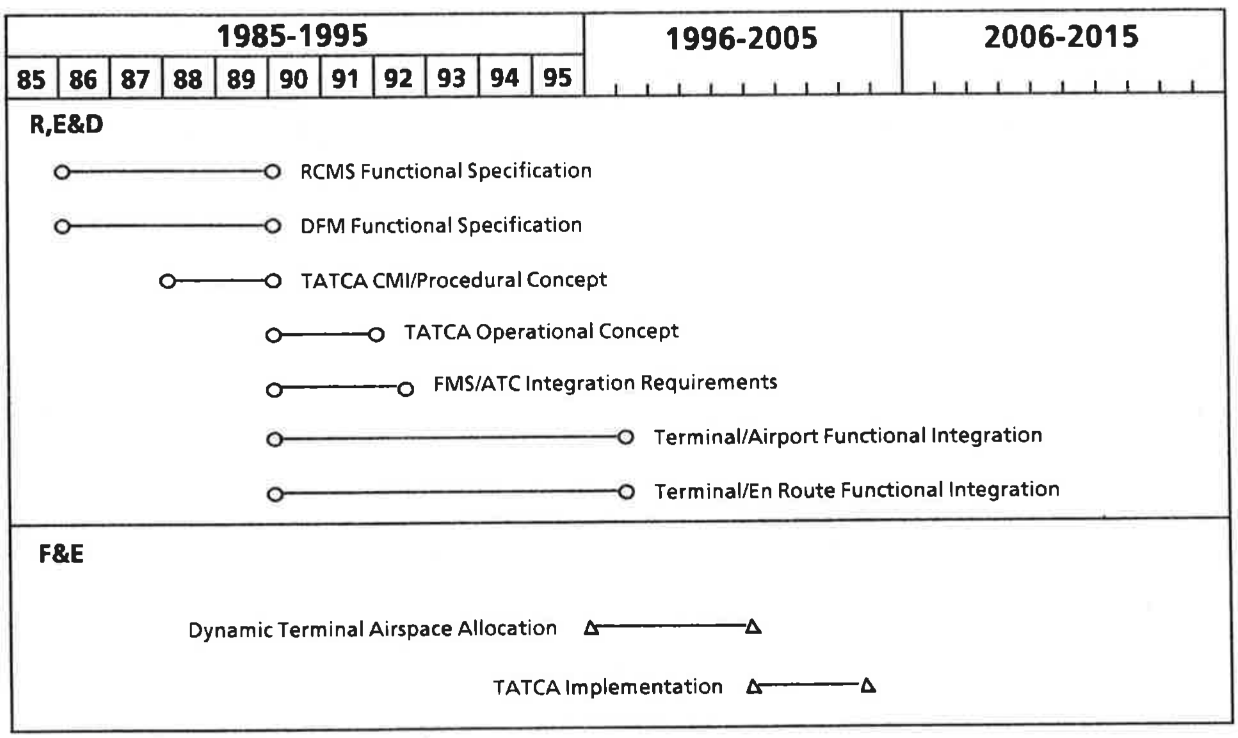
REMARKS/NOTES: Advanced TMS-1 now refers to Phase III Enhancements to 4341 Computer replacement. 12/89

3.16 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. 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 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.

MILESTONE SCHEDULE:



RESPONSIBLE OFFICE: ATR-530, (202) 267-9435

4 CAPACITY PLANNING STUDIES

4.1 AIRPORT CAPACITY ENHANCEMENT TASK FORCES

AIRPORT CAPACITY IMPROVEMENT IMPACT: **DEVELOP PLANS FOR MEETING FUTURE CAPACITY NEEDS AT THE NATION'S BUSIEST AIRPORTS THROUGH AIRPORT/FAA/USER EFFORTS**

The Federal Aviation Administration is sponsoring 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. The airport task forces will investigate the application of new airspace procedures, new NAVAIDS, installation of other systems, airport development, and other prospective capacity improvements.

Each task force will prepare a report recommending a comprehensive program to improve capacity and reduce the level and cost of delay at a particular airport. The impact of the proposed improvements will be simulated using an airport capacity model. This program provides 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. An action plan will incorporate the programs deemed viable by the Task Force.

The FAA proposes to participate in Airport Capacity Enhancement Task Forces (Figure 4-1) at approximately fifty of the U.S.'s busiest airports. It is the FAA's intent that the Task Forces become forums that develop capacity enhancement action plans over a six-to-nine month period and hold periodic implementation review meetings. This entire process would be repeated on a multi-year cycle.

RESPONSIBLE OFFICE: ACP-4, (202) 267-8791

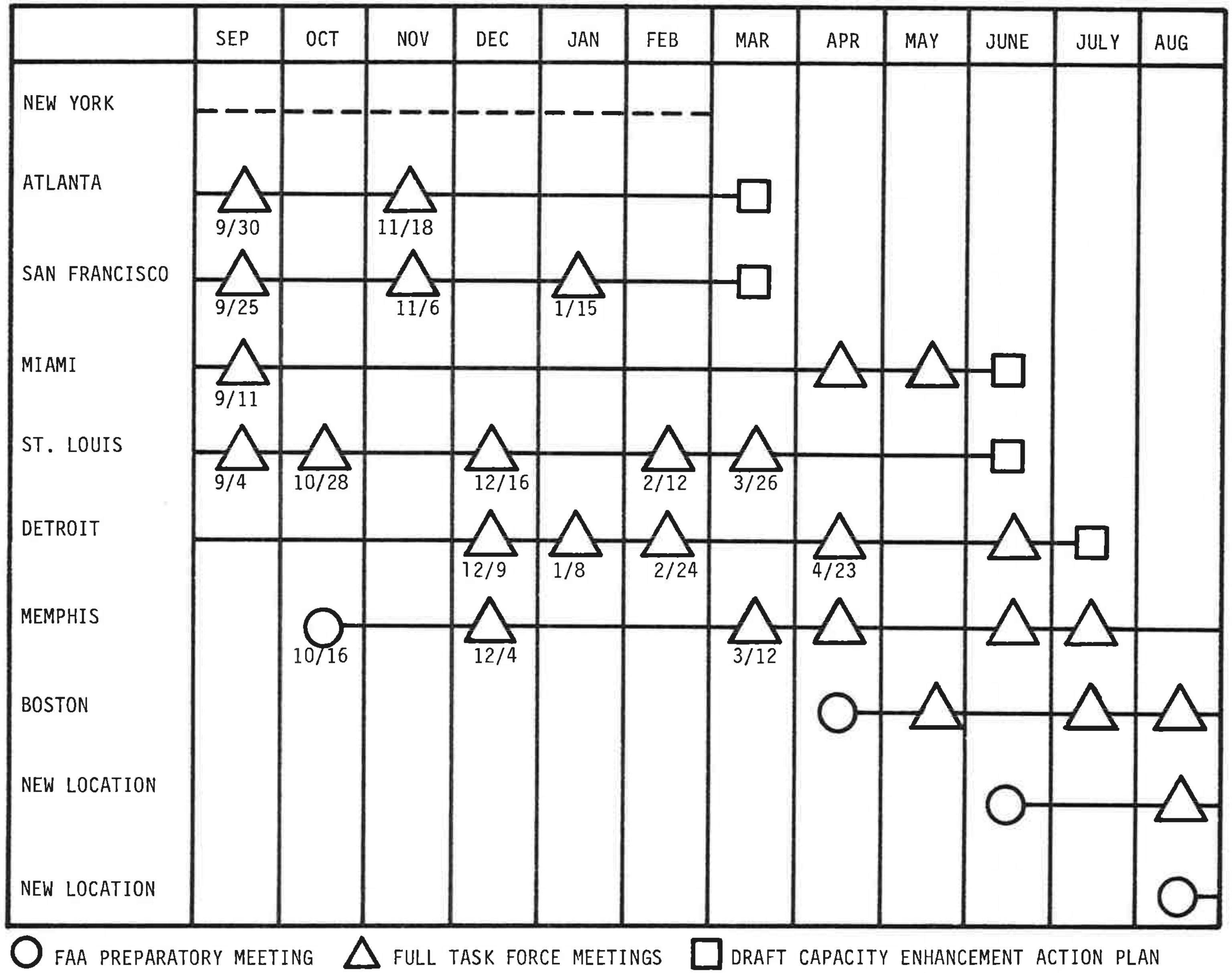


FIGURE 4-1. AIRPORT CAPACITY ENHANCEMENT TASK FORCES
Status Report - March 1987

4.2 AIRPORT CAPACITY AND DELAY MODELS

AIRPORT CAPACITY IMPROVEMENT IMPACT: **ANALYZE CONGESTION 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 airports and in multi-airport terminal areas. This project seeks to improve existing simulation models and to conduct studies to validate the results of those models. The FAA plans 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 to determine which capacity enhancement options provide the greatest benefits.

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 ADSIM model, used by the FAA Technical Center to measure delay; the SIMMOD model, used by the Office of Environment and Energy to measure fuel consumption; 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 to solve 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 use this proven analytical tool.

The model will be made available to FAA analysts to study other complex terminal areas and for the Air Traffic Services West Coast Plan and East Coast Plan (northern tier). 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 new air traffic control procedures on delay.

The ***Airport Machine*** was developed as a color-graphics simulation of airport runway and taxiway operations. The interactive capability of the model allows it to be used as a training aid, as well as a planning tool for studying runway and taxiway design. The model will be made available to regional FAA offices during FY 1987, FY 1988 and FY 1989.

MILESTONE SCHEDULE:

	Scheduled Completion	Revised Scheduled Completion	Actual Completion
• Evaluate Airport Machine at LGA			10/86
• Validate Airport Machine			10/86
• Airport Machine application in FAA Regions	9/30/87 (first three regions)		
• SIMMOD			
Enhancements complete	9/87		
Validate on New York Airport	3/87		
2 airspace simulations	9/87		

1985-1995											1996-2005	2006-2015
85	86	87	88	89	90	91	92	93	94	95		

R,E&D

- o Evaluate Airport Machine
- o Validate Airport Machine
- o Airport Machine Available in FAA Regions
- o SIMMOD Enhancements Complete
- o Calibrate SIMMOD on NY Airports
- o Validate SIMMOD on NY Airports
- o SIMMOD Available to FAA Regions

RESPONSIBLE OFFICE: AEE-200, (202) 267-3534
APP-400, (202) 267-3451
ACT-310, (202) 482-4129

REMARKS/NOTES: When SIMMOD is made available to FAA Regions, it will require a training program; ADSIM enhancements will require funding.

4.3 ENVIRONMENTAL PROGRAMS

AIRPORT CAPACITY IMPROVEMENT IMPACT: **HELP REDUCE ENVIRONMENT-RELATED CONSTRAINTS ON THE GROWTH OF THE NATIONAL AIR TRANSPORTATION SYSTEM**

The goal of this project is to reduce constraints on the growth of the national air transportation system, especially on airport capacity, by developing the methods, technology and expertise to mitigate the environmental impacts of such growth.

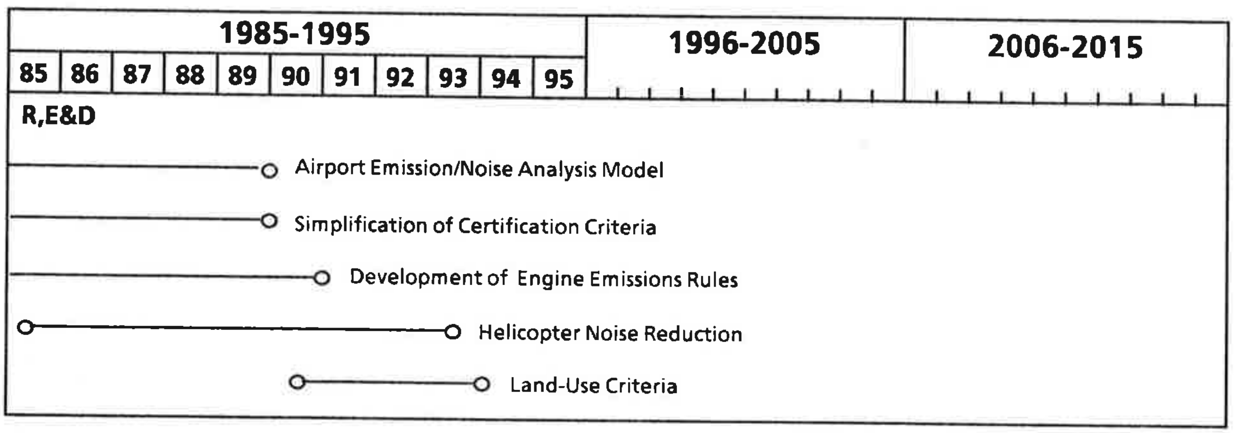
Efforts have focused on reducing the noise and pollution produced by air traffic. Aircraft noise has been reduced at the source through certification standards. The noisest aircraft (Stage I) were prohibited from operating at U.S. airports after December 31, 1985. Consideration is being given to further restricting the certification and operation of a next tier of noisier aircraft (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.

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. Additional aircraft noise efforts will include developing and maintaining accurate information on the noise characteristics of current and anticipated aircraft, determining the need for control of noise and sonic boom from these aircraft, developing and validating methods for predicting the noise generated by various aircraft components, working closely with NASA and the aviation industry on state-of-the-art technology in aviation noise control and evaluating the costs associated with this technology, and assessing the benefits and costs of simpler certification criteria.

In accordance with the Administrator's Airport Capacity 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 in this area. 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 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.

MILESTONE SCHEDULE:

	Scheduled Completion	Revised Scheduled Completion	Actual Completion
• SFAR-37 Revise Emission and Dispersion Modeling System	FY 1987		
• Notice of Proposed Policy on Airport Access and Capacity			1/86
• Stage II Aircraft Phase-out	Not Scheduled		



RESPONSIBLE OFFICE: AEE-110, (202) 267-3558
AEE-30, (202) 267-8933

REMARKS/NOTES: Land-use criteria not presently being tracked in R,E&D 11.6 Environmental Impact Studies. User's Guide shows how the EDMS system evolved and instructs the user on how to input and process data to produce:

1) An emissions inventory of all sources at an airport/airbase.
2) An estimate of the concentrations of these sources at specified locations.

APPENDIX A. AIRPORTS: ACTIVITY LEVELS AND CHARACTERISTICS

A-1 Passenger Enplanements at the Top 50 Airports

A-2 Aircraft Operations at the Top 50 Towered Airports

A-3 Airports that Employ Noise-Related Restrictions on Use

APPENDIX A-1. PASSENGER ENPLANEMENTS AT THE TOP 50 AIRPORTS

TABLE A-1-1. TOP 50 AIRPORTS RANKED BY 1985 TOTAL PASSENGER ENPLANEMENTS

RANK	AIRPORT	TOTAL ENPLANEMENTS[1] (000s)	PERCENT OF TOTAL[2]	CUMULATIVE PERCENT
1	Chicago O'Hare	23,194	5.7	5.7
2	Atlanta Hartsfield	21,621	5.3	11.0
3	Los Angeles	19,547	4.8	15.8
4	Dallas - Fort Worth	18,276	4.5	20.3
5	New York Kennedy	16,983	4.2	24.5
6	Newark	14,408	3.5	28.0
7	Denver Stapleton	14,387	3.5	31.5
8	San Francisco	12,233	3.0	34.5
9	Miami	10,897	2.7	37.2
10	Boston Logan	10,343	2.5	39.7
11	New York LaGuardia	10,238	2.5	42.2
12	St. Louis International	9,615	2.4	44.6
13	Honolulu	9,109	2.2	46.8
14	Detroit Metro	7,489	1.8	48.6
15	Minneapolis	7,479	1.8	50.4
16	Pittsburgh	7,328	1.8	52.2
17	Washington National	7,181	1.8	54.0
18	Houston Intercontinental	7,001	1.7	55.7
19	Phoenix Sky Harbor	6,668	1.6	57.3
20	Seattle Tacoma	6,253	1.5	58.8
21	Philadelphia	5,578	1.4	60.2
22	Las Vegas	5,205	1.3	61.5
23	Charlotte	4,998	1.2	62.7
24	Orlando	4,951	1.2	63.9
25	Tampa	4,359	1.1	65.0

[1] Includes U.S. certificated route air carriers, foreign flag carriers, supplementals, air commuters, and air taxis.
[2] Based on 407 million passenger enplanements at 573 airports with 2,500 or more enplanements in FY 1985.
Source: FAA Terminal Area Forecasts

TABLE A-1-1. TOP 50 AIRPORTS RANKED BY 1985 TOTAL PASSENGER ENPLANEMENTS (CONT.)

RANK	AIRPORT	TOTAL ENPLANEMENTS[1] (000s)	PERCENT OF TOTAL[2]	CUMULATIVE PERCENT
26	Salt Lake City	4,235	1.0	66.0
27	San Diego	4,000	1.0	67.0
28	Baltimore	3,861	1.0	68.0
29	Houston Hobby	3,711	0.9	68.9
30	Kansas City	3,508	0.9	69.8
31	Ft. Lauderdale	3,272	0.8	70.6
32	Dallas Love Field	3,257	0.8	71.4
33	Cleveland	3,219	0.8	72.2
34	Memphis	3,200	0.8	73.0
35	New Orleans	3,181	0.8	73.8
36	Portland	2,588	0.6	74.4
37	San Juan	2,541	0.6	75.0
38	San Antonio	2,295	0.6	75.6
39	Washington Dulles	2,189	0.5	76.1
40	San Jose	2,180	0.5	76.6
41	Cincinnati	2,162	0.5	77.1
42	Oakland	2,132	0.5	77.6
43	Kahului	2,021	0.5	78.1
44	Albuquerque	1,966	0.5	78.6
45	Palm Beach	1,876	0.5	79.1
46	Austin Muni	1,819	0.4	79.5
47	Indianapolis	1,793	0.4	79.9
48	Dayton	1,747	0.4	80.3
49	Windsor Locks	1,747	0.4	80.7
50	Buffalo	1,745	0.4	81.1

[1] Includes U.S. certificated route air carriers, foreign flag carriers, supplementals, air commuters, and air taxis.
[2] Based on 407 million passenger enplanements at 573 airports with 2,500 or more enplanements in FY 1985.
Source: FAA Terminal Area Forecasts

APPENDIX A-2. AIRCRAFT OPERATIONS AT THE TOP 50 TOWERED AIRPORTS

TABLE A-2-1. TOP 50 TOWERED AIRPORTS RANKED BY 1985 TOTAL AIRCRAFT OPERATIONS

RANK	AIRPORT	TOTAL OPERATIONS[1] (000s)	PERCENT OF TOTAL[2]	CUMULATIVE PERCENT
1	Chicago O'Hare International	768.1	1.3	1.3
2	Atlanta International	749.9	1.3	2.6
3	Dallas/Ft. Worth Regional	547.9	1.0	3.6
4	Los Angeles International	546.0	0.9	4.5
5	Santa Ana	521.6	0.9	5.4
6	Van Nuys	503.5	0.9	6.3
7	Denver Stapleton International	502.9	0.9	7.2
8	St. Louis International	411.3	0.7	7.9
9	Boston Logan	402.7	0.7	8.6
10	Newark	400.2	0.7	9.3
11	Long Beach	398.6	0.7	10.0
12	San Francisco	396.2	0.7	10.7
13	Phoenix Sky Harbor International	394.3	0.7	11.4
14	Seattle Boeing	383.5	0.7	12.1
15	Oakland International	370.6	0.6	12.7
16	New York La Guardia	367.3	0.6	13.3
17	Detroit Metropolitan	366.3	0.6	13.9
18	San Jose Municipal	364.9	0.6	14.5
19	Minneapolis St. Paul International	362.0	0.6	15.1
20	Pittsburgh Greater International	360.9	0.6	15.7
21	Honolulu	353.9	0.6	16.3
22	Philadelphia International	350.7	0.6	16.9
23	Denver Arapahoe	340.8	0.6	17.5
24	New York Kennedy	338.6	0.6	18.1
25	Anchorage Merrill	334.4	0.6	18.7

[1] All arrivals and departures performed by military, general aviation, and air carrier aircraft.
[2] Based on 58 million aircraft operations at 399 FAA-operated airport traffic control towers in FY 1985.
Source: FAA Air Traffic Activity FY 1985

APPENDIX A-2-1. TOP 50 TOWERED AIRPORTS RANKED BY 1985 TOTAL AIRCRAFT OPERATIONS (CONT.)

RANK	AIRPORT	TOTAL OPERATIONS[1] (000s)	PERCENT OF TOTAL[2]	CUMULATIVE PERCENT
26	Memphis International	332.1	0.6	19.3
27	Washington National	330.6	0.6	19.9
28	Charlotte Douglas	329.5	0.6	20.5
29	Miami International	329.5	0.6	21.1
30	Houston Intercontinental	316.3	0.6	21.7
31	Houston Hobby	312.2	0.5	22.2
32	Pontiac	306.4	0.5	22.7
33	Las Vegas International	301.9	0.5	23.2
34	Dallas Love Field	301.2	0.5	23.7
35	Tamiami	300.8	0.5	24.2
36	Baltimore International	283.7	0.5	24.7
37	New Orleans	280.6	0.5	25.2
38	Teterboro	271.6	0.5	25.7
39	Tampa International	267.7	0.5	26.2
40	Torrance International	260.0	0.5	26.7
41	Fort Worth Moacham	258.1	0.5	27.2
42	San Diego Montgomery	252.7	0.4	27.6
43	Salt Lake City International	252.3	0.4	28.0
44	Caldwell	251.7	0.4	28.4
45	Burbank	245.3	0.4	28.8
46	Chicago Palwaukee	244.5	0.4	29.2
47	Bedford	244.4	0.4	29.6
48	Hayward	243.2	0.4	30.0
49	Deer Valley	242.6	0.4	30.4
50	Concord	241.0	0.4	30.8

[1] All arrivals and departures performed by military, general aviation, and air carrier aircraft.
[2] Based on 58 million aircraft operations at 399 FAA-operated airport trafic control towers in FY 1985.
Source: FAA Air Traffic Activity FY 1985

APPENDIX A-3. AIRPORTS THAT EMPLOY NOISE-RELATED RESTRICTIONS ON USE*

Airports are listed that employ at least one noise control strategy restricting use of the airport. These strategies have been grouped into the following six categories:

Category 1: Limits on the Number of Operations:

Limit on the number of operations by hour, day, month, year or noise capacity;

Complete curfew.

Category 2: Use Restrictions by Aircraft Type or Noise Level:

Use restriction by aircraft type or class;

Use restriction based on noise levels;

Use restriction based on Part 36;

Use restriction based on AC 36-3.

Category 3: Runway Restrictions:

Preferential runway system;

Runway restriction imposed for specific aircraft type;

Displaced runway threshold;

Rotational runway system.

Category 4: Weight or Thrust Limits:

Takeoff thrust reduction;

Reverse thrust limits;

Weight or thrust limit.

Category 5: Flight Path Restrictions:

Arrivals or departures over a body of water;

Maximum safe climb on takeoff;

Informal flight operation restriction;

Local pattern restrictions.

Categroy 6: Other:

Flight training restriction;

Shift operations to a reliever airport.

*This appendix was prepared using the TSC Airport Capacity-Noise Control Database. The information presented in the table comes from Patricia A. Cline, Airport Noise Control Strategies, Federal Aviation Administration. Office of Environment and Energy. Report No. FAA-EE-86-2, May 1986.

TABLE A-3-1. NOISE CONTROL STRATEGIES BY AIRPORT

Airport LOCID	Limits on the Number of Operations	Use Restrictions by Aircraft Type or Noise Level	Runway Restrictions	Weight or Thrust Limits	Flight Path Restrictions	Other
000			x			
022			x			
0Q9					x	
1F0		x		x		
1N2					x	
1V5					x	
22G				x	x	
39N			x			
3LZ					x	
3R9	x					
3V5				x	x	
4AC						x
5SI					x	
6G3					x	
9R5					x	
ABE			x			x
ABQ			x	x	x	
ABR			x			
ACY						x
ADS						x
AGC						x
AID						x
ALB			x			
ALN	x					
AMA					x	
ANC			x		x	
AOO					x	
APF					x	
ARB			x	x	x	
ARR					x	
ASE					x	
ATW			x		x	
AUS						x
AVP					x	
AZO		x	x			
BCT					x	
BDL						x
BDR			x	x		x
BED		x	x		x	x
BFI			x		x	x
BFL						x
BHM						x
BIL			x	x		
BJC					x	
BLH				x	x	
BLI			x			
BNA			x			
BOI			x			x
BOS		x	x		x	x
BTR			x			

TABLE A-3-1. NOISE CONTROL STRATEGIES BY AIRPORT (CONT.)

Airport LOCID	Limits on the Number of Operations	Use Restrictions by Aircraft Type or Noise Level	Runway Restrictions	Weight or Thrust Limits	Flight Path Restrictions	Other
BUR	x	x	x		x	
BVY			x			x
BWI			x			x
CAK			x			
CCR			x		x	
CDW			x			
CGF		x	x	x	x	x
CGS					x	
CHS						x
CID						x
CLE			x			
CLL			x			
CLM					x	
CLS					x	
CLT					x	
CLW					x	x
CMA			x		x	
CMH		x				
CMI					x	
COS			x			
CPM		x	x			
CPS			x			
CRQ		x		x		x
CSG			x			
CUB			x			
DAB			x			
DAL			x		x	x
DAY					x	
DCA	x	x	x		x	
DEC					x	
DEN			x			x
DET		x	x			
DFW			x			x
DPA					x	
DTW					x	
ECG					x	
ELD			x			
ELM						x
ELP		x	x			x
EMT			x	x		
EWR		x	x		x	
FAI			x		x	
FAR					x	
FAT						x
FCM		x		x		x
FFZ					x	
FLL			x			x
FLO			x			
FMY			x	x		x
FNT					x	

TABLE A-3-1. NOISE CONTROL STRATEGIES BY AIRPORT (CONT.)

Airport LOCID	Limits on the Number of Operations	Use Restrictions by Aircraft Type or Noise Level	Runway Restrictions	Weight or Thrust Limits	Flight Path Restrictions	Other
FOK			x			
FRG			x		x	
FSD					x	
FTW					x	
FUL			x	x	x	
FWA					x	
FXE			x		x	
GAI					x	
GJT			x			
GMU				x		x
GON					x	
GRB					x	x
GRR			x		x	
GTF			x			
GVW					x	
GXY					x	
GYR					x	
HDN					x	
HFD		x				
HHR			x			
HIO			x			
HNL			x			
HOU			x			
HPN	x	x			x	
HQM			x		x	
HRL		x				
HUF					x	
HVN					x	
HWD		x				
HWO			x	x		
HYA			x			x
I77		x		x	x	
IAD			x			
IAH					x	
ICT			x			
ILG			x			x
ILM						x
IND					x	
INT			x			
IOW			x		x	
ISN					x	
ITO			x			
JAC	x	x	x		x	x
JAX			x			
JFK		x	x		x	
JNU					x	
KTN					x	
L16			x			
L32					x	
L35					x	x

TABLE A-3-1. NOISE CONTROL STRATEGIES BY AIRPORT (CONT.)

Airport LOCID	Limits on the Number of Operations	Use Restrictions by Aircraft Type or Noise Level	Runway Restrictions	Weight or Thrust Limits	Flight Path Restrictions	Other
LAS			x			
LAX			x		x	x
LBE			x			
LDJ					x	
LGA		x	x		x	
LGB		x	x			
LIH			x			
LIT						x
LNA				x		
LNS			x			
LOU		x	x		x	x
LSE			x		x	
LWM			x			x
MCI						x
MCO			x			x
MDT						x
MDW					x	
MEB		x	x			
MFR			x			
MIA		x	x			x
MKE		x	x	x	x	x
MKG	x		x			
MKY					x	
MLB			x			
MLE					x	
MMH					x	
MMU			x		x	
MOD		x	x			
MRI				x		
MSN		x	x		x	x
MSP		x	x	x		x
MTH		x			x	
MTN			x			x
MVY		x			x	
MWC		x				
MWH			x			
MYF			x			x
N24			x			
N67					x	
N87					x	x
001	x				x	
OAK			x		x	
OGG			x			
OMA			x			x
ONT			x			x
OPF			x			
ORD		x	x			
ORF			x		x	
ORH			x			
ORL			x			

TABLE A-3-1. NOISE CONTROL STRATEGIES BY AIRPORT (CONT.)

Airport LOCID	Limits on the Number of Operations	Use Restrictions by Aircraft Type or Noise Level	Runway Restrictions	Weight or Thrust Limits	Flight Path Restrictions	Other
OSU			x		x	x
OWB			x			
OWD		x	x			x
OXR					x	x
PAE		x			x	
PBI			x	x		x
PDK			x		x	
PDX			x	x	x	x
PFN			x			
PHL			x		x	x
PHX					x	
PIE		x			x	
PIR			x			
PIT			x			x
PMP		x		x		
PNE			x			
PNS			x			
POU			x		x	
PSC			x			
PSF			x			
PSP			x			
PTK					x	
PUB			x			
PVD		x	x	x		
PWA				x		
PWM			x			
Q64						x
Q99	x	x			x	
RBD			x		x	
RFD			x		x	x
RHV		x	x			x
RIC			x			x
RLD			x		x	
RNO			x		x	
ROC			x			
RSW				x		
S17					x	
S19					x	
S21					x	
S26					x	
S50					x	
SAC		x	x	x		x
SAN		x	x			x
SAT			x	x		
SBA			x		x	x
SBN					x	
SCK						x
SDF			x			
SDL						x
SDM			x			

TABLE A-3-1. NOISE CONTROL STRATEGIES BY AIRPORT (CONT.)

Airport LOCID	Limits on the Number of Operations	Use Restrictions by Aircraft Type or Noise Level	Runway Restrictions	Weight or Thrust Limits	Flight Path Restrictions	Other
SEA			x		x	
SFO			x		x	x
SFZ					x	
SHV			x			x
SIT					x	
SJC		x				x
SJU			x			
SLC		x	x		x	
SMF			x			x
SMO		x	x			x
SMX		x	x		x	x
SNA		x	x	x	x	
SOP					x	
SPG					x	
SPI		x	x	x	x	x
SPS		x	x	x		
SQL			x			
STL				x		x
STP			x		x	
STS			x		x	
STX					x	
SUN		x	x			
SWF			x			
SZP					x	
TEB			x	x		
TIW					x	
TLH			x			
TOA						x
TOL					x	
TPA			x			
TTN						x
TUL					x	
TUS			x			x
TVC			x		x	
TVL		x			x	
UGN			x			
UKI		x			x	
VNY		x	x		x	x
VRB			x			
W09					x	
W35				x		
W52						x
W75					x	
W98					x	
X16					x	
YIP				x		
YNG				x	x	
TOTALS:	9	54	163	37	143	83

TABLE A-3-2. AIRPORT NAME, CITY AND STATE BY LOCATION ID

LOCID	AIRPORT NAME	CITY	STATE
000	Alturas Municipal	Alturas	CA
022	Columbia	Columbia	CA
0Q9	Sonoma Skypark	Sonoma	CA
1F0	Downtown Ardmore	Ardmore	OK
1N2	Spadaro	East Moriches	NY
1V5	Boulder Municipal	Boulder	CO
22G	Lorain County Regional	Lorain	OH
39N	Princeton	Princeton	NJ
3LZ	Sky Ranch Estates	Sandy Valley	NV
3R9	Austin Lakeway	Austin	TX
3V5	Downtown Fort Collins Airpark	Fort Collins	CO
4AC	Coronado	Albuquerque	NM
5SI	George Felt	Roseburg	OR
6G3	Palmyra Airpark	Palmyra	NY
9R5	Hunt	Portland	TX
ABE	Allentown-Bethlehem-Easton	Allentown	PA
ABQ	Albuquerque International	Albuquerque	NM
ABR	Aberdeen Regional	Aberdeen	SD
ACY	Atlantic City	Atlantic City	NJ
ADS	Addison	Dallas	TX
AGC	Allegheny County	Pittsburgh	PA
AID	Anderson Municipal	Anderson	IN
ALB	Albany County	Albany City	NY
ALN	Civic Memorial	Alton	IL
AMA	Amarillo International	Amarillo	TX
ANC	Anchorage International	Anchorage	AK
AOO	Altoona-Blair	Altoona	PA
APF	Naples Municipal	Naples	FL
ARB	Ann Arbor Municipal	Ann Arbor	MI
ARR	Aurora Municipal	Aurora	IL
ASE	Sardy Field	Aspen Pitkins	CO
ATW	Appleton	Appleton	WI
AUS	Robert Mueller Municipal	Austin	TX
AVP	Wilkes-Barre/Scranton International	Wilkes-Barre/Scran.	PA
AZO	Kalamazoo County	Kalamazoo	MI
BCT	Boca Raton	Boca Raton	FL
BDL	Bradley International	Windsor Locks	CT
BDR	Igor I. Sikorsky Memorial	Bridgeport	CT
BED	Lawrence G. Hanscom Field	Bedford	MA
BFI	Boeing Field/King County International	Seattle	WA
BFL	Meadows Field	Bakersfield	CA
BHM	Birmingham Municipal	Birmingham	AL
BIL	Billings Logan International	Billings	MT
BJC	Broomfield	Denver	CO
BLH	Blythe	Blythe	CA
BLI	Bellingham International	Bellingham	WA
BNA	Nashville Metropolitan	Nashville	TN
BOI	Boise Air Terminal/Gowen Field	Boise	ID
BOS	Gen. Edward Lawrence Logan International	Boston	MA
BTR	Baton Rouge Metropolitan/Ryan Field	Baton Rouge	LA
BUR	Burbank-Glendale-Pasadena	Burbank	CA

TABLE A-3-2. AIRPORT NAME, CITY AND STATE BY LOCATION ID (CONT.)

LOCID	AIRPORT NAME	CITY	STATE
BVY	Beverly Municipal	Beverly	MA
BWI	Baltimore Washington International	Baltimore	MD
CAK	Akron-Canton Regional	Akron	OH
CCR	Buchanan Field	Concord	CA
CDW	Essex County	Caldwell	NJ
CGF	Cuyahoga County	Cleveland	OH
CGS	College Park	College Park	MD
CHS	Charleston Municipal	Charleston	SC
CID	Cedar Rapids International	Cedar Rapids	IA
CLE	Cleveland-Hopkins International	Cleveland	OH
CLL	Easterwood Field	College Station	TX
CLM	William Fairchild International	Port Angeles	WA
CLS	Chehalis-Centralia	Chehalis	WA
CLT	Charlotte/Douglas International	Charlotte	NC
CLW	Clearwater Airpark	Clearwater	FL
CMA	Camarillo	Camarillo	CA
CMH	Port Columbus International	Columbus	OH
CMI	University of Illinois	Champaign/Urbana	IL
COS	City of Colorado Springs	Colorado Springs	CO
CPM	Compton	Compton	CA
CPS	Bi-State Parks	E. St. Louis	IL
CRQ	Palomar Airport	Carlsbad	CA
CSG	Columbus Metropolitan	Columbus	GA
CUB	Owens Field	Columbia	SC
DAB	Daytona Beach Regional	Daytona	FL
DAL	Dallas Love Field	Dallas	TX
DAY	James M. Cox Dayton International	Dayton	OH
DCA	Washington National	Washington	DC
DEC	Decatur	Decatur	IL
DEN	Stapleton International	Denver Stapleton	CO
DET	Detroit City	Detroit	MI
DFW	Dallas-Fort Worth Regional	Dallas	TX
DPA	Dupage County	Chicago	IL
DTW	Detroit Metropolitan Wayne	Detroit	MI
ECG	Elizabeth City	Elizabeth City	NC
ELD	Goodwin Field	El Dorado	AR
ELM	Chemung County	Elmira	NY
ELP	El Paso International	El Paso	TX
EMT	El Monte	El Monte	CA
EWR	Newark International	Newark	NJ
FAI	Fairbanks International	Fairbanks	AK
FAR	Hector Field	Fargo	ND
FAT	Fresno Air Terminal	Fresno	CA
FCM	Flying Cloud	Minneapolis	MN
FFZ	Falcon Field	Mesa	AZ
FLL	Fort Lauderdale-Hollywood	Fort Lauderdale	FL
FLO	Florence City-County	Florence	SC
FMY	Page Field	Fort Myers	FL
FNT	Bishop	Flint	MI
FOK	Suffolk County	Westhampton Beach	NY
FRG	Republic Field	Farmingdale	NY

TABLE A-3-2. AIRPORT NAME, CITY AND STATE BY LOCATION ID (CONT.)

LOCID	AIRPORT NAME	CITY	STATE
FSD	Joe Foss Field	Sioux Falls	SD
FTW	Meacham Field	Fort Worth	TX
FUL	Fullerton Municipal	Fullerton	CA
FWA	Fort Wayne Municipal/Baer Field	Fort Wayne	IN
FXE	Fort Lauderdale Executive	Fort Lauderdale	FL
GAI	Montgomery County Airpark	Gaithersburg	MD
GJT	Walker Field	Grand Junction	CO
GMU	Greenville Downtown	Greenville	SC
GON	Groton-New London	Groton	CT
GRB	Austin-Straubel Field	Green Bay	WI
GRR	Kent County International	Grand Rapids	MI
GTF	Great Falls International	Great Falls	MT
GVW	Richards-Gebaur	Kansas City	MO
GXY	Greeley-Weld	Greeley	CO
GYR	Phoenix Litchfield Municipal	Goodyear	AZ
HDN	Hayden-Yampa Valley	Hayden	CO
HFD	Hartford-Brainard	Hartford	CT
HHR	Hawthorne Municipal	Hawthorne	CA
HIO	Portland-Hillsboro	Hillsboro	OR
HNL	Honolulu International	Honolulu	HI
HOU	William P. Hobby	Houston	TX
HPN	Westchester County	White Plains	NY
HQM	Bowerman Field	Hoquian	WA
HRL	Rio Grande Valley International	Harlingen	TX
HUF	Hulman Field	Terre Haute	IN
HVN	Tweed-New Haven	New Haven	CT
HWD	Hayward Air Terminal	Hayward	CA
HWO	North Perry	Hollywood	FL
HYA	Barnstable Municipal	Hyannis	MA
I77	Blue Ash	Cincinnati	OH
IAD	Dulles International	Chantilly	VA
IAH	Houston Intercontinental	Houston	TX
ICT	Wichita Mid-Continent	Wichita	KS
ILG	Greater Wilmington	Wilmington	DE
ILM	New Hanover County	Wilmington	NC
IND	Indianapolis International	Indianapolis	IN
INT	Smith Reynolds	Winston Salem	NC
IOW	Iowa City Municipal	Iowa City	IA
ISN	Sloulin Field International	Williston	ND
ITO	General Lyman Field	Hilo	HI
JAC	Jackson Hole	Jackson Hole	WY
JAX	Jacksonville International	Jacksonville	FL
JFK	John F. Kennedy International	Kennedy	NY
JNU	Juneau International	Juneau	AK
KTN	Ketchikan International	Ketchikan	AK
L16	Meadowlark	Huntington Beach	CA
L32	Oceanside Municipal	Oceanside	CA
L35	Big Bear City	Big Bear City	CA
LAS	McCarran International	Las Vegas	NV
LAX	Los Angeles International	Los Angeles	CA
LBE	Westmoreland County	Latrobe	PA

TABLE A-3-2. AIRPORT NAME, CITY AND STATE BY LOCATION ID (CONT.)

LOCID	AIRPORT NAME	CITY	STATE
LDJ	Linden	Linden	NJ
LGA	LaGuardia International	LaGuardia	NY
LGB	Long Beach/Daugherty Field	Long Beach	CA
LIH	Lihue	Lihue	HI
LIT	Adams Field	Little Rock	AR
LNA	Palm Beach County Park	W. Palm Beach	FL
LNS	Lancaster	Lancaster	PA
LOU	Bowman Field	Louisville	KY
LSE	La Crosse Municipal	La Crosse	WI
LWM	Lawrence Municipal	Lawrence	MA
MCI	Kansas City International	Kansas City	MO
MCO	Orlando International	Orlando	FL
MDT	Harrisburg International/Olmsted Field	Harrisburg	PA
MDW	Chicago Midway	Chicago	IL
MEB	Laurinburg-Maxton	Maxton	NC
MFR	Medford-Jackson County	Medford	OR
MIA	Miami International	Miami	FL
MKE	General Mitchell Field	Milwaukee	WI
MKG	Muskegon County	Muskegon	MI
MKY	Marco Island	Marco Isle.	FL
MLB	Melbourne Regional	Melbourne	FL
MLE	Millard	Omaha	NE
MMH	Mammoth Lakes	Mammoth Lakes	CA
MMU	Morristown Municipal	Morristown	NJ
MOD	Modesto City/Harry Sham Field	Modesto	CA
MRI	Merrill Field	Anchorage	AK
MSN	Dane County	Madison	WI
MSP	Minneapolis-St. Paul	Minneapolis	MN
MTH	Marathon Flight Strip	Marathon	FL
MTN	Glenn L. Martin State	Baltimore	MD
MVY	Martha's Vineyard	Martha's Vineyard	MA
MWC	Lawrence J. Timmerman	Milwaukee	WI
MWH	Grant County	Moses Lake	WA
MYF	Montgomery Field	San Diego Montgomery	CA
N24	Ramapo Valley	Spring Valley	NY
N67	Wings Field	Philadelphia	PA
N87	Trenton-Robbinsville	Robbinsville	NJ
O01	Santa Rosa Air Center	Santa Rosa	CA
OAK	Metropolitan Oakland International	Oakland	CA
OGG	Kahului	Kahului	HI
OMA	Eppley Airfield	Omaha	NE
ONT	Ontario International	Ontario	CA
OPF	Opa Locka	Opa-Locka	FL
ORD	Chicago-O'Hare International	Chicago	IL
ORF	Norfolk International	Norfolk	VA
ORH	Worchester Municipal	Worcester	MA
ORL	Herndon	Orlando	FL
OSU	Ohio State University	Columbus	OH
OWB	Owensboro-Daviess	Owensboro	KY
OWD	Norwood Memorial	Norwood	MA
OXR	Oxnard Field	Oxnard Ventura	CA

TABLE A-3-2. AIRPORT NAME, CITY AND STATE BY LOCATION ID (CONT.)

LOCID	AIRPORT NAME	CITY	STATE
PAE	Snohomish County/Paine Field	Everett	WA
PBI	Palm Beach International	W. Palm Beach	FL
PDK	Dekalb-Peachtree	Atlanta	GA
PDX	Portland International	Portland	OR
PFN	Panama City-Bay County	Panama City	FL
PHL	Philadelphia International	Philadelphia	PA
PHX	Phoenix Sky Harbor International	Phoenix	AZ
PIE	St. Petersburg-Clearwater International	St. Petersburg	FL
PIR	Pierre Municipal	Pierre	SD
PIT	Greater Pittsburgh International	Pittsburgh	PA
PMP	Pompano Beach Airpark	Pompano Beach	FL
PNE	North Philadelphia	Philadelphia	PA
PNS	Pensacola Regional	Pensacola	FL
POU	Dutchess County	Poughkeepsie	NY
PSC	Tri-Cities	Pasco	WA
PSF	Pittsfield Municipal	Pittsfield	MA
PSP	Palm Springs Municipal	Palm Springs	CA
PTK	Oakland-Pontiac	Pontiac	MI
PUB	Pueblo Memorial	Pueblo	CO
PVD	Theodore Francis Green State	Providence	RI
PWA	Wiley Post	Oklahoma City	OK
PWM	Portland International Jetport	Portland	ME
Q64	Alameda	Albuquerque	NM
Q99	San Martin	San Martin	CA
RBD	Redbird	Dallas	TX
RFD	Greater Rockford	Rockford	IL
RHV	Reid-Hillview Field	San Jose	CA
RIC	Richard Evelyn Byrd International	Richmond	VA
RLD	Richland	Richland	WA
RNO	Reno Cannon International	Reno	NV
ROC	Rochester-Monroe County	Rochester	NY
RSW	Southwest Florida	Fort Myers	FL
S17	Orcas Island	Eastsound	WA
S19	Friday Harbor	Friday Harbor	WA
S21	Sunriver	Bend	OR
S26	Ocean Shores Municipal	Ocean Shores	WA
S50	Auburn Municipal	Auburn	WA
SAC	Sacramento Executive	Sacramento	CA
SAN	San Diego International/Lindbergh Field	San Diego Lindbergh	CA
SAT	San Antonio International	San Antonio	TX
SBA	Santa Barbara Municipal	Santa Barbara	CA
SBN	Michiana Regional	South Bend	IN
SCK	Stockton Metropolitan	Stockton	CA
SDF	Standiford Field	Louisville	KY
SDL	Scottsdale Municipal	Scottsdale	AZ
SDM	Brown Field Municipal	San Diego	CA
SEA	Seattle-Tacoma	Seattle	WA
SFO	San Francisco International	San Francisco	CA
SFZ	North Central State	Pawtucket	RI
SHV	Shreveport Regional	Shreveport	LA
SIT	Sitka	Sitka	AK

TABLE A-3-2. AIRPORT NAME, CITY AND STATE BY LOCATION ID (CONT.)

LOCID	AIRPORT NAME	CITY	STATE
SJC	San Jose Municipal	San Jose	CA
SJU	Puerto Rico International	San Juan	PR
SLC	Salt Lake City International	Salt Lake City	UT
SMF	Sacramento Metropolitan	Sacramento	CA
SMO	Santa Monica Municipal	Santa Monica	CA
SMX	Santa Maria Public	Santa Maria	CA
SNA	John Wayne/Orange County	Santa Ana	CA
SOP	Moore County	Southern Pines	NC
SPG	Albert Whitted	St. Petersburg	FL
SPI	Capital	Springfield	IL
SPS	Sheppard AFB/Wichita Falls Municipal	Wichita Falls	TX
SQL	San Carlos	San Carlos	CA
STL	Lambert-St. Louis International	St. Louis	MO
STP	St. Paul Downtown/Holman	St. Paul	MN
STS	Sonoma County	Santa Rosa	CA
STX	Alexander Hamilton	St. Croix	VI
SUN	Friedman Memorial	Hailey	ID
SWF	Stewart	Newburgh	NY
SZP	Santa Paula	Santa Paula	CA
TEB	Teterboro	Teterboro	NJ
TIW	Tacoma Narrows	Tacoma	WA
TLH	Tallahassee Municipal	Tallahassee	FL
TOA	Torrance Municipal	Torrance	CA
TOL	Toledo Express	Toledo	OH
TPA	Tampa International	Tampa	FL
TTN	Mercer County	Trenton	NJ
TUL	Tulsa International	Tulsa	OK
TUS	Tucson International	Tucson	AZ
TVC	Cherry Capital	Traverse City	MI
TVL	Lake Tahoe	S.Lake Tahoe	CA
UGN	Waukegan Memorial	Waukegan	IL
UKI	Ukiah Municipal	Ukiah	CA
VNY	Van Nuys	Van Nuys	CA
VRB	Vero Beach Municipal	Vero Beach	FL
W09	Leesburg Municipal	Leesburg	VA
W35	Potomac Airpark	Berkeley Springs	WV
W52	Horace Williams	Chapel Hill	NC
W75	Saluda	Saluda	VA
W98	Chesterfield County	Richmond	VA
X16	Vandenberg	Tampa	FL
YIP	Willow Run	Detroit	MI
YNG	Youngstown Municipal	Youngstown	OH

APPENDIX B. ESTIMATION PROCEDURES USED IN THE PLAN

B-1 Cost of Delay

B-2 Estimation of Delay and Delay Reduction Benefits

B-3 Capacity for Converging Approaches at Selected Airports

APPENDIX B-1. COST OF DELAY

B-1.1. INTRODUCTION

The cost of delay to the aviation community is identified in terms of increased airline operating costs and passenger time lost in air travel. The estimation of these costs pertains only to delays encountered by scheduled air carriers and their passengers. Data on delays to general aviation and commuter traffic are not available. Since this traffic also encounters airport congestion and delay, the estimate of the cost of delay underestimates the total cost.

This appendix describes the method employed to develop the cost of delay estimates and presents initial estimates of the magnitude of these costs. The estimates of the cost of delay are presented separately for air carriers and passengers.

B-1.2. AIR CARRIER COST OF DELAY

Air carrier cost of delay is estimated from data on scheduled air carrier direct operating costs for various aircraft types, average delay estimates experienced by Standardized Delay Reporting System (SDRS) air carriers at SDRS airports for various stages of flight, and scheduled air carrier operations by aircraft type at SDRS airports.

Air carrier cost of delay varies according to the stage of flight in which an aircraft is delayed. For example, delays that occur while an aircraft is airborne or while an aircraft is taxiing will be considerably more expensive than delays that occur at the gate. Air carriers primarily incur crew expenses during a gate hold while additional direct operating expenses are incurred during an airborne or a taxi delay. As a result, delay costs are estimated for the following three aggregate stage of flight categories:

- Taxi-in and Taxi-out;
- Airborne; and
- ATC Gatehold.

Table B-1-1 shows the average delay per operation by stage of flight encountered by SDRS carriers at SDRS airports.

The mix and level of air activity by aircraft type also affects air carrier cost of delay. For each SDRS airport, data were collected for scheduled service aircraft operations of certificated route air carriers by aircraft type.[1] In addition, aircraft direct operating costs, presented on a block hour basis, were used with aircraft activity data to estimate the magnitude of delay cost.[2] Table B-1-2 identifies direct operating costs for the predominant turbo-fan aircraft at SDRS airports. These aircraft types account for 92 percent of total aircraft operations by scheduled service certificated route air carriers at SDRS airports.

Scheduled service air carrier operations by aircraft type for each SDRS airport were used with average delay by stage of flight to estimate the total annual hours of delay for scheduled air carrier service by aircraft type and stage of flight. Aircraft direct operating cost items were examined in relation to the expenses incurred by air carriers for the three aggregate stage of flight categories. Total aircraft direct operating expenses (cockpit and cabin crew, fuel, oil, direct maintenance and other) were applied to delay hours occurring within the airborne stage of flight. For the air taxi stage of flight, total direct operating expenses less fuel consumption expense were applied to delay

[1] FAA 1985 Airport Activity Statistics.
[2] DOT 1985 Aircraft Operating and Performance Report, CAB Form 41 , Schedules P-5.1 and P-5.2.

TABLE B-1-1. AVERAGE MINUTES DELAY PER OPERATION AT SDRS AIRPORTS

Airport	Average Delay O,I	Average Delay A	Average Delay T	Total Delay Per Ops
Atlanta	5.14	3.17	.18	8.49
Boston	5.25	1.58	1.38	8.21
Baltimore Washington	2.55	1.25	.73	4.53
Charleston	2.55	1.05	1.08	4.68
Cleveland	2.61	1.18	1.14	4.93
Washington National	4.85	1.28	.62	6.75
Denver Stapleton	3.90	2.14	.47	6.51
Dallas Ft. Worth	6.03	2.51	2.00	8.74
Detroit Metro	4.12	1.80	.91	6.83
Newark	6.61	2.97	1.30	10.88
Washington Dulles	2.95	1.69	.60	5.24
Houston Intercontinental	3.32	1.23	.51	5.06
Indianapolis	2.14	1.23	.85	4.22
Jacksonville	2.77	.83	.56	4.16
New York Kennedy	6.52	2.17	.70	9.39
Los Angeles	3.84	2.82	1.05	7.71
New York LaGuardia	7.47	1.87	.37	9.71
Memphis	2.99	1.37	.74	5.10
Miami	4.34	.89	.64	5.87
Minneapolis St. Paul	2.61	2.11	.82	5.54
New Orleans	2.18	.81	.46	3.45
Chicago O'Hare	6.47	2.47	.13	9.07
Philadelphia	3.06	1.49	.65	5.20
Phoenix	3.95	1.83	.61	6.39
Pittsburgh	3.12	1.38	.69	5.19
Raleigh Durham	2.76	.91	.93	4.60
Seattle Tacoma	1.89	2.69	.54	5.12
San Francisco	6.21	2.85	1.24	10.30
St. Louis Lambert	3.61	1.93	.75	6.29
Tampa	2.78	.98	.40	4.16

Average Delay = Average number of delay minutes per total operations for each stage of flight

O, I = Taxi-out and Taxi-in Stage of Flight
A = Airborne Stage of Flight
T = ATC Gate Hold Stage of Flight

Source: 1985 SDRS

TABLE B-1-2. PREDOMINANT AIRCRAFT TYPES USED IN ESTIMATING AIR CARRIER COST OF DELAY

Aircraft	Average Operating Expense ($/Blk Hr.)	Average Crew Expense ($/Blk Hr.)
DC 9	$1,889	$ 519
B 737	1,646	593
B 727	1,959	720
MD 80	1,848	568
B 757	1,693	742
B 767	2,270	964
A 300	2,889	1,158
DC 10	3,554	1,112
L 1011	3,789	1,490
B 747	4,813	1,295

Average Operating Expense represents the cost items (crew, fuel, oil, direct maintenance and other) associated with flying operations.

Average Crew Expense represents the cost items for cockpit and cabin personnel associated with flying operations.

$/Blk Hr. = Average Operating Expenses associated with the hours computed from the moment the aircraft first moves under its own power for purposes of flight, until it comes to rest at the next point of landing.

Source: DOT 1985 Aircraft Operating and Performance Report, CAB Form 41, Schedules P-5.1 and P-5.2.

hours occurring within this category. Crew expenses (full expense for cabin personnel and one half expense for cockpit personnel) were applied to delay hours occurring within the gate stage of flight.

The total air carrier cost of delay estimates at SDRS airports were calculated by summing the direct operating cost expenses of each aircraft type for the three aggregate stage of flight categories within each SDRS airport.

Table B-1-3 presents the total air carrier cost of delay at the SDRS airports. The total air carrier cost of delay at the SDRS airports in 1985 was estimated at $1.2 billion. The delay hours presented in Table B-1-3 represent the total delay hours incurred by the predominant turbo-fan aircraft at each SDRS airport for the three aggregate stage of flight categories. Average delay cost per hour is the result of aircraft direct operating cost expenses, weighted by individual turbo-fan aircraft activity and average delay by stage of flight.

The SDRS airports used in this study are estimated to represent approximately 65 percent of all delays encountered in 1985.[3] Because direct extrapolation of SDRS delay and delay cost to all air carrier flights is not recommended[4] (the measure of the level of SDRS airport operations in relation to total U.S. airport operations) the percentage of SDRS airport delay to all delays encountered in 1985 was used to factor the range of total system-wide air carrier cost of delay.

The initial estimate of the total air carrier cost of delay at SDRS airports was factored up by the reciprocal of the percentage of SDRS delays to the total U.S. delays to provide a range of the system-wide impact of delays on air carrier operating costs. Using the factor of 1.54 (1/0.65), the total system-wide air carrier cost of delay estimate increases to approximately $1.8 billion. In relation to 1985 air carrier total operating expenses for flying operations, the system-wide air carrier cost of delay estimate represents approximately 7 percent of total industry-wide direct operating expenses.

B-1.3. PASSENGER COST OF DELAY

The cost of delay to passengers is estimated from data on total revenue passengers enplaned in domestic and international scheduled service by large certificated route air carriers at SDRS airports, average delay estimates experienced by SDRS air carriers at SDRS airports, and the value of passenger time in air travel.

The number of passenger delay hours varies according to the average delay per aircraft operation experienced by the SDRS carriers at SDRS airports. Passenger delay will not vary by stage of aircraft flight. Passenger delay time by airport will equal the average delay time per aircraft operation as shown in Table B-1-1. Using average delay data in Table B-1-1 and total revenue passengers enplaned during scheduled service, total passenger hours delayed for SDRS airports are calculated and presented in Table B-1-4. Based on FAA Airport Activity Statistics and average delay estimates by SDRS carriers at SDRS airports, passengers lost more than 30 million hours at the 30 SDRS airports as a result of delay in 1985.

The value of time in air travel will also affect the magnitude of passenger delay cost estimates at SDRS airports. An FAA policy report[5] recommends that the hourly earnings rate of a typical air traveler be used as the basis for valuing the time of air travelers. The report further recommends that the hourly value of time of air travelers be updated by applying the Department of Labor Bureau of Labor Statistics Index of Adjusted Hourly Earnings. Based on the FAA recommended valuing

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[3] TSC Staff Study, "TSC Airport Capacity Projects Benefits Estimation Model", forthcoming.

[4] FAA, APO-120 Technical Memorandum, "Guidance for Use of the Standardized Delay Reporting System (SDRS) Data", October, 1986.

[5] Economic Values for Evaluation of Federal Aviation Administration Investment and Regulatory Programs, Report Number FAA-APO-81-3, September 1981.

TABLE B-1-3. 1985 AIR CARRIER COST OF DELAY AT SDRS AIRPORTS

Airport	Ops	Delay Hours	Ave Delay Cost/Hour ($)	A/C Cost Of Delay ($M)
Atlanta	531,898	75,530	$1,562	$118.0
Boston	187,852	25,736	1,625	41.8
Baltimore Washington	106,478	8,092	1,395	11.3
Charleston AFB/Muni	20,900	1,651	1,245	2.1
Cleveland Hopkins	93,302	7,744	1,273	9.9
Washington National	181,566	20,335	1,492	30.3
Denver Stapleton	322,486	35,151	1,575	55.4
Dallas Ft. Worth	411,228	72,376	1,555	112.5
Detroit Metro	209,554	23,888	1,335	31.9
Newark	276,698	50,359	1,619	81.5
Washington Dulles	67,240	5,850	1,578	9.2
Houston Intercontinental	167,860	14,940	1,464	21.9
Indianapolis	63,580	4,514	1,258	5.7
Jacksonville	38,622	2,665	1,441	3.8
New York Kennedy	135,298	21,242	2,488	52.9
Los Angeles Int'l	306,812	39,579	1,752	69.3
New York LaGuardia	228,780	37,062	1,706	63.2
Memphis	153,764	13,070	1,171	15.3
Miami	150,360	14,735	1,902	28.0
Minneapolis - St. Paul	203,666	18,941	1,394	26.4
New Orleans	82,532	4,787	1,429	6.8
Chicago O'Hare	509,742	76,897	1,822	140.2
Philadelphia	130,840	11,446	1,476	16.9
Phoenix Sky Harbor	201,116	21,519	1,494	32.2
Pittsburgh	190,076	16,537	1,240	20.5
Raleigh Durham	50,410	3,882	1,341	5.2
Seattle Tacoma	129,178	11,109	1,568	17.4
San Francisco	232,954	40,301	1,745	70.3
St. Louis Lambert	274,996	28,875	1,427	41.2
Tampa	113,014	7,798	1,562	12.2
TOTAL	5,773,512	716,684	$1,609	$1,153.4

Ops = Scheduled service operations (one operation = one arrival plus one departure per flight) of certificated route air carriers for predominant turbo- fan aircraft. The predominant aircraft include: DC 9, B 737, B 727, MD 80, B 757, B 767, A 300, DC 10, L 1011, B 747.

A/C Cost = Air carrier cost of delay is for the predominant turbo-fan aircraft at each SDRS airport.

Source: FAA Airport Activity Statistics, CAB Form 41, Schedules P-5.1 and P- 5.2, and Standard Delay Reporting System

TABLE B-1-4. 1985 ENPLANEMENTS AND PASSENGER HOURS DELAYED AT SDRS AIRPORTS

Airport	Enplaned Passengers (000s)	Passenger Hours Delayed (000s)
Atlanta	20,665	2,952
Boston Logan	9,090	1,259
Baltimore Washington	3,403	258
Charleston AFB/Muni	499	41
Cleveland Hopkins	3,007	228
Washington National	6,728	767
Denver Stapleton	13,854	1,489
Dallas Ft. Worth	17,659	2,578
Detroit Metro	7,149	816
Newark	14,268	2,573
Washington Dulles	2,283	205
Houston Intercontinental	6,304	526
Indianapolis	1,735	177
Jacksonville	1,159	83
New York Kennedy	9,977	1,573
Los Angeles International	15,871	1,833
New York LaGuardia	9,607	1,622
Memphis	3,468	320
Miami	7,657	763
Minneapolis - St. Paul	7,210	1,270
New Orleans	2,904	174
Chicago O'Hare	21,471	3,371
Philadelphia	4,748	371
Phoenix Sky Harbor	6,703	643
Pittsburgh	6,969	598
Raleigh Durham	1,342	106
Seattle Tacoma	5,692	478
San Francisco	10,919	1,851
St. Louis Lambert	9,543	1,040
Tampa	3,995	269
TOTAL	235,870	30,234

Enplaned Passengers = Total domestic and international scheduled service enplaned revenue passengers for large certificated route air carriers.

Source: FAA Airport Activity Statistics, and Standardized Delay Reporting System

valuing and updating methods, the value of passenger time in air travel in 1985 was estimated to be $23.00 per hour.

The total passenger cost of delay estimate at SDRS airports is found by summing the product of passenger hours and the average value of passenger time in air travel for each SDRS airport. Table B-1-5 presents the 1985 total passenger cost of delay at the SDRS airports. The total passenger cost of delay at SDRS airports in 1985 is estimated to be approximately $700 million. To provide a range of the system-wide impacts of delay on passenger inconvenience, the SDRS passenger cost estimate is factored up by the reciprocal of the percentage of SDRS delays to total U.S. airport delays. Using the factor 1.54 (1/0.65), the total system-wide passenger cost of delay estimate increases to approximately $1.1 billion.

B-1.4 TOTAL COST OF DELAY

Delay represents a considerable cost to the aviation community in terms of increased airline operating costs and passenger inconvenience. The cost of delay in 1985 is estimated to be $1.2 billion for scheduled air carriers at SDRS airports and up to $1.8 billion system-wide. This constitutes approximately 7 percent of the scheduled air carriers' total direct operating costs. These delays cost passengers in the order of $700 million at SDRS airports and up to $1.1 billion system-wide. Taken together, delays in 1985 cost up to $2.9 billion. Table B-1-6 presents air carrier and passenger costs of delay for each of the 30 SDRS airports.

TABLE B-1-5. 1985 PASSENGER COST OF DELAY AT SDRS AIRPORTS

Airport	Passenger Hours Delayed (000s)	Passenger Cost of Delay ($M)
Atlanta	2,952	$67.9
Boston Logan	1,259	29.0
Baltimore Washington	258	5.9
Charleston AFB/Muni	41	.9
Cleveland Hopkins	228	5.2
Washington National	767	17.6
Denver Stapleton	1,489	34.3
Dallas Ft. Worth	2,578	59.3
Detroit Metro	816	18.8
Newark	2,573	59.2
Washington Dulles	205	4.7
Houston Intercontinental	526	12.1
Indianapolis	177	4.1
Jacksonville	83	1.9
New York Kennedy	1,573	36.2
Los Angeles International	1,833	42.2
New York LaGuaradia	1,622	37.3
Memphis	320	7.4
Miami	763	17.6
Minneapolis - St. Paul	1,270	29.2
New Orleans	174	4.0
Chicago O'Hare	3,371	77.5
Philadelphia	371	8.5
Phoenix Sky Harbor	643	14.8
Pittsburgh	598	13.8
Raleigh Durham	106	2.4
Seattle Tacoma	478	11.0
San Francisco	1,851	42.6
St. Louis Lambert	1,040	23.9
Tampa	269	6.2
TOTAL	30,234	$695.4

Source: FAA Airport Activity Statistics, and Standardized Delay Reporting System

TABLE B-1-6. 1985 AIR CARRIER AND PASSENGER COSTS OF DELAY

Airport	Air Carrier Cost of Delay ($M)	Passenger Cost of Delay ($M)	Total Cost of Delay ($M)
Atlanta	$118.0	$67.9	$185.9
Boston	41.8	29.0	70.8
Baltimore Washington	11.3	5.9	17.2
Charleston AFB/Muni	2.1	.9	3.0
Cleveland Hopkins	9.9	5.2	15.1
Washington Nationál	30.3	17.6	47.9
Denver Stapleton	55.4	34.3	89.7
Dallas Ft. Worth	112.5	59.3	171.8
Detroit Metro	31.9	18.8	50.7
Newark	81.5	59.2	140.7
Washington Dulles	9.2	4.7	13.9
Houston Intercontinental	21.9	12.1	34.0
Indianapolis	5.7	4.1	9.8
Jacksonville	3.8	1.9	5.7
New York Kennedy	52.9	36.2	89.1
Los Angeles International	69.3	42.2	111.5
New York LaGuardia	63.2	37.3	100.5
Memphis	15.3	7.4	2.7
Miami	28.0	17.6	45.6
Minneapolis - St. Paul	26.4	29.2	55.6
New Orleans	6.8	4.0	10.8
Chicago O'Hare	140.2	77.5	217.7
Philadelphia	16.9	8.5	25.4
Phoenix Sky Harbor	32.2	14.8	47.0
Pittsburgh	20.5	13.8	34.3
Raleigh Durham	5.2	2.4	7.6
Seattle Tacoma	17.4	11.0	28.4
San Francisco	70.3	42.6	112.9
St. Louis Lambert	41.2	23.9	65.1
Tampa	12.2	6.2	18.4
TOTAL	$1,153.4	$695.4	$1,848.8

Source: FAA Airport Activity Statistics, DOT Aircraft Operating and Performance Report, CAB Form 41, Schedules P-5.1 and P-5.2, and FAA Standardized Delay Reporting System.

APPENDIX B-2. ESTIMATION OF DELAY AND DELAY REDUCTION BENEFITS

B-2.1. BENEFIT ESTIMATION METHOD

In order to compare different capacity enhancement projects, it is necessary to quantify the benefits that might be expected from each. A complete quantification of benefits would require estimating the cost changes that would result from adoption of a project at each possible airport, to airlines, passengers, and general aviation users. The information necessary for such a complete estimate is not available. In this study the major benefit quantified is the reduction in delay to air carrier operations. The second benefit measured delay to passengers. The delay per operation is applied to the total passenger counts, both air carrier passengers and commuter/air-taxi passengers, yielding a rough measure of passenger delays. This measure is probably a lower bound on passenger delays, because load factors and possibly aircraft size are larger than average during the peak scheduled flight periods when delays are most likely.[1]

Several steps were necessary to construct estimates of the delay to air carrier operations that would result from particular projects. The first of these was the development of a formula that relates delay per air carrier operation to airport capacity utilization. The second step was to select the group of airports most likely to have capacity or delay problems now, or in the near future, and to collect the necessary data concerning each airport in the group. The final step was to determine when a project was applicable at each airport in the group, and what its effects were on capacity at each affected airport. The following subsections treat each of these steps broadly.[2]

B-2.2 DEVELOPMENT OF THE DELAY FORMULA

The formula relating air carrier delays to airport capacity utilization was estimated from recent historical data using linear regression techniques. From the SDRS database, annual average delays on air carrier flights were calculated. These averages were obtained for 32 airports for three successive years, 1983 to 1985, with 1985 data for only 10 additional airports. The number of annual operations carried out by the reporting airlines was also computed from the SDRS database. The total numbers of air carrier and non-air-carrier operations at each airport for each year were taken from the FAA tower counts published by the FAA. Two separate capacity utilization terms were defined: the ratio of air-carrier operations to capacity and the ratio of non-air- carrier operations to capacity. Capacity was defined to be a weighted average of IFR and VFR capacity. These capacities were taken from the FAA's NPIAS database. The weights used were airport- specific and derived from the report Ceiling-Visibility Climatological Study and Systems Enhancement Factors, prepared for the FAA by the National Oceanic and Atmospheric Administration.

Several regressions were performed, experimenting with different nonlinear functional forms, each more or less consistent with the theoretical curve shown in Figure 2-1. It was not possible to select one form definitely from the estimation data, since none of this averaged delay data reaches the extremely steep portion of the theoretical curve. The formula ultimately chosen was:

$$\begin{aligned}\text{DELAY/AC-OP} \;=\; & -6.25 \\ & + 5.59 \bullet (\text{IFR\%} \bullet \text{EXP}(\text{AC-OPS/IFR-CAP}) + \text{VFR\%} \bullet \text{EXP}(\text{AC-OPS/VFR-CAP})) \\ & + 3.51 \bullet (\text{IFR\%} \bullet \text{EXP}(\text{GA-OPS/IFR-CAP}) + \text{VFR\%} \bullet \text{EXP}(\text{GA-OPS/VFR-CAP}))\end{aligned}$$

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1 Other measures are possible with the data at hand, but their meanings are equivocal. The computed delays per operation could be applied to other classes of operations -- commuter, air taxi and general aviation. This would make some sense in the case of commuter airline operations, because these do have a fixed schedule. On the other hand, it will be shown that the formula for delay per operation was estimated using only delays to air carrier operations, so that the application of the formula to other classes seems unwarranted. In the case of unscheduled operations, especially GA operations, the very definition of delay is problematic.

2 Technical details will be available in the forthcoming TSC Staff Study "Airport Capacity Projects Benefits Estimation Model."

The variables are defined as follows:

DELAY/AC-OP:	Minutes of delay per air carrier operation
AC-OPS:	Number of air carrier operations
GA-OPS:	Number of non-air-carrier operations
IFR-CAP:	IFR Capacity
VFR-CAP	VFR Capacity
IFR%	Percentage of time that IFR weathers conditions prevail
VFR%	Percentage of time that VFR weather conditions prevail

The "EXP" function takes e = 2.7128.. to its argument's power. All of the parameter estimates in the formula are significant at the five percent level, and the R-squared for the estimation is 0.63.

B-2.3 THE GROUP OF AIRPORTS TO BE ANALYZED

A set of 240 airports was selected in the hope of including every airport that might have any kind of capacity problem between now and the year 2000.

Airports were selected if they had high levels of 1982 total aircraft operations, high levels of 1982 air carrier operations, high levels of 1992 total aircraft operations or high levels of 1992 air carrier operations. The source for the operations data used in making the selections was the published 1986 NPIAS report. A few additional airports were added because they appeared in prior lists of airports that might have capacity problems by the year 2000.

A data file was constructed containing much potentially useful information about each of the 240 airports. Information on 1984 and 1994 operations and passenger enplanements is from the FAA's airport traffic forecasts. Information on capacity measures comes from the most recently available NPIAS file. Information on the number of runways, their lengths and their configuration, comes from the FAA's Landing Facilities Database.

B-2.4 CALCULATION OF PROJECT BENEFITS

The delay formula was applied twice to each of the 240 airports to produce 1984 and 1994 baseline delay estimates. Likewise, the delay formula was used to produce 1984 and 1994 delay estimates for any project/airport pair such that the project was deemed applicable at the airport. No attempt was made to model a feedback from delay on demand for airport use; the same FAA operations data were used for the baselines and the post- project estimates.

In most cases, the effect of a capacity enhancement project can be represented by having the project change either the IFR or VFR capacity, or both, and using the delay formula to translate these changes into delay changes. The exception to this is the project involving the construction of new separate short runways for non-air-carrier operations. This is analyzed by removing one-half of the non-air-carrier operations from the delay formula, without changing the capacities.

The IFR capacity changes on to projects were mostly based on analyses made using the FAA Airfield Capacity Model and available in published research reports. The standard percentage changes for each project are listed in Table B-2-1. In no case, however, was the IFR capacity allowed to exceed the original VFR capacity.

Changes in VFR capacities for new runways, and a few of the IFR capacities for new runways, were based on tables from the FAA <u>Airport Capacity Manual</u>.

TABLE B-2-1. EFFECT OF PROJECTS ON IFR HOURLY CAPACITY

Project	Percent Change in IFR Capacity
Reduced Longitudinal Separation	3
Terminal ATC Automation	8
Simultaneous IFR Converging Approaches	100
Independent Close-Parallel IFR Approaches	39
Dependent Close-Parallel IFR Approaches	39
Triple IFR Approaches	7, 20 or 50[1]
Separate Short Runways	39 or 100[2]
New Runways	39[3]

[1] Depends on runway configuration.

[2] Depends on whether the short runway is converging or parallel to the major runway. Capacity increase is also restricted if less than one half of the airport's traffic is non-air- carrier.

[3] In some cases, Capacity Manual tables were used instead.

Several kinds of rules were used for deciding what projects might apply at particular airports. For the case of new runways, only airports that had recently completed new runways, or had started or were about to start new runways, were included. For Terminal ATC Automation, any airport having non-zero IFR capacity was included. For all other projects, the decision was based upon a study of the airport's runway layout to see if the concept was conceivably applicable. The lists of airports to which projects are applied should therefore be an upper bound; many airports might in practice be excluded because of noise or terrain restrictions, or other reasons not captured in the data collected for these airports. Table B-2-2 lists all 240 database airports, and shows for each which projects are applicable, and the size grouping with regard to 1994 benefits from each project.

TABLE B-2-2. DATABASE AIRPORTS RANKED WITH RESPECT TO EIGHT PROJECTS

STATE	CITY	AIRPORT	TA	RL	IC	DP	IP	SS	TR	RW
AK	ANCHORAGE	ANCHORAGE INTERNATIONAL	5	5	3	0	0	0	0	0
AK	ANCHORAGE	MERRILL FIELD	7	7	0	0	0	0	0	0
AK	BETHEL	BETHEL	6	6	0	0	0	0	0	0
AK	FAIRBANKS	FAIRBANKS INTERNATIONAL	6	6	0	0	0	0	0	0
AK	SOLDOTNA	SOLDOTNA	7	7	0	0	0	0	0	0
AL	BIRMINGHAM	BIRMINGHAM MUNICIPAL	6	6	0	0	0	0	0	0
AL	EVERGREEN	MIDDLETON FIELD	7	7	0	0	0	0	0	0
AR	LITTLE ROCK	ADAMS FIELD	6	6	4	0	0	0	0	0
AZ	COOLIDGE	COOLIDGE MUNICIPAL	7	7	0	0	0	0	0	0
AZ	GOODYEAR	PHOENIX-LITCHFIELD MUNICIPAL	7	7	0	0	0	0	0	0
AZ	GRAND CANYON	GRAND CANYON NATIONAL PARK	7	7	0	0	0	0	0	0
AZ	MESA	FALCON FIELD	7	7	0	0	0	0	0	0
AZ	PHOENIX	PHOENIX SKY HARBOR INT	6	0	0	0	3	0	0	1
AZ	PHOENIX	PHOENIX-DEER VALLEY MUNICIPAL	7	7	0	0	0	0	0	0
AZ	PRESCOTT	ERNEST A. LOVE FIELD	7	7	7	0	0	0	0	0
AZ	SCOTTSDALE	SCOTTSDALE MUNICIPAL	7	7	0	0	0	0	0	0
AZ	TUCSON	RYAN FIELD	7	7	0	0	0	0	0	0
AZ	TUCSON	TUCSON INTERNATIONAL	6	6	6	0	0	0	0	0
CA	BAKERSFIELD	MEADOWS FIELD	6	6	0	0	0	0	0	0
CA	BURBANK	BURBANK-GLENDALE-PASADENA	5	4	3	0	0	0	0	0
CA	CAMARILLO	CAMARILLO	7	7	0	0	0	0	0	0
CA	CARLSBAD	MCCLELLAN-PALOMAR	7	7	0	0	0	0	0	0
CA	CHINO	CHINO	7	7	0	0	0	0	0	0
CA	COMPTON	COMPTON	7	7	0	0	0	0	0	0
CA	CONCORD	BUCHANAN FIELD	7	7	0	0	0	0	0	0
CA	CORONA	CORONA MUNICIPAL	7	7	0	0	0	0	0	0
CA	EL MONTE	EL MONTE	7	7	0	0	0	0	0	0
CA	FRESNO	FRESNO AIR TERMINAL	6	6	0	0	0	0	0	0
CA	FULLERTON	FULLERTON MUNICIPAL	7	7	0	0	0	0	0	0
CA	HAYWARD	HAYWARD AIR TERMINAL	7	7	0	0	0	0	0	0
CA	LA VERNE	BRACKET FIELD	7	7	0	0	0	0	0	0

Note:
TA = Terminal ATC Automation
RL = Reduced Longitudinal Separations
IC = Simultaneous IFR Converging Approaches
DP = Dependent Close Parallel IFR Approaches
IP = Independent Close Parallel IFR Approaches
TR = Triple IFR Approaches
SS = Separate Short Runways
RW = New Runways

Note:
1 = Top 5 Airports in 1994 Benefit for This Project
2 = 6-10 in 1994 Benefit for This Project
3 = 11-20 in 1994 Benefit for This Project
4 = 21-30 in 1994 Benefit for This Project
5 = 31-40 in 1994 Benefit for This Project
6 = Other Airport with 1994 Benefit for This Project
7 = Airport Could Benefit, but lacks AC Ops or IFR Capacity
0 = Airport at Which This Project Is Not Applicable

TABLE B-2-2. DATABASE AIRPORTS RANKED WITH RESPECT TO EIGHT PROJECTS (CONT.)

STATE	CITY	AIRPORT	TA	RL	IC	DP	IP	SS	TR	RW
CA	LANCASTER	GEN WM. J. FOX AIRFIELD	7	7	0	0	0	0	0	0
CA	LIVERMORE	LIVERMORE MUNICIPAL	7	7	0	0	0	0	0	0
CA	LONG BEACH	LONG BEACH-DAUGHERTY FIELD	6	0	0	0	2	0	0	0
CA	LOS ANGELES	LOS ANGELES INTERNATIONAL	1	1	0	0	0	0	0	0
CA	NOVATO	GNOSS FIELD	7	7	0	0	0	0	0	0
CA	OAKLAND	METRO OAKLAND INTERNATIONAL	3	3	1	1	0	0	0	0
CA	ONTARIO	ONTARIO INTERNATIONAL	4	3	0	0	0	0	0	0
CA	PALO ALTO	PALO ALTO	7	7	0	0	0	0	0	0
CA	PORTERVILLE	PORTERVILLE MUNICIPAL	7	7	0	0	0	0	0	0
CA	RIVERSIDE	RIVERSIDE MUNICIPAL	7	7	0	0	0	0	0	0
CA	SACRAMENTO	SACRAMENTO EXEC	7	7	7	0	0	0	0	0
CA	SACRAMENTO	SACRAMENTO METRO	6	6	0	0	0	0	0	0
CA	SAN CARLOS	SAN CARLOS	7	7	0	0	0	0	0	0
CA	SAN DIEGO	BROWN FIELD MUNICIPAL	7	7	0	0	0	0	0	0
CA	SAN DIEGO	GILLESPIE FIELD	7	7	0	0	0	0	0	0
CA	SAN DIEGO	MONTGOMERY FIELD	7	7	0	0	0	0	0	0
CA	SAN DIEGO	SAN DIEGO INT-LINDBERGH FIELD	5	4	3	0	0	0	0	0
CA	SAN FRANCISCO	SAN FRANCISCO INTERNATIONAL	2	2	0	0	0	0	0	0
CA	SAN JOSE	REID-HILLVIEW	7	7	0	0	0	0	0	0
CA	SAN JOSE	SAN JOSE MUNICIPAL	4	4	0	0	0	0	0	0
CA	SAN LUIS OBISPO	SAN LUIS OBISPO COUNTY	7	7	7	0	0	0	0	0
CA	SANTA ANA	JOHN WAYNE ARPT-ORANGE CO	4	4	0	0	0	0	0	0
CA	SANTA BARBARA	SANTA BARBARA MUNICIPAL	6	6	0	0	0	0	0	0
CA	SANTA MONICA	SANTA MONICA MUNICIPAL	7	7	0	0	0	0	0	0
CA	TORRANCE	TORRANCE MUNICIPAL	7	7	0	0	0	0	0	0
CA	VAN NUYS	VAN NUYS	7	7	0	0	0	0	0	0
CO	COLORADO SPRINGS	CITY OF COLORADO SPRINGS MUNI	6	6	5	0	0	0	0	0
CO	DENVER	CENTENNIAL	7	7	0	0	0	0	0	0
CO	DENVER	JEFFCO	7	7	0	0	0	0	0	0
CO	DENVER	STAPLETON INTERNATIONAL	1	1	1	0	0	0	0	2
CO	GREELEY	GREELEY-WELD COUNTY	7	7	0	0	0	0	0	0

Note:
TA = Terminal ATC Automation
RL = Reduced Longitudinal Separations
IC = Simultaneous IFR Converging Approaches
DP = Dependent Close Parallel IFR Approaches
IP = Independent Close Parallel IFR Approaches
TR = Triple IFR Approaches
SS = Separate Short Runways
RW = New Runways

Note:
1 = Top 5 Airports in 1994 Benefit for This Project
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4 = 21-30 in 1994 Benefit for This Project
5 = 31-40 in 1994 Benefit for This Project
6 = Other Airport with 1994 Benefit for This Project
7 = Airport Could Benefit, but lacks AC Ops or IFR Capacity
0 = Airport at Which This Project Is Not Applicable

TABLE B-2-2. DATABASE AIRPORTS RANKED WITH RESPECT TO EIGHT PROJECTS (CONT.)

STATE	CITY	AIRPORT	TA	RL	IC	DP	IP	SS	TR	RW
CT	BRIDGEPORT	IGOR I SIKORSKY MEMORIAL	7	7	0	0	0	0	0	0
CT	DANBURY	DANBURY MUNICIPAL	7	7	0	0	0	0	0	0
CT	HARTFORD	HARTFORD BRAINARD	7	7	7	0	0	0	0	0
CT	WINDSOR LOCKS	BRADLEY INTERNATIONAL	6	6	3	0	0	0	0	0
DC	WASHINGTON	DULLES INTERNATIONAL	6	5	0	0	0	0	2	0
DC	WASHINGTON	WASHINGTON NATIONAL	3	3	0	0	0	0	0	0
DE	WILMINGTON	GREATER WILMINGTON-NEW CASTLE	6	6	6	0	0	0	0	0
FL	DAYTONA BEACH	DAYTONA BEACH REGIONAL	6	6	0	3	0	0	0	0
FL	FORT LAUDERDALE	FORT LAUDERDALE EXECUTIVE	7	7	7	0	0	0	0	0
FL	FORT LAUDERDALE	FORT LAUDERDALE-HOLLYWOOD INT	6	6	5	0	2	0	0	0
FL	FORT MYERS	PAGE FIELD	7	7	0	0	0	0	0	0
FL	FORT PIERCE	ST LUCIE CO INTERNATIONAL	7	7	7	0	0	0	0	0
FL	HOLLYWOOD	NORTH PERRY	7	7	0	0	0	0	0	0
FL	JACKSONVILLE	JACKSONVILLE INTERNATIONAL	6	6	4	0	0	0	0	0
FL	MELBOURNE	MELBOURNE REGIONAL AIRPORT	6	6	6	3	0	0	0	0
FL	MIAMI	MIAMI INTERNATIONAL	6	6	0	0	0	0	0	0
FL	MIAMI	OPA-LOCKA AIRPORT	7	0	7	0	0	0	0	0
FL	MIAMI	TAMIAMI	7	0	0	0	7	0	0	0
FL	ORLANDO	ORLANDO EXECUTIVE	7	7	7	0	0	0	0	0
FL	ORLANDO	ORLANDO INTERNATIONAL	4	4	0	1	0	0	0	0
FL	SARASOTA	SARASOTA-BRADENTON	6	6	0	0	0	0	0	0
FL	ST. PETERSBURG	ST. PETERSBURG CLEARWATER INT	6	6	5	0	0	0	0	0
FL	TAMPA	TAMPA INTERNATIONAL	6	5	0	0	0	0	0	0
FL	VERO BEACH	VERO BEACH MUNICIPAL	7	7	7	7	0	0	0	0
FL	WEST PALM BEACH	PALM BEACH INTERNATIONAL	6	6	0	0	0	0	0	0
GA	ATLANTA	DEKALB-PEACHTREE	7	7	0	0	0	0	0	0
GA	ATLANTA	FULTON COUNTY - BROWN FIELD	7	7	7	0	0	0	0	0
GA	ATLANTA	WILLIAM B HARTSFIELD-ATLANTA	1	1	0	0	0	0	1	0
HI	HONOLULU	HONOLULU INTERNATIONAL	6	6	0	0	0	0	0	0
HI	KAHULUI	KAHULUI	6	6	6	0	0	0	0	0
IA	DES MOINES	DES MOINES MUNICIPAL	6	6	0	0	0	0	0	0

Note: TA = Terminal ATC Automation
RL = Reduced Longitudinal Separations
IC = Simultaneous IFR Converging Approaches
DP = Dependent Close Parallel IFR Approaches
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Note: 1 = Top 5 Airports in 1994 Benefit for This Project
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6 = Other Airport with 1994 Benefit for This Project
7 = Airport Could Benefit, but lacks AC Ops or IFR Capacity
0 = Airport at Which This Project Is Not Applicable

TABLE B-2-2. DATABASE AIRPORTS RANKED WITH RESPECT TO EIGHT PROJECTS (CONT.)

STATE	CITY	AIRPORT	TA	RL	IC	DP	IP	SS	TR	RW
ID	BOISE	BOISE AIR TERMINAL	6	6	0	0	0	0	0	0
IL	AURORA	AURORA MUNICIPAL	7	7	0	0	0	0	0	0
IL	CHAMPAIGN/URBANA	UNIVERSITY OF ILLINOIS-WILL	6	6	6	0	0	0	0	0
IL	CHICAGO	CHICAGO MIDWAY	5	4	0	0	0	0	0	0
IL	CHICAGO	CHICAGO-O'HARE INTERNATIONAL	1	1	0	0	0	0	1	0
IL	CHICAGO	MERRILL C. MEIGS	7	7	0	0	0	0	0	0
IL	CHICAGO/WEST CHICAGO	DU PAGE	7	7	7	0	0	0	0	0
IL	CHICAGO/WHEELING/PRO	PALWAUKEE	7	7	7	7	0	0	0	0
IL	ROCKFORD	GREATER ROCKFORD	6	6	6	0	0	0	0	0
IL	ROMEOVILLE	LEWIS UNIVERSITY	7	7	0	0	0	0	0	0
IL	WAUKEGAN	WAUKEGAN REGIONAL	7	7	0	0	0	0	0	0
IN	INDIANAPOLIS	INDIANAPOLIS INTERNATIONAL	6	5	4	0	0	2	0	0
KS	WICHITA	WICHITA MID-CONTINENT	6	6	0	0	0	0	0	0
KY	COVINGTON	GREATER CINCINNATI INT	3	3	0	0	0	1	0	0
KY	LOUISVILLE	BOWMAN FIELD	7	7	0	0	0	0	0	0
KY	LOUISVILLE	STANDIFORD FIELD	6	5	0	0	0	0	0	0
LA	BATON ROUGE	BATON ROUGE METROPOLITAN	6	6	0	0	0	0	0	0
LA	HOUMA	HOUMA-TERREBONNE	7	7	0	0	0	0	0	0
LA	LAFAYETTE	LAFAYETTE REGIONAL	6	6	6	0	0	0	0	0
LA	NEW ORLEANS	LAKEFRONT	7	7	7	0	0	0	0	0
LA	NEW ORLEANS	NEW ORLEANS INT (MOISSANT)	5	5	3	0	0	0	0	2
MA	BEDFORD	LAURENCE G HANSCOM FIELD	7	7	0	0	0	0	0	0
MA	BEVERLY	BEVERLY MUNICIPAL	7	7	0	0	0	0	0	0
MA	BOSTON	GEN EDW L LOGAN INTERNATIONAL	3	3	2	1	0	0	0	0
MA	HYANNIS	BARNSTABLE MUNICIPAL	6	6	4	0	0	0	0	0
MA	LAWRENCE	LAWRENCE MUNICIPAL	7	7	0	0	0	0	0	0
MA	NANTUCKET	NANTUCKET MEMORIAL	6	6	0	0	0	0	0	0
MA	NORWOOD	NORWOOD MEMORIAL	7	7	7	0	0	0	0	0
MD	BALTIMORE	BALTIMORE-WASHINGTON INT	4	4	0	0	0	1	0	2
MD	BALTIMORE	GLENN L MARTIN STATE	7	7	0	0	0	0	0	0
MD	GAITHERSBURG	MONTGOMERY CO AIRPARK	7	7	0	0	0	0	0	0

Note: TA = Terminal ATC Automation
RL = Reduced Longitudinal Separations
IC = Simultaneous IFR Converging Approaches
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IP = Independent Close Parallel IFR Approaches
TR = Triple IFR Approaches
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6 = Other Airport with 1994 Benefit for This Project
7 = Airport Could Benefit, but lacks AC Ops or IFR Capacity
0 = Airport at Which This Project Is Not Applicable

TABLE B-2-2. DATABASE AIRPORTS RANKED WITH RESPECT TO EIGHT PROJECTS (CONT.)

STATE	CITY	AIRPORT	TA	RL	IC	DP	IP	SS	TR	RW
MI	DETROIT	DETROIT METROPOLITAN-WAYNE	3	0	0	0	0	0	2	0
MI	DETROIT	WILLOW RUN	6	6	0	0	0	0	0	0
MI	FLINT	BISHOP	6	6	6	0	0	0	0	0
MI	GRAND RAPIDS	KENT COUNTY INTERNATIONAL	6	6	0	0	0	0	0	0
MI	LANSING	CAPITAL CITY	7	7	0	7	0	0	0	0
MI	PONTIAC	OAKLAND-PONTIAC	6	6	6	0	0	0	0	0
MN	MINNEAPOLIS	ANOKA COUNTY-JANES FIELD	7	7	7	0	0	0	0	0
MN	MINNEAPOLIS	CRYSTAL	7	7	0	0	0	0	0	0
MN	MINNEAPOLIS	FLYING CLOUD	7	7	0	0	0	0	0	0
MN	MINNEAPOLIS	MINNEAPOLIS-ST PAUL INT/WOLD	3	0	0	0	1	0	0	0
MO	KANSAS CITY	DOWNTOWN	7	7	0	0	0	0	0	0
MO	KANSAS CITY	KANSAS CITY INTERNATIONAL	5	4	3	0	0	0	0	0
MO	ST LOUIS	LAMBERT-ST LOUIS INT	2	2	1	1	0	0	0	0
MO	ST LOUIS	SPIRIT OF ST LOUIS	7	0	0	0	0	0	0	0
MT	BILLINGS	BILLINGS-LOGAN INTERNATIONAL	6	6	0	3	0	0	0	0
NC	CHARLOTTE	CHARLOTTE/DOUGLAS INT	2	2	0	0	0	0	0	0
NC	GREENSBORO	GREENSBORO-HIGH POINT-WINSTON	6	6	4	0	0	0	0	0
NC	RALEIGH	RALEIGH-DURHAM	4	0	2	0	1	0	2	1
ND	GRAND FORKS	GRAND FORKS INTERNATIONAL	6	6	0	0	3	0	0	0
NE	LINCOLN	LINCOLN MUNICIPAL	6	0	0	0	2	0	0	0
NE	OMAHA	EPPLEY AIRFIELD	6	6	3	2	0	0	0	0
NH	MANCHESTER	MANCHESTER MUNICIPAL	6	6	0	0	0	0	0	0
NJ	ATLANTIC CITY	ATLANTIC CITY	6	6	3	0	0	0	0	0
NJ	ATLANTIC CITY	ATLANTIC CITY MUNI. /BADER	7	7	0	0	0	0	0	0
NJ	BELMAR/FARMINGDALE	ALLAIRE AIRPORT	7	7	0	0	0	0	0	0
NJ	CALDWELL	ESSEX COUNTY AIRPORT	7	7	0	0	0	0	0	0
NJ	MORRISTOWN	MORRISTOWN MUNICIPAL AIRPORT	7	7	0	0	0	0	0	0
NJ	NEWARK	NEWARK INTERNATIONAL AIRPORT	1	1	1	0	0	0	0	0
NJ	ROBBINSVILLE	TRENTON-ROBBINSVILLE	7	7	0	0	0	0	0	0
NJ	TETERBORO	TETERBORO AIRPORT	7	7	0	0	0	0	0	0
NJ	TRENTON	MERCER COUNTY AIRPORT	6	6	6	0	0	0	0	0

Note:
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TABLE B-2-2. DATABASE AIRPORTS RANKED WITH RESPECT TO EIGHT PROJECTS (CONT.)

STATE	CITY	AIRPORT	TA	RL	IC	DP	IP	SS	TR	RW
NM	ALBUQUERQUE	ALBUQUERQUE INTERNATIONAL	6	6	5	0	0	0	0	0
NM	ALBUQUERQUE	DOUBLE EAGLE II	7	7	0	0	0	0	0	0
NV	LAS VEGAS	MCCARRAN INTERNATIONAL	6	6	5	0	0	0	0	1
NV	RENO	RENO CANNON INTERNATIONAL	6	6	0	0	0	0	0	0
NY	ALBANY	ALBANY COUNTY	6	6	0	0	0	0	0	0
NY	BUFFALO	GREATER BUFFALO INTERNATIONAL	6	5	0	0	0	0	0	0
NY	FARMINGDALE	REPUBLIC AIRPORT	7	7	0	0	0	0	0	0
NY	ISLIP	LONG ISLAND - MAC ARTHUR	6	6	4	0	0	0	0	0
NY	NEW YORK	JOHN F KENNEDY INTERNATIONAL	3	3	0	0	0	0	1	0
NY	NEW YORK	LAGUARDIA	3	2	0	0	0	2	0	0
NY	NIAGARA FALLS	NIAGARA FALLS INTERNATIONAL	7	7	0	0	0	0	0	0
NY	ROCHESTER	ROCHESTER MONROE COUNTY	6	6	3	0	0	0	0	0
NY	SYRACUSE	SYRACUSE-HANCOCK INTERNATIONAL	6	6	4	0	0	0	0	0
NY	WHITE PLAINS	WESTCHESTER COUNTY	6	6	0	0	0	0	0	0
OH	AKRON	AKRON-CANTON REGIONAL	6	6	0	0	0	0	0	0
OH	CINCINNATI	CINCINNATI MUNI-LUNKEN FIELD	7	7	0	7	0	0	0	0
OH	CLEVELAND	CLEVELAND-HOPKINS INTERNATIONA	4	4	2	0	1	0	0	0
OH	CLEVELAND	CUYAHOGA COUNTY	7	7	0	0	0	0	0	0
OH	COLUMBUS	OHIO STATE UNIVERSITY	7	7	0	7	0	0	0	0
OH	COLUMBUS	PORT COLUMBUS INTERNATIONAL	6	6	0	0	0	1	0	0
OH	DAYTON	JAMES M COX DAYTON INT	6	6	0	0	0	0	0	0
OK	NORMAN	UNIV OF OKLA WESTHEIMER AIRPOR	7	7	7	0	0	0	0	0
OK	OKLAHOMA CITY	WILEY POST	7	7	7	7	0	0	0	0
OK	OKLAHOMA CITY	WILL ROGERS WORLD AIRPORT	6	6	0	0	0	0	0	0
OK	TULSA	RICHARD LLOYD JONES, JR.	7	7	0	0	0	0	0	0
OK	TULSA	TULSA INTERNATIONAL	6	6	0	0	0	0	0	0
OR	AURORA	AURORA STATE	7	7	0	0	0	0	0	0
OR	EUGENE	MAHLON SWEET FIELD	6	6	0	0	0	0	0	0
OR	PORTLAND	PORTLAND INTERNATIONAL	5	0	0	0	1	0	0	0
PA	BEAVER	BEAVER COUNTY	7	7	0	0	0	0	0	0
PA	MONONGAHELA	ROSTRAVER	7	7	0	0	0	0	0	0

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TABLE B-2-2. DATABASE AIRPORTS RANKED WITH RESPECT TO EIGHT PROJECTS (CONT.)

STATE	CITY	AIRPORT	TA	RL	IC	DP	IP	SS	TR	RW
PA	PHILADELPHIA	NORTHEAST PHILADELPHIA	7	7	0	0	0	0	0	0
PA	PHILADELPHIA	PHILADELPHIA INTERNATIONAL	4	3	0	2	0	1	0	0
PA	PITTSBURGH	GREATER PITTSBURGH INTERNATION	3	3	0	0	0	0	1	0
PR	SAN JUAN	PUERTO RICO INTERNATIONAL	6	6	6	0	0	0	0	0
RI	PROVIDENCE	THEODORE F GREEN STATE	6	6	0	2	0	0	0	0
SC	CHARLESTON	CHARLESTON AFB/INTERNATIONAL	6	6	0	0	0	0	0	0
SC	COLUMBIA	COLUMBIA METROPOLITAN	6	6	5	0	0	0	0	0
TN	KNOXVILLE	MCGHEE-TYSON	6	6	0	3	0	0	0	0
TN	MEMPHIS	MEMPHIS INTERNATIONAL	4	0	2	0	1	0	2	0
TN	NASHVILLE	NASHVILLE METROPOLITAN	6	6	0	2	0	0	0	0
TX	ARLINGTON	ARLINGTON MUNICIPAL	7	7	0	0	0	0	0	0
TX	AUSTIN	AUSTIN EXECUTIVE AIRPARK	7	7	0	0	0	0	0	0
TX	AUSTIN	ROBERT MUELLER MUNICIPAL	5	5	0	0	0	0	0	0
TX	CONROE	MONTGOMERY COUNTY	7	7	0	0	0	0	0	0
TX	CORPUS CHRISTI	CORPUS CHRISTI INTERNATIONAL	6	6	5	0	0	0	0	0
TX	DALLAS	ADDISON	7	7	0	0	0	0	0	0
TX	DALLAS	DALLAS LOVE FIELD	5	0	0	0	2	0	0	0
TX	DALLAS	REDBIRD	7	7	0	0	0	0	0	0
TX	DALLAS-FT WORTH	DALLAS/FORT WORTH INTERNATIONA	2	2	0	0	0	0	1	1
TX	EL PASO	EL PASO INTERNATIONAL	6	6	6	3	0	0	0	0
TX	FORT WORTH	MEACHAM FIELD	7	7	0	7	0	0	0	0
TX	GALVESTON	SCHOLES FIELD	7	7	7	0	0	0	0	0
TX	GRAND PRAIRIE	GRAND PRAIRIE MUNICIPAL	7	7	0	0	0	0	0	0
TX	HOUSTON	ANDRAU AIRPARK	7	7	0	0	0	0	0	0
TX	HOUSTON	DAVID WAYNE HOOKS MEMORIAL	7	7	0	0	0	0	0	0
TX	HOUSTON	HOUSTON INTERCONTINENTAL	2	3	1	1	0	0	0	1
TX	HOUSTON	WILLIAM P HOBBY	4	4	2	0	0	0	0	0
TX	LUBBOCK	LUBBOCK INTERNATIONAL	6	0	5	0	2	0	2	0
TX	MIDLAND	MIDLAND AIRPARK	7	7	7	0	0	0	0	0
TX	MIDLAND	MIDLAND REGIONAL AIRPORT	6	6	0	3	0	0	0	0
TX	SAN ANTONIO	SAN ANTONIO INTERNATIONAL	5	5	3	2	0	0	0	0

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TABLE B-2-2. DATABASE AIRPORTS RANKED WITH RESPECT TO EIGHT PROJECTS (CONT.)

STATE	CITY	AIRPORT	TA	RL	IC	DP	IP	SS	TR	RW
TX	WICHITA FALLS	SHEPPARD AFB/WICHITA FALLS	7	7	0	0	0	0	0	0
UT	SALT LAKE CITY	SALT LAKE CITY INTERNATIONAL	6	0	0	0	0	0	0	2
VA	MANASSAS	MANASSAS MUNI/DAVIS FIELD	7	7	0	0	0	0	0	0
VA	NEWPORT NEWS	PATRICK HENRY INTERNATIONAL	7	7	7	0	0	0	0	0
VA	NORFOLK	NORFOLK INTERNATIONAL	6	6	0	0	0	0	0	0
VA	RICHMOND	RICHARD EVELYN BIRD INT	6	6	4	0	0	0	0	0
VI	CHARLOTTE AMALIE	HARRY S TRUMAN	6	6	0	0	0	0	0	0
VI	CHRISTIANSTED	ALEXANDER HAMILTON	6	6	0	0	0	0	0	0
VT	BURLINGTON	BURLINGTON INTERNATIONAL	6	6	5	0	0	0	0	0
WA	ARLINGTON	ARLINGTON MUNICIPAL	7	7	0	0	0	0	0	0
WA	AUBURN	AUBURN MUNICIPAL	7	7	0	0	0	0	0	0
WA	EVERETT	SNOHOMISH COUNTY PAINE FIELD	7	7	0	0	0	0	0	0
WA	MOSES LAKE	GRANT COUNTY	7	7	7	7	0	0	0	0
WA	PASCO	TRI-CITIES	6	6	0	0	0	0	0	0
WA	PUYALLUP	PIERCE COUNTY - THUN FIELD	7	7	0	0	0	0	0	0
WA	RENTON	RENTON MUNICIPAL	7	7	0	0	0	0	0	0
WA	SEATTLE	BOEING FIELD/KING COUNTY INT	6	6	0	0	0	0	0	0
WA	SEATTLE	SEATTLE-TACOMA INTERNATIONAL	3	3	0	0	0	0	0	0
WA	SPOKANE	SPOKANE INTERNATIONAL	6	6	4	0	0	0	0	0
WA	VANCOUVER	EVERGREEN FIELD	7	7	0	0	0	0	0	0
WI	MADISON	DANE COUNTY REGIONAL	6	6	4	0	0	0	0	0
WI	MILWAUKEE	GENERAL MITCHELL FIELD	6	5	0	0	0	1	0	0
WV	CHARLESTON	KANAWHA	6	6	5	0	0	0	0	0

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APPENDIX B-3. CAPACITY FOR CONVERGING APPROACHES AT SELECTED AIRPORTS

Table B-3-1 shows the capacity achievable with the use of converging approaches at the ***22 pacing*** and the ***next 17*** airports identified by ATA. Of the 39 airports, 33 have either independent or dependent converging potential applications. The capacities for independent converging approaches have been estimated using the FAA Airfield Capacity Model. The capacities for dependent converging approaches (intersecting runways) have been estimated by assuming procedures that prevent simultaneous missed approaches and simultaneous presence of aircraft at runway intersections.[1]

The independent converging capacities shown for each candidate airport are achievable for the corresponding minimum decision heights allowed at each airport during independent converging operations. The dependent converging capacities shown in the table are assumed to be achievable for CAT 1 minima.

Of the 33 airports listed, the following would not show capacity benefits from operating converging approaches because they can currently obtain the same or greater capacities by using parallel runways: CLT, DFW, DTW, IAD, MIA, ORD, PIT, and TPA. Of these airports, the following would benefit if the converging approaches were run as part of a triple approach operation (triple runways exist): DFW, IAD, and ORD.

The following airports could also obtain capacities similar to or greater than those of converging approaches if parallel approaches to runways spaced less than 4,300 feet (and more than 3,000 feet) apart were allowed: JFK, FLL, MEM, MSP, PDX, RDU, SLC.

[1] **FAA-EM-82-4, Appendix E**

TABLE B-3-1. IFR CAPACITY FOR CONVERGING APPROACHES

Airport	Runways	IFR Capacity Converg.	IFR Capacity Curr. Best
ANC - Anchorage	14/16[1]	48.0	24.0[3]
BNA - Nashville	2L/31[2]	45.3	25.6[3]
BOS - Boston	4R/33L[2]	45.2	26.0[3]
BWI - Baltimore	28/33L[2]	45.7	26.0[3]
CLE - Cleveland	10L/5R[2]	43.4	25.2[3]
CLT - Charlotte	18R/23[1]	53.4	53.4[3]
CVG - Cincinnati	27L/36[2]	48.3	26.9[3]
DCA - Washington	36/33[2]	46.1	26.3[3]
DEN - Denver	17L/26L[1]	51.0	25.5[3]
DFW - Dallas	35R/31R[1]	53.0	53.0[4]
DTW - Detroit	3R/9[1]	50.3	50.3[5]
EWR - Newark	11/4R[1]	50.6	25.3[3]
FLL - Ft. Lauderdale	27R/31[2]	42.9	34.7[5]
HOU - Houston H.	17/22[2]	43.6	24.6[3]
IAD - Dulles	12/19R[1]	51.0	51.0[4]
IAH - Houston	26/32R[1]	50.8	25.4[3]
JFK - New York	13R/22L[1]	49.0	36.9[5]
LAS - Las Vegas	19/25[1]	48.0	24.0[3]
LGA - New York	4/31[2]	45.8	26.5[3]
MCI - Kansas City	19/27[1]	55.0	27.5[3]
MEM - Memphis	36L/27[1]	49.2	35.2[5]
MIA - Miami	27R/30[1]	50.2	50.2[4]
MSP - Minneapolis	22/29L[2]	44.0	35.5[5]
ORD - Chicago	22R/27L[1]	53.7	53.7[4]
PDX - Portland	10R/2[2]	44.9	35.5[5]
PHL - Philadelphia	17/9R[1]	50.4	25.2[3]
PIT - Pittsburgh	14/10C[2]	44.9	53.4[4]
RDU - Raleigh	32/5L[1]	49.2	35.4[5]
SDF - Louisville	31/25[1]	47.2	23.8[3]
SFO - San Francisco	10L/1R[2]	45.1	25.2[3]
SLC - Salt Lake City	14/16L[1]	50.8	36.2[5]
STL - St. Louis	24/30R[1]	51.8	25.9[6]
TPA - Tampa	27/18R[1]	49.2	49.2[4]

1 **Independent converging approaches**
2 **Dependent converging approaches**
3 **Single runway approaches**
4 **Independent parallel approaches**
5 **Dependent parallel approaches**
6 **Single runway; does not consider "side step" procedure used at STL.**

APPENDIX C. ABBREVIATIONS

APPENDIX C. ABBREVIATIONS

AAS	Advanced Automation System
ACF	Area Control Facilities
ACPO	Airport Capacity Program Office
ADAP	Airport Development Aid Program
ADSIM	Airfield Delay Simulation Model
AIP	Airport Improvement Program
ARTCC	Air Route Traffic Control Center
ARTS	Automated Radar Terminal System
ASDE	Airport Surface Detection Equipment
ATA	Air Transport Association
ATC	Air Traffic Control
AWOS	Automated Weather Observing System
CFC	Central Flow Control
DME/P	Precision Distance Measuring Equipment
EDCT	Estimated Departure Clearance Time
F&E	Facilities & Equipment
FAAP	Federal Aid Airport Program
GA	General Aviation
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
ILS	Instrument Landing System
ITF	Industry Task Force on Air Capacity Improvement and Delay Reduction
LLWAS	Low Level Wind Shear Alert System
MLS	Microwave Landing System
MOPS	Minimum Operational Performance Specifications
MSAW	Minimum Safe Altitude Warning
NAPRS	National Airspace Performance Reporting System
NAS	National Airspace System
NAVAID	Navigational Aid
NDT	Non-Destructive Testing
NEXRAD	Next Generation Weather Radar
NPIAS	National Plan of Integrated Airport Systems
PATCO	Professional Air Traffic Controller's Organization
PCI	Pavement Condition Index
PGP	Planning Grant Program
R,E&D	Research, Engineering & Development
RCMS	Runway Configuration Management System
RMM	Remote Maintenance Monitoring
RNAV	Area Navigation
RVR	Runway Visual Range

SCIA	Simultaneous Converging Instrument Approaches
SDRS	Standardized Delay Reporting System
SIMMOD	Airport and Airspace Delay and Fuel Consumption Simulation Model
ST&G	Standards and Guidelines
STEP	Service Test and Evaluation Program
STOL	Short Takeoff and Landing
TATCA	Terminal Air Traffic Control Automation
TDWR	Terminal Doppler Weather Radar
TMS	Traffic Management System
TMU	Traffic Management Unit
TSC	Transportation Systems Center
VFR	Visual Flight Rules
VTOL	Vertical Takeoff and Landing