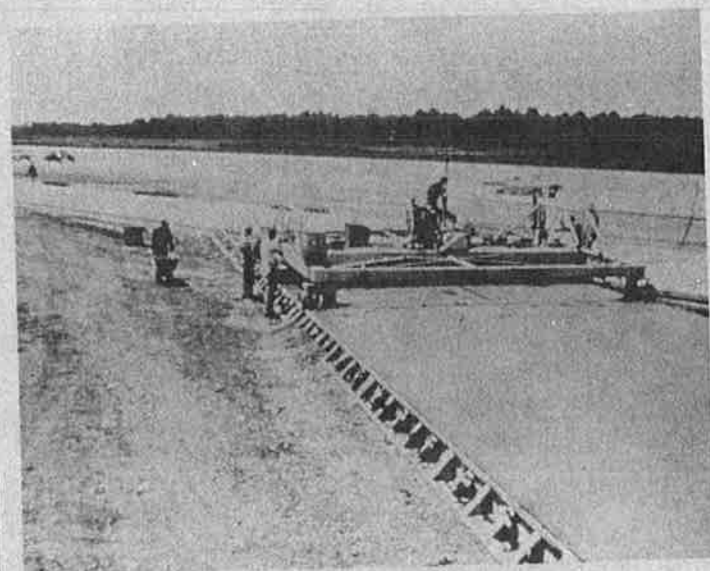
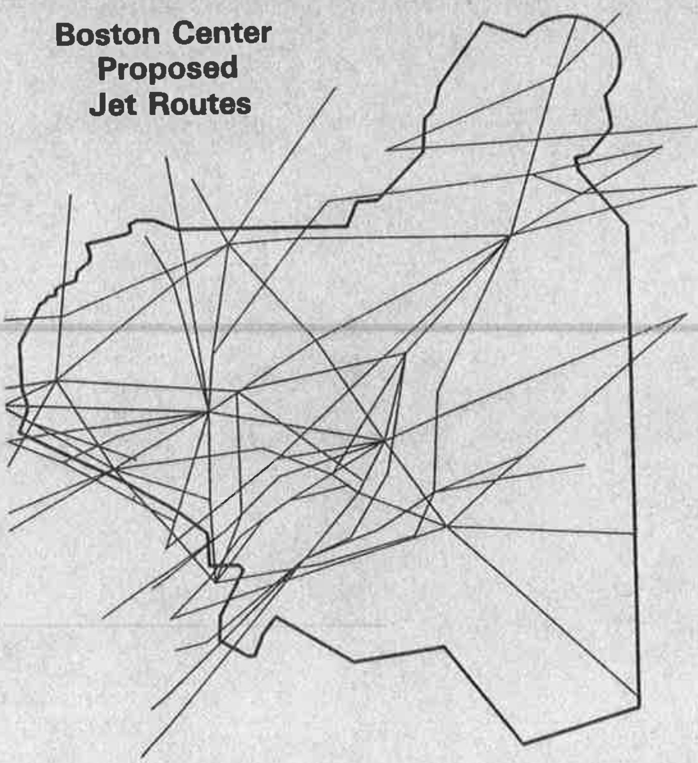
U.S. Department
of Transportation
**Federal Aviation
Administration**

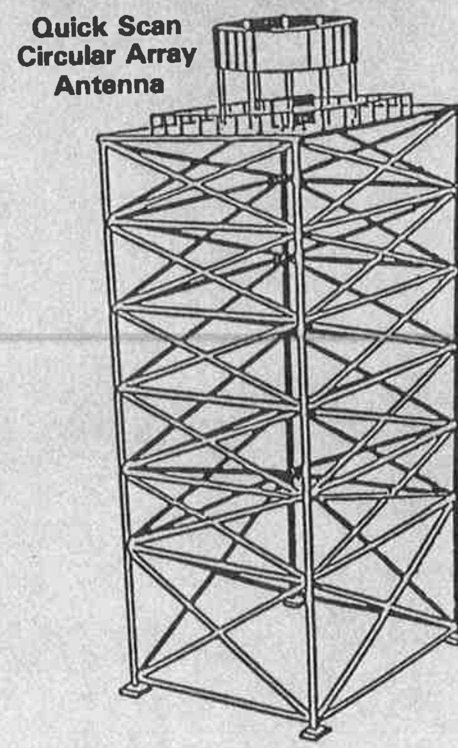
Airport Capacit
Enhancement Plan

DOT/FAA/CP/88-4
DOT-TSC-FAA-88-2

1988







Prepared for
Airport Capacity Program Office
Washington DC 20591

Prepared by
Transportation Systems Center
Cambridge MA 02142

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/CP/88-4		

4. Title and Subtitle AIRPORT CAPACITY ENHANCEMENT PLAN 1988	5. Report Date April 1988 6. Performing Organization Code DTS-42
7. Author(s)	8. Performing Organization Report No. DOT-TSC-FAA-88-2
9. Performing Organization Name and Address U.S. Department of Transportation Research and Special Programs Administration Transportation Systems Center Cambridge, MA 02142	10. Work Unit No. (TRAIS) FA814/A8028 11. Contract or Grant No.
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration Airport Capacity Program Office Washington, DC 20591	13. Type of Report and Period Covered FINAL REPORT May 1987 - April 1988 14. Sponsoring Agency Code ACP-1

15. Supplementary Notes

The report resulted from a collaborative effort led by the Airport Capacity Program Office with support from other FAA groups, the Transportation Systems Center, and the Transportation Systems Engineering Division of The MITRE Corporation.

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 cause 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 development; 2) airspace control procedures; 3) additional equipment and systems; and 4) capacity planning studies. A description of each project is provided, along with significant milestones and expected capacity-related benefits.

17. Key Words	18. Distribution Statement
AIRPORT CAPACITY CAPACITY ENHANCEMENT DELAY REDUCTION	DOCUMENT IS AVAILABLE TO THE PUBLIC THROUGH THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VIRGINIA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	288	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

PREFACE

The Federal Aviation Administration (FAA) has sponsored the 1988 Airport Capacity Enhancement Plan. The Plan was developed by the FAA's Airport Capacity Program Office (ACPO) to provide the leadership in the FAA's effort to increase system capacity and reduce flight delays in the National Airspace System while preserving public safety and the environment.

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT.)

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (CONT.)

LIST OF TABLES

LIST OF TABLES (CONT.)

EXECUTIVE SUMMARY

The Airport Capacity Enhancement Plan provides an overview of the Federal Aviation Administration's efforts to reduce delays and promote growth of the air transportation industry in a safe and efficient manner through its airport capacity enhancement program. While there are other means to alleviate delays, only by increasing the capacity of the airport system can the nation reduce delays without limiting aviation growth.

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 address the problem of airport capacity and aircraft delays, consisting of four broad areas:

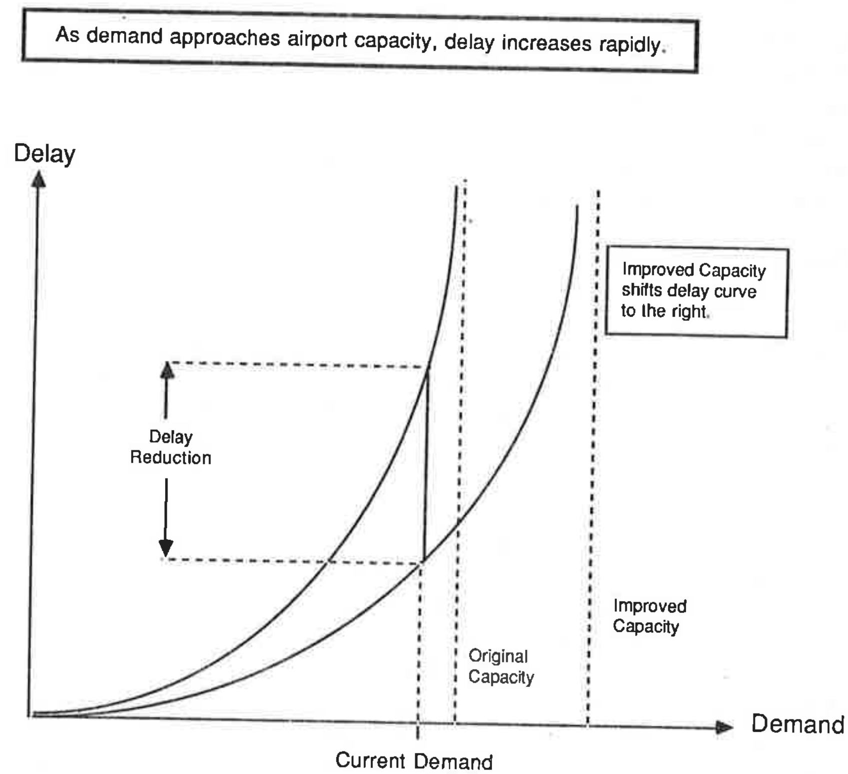
- Airport Development;
- Airspace Control Procedures
- Additional Equipment and Systems; and
- Capacity Planning Studies.

Airport construction and expansion represents the most beneficial and direct approach to increasing capacity at many airports. A priority of the capacity enhancement program is to study the feasibility of ways to promote new construction, particularly new runways. Improved airspace control procedures can also contribute directly 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.

Congestion and Delay

The fundamental relationship between capacity, demand, and delay is shown in Figure ES-1.

FIGURE ES-1. RELATIONSHIP BETWEEN DELAY, DEMAND, AND CAPACITY



As demand approaches capacity, delay increases. However, market forces limit demand long before it reaches capacity. It can be seen in the picture that when demand is high, relative to capacity, a slight improvement in capacity can significantly reduce delay.

During 1987, over 450 million passengers as well as billions of dollars worth of cargo, were carried by the air transportation system.

In 1986, the top 50 primary commercial airports accounted for approximately 80 percent of all passenger enplanements and for over 30 percent of all aircraft operations.

Between 1987 and 1999, operations will grow by 33 percent and passenger enplanements by 72 percent.

During 1987, over 450 million passengers as well as billions of dollars worth of cargo, were carried by the air transportation system. Although there are 5,700 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 approximately 80 percent of all passenger enplanements and for 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. Average daily operations have increased steadily over the past three years at an average rate of 2.5 percent per year. Recent FAA projections indicate that between 1987 and 1999, operations will grow by 33 percent and passenger enplanements by 72 percent. At many airports the anticipated traffic levels cannot be accommodated without creating or adding to congestion.

The high traffic levels, particularly at large hub airports, are often accompanied by rising numbers of delayed operations. Operations delayed for at least 15 minutes averaged 1076 per day in FY87 -- approximately the same as FY86, but still 17 percent higher than FY85. While delays remain a serious problem, there have been improvements. For example, average daily delays for the last six months of FY87 are 15 percent below the levels indicated during the same period of FY86. In addition, delays continued to decrease during the first quarter of FY88, which may reflect the impact of recent capacity improvements.

Average daily delays for FY87 are 15 percent below the levels indicated during the same period of FY86.

Although the total volume of delays has increased, the distribution of delays by reported cause has not changed significantly over the past few years. In 1987, 68 percent of delays were attributed to weather, up 8 percent from 1984. Delays related to airport and center volume, the next most significant causes, fell in 1987 to 11 percent and 12 percent, respectively. Delays due to other causes continued to comprise a small percentage of total delays.

In 1987, 68 percent of delays were attributed to weather

Reported delays include only those flights delayed 15 minutes or more, but in reality most delays are under 15 minutes in duration. During the taxi-in phase 80.9 percent of flights were delayed between 1 and 14 minutes, but only 2.2 percent were delayed from 15 to 29 minutes. The taxi-out phase is very similar but delays were somewhat longer: 10.2 percent of flights were delayed between 15 and 29 minutes. During all phases, some flights experienced no (zero minutes) delay: 93.7 percent during the gatehold phase and 36.8 percent while airborne.

In 1987, the percentage of airport operations that were delayed 15 minutes or more, ranged from a high of 6.8 percent to virtually no delay

Congestion and delay vary considerably among airports. In 1987, the percentage of operations that were delayed 15 minutes or more, ranged from a high of 6.8 percent to virtually no delay. At thirteen of 22 major airports, the percentage of operations delayed in 1987 was less than in 1986. In fact, some showed significant improvements in 1987. Five of the 22 airports experienced a slight increase, but the average in 1987 indicates an overall decrease in the percentage of flights delayed.

At 13 of 22 major airports, the percentage of operations delayed in 1987 was less than in 1986.

By 1996, 32 airports are forecast to have more than 20,000 aircraft-hours of delay assuming no increase in capacity. Previous editions of this plan have concentrated on providing data to illuminate the magnitude of this problem, showing what possible solutions exist, and showing that research and development activities are underway to address the problem. This edition emphasizes the FAA's near-term plans for airport capacity improvement. It provides a more detailed explanation of what is being done and what can be done at 50 major airports, including the 32 airports expected to have the most severe delay problems.

By 1996, 32 airports are forecast to have more than 20,000 aircraft-hours of delay assuming no increase in capacity

Airport Development Activities

The first approach to airport capacity enhancement is to facilitate airport development activities, such as the construction of new airports and runways, additional aprons and taxiways, and improvements to supporting facilities, such as runway lighting systems. The funds for such activities are provided, in part, by the Airport Improvement Program and in part by the airport owner. Under the AIP program construction of eight new general aviation reliever airports has begun since 1982. Over the last year, two major new runways have been completed and 10 new air carrier runways are well along in the planning process. In addition, over $155 million have been invested in 96 smaller airports near 50 major airports. The goal is to provide higher quality service to those aircraft that have the flexibility to use shorter runways at near-by airports. The resulting reliever airport system is providing a network of high quality services for business aircraft near major metropolitan areas.

Over the last year, two major new runways have been completed and 10 new air carrier runways are well along in the planning process.

Airspace Control Procedures

The second approach to the capacity/delay problem is to develop the procedural changes that safely allow more aircraft to use the existing runway system in adverse weather conditions.

The development of new procedures is the primary means of increasing capacity at airports such as New York La Guardia, and Washington National, where the lack of surrounding land prohibits the construction of new runways. The limitations of the existing radars, cockpit instrumentation, and automated systems for the pilots and controllers, combine to limit airport capacity, especially on the arrival phase. When weather reduces visibility, the need to operate under Instrument Flight Rules (IFR) required separations reduce landing capacity by as much as 50 percent from that of clear-weather capacity available under Visual Flight Rules (VFR). When this IFR to VFR gap in capacity is large and the number of users exceeds the IFR capacity, changes in the weather can cause very serious disruptions in service and result in long delays. Consequently, the focus of procedural solutions is on closing the IFR/VFR gap by increasing IFR capacity.

Recently, several new procedures have helped relieve some of the congestion. By improving the amount of in-trail spacing between like-sized aircraft on final approach, a small increase in capacity (2-3 percent) is possible. This has been accomplished at 13 airports over the last two years with another six airports scheduled to implement this procedure. Another accomplishment has been the development of control procedures that permit the independent use of two arrival streams to converging runways under IFR conditions. This has helped the operation at two major airports.

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

- Independent IFR Approaches to Converging Runways
- Dependent (Alternating) IFR Approaches to Converging Runways
- Improved Independent Parallel IFR Approaches
- Improved Dependent Parallel IFR Approaches
- Triple IFR Approaches
- Separate Short Runways
- Improved In-trail Separation

Additional Equipment and Systems

New technology, when fully implemented, will allow for the safe reduction in minimum spacings between approach courses. A new aircraft sensor with a faster update rate is being tested at Raleigh-Durham Airport to determine whether independent parallel approaches separated by less than 4300 feet can be safely used. This will enable many existing airports to increase their IFR arrival capacity. Also, new runways can be built closer to existing ones while still allowing independent IFR operations.

There is an extensive research and development program underway to provide new technology for airport terminal operations. Systems such as the Mode S data link, Microwave Landing System, and wind shear detection systems may provide help in closing the IFR/VFR gap. Further research is also being conducted on the following projects:

- Instrument Landing System (ILS)
- Weather Radar Program
- Wind Shear Detection Sensor Development (LLWAS)
- Weather Sensor Implementation/Upgrade
- Terminal Doppler Weather Radar
- Advanced Wind Shear Sensor Development
- Wake Vortex Avoidance Forecasting
- Advanced Traffic Management System
- Terminal Radar Enhancements
- Airport Surface Detection Equipment (ASDE-3)
- Mode S Data Link Applications Development
- MLS/ILS Based Surveillance Systems (MILSS)
- Terminal ATC Automation

Capacity Planning Studies

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.

It is important to begin to study the capacity problem at individual airports because no single improvement is the most beneficial at every airport. Airspace restrictions, runway layout, equipment availability, and local geography determine what equipment and procedures are best suited for achieving capacity improvements at a particular site. The FAA has a number of projects and programs that support capacity enhancement at specific airports by developing analytical tools or serving as catalysts for the adoption of other capacity enhancement actions. One program, 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, for evaluating revised aircraft control procedures proposed for the heavily traveled East and West Coast corridors.

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

- Airport Capacity Enhancement Task Forces
- Airport Capacity and Delay Models
- Environmental Programs

Summary

The lack of sufficient airport capacity has neither a single cause nor a simple solution. The FAA, however, through its safe 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 safely 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 hub airports, where financial and market incentives underlie an increase in operations, demand for services are expected to increase at a faster rate than capacity.

The projects described in this plan will enhance capacity and alleviate some 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 furnishing airports with new equipment and systems, including more precise surveillance 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.

CHAPTER 1

INTRODUCTION TO THE AIRPORT CONGESTION AND DELAY PROBLEM

Air transportation is of vital importance to the nation's economy. It is estimated that the industry contributes close to $50 billion in annual revenues and employs approximately 500,000 people. Local airports attract new business, facilitate trade, promote tourism, and support local employment in service industries such as car rentals and lodging. Air transportation will continue to be vital to the economy and the demand for air services will continue to increase. It is necessary to ensure adequate planning for this growth so that the system is not constrained.

The air transportation industry contributes close to $50 billion in annual revenues and employs approximately 500,000 people

1.1 LEVEL OF AVIATION ACTIVITY

Safe and efficient aviation would not be possible without the nation's extensive system of airways and landing areas. Based on the latest data, there are 3,200 airports that have at least one paved and lighted runway available to the public. Of these, 543 airports each enplane more than 2,500 passengers annually, and 408 are primary airports. Primary airports are public-use commercial service airports that enplane at least 10,000 passengers enplaned annually at U. S. airports. The 406 primary airports handled approximately 441 million enplanements in 1986.

3,200 airports have at least one paved and lighted runway. 543 airports each enplane more than 2,500 passengers annually

406 primary airports handled approximately 441 million enplanements in 1986.

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 approximately 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 primary commercial airports accounted for approximately 80 percent of all passenger enplanements in 1986.

Air traffic levels have continued to increase during recent years and have often been accompanied by an increase in the number of operations delayed. Figures 1-2 and 1-3 show average daily operations and average daily delays, respectively. As shown in Figure 1-2, average daily operations have increased steadily at an average rate of 2.5 percent per year from FY85 to FY87. Both figures 1-2 and 1-3 reflect a seasonal pattern of operations and delays generally declining during December - March and gradually increasing throughout the rest of the year.

Average daily operations increased steadily at an average rate of 2.5 percent per year from FY85 to FY87

---

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

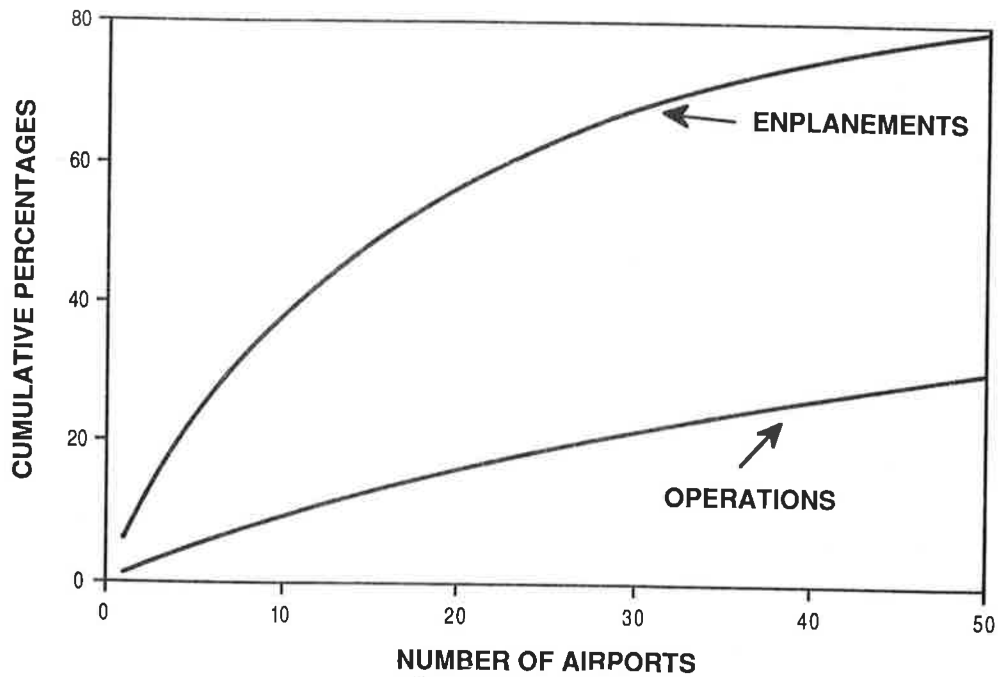


FIGURE 1-1. PASSENGER ENPLANEMENTS AND AIRCRAFT OPERATIONS, 1986

Average daily delays remain a problem to be addressed. For example, operations delayed at least 15 minutes averaged 1076 per day during FY87. As shown in Figure 1-3, average daily delays rose 17 percent from FY85 to FY86, but remained constant from FY86 to FY87. While the trend indicates that delays are increasing, there have been and will be improvements in the system which slow the increase and may, from time to time, decrease delays. The last six months of FY87 illustrate this point. During that period, average daily delays were approximately 15 percent below the levels indicated during last six months of FY86. Average daily delay figures for the first quarter of FY88 extend this pattern. Delays during the first quarter of FY88 were 32 percent below the average for the first quarter of FY87. In fact, first quarter FY88 average daily delays are well below the levels recorded during the first quarters of FY85 and FY86 (24 percent and 22 percent respectively). This pattern, which is also illustrated in Figure 1-4 - delays per 1,000 operations, may reflect the impact of recent capacity improvements, particularly the East Coast Plan (see Chapters 1.8 and 4.2).

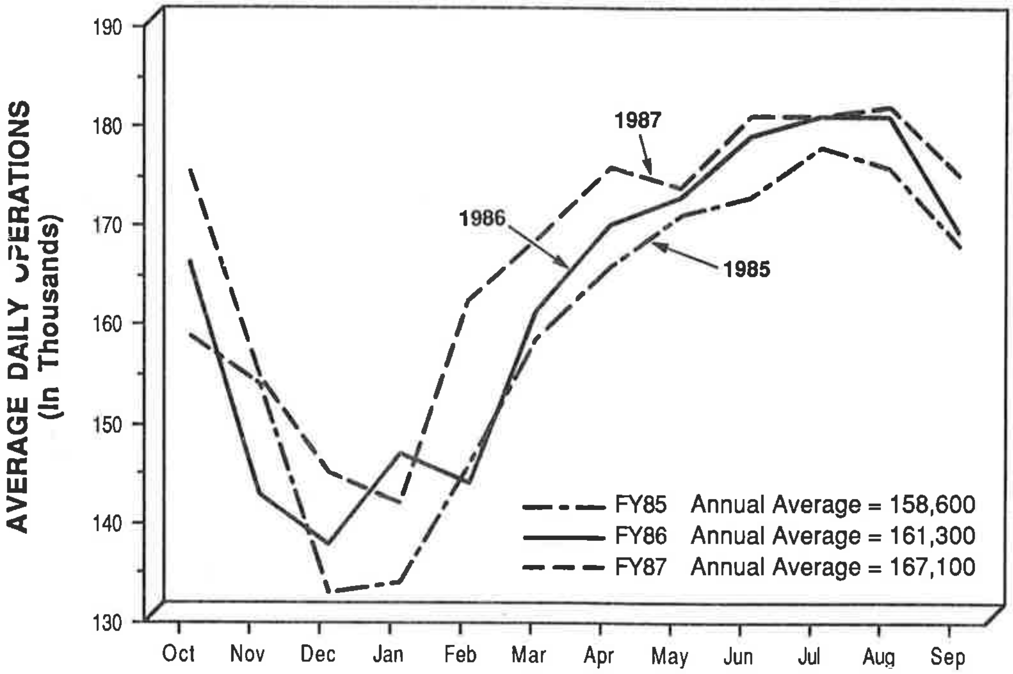


FIGURE 1-2. AVERAGE DAILY OPERATIONS

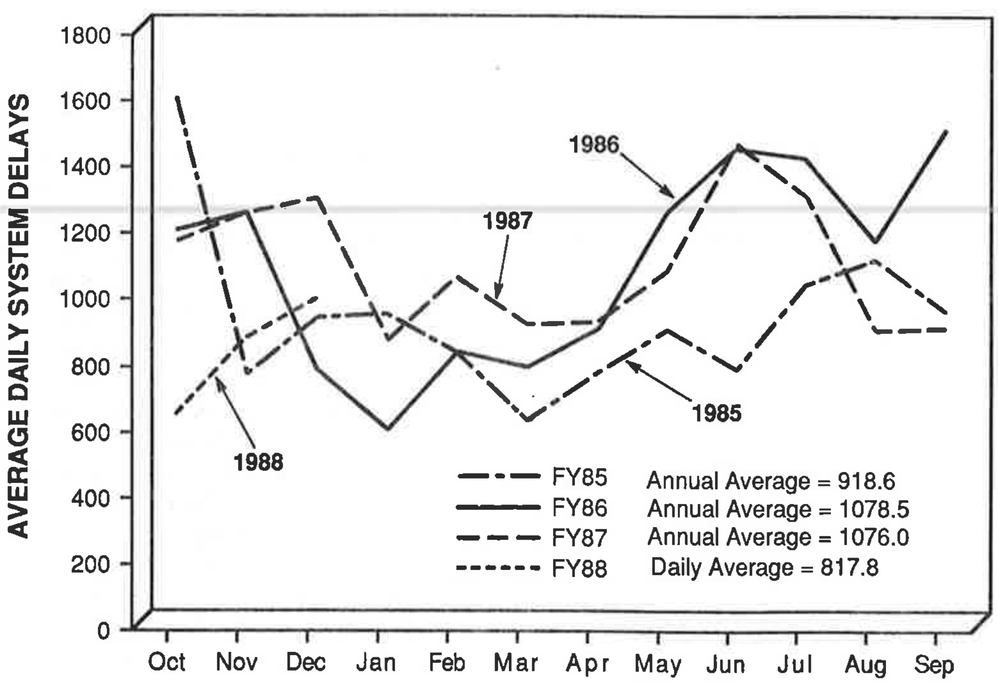


FIGURE 1-3. AVERAGE DAILY DELAYS

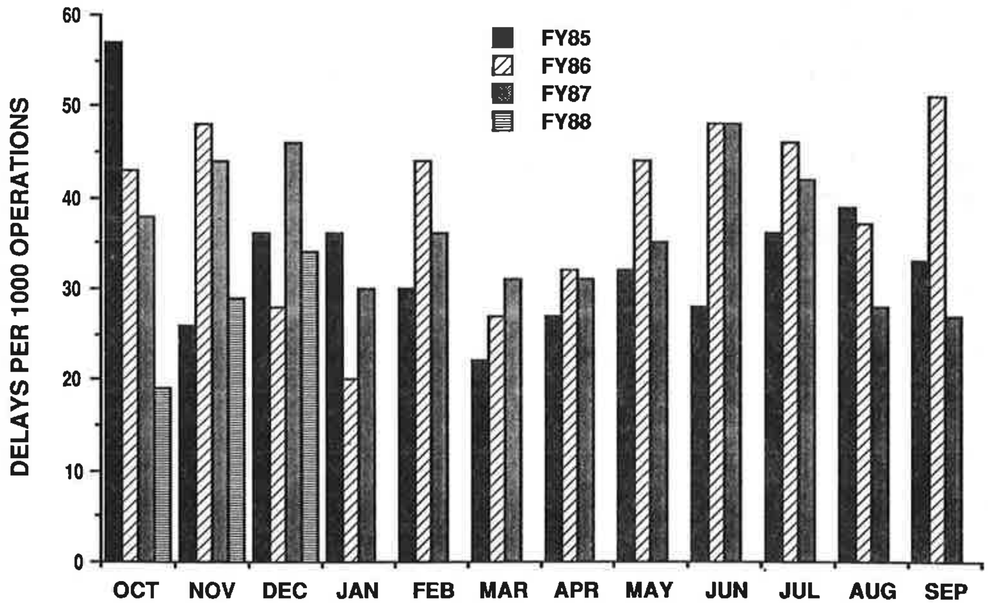


FIGURE 1-4. AIR TRAFFIC SYSTEM DELAYS PER 1,000 OPERATIONS*

* Includes delays of 15 minutes or more at 22 airports.

1.2 CAPACITY AND DELAY: PROBLEM DEFINITION

Capacity

Airport capacity is the maximum number of aircraft operations (either takeoffs or landings) 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 also 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. 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. Throughput and delay are observed and, taken together, may be used to measure capacity. Throughput is 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, 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 airport operating variability.

As demand increases, delays rise at an increasing rate. This relationship between capacity, demand, and delay is depicted in Figure 1-5. For a given capacity, there is a relationship 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. By improving capacity, the curve shifts to the right and if demand remains at the current level, delays will be reduced.

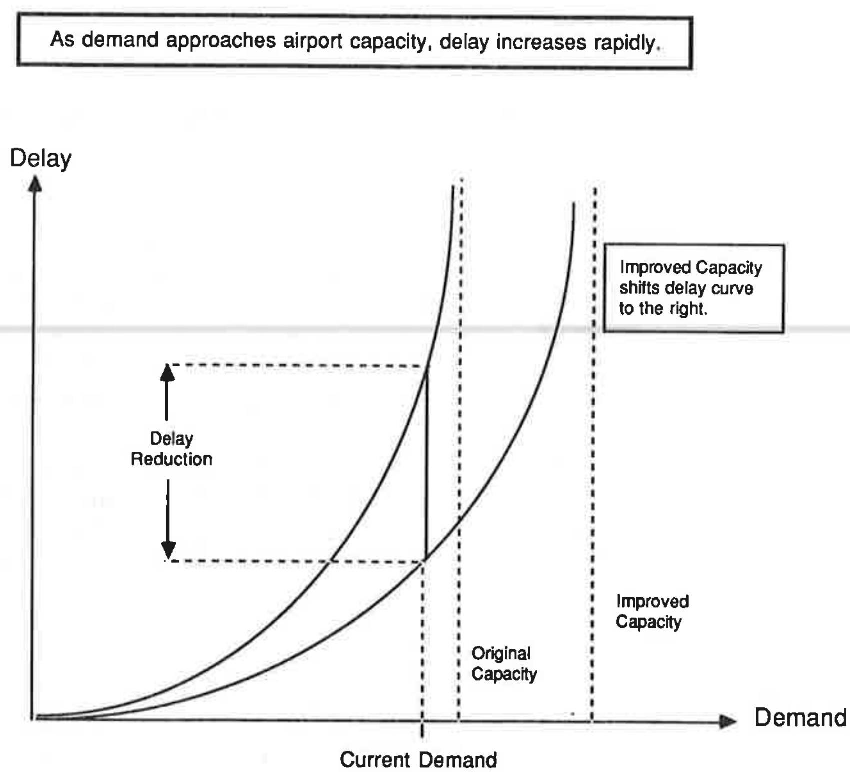


FIGURE 1-5. DELAY, DEMAND, AND CAPACITY

Congestion

Congestion refers to the formation of queues of aircraft awaiting permission to arrive or depart. Variability in capacity and in the pattern of demand results in airport congestion. 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.

1.3 FACTORS AFFECTING AIRPORT CAPACITY

The primary determinant of an airport's capacity is its physical design, including the number, length, and location of runways, runway 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. They include constraints imposed by airport resources, meteorological conditions, and air traffic control procedures. Noise considerations and the pattern of aircraft demand are also important determinants.

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 the number of airport operations at certain times of the day, and preferential use of particular runways or the periodic rotation through alternative runways. The impact may be severe when restrictions are placed on those runway configurations with the highest capacity.

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 required between different sizes of aircraft and differences in the runway occupancy times of different types of aircraft. Because the different requirements are most significant between heavy and small aircraft, the capacity is most adversely affected at major airports where heavy jets must share a runway with light commuter or general aviation aircraft.

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 aircraft demand is also split unevenly between departures and arrivals.

1.4 DELAY

Delay is difficult to measure and there is no industry-wide agreement on an appropriate definition of delay. Measures of delay can be used to determine trends (whether delay is increasing or decreasing), and any consistent measure of relative changes in delay is useful. The FAA maintains two systems for continuously monitoring delay: the National Airspace Performance Reporting System (NAPRS) and the Standardized Delay Reporting System (SDRS). NAPRS consists of reports of serious delay conditions submitted from air traffic control facilities and includes information on the causes of delay. SDRS consists of reports on the length of delay for each of four phases of flights, and is submitted by three air carriers. Both systems define delay as actual minus optimal, not scheduled, flight time since airline schedules can anticipate some delay.

Delay by Cause

The National Airspace Performance Reporting System (NAPRS) compiles reports on a sample of delays of 15 minutes and longer, broken down by cause, for 22 airports.[2] Using NAPRS data, Table 1-1 identifies the percentage and total number of delayed operations by cause for the years 1984-1987. Delays fluctuated dramatically between 1984 and 1987. Between 1984 and 1985 delays decreased 17 percent, but increased 25 percent from 1985 to 1986 and then dropped 22 percent in 1987.

Between 1984 and 1985 delays increased 17 percent but increased 25 percent from 1985 to 1986 and then dropped 22 percent in 1987

[2] 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.

TABLE 1-1. PERCENTAGE OF DELAY BY CAUSE, 1984 - 1987

AIRPORT	1984	1985	1986	1987
WEATHER	60%	68%	67%	67%
AIRPORT VOLUME	18	12	16	11
CENTER VOLUME	16	11	10	13
RUNWAY CONSTRUCTION	3	6	3	4
EQUIPMENT	2	2	3	4
OTHER	1	1	1	1
TOTAL DELAYS (000s)	404	334	418	325
PERCENT OF CHANGE FROM PREVIOUS YEAR		-17%	+ 25%	-22%

SOURCE: NAPRS

Distribution of delays by cause has not changed significantly over the past 4 years. 68 percent of delays in 1987 were attributed to weather

The distribution of delays by cause has not changed significantly over the past 4 years. As illustrated in Figure 1-6, weather remains the primary cause of delay; 68 percent of delays in 1987 were attributed to weather, up 8 percent from 1984. Delays related to airport and center volume fell in 1987. The share of delays due to airport volume declined from 18 percent in 1984 to 11 percent in 1987. Similarly, delay attributed to center volume fell from 16 percent in 1984 to 12 percent in 1987. Delays due to other causes continue to comprise a small percentage of total delays.

Weather-caused delays can be reduced. When the visibility is low, air traffic control procedures are different. If these low-visibility Instrument Flight Rule (IFR) procedures can be improved, delays may be decreased.

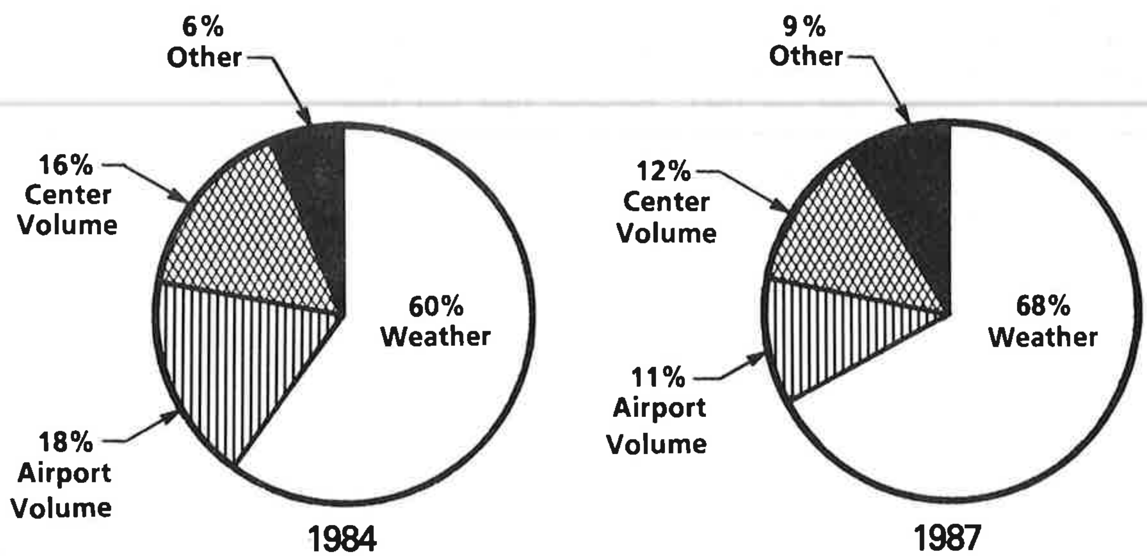


FIGURE 1-6. DELAY BY CAUSE 1984 VS 1987

Delay by Phase of Flight

Table 1-2 shows the average delay per flight experienced by SDRS carriers at 32 major airports from 1984 to 1986[3]. Average total delay in 1986 was approximately 10 percent higher than in 1985[4]. Taxi-in and taxi-out delays rose by 14 percent and 20 percent respectively, while airborne delay fell seven percent.

TABLE 1-2. DELAY BY PHASE OF FLIGHT, 1984-1986[5]

FLIGHT PHASE	AVERAGE DELAY (in minutes)		
	1984	1985	1986
ATC GATE HOLD	0.7	1.0	1.1
TAXI-OUT	6.5	6.4	7.3
AIRBORNE	4.0	4.0	3.7
TAXI-IN	2.4	2.5	3.0
TOTAL*	13.6	13.8	15.2

SOURCE: NAPRS

* TOTAL DIFFERS FROM SUM DUE TO ROUNDING

[3] The SDRS carriers perform approximately one-fourth of all air carrier operations. While this data provides 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 delay is slightly higher than the average for all carriers if SDRS carriers fly a higher than average percentage of flights into congested airports.

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

[5] The SDRS contains data on flight delays (to the closest minute) experienced by three airlines: Eastern, American and United. The SDRS compiles data on flight delay by phase of flight as follows:

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

Most of the delays in each phase of flight were between 1 and 14 minutes in duration.

While average delay has been used to show trends in the amount of delays over time, any average obscures much of the variation in delay. Table 1-3 shows the distribution of the length of delays in increments of 0, 15 and then 30 minutes. Most of the delays in each phase of flight were between 1 and 14 minutes in duration. For example, during the taxi-out phase, 79.9 percent of flights were delayed between 1 and 14 minutes, and 10.2 percent were delayed 15 to 29 minutes.

Similarly, during the taxi-in phase, 80.9 percent of flights were delayed between 1 and 14 minutes, compared to 2.2 percent during the next 15 minutes.

During all phases, some flights experienced no (zero minutes) delay. The most notable example is the gatehold phase, during which 93.7 percent of flights experienced no delay.

TABLE 1-3. PERCENTAGE OF FLIGHTS DELAYED BY LENGTH OF DELAY*

LENGTH OF DELAY (in minutes)	GATE-HOLD	TAXI-OUT	AIRBORNE	TAXI-IN
0	93.7%	7.9%	36.8%	16.3%
1-14	3.8	79.9	58.6	80.9
15 - 29	1.5	10.2	3.7	2.2
30 - 59	0.7	1.7	0.8	0.5
60 +	0.3	0.3	0.1	0.1
TOTAL	100.0%	100.0%	100.0%	100.0%

* TOTAL SDRS SYSTEM - JAN-DEC 1986

Delay by Airport

The percentage of operations delayed ranged from 6.8 percent at San Francisco to virtually no delay (0.1 percent) at Las Vegas McCarran

There was an overall decrease in the percentage of operations delayed 15 minutes or more in 1987

Congestion and delay vary considerably from airport to airport. Table 1-4 is based on NAPRS data and shows the percentage of operations delayed more than 15 minutes at 22 major air carrier airports from 1985 to 1987. The percentage of operations delayed in 1987 ranged from 6.8 percent at San Francisco International to virtually no delay (0.1 percent) at Las Vegas McCarran and Cleveland-Hopkins. For 13 of the 22 airports, the percentage of operations delayed in 1987 was less than the percentage of operations delayed in 1986. Newark International, Boston's Logan International and New York's Kennedy and La Guardia experienced significant decreases in 1987, which may reflect the impact of the East Coast Plan. Five of the 22 airports experienced an increase in the percentage of operations delayed, but the average in 1987 indicates an overall decrease in the percentage of operations delayed 15 minutes or more.

TABLE 1-4. PERCENTAGE OF OPERATIONS DELAYED 15 MINUTES OR MORE

AIRPORT	PERCENTAGE		
	1985	1986	1987
NEWARK INTERNATIONAL	9.2	13.8	6.5
NEW YORK LA GUARDIA	9.2	8.9	6.5
NEW YORK KENNEDY	6.1	7.0	6.5
ATLANTA HARTSFIELD INTERNATIONAL	6.2	6.5	6.2
SAN FRANCISCO INTERNATIONAL	3.4	5.3	6.2
BOSTON LOGAN INTERNATIONAL	6.1	7.3	4.8
CHICAGO O'HARE INTERNATIONAL	4.1	5.6	4.6
DENVER STAPLETON INTERNATIONAL	4.6	3.2	3.7
PHILADELPHIA INTERNATIONAL	0.9	2.0	3.7
LOS ANGELES INTERNATIONAL	0.8	1.1	3.3
WASHINGTON NATIONAL	2.0	3.2	2.3
DALLAS / FORT WORTH INTERNATIONAL	1.7	2.6	2.0
ST LOUIS - LAMBERT INTERNATIONAL	4.6	4.4	1.6
DETROIT METROPOLITAN	2.1	1.3	1.5
MINNEAPOLIS INTERNATIONAL	2.2	3.9	0.7
GREATER PITTSBURGH INTERNATIONAL	1.7	0.6	0.7
KANSAS CITY INTERNATIONAL	0.3	1.0	0.5
HOUSTON INTERNATIONAL	0.3	0.2	0.5
MIAMI INTERNATIONAL	0.3	0.7	0.4
FT. LAUDERDALE - HOLLYWOOD INT'L	0.1	0.3	0.2
CLEVELAND HOPKINS INTERNATIONAL	0.1	0.3	0.1
LAS VEGAS MCCARRAN INTERNATIONAL	0.0	0.0	0.1
AVERAGE	3.4	4.0	3.2

SOURCE: NAPRS - 22 MAJOR AIRPORTS

1.5 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 1986 cost the scheduled air carriers and their passengers up to five billion dollars system wide[6]. 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. Since these users also encounter airport congestion and delay, the estimate of cost of delay understates the total cost.

[6] The cost estimates made by the FAA Office of Aviation Policy and Plans are comprised of about \$1.8 billion in extra airline operating costs and \$3.2 billion in the value of time lost by passengers.

1.6 PROJECTED AIRCRAFT OPERATIONS

Passenger enplanements are expected to grow an average of 4.6 percent annually between 1987 and 1999. Enplanements in 1999 are projected to be 72 percent above the 1986 level

With steady economic growth and stable aviation fuel costs, domestic passenger enplanements are expected to grow an average of 4.6 percent annually between 1987 and 1999. Enplanements in 1999 are projected to be 72 percent above the 1987 level. While a 72 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 120 percent. Between 1987 and 1999, total aircraft operations at towered airports are expected to increase by 33 percent, an annual growth rate of 2.4 percent. This includes 32 percent growth in air carrier operations, 45 percent growth in commuter operations, and 33 percent growth in general aviation operations. Forecast estimates of total operations at 50 airports are presented in Table 1-5.

1.7 SELECTION OF FORECAST DELAY-PROBLEM AIRPORTS

32 major airports are forecast to have more than 20,000 hours of air carrier delay in 1996

Delays are expected to increase at most airports. In order to provide some specific examples of how this problem can be addressed, this plan will focus on the 32 major airports that are forecast to have more than 20,000 hours of delay in 1996. The forecasts provide the baseline scenario with no improvement in capacity[7]. It is expected that implementation of actions described in this plan will reduce the actual amount of delay.

Figures 1-7 and 1-8 show airports that in 1986 and 1996 exceeded and are forecast to exceed 20,000 hours of annual air carrier delay as determined from the data in Table 1-6. The number of these airports increases from 18 in 1986 to 32 in 1996. By 1996 11 airports will have exceeded an annual air carrier delay level of 50,000 hours.

---

[7] Delay forecasts are based on a formula that relates historical activity with reported delay with an average error of about 10 percent. The predictions use as input current FAA activity forecasts that are subject to change as assumptions about future events are modified.

The delay forecasts assume no future change in system capacity. In particular, the formula does not consider recent improvements such as the East Coast Plan implemented in 1987, nor expected future improvements such as completely new airports at Austin, Texas and Denver, Colorado.

TABLE 1-5. ACTUAL AND PROJECTED GROWTH IN TOTAL OPERATIONS AT 50 SDRS AIRPORTS 1986 - 1996

AIRPORT	TOTAL OPERATIONS 1986	FORECAST OPERATIONS 1996	PERCENT CHANGE 1986 - 1996
	(thousands of operations)		
Chicago O'Hare International	794	912	14.9
Atlanta Hartsfield International	787	808	2.7
Dallas/Fort Worth International	576	653	13.4
Denver Stapleton International	525	642	22.3
Los Angeles International	580	623	7.4
Phoenix Sky Harbor	417	556	33.3
St. Louis Lambert International	458	556	21.4
San Jose Municipal	351	537	53.0
Boston Logan International	424	512	20.8
Detroit Metropolitan	380	502	32.1
Philadelphia International	378	483	27.8
Memphis International	382	482	26.2
Oakland International	388	476	22.7
Minneapolis-St. Paul International	400	460	15.0
Houston Intercontinental	298	458	53.7
Las Vegas McCarran International	365	455	24.7
San Francisco International	430	455	5.8
Miami International	351	448	27.6
Pittsburgh International	366	446	21.9
Honolulu International	368	444	20.7
Newark International	414	440	6.3
Salt Lake City International	277	418	50.9
Washington Dulles	285	404	41.8
Orlando International	220	384	74.6
Washington National	326	384	17.8
Baltimore-Washington International	285	383	34.4
Raleigh/Durham	210	376	79.0
Albuquerque International	226	370	63.7
New York La Guardia	366	370	1.1
Tampa International	253	368	45.5
New York Kennedy	317	367	15.8
Port Columbus International	194	237	22.2
Nashville Metropolitan	252	332	31.7
San Antonio International	199	324	62.8
Cincinnati Municipal	183	308	68.3
Kansas City International	208	303	45.7
West Palm Beach International	225	302	34.2
Seattle Tacoma	260	301	15.8
Austin Mueller Municipal	209	294	40.7
Portland International	224	262	17.0
Cleveland Hopkins International	238	258	8.4
Indianapolis International	209	256	22.5
New Orleans International	169	252	49.1
Dayton International	194	237	22.2
Milwaukee Mitchell Field	192	233	21.4
Windsor Locks Bradley International	163	230	41.1
Ontario International	134	209	56.0
San Diego International	170	205	20.6
Sacramento Metropolitan	161	196	21.7
Jacksonville International	150	182	21.3

Source: FAA Office of Policy and Plans

FIGURE 1-7. AIRPORTS EXCEEDING 20,000 HOURS OF ANNUAL AIRCRAFT DELAY IN 1986

FIGURE 1-8. **AIRPORTS FORECAST TO EXCEED 20,000 HOURS OF ANNUAL AIRCRAFT DELAY IN 1996, ASSUMING NO CAPACITY IMPROVEMENTS**

TABLE 1-6. PRESENT AND FUTURE AIR CARRIER DELAY AT 50 SDRS AIRPORTS 1986 - 1996

AIRPORT	TOTAL HOURS OF DELAY 1986	TOTAL HOURS OF DELAY 1996	PERCENT CHANGE 1986 - 1996
Denver Stapleton International	38,400	158,200	312.0
Chicago O'Hare International	133,200	156,000	17.1
Atlanta Hartsfield International	87,600	103,300	17.9
Dallas/Fort Worth International	76,000	90,000	18.4
Newark International	60,000	67,100	11.8
Phoenix Sky Harbor	24,200	66,200	173.6
Los Angeles International	56,200	61,900	10.1
St. Louis Lambert International	35,100	59,900	70.7
San Francisco International	57,100	59,000	3.3
Detroit Metropolitan	27,200	57,700	112.1
Washington Dulles	12,900	54,300	320.9
New York La Guardia	43,300	47,000	8.5
Boston Logan International	34,500	46,700	35.4
Honolulu International	23,800	44,500	87.0
New York Kennedy	33,000	43,800	32.7
Minneapolis-St. Paul International	29,700	43,700	47.1
Orlando International	13,400	43,600	225.4
Philadelphia International	18,700	41,700	123.0
Miami International	31,000	41,500	33.9
Salt Lake City International	14,700	30,300	106.1
Houston Intercontinental	16,400	29,100	77.4
Washington National	24,300	28,800	18.5
Memphis International	18,300	27,000	47.5
Kansas City International	13,600	26,000	91.2
Pittsburgh International	20,000	24,500	22.5
San Jose Municipal	12,100	24,300	100.8
Seattle Tacoma	17,500	24,100	37.7
Las Vegas International	14,100	23,700	68.1
Nashville Metropolitan	11,300	23,500	108.0
Cincinnati Municipal	6,800	23,400	244.1
Ontario International	8,400	22,600	169.0
Raleigh/Durham	4,800	21,600	350.0
Tampa International	10,400	19,300	85.6
San Diego International	13,400	19,100	42.5
Baltimore-Washington International	11,800	16,800	42.4
Cleveland Hopkins International	11,900	12,700	6.7
Albuquerque International	7,200	12,400	72.2
Dayton International	9,500	12,400	30.5
Port Columbus International	4,600	12,300	167.4
Windsor Locks Bradley International	6,000	11,900	98.3
Oakland International	6,800	11,600	70.6
Milwaukee Mitchell Field	6,000	11,000	83.3
Portland International	8,800	10,100	14.8
New Orleans International	5,300	8,500	60.4
San Antonio International	6,100	8,000	31.1
Austin Mueller Municipal	4,700	7,000	48.9
West Palm Beach International	4,400	7,900	79.5
Indianapolis International	5,800	6,900	19.0
Sacramento Metropolitan	4,000	5,200	30.0
Jacksonville International	4,200	5,100	21.4

1.8 FAA INVOLVEMENT IN AIRPORT CAPACITY ENHANCEMENT

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 address the problem of airport capacity and aircraft delays. This program covers of four broad areas:

- Airport Expansion;
- Airspace Control Procedures;
- Additional Equipment and Systems; and
- Capacity Planning Studies.

Airport construction and expansion represents the most beneficial and direct approach to increase 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 equipment, 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.

Airport Grants-In-Aid

The improvement of airports' ability to accomodate increased traffic effciently is a major FAA goal. There has been significant federal investment in the United States aiport system through the Airport Improvement Program and earlier grant-in-aid programs. These include the Federal Aid Airport Program (FAAP) established by 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. From 1971 to 1987, grants totaling $8 billion were approved for airport planning and development.

From 1971 to 1987, grants totaling $8 billion were approved for airport planning and development

Industry Task Force on Airport Capacity

Recognizing the threat to aviation growth posed by congestion and delay, in 1982, the FAA asked the aviation community to study the problem of airport congestion through the Industry Task Force (ITF) on Airport Capacity Improvement and Delay Reduction chaired by the Airport Operators Council International. The ITF has endorsed 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 airport action plan for reducing airport delay. Currently, eight airport task forces are actively studying local airport problems. 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 Analysis Models

The FAA has sponsored the development and use of several analytical models that measure and predict changes in airport capacity and delay associated with changes in the airport's configuration and demand profile (types and quantities of aircraft), or changes in ATC procedures. The FAA has used the expert resources of airlines, research organizations, NASA, and private consultants to use these models effectively.

The Airport and Airspace Delay Model, SIMMOD, was applied in the Northern Tier - East Coast Plan Airspace Study, and is currently being used in development of the West Coast Plan

The Airport and Airspace Delay and Fuel Consumption Simulation Model, SIMMOD, was applied in the Northern Tier-East Coast Plan Airspace Study and is currently being used in development of the West Coast Plan. SIMMOD was used to simulate 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 examines new departure and arrival routes, and other procedures to reduce delay.

The FAA has undertaken the development of The National Airspace System Performance Analysis Capability (NASPAC) to provide a tool for studying the nation's terminal and enroute airspace network.

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 is made by local airport authorities. 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 established the Airport Capacity Program Office (ACPO). The ACPO maintains current information on capacity and delay, coordinates the various FAA efforts to increase capacity, assists airport users and operators in their efforts to relieve congestion, and serves as a central planning body for developing and advocating capacity enhancement policies and programs.

One of ACPO's responsibilities is to prepare the Airport Capacity Enhancement Plan that provides guidance 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 delay by means other than the increase in system capacity.

1.9 SUMMARY OF MAJOR ACCOMPLISHMENTS IN 1987

Several accomplishments related to airport capacity improvement and delay reduction took place during 1987. Among these are the following:

1.9.1 New Runways at Major Air Carrier Airports

Two new runways were constructed and commissioned at major air carrier airports: one at Dallas-Ft. Worth International Airport (DFW), and the other at Houston Intercontinental Airport (IAH).

Two new runways were constructed at major air carrier airports: Dallas-Fort Worth International Airport and Houston Intercontinental Airport

The new runway at DFW, 13R/31L, constitutes its sixth air carrier runway. It provides DFW with the same operational capabilities when conducting operations from the south (arrivals) as it currently has for operations from the north. It has the potential for allowing triple arrival streams in both directions; this translates into large capacity increases, and thus delay reductions, during IFR periods.

The new runway at IAH, 9/27, is its third air carrier runway. It allows independent parallel operations, which can represent a doubling in capacity during Instrument Meterological Conditions (IMC).

1.9.2 Implementation of Improved Longitudinal IFR Separation

13 airports implemented improved longitudinal separation in 1987.

Implementation at specific airports of improved longitudinal separations in IFR started during 1987. This procedure, as described in Chapter 3, allows the improvement in separation from 3 to 2.5-nmi between like-type pairs of aircraft on the same approach. Following FAA's approval of the procedure (for dry runways) in November 1986, 13 airports implemented it in 1987 beginning with Atlanta Hartsfield International on February 1, 1987. Atlanta was followed by Dallas/Ft. Worth, Nashville, Charlotte (NC), Tampa, Cincinnati Covington, Los Angeles, Denver Stapleton, Boston Logan, New York Kennedy, Newark, Norfolk, and Baltimore-Washington.

1.9.3 Development of New Airport Surveillance Systems for Independent Parallel and Converging IFR Approaches

New surveillance systems having greater accuracy, high scanning rates, and improved controller displays, are under development and promise significant gains in capacity at major airports because they will permit two streams of independent arrivals on closely spaced parallel runways.

Two prototype quick-scan systems have been designed and will be demonstrated at Raleigh-Durham and Memphis Airports in 1988. Both systems provide improved accuracy, higher scan rates, and improved displays, allowing the controllers and engineers the opportunity to demonstrate and study the operational advantages of the new surveillance systems.

Independent IFR approaches to converging as well as parallel runways would potentially increase the capacity at 75 current airports.

The quick-scan system at Memphis will also be used to monitor approaches to converging runways. The ability to make independent IFR approaches to converging as well as parallel runways would potentially increase the capacity at 75 current airports. The FAA is developing procedures that will use the improved sensors to permit operations on closely spaced converging runways.

1.9.4 SIMMOD Airport/Airspace Planning Model

50 hours of daily aircraft flight time reduction will produce a savings of $80,000 per day to scheduled air carriers

The East Coast Plan, West Coast Plan, and individual airports have benefited from the analyses provided by this system. SIMMOD was used to simulate enroute airspace operations in the Boston Center. Airways and departure route realignments and sector revisions were evaluated. It is estimated that, as a result of this evaluation, on an average day 28 hours of aircraft delay and 22 hours of nominal travel time will be eliminated for a total reduction of 50 hours. This will produce a savings of $80,000 per day to scheduled air carriers. Chapter 4.2 describes SIMMOD in more detail.

1.9.5 Development of Dependent Converging IFR Approaches and Terminal Automation Concepts

During 1987, the concept of dependent converging IFR approaches was developed and approved. Analysis of this concept which potentially may be applied at 18 of the 50 major air carrier airports indicates that IFR capacities can be improved by about 20 percent as a consequence of lower minima than those that can be obtained under independent converging IFR approaches. A prototype controller visualization aid developed by the MITRE Corporation will be used to validate this concept. Chapter 3.2 provides additional detail.

Dependent converging IFR approaches are applied at 18 major air carrier airports. IFR capacities can be improved by about 20 percent

1.9.6 Research on using a 1.5-NMI Diagonal Separation for Dependent Parallel IFR Approaches

A project was begun in 1987 on the potential feasibility of improving minimum diagonal separation for instrument approaches on parallel runways separated by at least 2500 but less than 4300 feet. The FAA Technical Center will begin a simulation of this concept in 1988 prior to its demonstration at several airports. Chapter 3.4 provides additional detail.

1.9.7 Airport Capacity Task Forces

Two airport capacity task forces, Atlanta and San Francisco, completed their activities and published their recommendations in 1987.

The San Francisco Task Force studied Oakland and San Jose International Airports in addition to San Francisco International. Its recommendations range from improving noise barriers to constructing a new runway. The task forces and their recommendations are described further in Chapter 4.1 and Appendix F.

One of the principal recommendations of the Atlanta Task Force was the development of a new commuter runway complex, south of the airport, to be used simultaneously with the current air carrier configurations. Based on this recommendation requiring the use of three simultaneous approaches, the FAA has started the analysis and development of procedures that may allow triple IFR approaches at Atlanta. Other recommended improvements include lights and exits, new concourses, and new traffic management procedures.

CHAPTER 2

AIRPORT DEVELOPMENT

The FAA will continue to encourage efforts to safely increase the capacity of the national airport system through the construction of new runways and airports. However, the FAA is only one element in a complex process that involves the cooperation of almost all facets of the aviation industry as well as many elements outside of the industry.

The construction of new airports and runways is the most effective means of enhancing capacity and reducing delay. A new runway can change an airport's capacity in several ways depending on its length and location. The addition of a new runway that allows an additional independent arrival or departure stream results in a 33 to 100 percent capacity increase in VFR (depending on whether the baseline is a single, dual, or triple runway configuration), and a 50 to 100 percent increase in IFR (depending upon whether the baseline is a single runway, two dependent, or two independent runways).[1] Consequently, the greatest capacity increases come from the addition of a new runway, properly spaced to allow an additional independent arrival or departure stream. 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 addition of a new runway results in a 33 to 100 percent capacity increase

The FAA provides financial support for airport construction under the Airport Improvement Program (AIP) using funds provided from Airport and Airway Trust Fund. The FY88 appropriation for the AIP is about $1.3 billion and much of that money will be used for projects that will directly enhance airport capacity. The FAA works with airport operators to plan and fund these construction efforts. A more complete list of AIP grant projects are given in Chapters 2.1, 2.2, and Appendix G.

The FY88 appropriation for the AIP is approximately $1.3 billion

[1] Source: FAA report FAA-DL5-87-1 prepared by the MITRE Corporation.

2.1 THE AIRPORT IMPROVEMENT PROGRAM

The Airport Improvement Program is a means by which the FAA participates in airport expansion and improvement projects. Through a grants-in-aid process, the FAA provides assistance to those airports undertaking or contemplating projects which will enhance capacity.

Established in 1970 under the Airport and Airway Development Act, the Airport and Airway Trust Fund has been the mechanism for federal funding of airport and airway improvements. The Airport and Airway Trust Fund supports four major FAA programs, one of which is the Airport Improvement Program. During 1987, funding for the AIP was approximately $1 billion. Of this sum, a substantial portion was used to fund capacity related projects.

During 1987, funding for the AIP was approximately $1 billion

Legislation to extend the Trust Fund has been passed under the Airport and Airway Safety and Capacity Expansion Act of 1987. Funding for the AIP was authorized at $1.7 billion a year for the period FY88-FY90, and $1.8 billon a year for FY91-FY92. Appropriation for the FY88 AIP is approximately $1.3 billion.

Funding for the AIP was authorized at $1.7 billion a year for the period FY88-FY90, and $1.8 billion a year for FY91-FY92. Appropriation for the FY88 AIP is approximately $1.3 billion

Enhancement Projects

Through the Airport Improvement Program, the FAA has made grants for the construction and improvement of runways and taxiways. Grants have also been made for apron construction and improvements, airport lighting, navigational aids, land acquisition, noise control measures, and terminal building improvements. These projects can directly or indirectly enhance airport capacity.

Construction of a new runway can increase an airport's capacity and reduce delay. Runway improvements and extensions will also ease delay problems because they will permit use by larger planes and thus make better use of capacity. New taxiways provide additional access to and from a runway and can relieve congestion on the runway and near the gates. Once an aircraft has landed on a runway, it can exit more quickly onto an available taxiway and free the runway for the next aircraft.

Construction of a new apron or expansion of an existing apron eases congestion on taxiways. The improvements will also permit aircraft to gain quicker access to the gates and to the runways, thereby reducing taxi in/taxi out time.

In addition, navigational aids, runway and taxiway lighting, land acquisition (for development and approaches) and terminal buildings all play a role in alleviating the delay problem.

Finally, noise control projects indirectly affect airport capacity. Noise control is an important aspect of the Airport Improvement Program--more than $70 million was allocated for each year during FY86 and FY87 for measures to relieve the noise problems in neighborhoods which surround most airports. Action such as soundproofing residences and land acquisition attempt to ease the noise problem without restricting operations.

More than $70 million was allocated for each year during FY86 and FY87 for measures to relieve noise

Table 2-1 provides a summary of total FY86 and FY87 grants awarded through the AIP to 50 major airports. The airports are ranked by 1986 total air carrier delay (SDRS). The figures shown do not reflect total AIP grants for each airport, but rather only those grants awarded for capacity related projects.[2]

Table G-2 in Appendix G provides a detailed list of capacity related projects and corresponding AIP grants for each of the 50 major airports.

[2]Grant categories considered capacity-related are listed in Table G-1 in Appendix G.

TABLE 2-1. TOTAL FY86 & FY87 CAPACITY RELATED GRANTS TO TOP 50 AIRPORTS. *

RANK	AIRPORT	CITY	TOTAL ($)
1	O'HARE INTERNATIONAL	CHICAGO	7,350,000
2	HARTSFIELD / ATLANTA INTERNATIONAL	ATLANTA	20,571,428
3	DALLAS - FORT WORTH INTERNATIONAL	DALLAS - FORT WORTH	8,100,000
4	NEWARK INTERNATIONAL	NEWARK	11,276,814
5	SAN FRANCISCO INTERNATIONAL	SAN FRANCISCO	- 0 -
6	LOS ANGELES INTERNATIONAL	LOS ANGELES	16,802,625
7	LA GUARDIA	NEW YORK	16,182,366
8	STAPLETON INTERNATIONAL	DENVER	16,610,374
9	LAMBERT - ST. LOUIS INTERNATIONAL	ST. LOUIS	18,926,297
10	LOGAN INTERNATIONAL	BOSTON	11,018,701

* RANKED BY TOTAL 1986 AIR CARRIER DELAY (SDRS)

TABLE 2-1. TOTAL FY86 & FY87 CAPACITY RELATED GRANTS TO TOP 50 AIRPORTS (Continued)

RANK	AIRPORT	CITY	TOTAL ($)
11	KENNEDY INTERNATIONAL	NEW YORK	12,100,658
12	MIAMI INTERNATIONAL	MIAMI	10,336,701
13	MINNEAPOLIS - ST. PAUL INTERNATIONAL	MINNEAPOLIS - ST. PAUL	9,691,389
14	DETROIT METROPOLITAN	DETROIT	18,499,403
15	WASHINGTON NATIONAL	WASHINGTON	- 0 -
16	PHOENIX SKY HARBOR	PHOENIX	17,498,903
17	HONOLULU INTERNATIONAL	HONOLULU	12,372,540
18	GREATER PITTSBURGH INTERNATIONAL	PITTSBURGH	5,641,523
19	PHILADELPHIA INTERNATIONAL	PHILADELPHIA	10,850,111
20	MEMPHIS INTERNATIONAL	MEMPHIS	2,157,916
21	SEATTLE - TACOMA INTERNATIONAL	SEATTLE	11,322,499
22	HOUSTON INTERCONTINENTAL	HOUSTON	8,145,932
23	SALT LAKE CITY INTERNATIONAL	SALT LAKE CITY	14,468,095
24	LAS VEGAS - McCARRAN INTERNATIONAL	LAS VEGAS	11,931,764
25	KANSAS CITY INTERNATIONAL	KANSAS CITY	1,845,000
26	SAN DIEGO INTERNATIONAL	SAN DIEGO	13,419,885
27	ORLANDO INTERNATIONAL	ORLANDO	17,971,975
28	DULLES INTERNATIONAL	WASHINGTON	- 0 -
29	PORT COLUMBUS INTERNATIONAL	COLUMBUS	8,753,904
30	SAN JOSE INTERNATIONAL	SAN JOSE	9,032,370

TABLE 2-1. TOTAL FY86 & FY87 CAPACITY RELATED GRANTS TO TOP 50 AIRPORTS (Continued)

RANK	AIRPORT	CITY	TOTAL ($)
31	CLEVELAND - HOPKINS INTERNATIONAL	CLEVELAND	10,750,493
32	BALTIMORE - WASHINGTON INTERNATIONAL	BALTIMORE	26,592,913
33	NASHVILLE METROPOLITAN	NASHVILLE	8,956,312
34	TAMPA INTERNATIONAL	TAMPA	3,652,209
35	DAYTON INTERNATIONAL	DAYTON	3,079,744
36	PORTLAND INTERNATIONAL	PORTLAND	5,365,248
37	ONTARIO INTERNATIONAL	ONTARIO	5,193,971
38	ALBUQUERQUE INTERNATIONAL	ALBUQUERQUE	2,673,000
39	CINCINNATI MUNICIPAL	CINCINNATI	1,644,700
40	METROPOLITAN OAKLAND INTERNATIONAL	OAKLAND	114,620
41	SAN ANTONIO INTERNATIONAL	SAN ANTONIO	5,239,040
42	BRADLEY INTERNATIONAL	WINDSOR LOCKS	1,271,250
43	GENERAL MITCHELL INTERNATIONAL	MILWAUKEE	2,650,713
44	INDIANAPOLIS INTERNATIONAL	INDIANAPOLIS	1,002,279
45	NEW ORLEANS INTERNATIONAL	NEW ORLEANS	350,000
46	RALEIGH - DURHAM	RALEIGH	5,390,257
47	WEST PALM BEACH INTERNATIONAL	WEST PALM BEACH	4,896,146
48	AUSTIN MUELLER MUNICIPAL	AUSTIN	5,661,622
49	JACKSONVILLE INTERNATIONAL	JACKSONVILLE	5,830,207
50	SACRAMENTO METROPOLITAN	SACRAMENTO	6,890,2252
		TOTAL	430,084,032

The additional capacity and reduced delays that result from runway construction projects illustrate the benefits of the AIP. To show the range of benefits, Table 2-2 identifies 16 representative airports planning new runways and Table 2-3 shows the capacities resulting from some of those new runways.

TABLE 2-2. AIRPORTS WITH PLANNED NEW RUNWAYS*

Baltimore	Las Vegas
Charlotte	Milwaukee
Cincinnati	Nashville
Dallas - Ft. Worth	New Orleans
Detroit	Norfolk
Houston Intercontinental	Orlando
Indianapolis	Salt Lake City
Kanasas City	San Jose

*** Of top 60 airports based on enplanements.**

TABLE 2-3. SAMPLE IFR CAPACITIES WITH PLANNED NEW RUNWAYS

Airport	Runway	Capacity (arrivals/hour)	
		Converging	Curr. Best
Baltimore	10R/28L	52.0[3]	26.0[4]
Cincinnati	18L/36R	53.2[3]	26.6[4]
Dallas - Ft. Worth	16L/34R	79.5[5]	53.0[3]
Houston Intercontinental	8L/26R	61.9[5]	53.0[3]
Indianapolis	4R/22L	38.2[6]	26.7[4]
Kansas City	1R/19L 9R/27L 18R/36L 18L/36R	55.0[3] 55.0[3] 82.5[5] 82.5[5]	27.5[4]
Nashville	2R/20L	50.2[3]	25.1[4]
New Orleans	N/S rwy	49.6[3]	24.8[4]
Orlando	17/35	50.2[3]	25.1[4]
Salt Lake City	16/34	50.8[3]	36.2[6]

[3]Independent parallel approaches.
[4]Single runway approaches.
[5]Triple approaches (currently not authorized).
[6]Dependent parallel approaches

The FAA is working with airport operators and the airlines to identify and encourage new runway projects, especially at airports where the delay problem is likely to become severe. Despite the large capacity gains, the construction of new runways is not feasible at all airports, especially at those where expansion is limited by land availability. This poses a significant problem, since many congested airports are surrounded by populated areas. Funding and environmental constraints may further prevent or complicate the building of new runways.

Of 32 airports projected to exceed 20,000 hours annual aircraft delay by 1996, nine have planned new runways that can alleviate delay problems. Figure 2-1 shows the 32 airports and identifies those with planned new runways.

Of 32 airports projected to exceed 20,000 hours annual aircraft delay in 1996, nine have planned new runways.

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 (a 9,000-foot runway, 150 feet wide, covers 31 acres of land). 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, only projects with demonstrated immediate need are normally programmed.

2.2 RELIEVER AIRPORTS

Reliever airports play an important role in easing capacity problems at primary airports by spreading aircraft operations over additional airports near these primary airports. In addition, since reliever airports are used mainly by smaller general aviation aircraft, they tend to segregate airport activity by aircraft size. The primary airports serve mostly larger, commercial service aircraft. The segregation of aircraft operations by size increases effective capacity because required time and distance separations are less between planes of similar size.

Segregation of aircraft operations by size increases effective capacity because required time and distance separations are less between planes of similar size.

2.2.1 FAA Support to Reliever Airports

The FAA provides assistance for construction and improvements at reliever airports under the Airport Improvement Program. The objective of these grants is to increase utilization of reliever airports by building new relievers and, for existing relievers, improving the facilities and navigational aids, and reducing environmental impacts on neighboring communities. The total FY86 and FY87 grants awarded to reliever airports of 50 major air carrier airports are shown in Table 2-4.

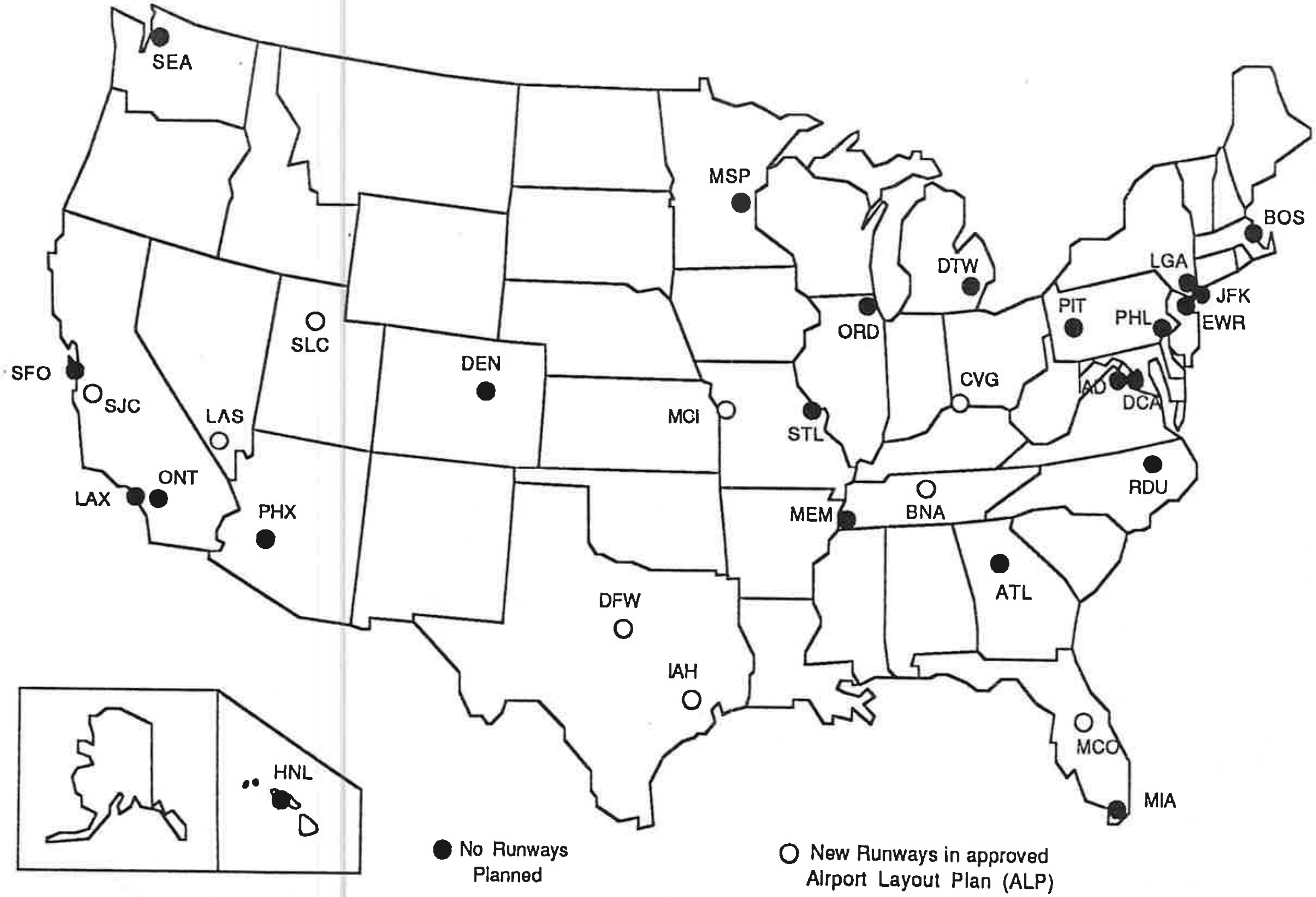


FIGURE 2-1. AIRPORTS FORECAST TO EXCEED 20,000 HOURS OF ANNUAL AIRCRAFT DELAY IN 1996, SHOWING THOSE WITH PLANNED NEW RUNWAYS

TABLE 2-4. TOTAL FY86 AND FY87 CAPACITY RELATED GRANTS TO RELIEVER AIRPORTS*

AIRPORT	TOTAL NUMBER OF RELIEVER AIRPORTS	NUMBER OF RELIEVERS RECEIVING GRANTS	TOTAL GRANTS ($)
CHICAGO O'HARE	5	4	16,732,742
ATLANTA - HARTSFIELD	10	4	9,514,086
DALLAS - FORT WORTH INTERNATIONAL	7	6	14,364,202
NEWARK INTERNATIONAL	7	3	3,325,533
SAN FRANCISCO INTERNATIONAL	3	2	269,100
LOS ANGELES INTERNATIONAL	5	2	1,045,520
NEW YORK LA GUARDIA	1	0	0
DENVER STAPLETON	3	3	8,597,592
ST. LOUIS - LAMBERT	6	1	1,438,233
BOSTON LOGAN	3	2	866,396
NEW YORK KENNEDY	1	0	0
MIAMI INTERNATIONAL	2	1	1,039,308
MINNEAPOLIS - ST. PAUL INTERNATIONAL	7	2	2,306,964
DETROIT METROPOLITAN	5	4	5,082,059
WASHINGTON NATIONAL	5	4	6,976,361
PHOENIX SKY HARBOR	6	6	9,846,456
HONOLULU INTERNATIONAL	0	0	0
PITTSBURGH INTERNATIONAL	5	4	4,065,320
PHILADELPHIA INTERNATIONAL	8	5	2,526,092
MEMPHIS INTERNATIONAL	3	2	456,701
SEATTLE TACOMA	6	3	4,659,810
HOUSTON INTERCONTINENTAL	6	2	1,907,590
SALT LAKE CITY INTERNATIONAL	1	1	129,000
LAS VEGAS - McCARRAN	1	1	15,000,000
KANSAS CITY INTERNATIONAL	3	3	9,618,287
SAN DIEGO INTERNATIONAL	3	0	0
ORLANDO INTERNATIONAL	2	2	763,600
WASHINGTON DULLES	0	0	0
COLUMBUS INTERNATIONAL	3	2	1,238,362
SAN JOSE MUNICIPAL	3	1	965,000
CLEVELAND - HOPKINS	5	2	4,935,733
BALTIMORE - WASHINGTON INTERNATIONAL	2	2	1,773,712
NASHVILLE METROPOLITAN	1	0	0

* RANKED BYTOTAL 1986 AIR CARRIER DELAY (SDRS)

TABLE 2-4. TOTAL FY86 AND FY87 CAPACITY RELATED GRANTS TO RELIEVER AIRPORTS (Continued)

AIRPORT	TOTAL NUMBER OF RELIEVER AIRPORTS	NUMBER OF RELIEVERS RECEIVING GRANTS	TOTAL GRANTS ($)
TAMPA INTERNATIONAL	4	3	3,699,406
DAYTON INTERNATIONAL	1	0	0
PORTLAND INTERNATIONAL	3	2	990,000
ONTARIO INTERNATIONAL	4	2	3,869,000
ALBUQUERQUE INTERNATIONAL	1	1	745,720
CINCINNATI MUNICIPAL	3	0	0
OAKLAND INTERNATIONAL	3	3	4,980,054
SAN ANTONIO INTERNATIONAL	1	1	1,568,930
WINDSOR LOCKS BRADLEY	3	1	128,700
MILWAUKEE - MITCHELL FIELD	4	3	7,766,890
INDIANAPOLIS INTERNATIONAL	6	4	5,435,758
NEW ORLEANS INTERNATIONAL	5	4	3,526,693
RALIEGH - DURHAM	2	0	0
WEST PALM BEACH INTERNATIONAL	2	0	0
AUSTIN MUELLER MUNICIPAL	1	0	0
JACKSONVILLE INTERNATIONAL	2	0	0
SACRAMENTO METROPOLITAN	1	0	0

Table G-3 in Appendix G provides a detailed list of capacity related projects and corresponding AIP grants for each of the relievers of the 50 major airports.[7]

Under the AIP program construction of eight new general aviation reliever airports has begun since 1982.

Under the AIP program construction of eight new general aviation reliever airports has begun since 1982. Table 2-5 lists these airports. They are intended to relieve demand at scheduled air carrier airports.

[7] Grant categories considered capacity-related are listed in Table G-1 in Appendix G.

TABLE 2-5. NEW RELIEVER AIRPORTS BEGUN UNDER THE AIRPORT IMPROVEMENT PROGRAM SINCE 1982

Relieved Airport	New Reliever	Location
Phoenix Sky Harbor	Glendale Municipal	Glendale, Arizona
Denver Stapleton	Front Range	Denver, Colorado
El Paso International	Santa Teresa	Santa Teresa, New Mexico
Portland International	Mulino	Mulino, Oregon
Nashville Metropolitan	John C. Tune	Nashville, Tennessee
Dallas/Fort Worth Regional	South Fort Worth	Ft. Worth, Texas
Houston Intercontinental	Sealy Regional	Sealy, Texas
Dallas/Fort Worth Regional	Municipal	Weatherford, Texas

2.2.2 Migration of General Aviation Aircraft

Delays at 32 airports forecast to have at least 20,000 hours of delay in 1996 will tend to be reduced by the natural transition of general aviation aircraft from airports with a high proportion of such activity to new or improved reliever airports. At congested airports with a significant level of general aviation activity (25 percent of total operations is the lower threshhold used in this analysis), there will be a migration of some of these aircraft (and their operations) to nearby reliever airports as they are improved and expanded. Table 2-6 identifies five airports forecast to exceed 20,000 hours of aircraft delay in 1996 that also had at least 25 percent general aviation operations in 1986. Existing and planned reliever airports are also listed for each of these airports.

Five airports forecast to exceed 20,000 hours of aircraft delay in 1996 had at least 25 percent general aviation operations in 1986

TABLE 2-6. AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1986, 25 PERCENT OR MORE GENERAL AVIATION TRAFFIC, AND NO PLANNED NEW RUNWAYS

Airport	Percent GA Operations	Reliever Airports
Ontario	30	Brackett Field Cable Rialto Municipal (Miro Field) Riverside Municipal
Memphis	25	Arlington Municipal Charles W. Baker General Dewitt Spain Olive Branch West Memphis Municipal
Phoenix	30	Chandler Municipal Falcon Field Glendale Municipal Phoenix-Deer Valley Municipal Phoenix-Litchfield Municipal Scottsdale Municipal New Airport Planned
Raleigh-Durham	51	3 New Airports Planned
Washington-Dulles	37	Leesburg Municipal[8] Manassas Municipal[8]

[8] The NPIAS designates these airports as relievers for Washington-National (DCA) however, they are both convenient to Washington-Dulles and will therefore relieve that airport.

Figure 2-2 shows the five airports listed in Table 2-6 and their existing or planned reliever airports.

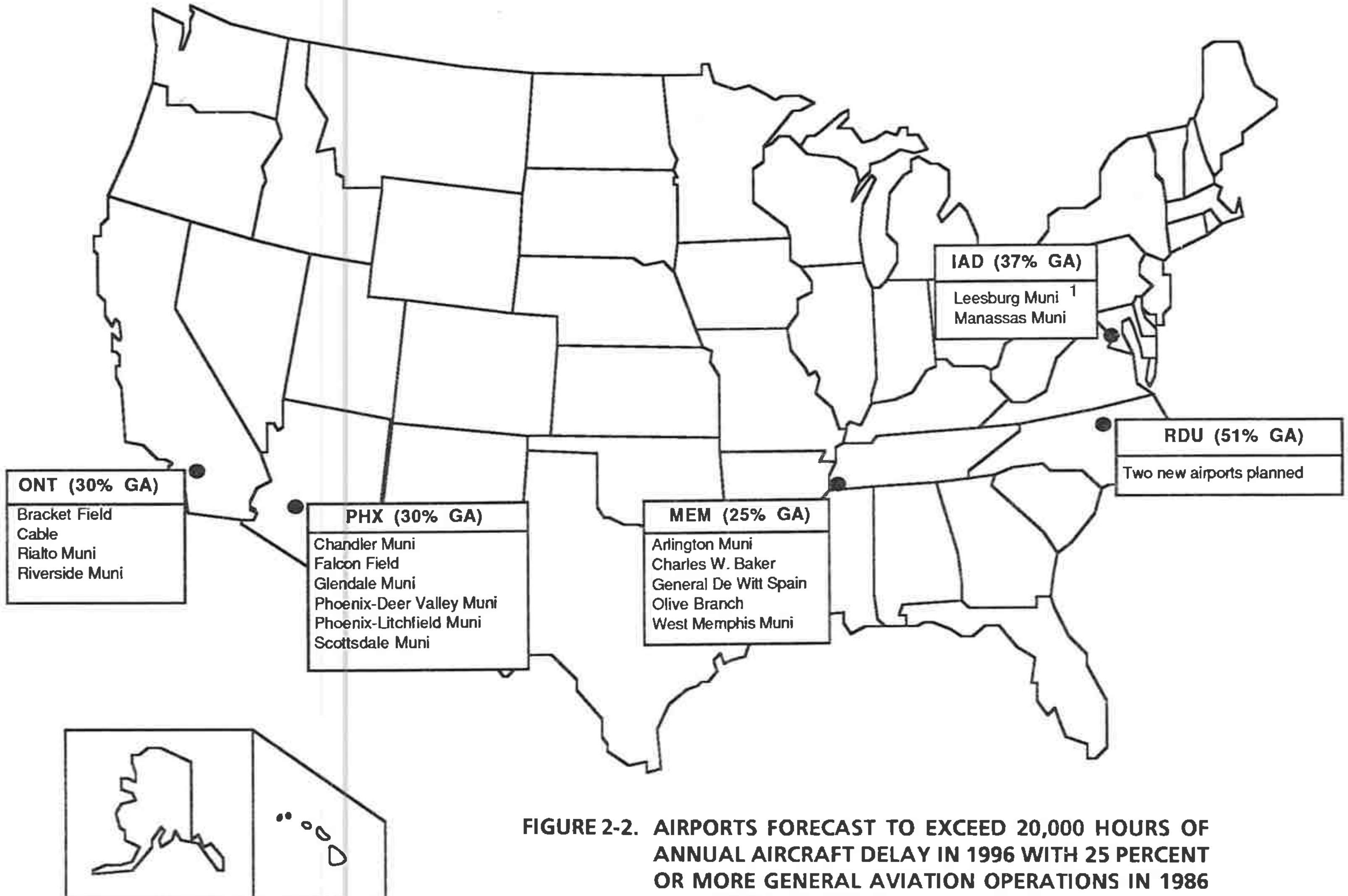


FIGURE 2-2. AIRPORTS FORECAST TO EXCEED 20,000 HOURS OF ANNUAL AIRCRAFT DELAY IN 1996 WITH 25 PERCENT OR MORE GENERAL AVIATION OPERATIONS IN 1986 AND THEIR RELIEVERS

[1] The NPIAS designates these airports as relievers for Washington-National (DCA) however, they are both convenient to Washington-Dulles and will therefore relieve that airport.

2.3 ALTERNATIVE GROWTH AIRPORTS

All but one of the 32 airports forecast to exceed 20,000 hours of annual aircraft delay in 1996 have other less congested air carrier airports in the general area

The development and use of nearby airports as alternative hubs for growth in scheduled operations is another adjustment that may tend to reduce forecast delays at airports expected to be delay-problem airports in the future. All but one of the 32 airports forecast to exceed 20,000 hours of annual aircraft delay in 1996 have other less delay problem commerical service airports in the general area (within 100 nautical miles of the delay-problem airport). As congestion becomes greater at the delay-problem airports, passengers may choose to travel to the alternative airports. For each of these airports, one or more airports have been identified that may be able to absorb some passenger traffic by increasing air carrier scheduled service.[9] This traffic diversion would tend to decrease forecast delays at the delay-problem airports. Even where nearby airports cannot absorb projected traffic increases from delay-problem airports, potential new connecting hub airports can be developed over the longer term.

A recent study[10] showed that hub airports developed since airline deregulation have exhibited one or more of the following characteristics:

- Strong origin/destination (O&D) market
- Good geographic location
- Expandable airport facilities
- Strong economy and availability of balanced workforce
- Ability to accommodate existing/planned scheduled service fleet

2.3.1 Capacity Potential Near Delay-Problem Airports

A set of potential alternate airports within 100 miles of the 32 delay problem airports was identified[11]. A conservative estimate of unused capacity was made of potential operations per year only for those airports with present or potential dual simultaneous IFR approach capabilities.

---

[9]The approach used to make this identification consisted of the following steps:
- Identify desirable characteristic of alternative airports
- Determine selection criteria
- Perform initial selection of alternate airports
- Narrow initial selection to workable number
- Evaluate candidates to identify high-payoff alternate airports

[10]Lopuszynski, Andrew J., "Perspectives on Airline Hubbing in the U.S.," Summer, 1986. (Unpublished paper by Purdue University FAA Summer Intern.)

[11]Appendix D details the selection criteria and Appendix E presents detailed information for 197 scheduled service airports that were considered as potential alternatives for the 32 airports forecast to exceed 20,000 hours annual aircraft delay by 1996.

Figure 2-3 shows the potential unused capacity at airports near each of the airports shown in Figure 1-7. The adjacent block to each delay-problem airport identifies all airports having dual simultaneous IFR approach capabilities and positive unused capacity. The number shown reflects the aggregate unused capacity in thousands of annual operations.

2.3.2 Potential New Connecting Hub Airports

Figure 2-4 identifies a set of potential new hub airports more than 100 miles from the 32 delay-problem airports, each with sufficient runway capacity to accommodate significant increased airport operations.

It is reasonable to assume that as flight delays grow at traditional connecting hub airports, airlines will develop new connecting hub airports. Recent examples include Raleigh-Durham, Nashville, and others.

From past experience, airlines tend to develop new connecting hubs at airports with an existing traffic base, good geographical location, expandable facilities and dual runway approach capability.

The potential new connecting hub airports in Figure 2-4 were selected generally from the 100 busiest airports ranked by total aircraft operations. Each airport selected has the capacity to permit dual approach streams under operations during instrument meteorological conditions. The actual development of new connecting hub will be a function of airline and local community decisions.

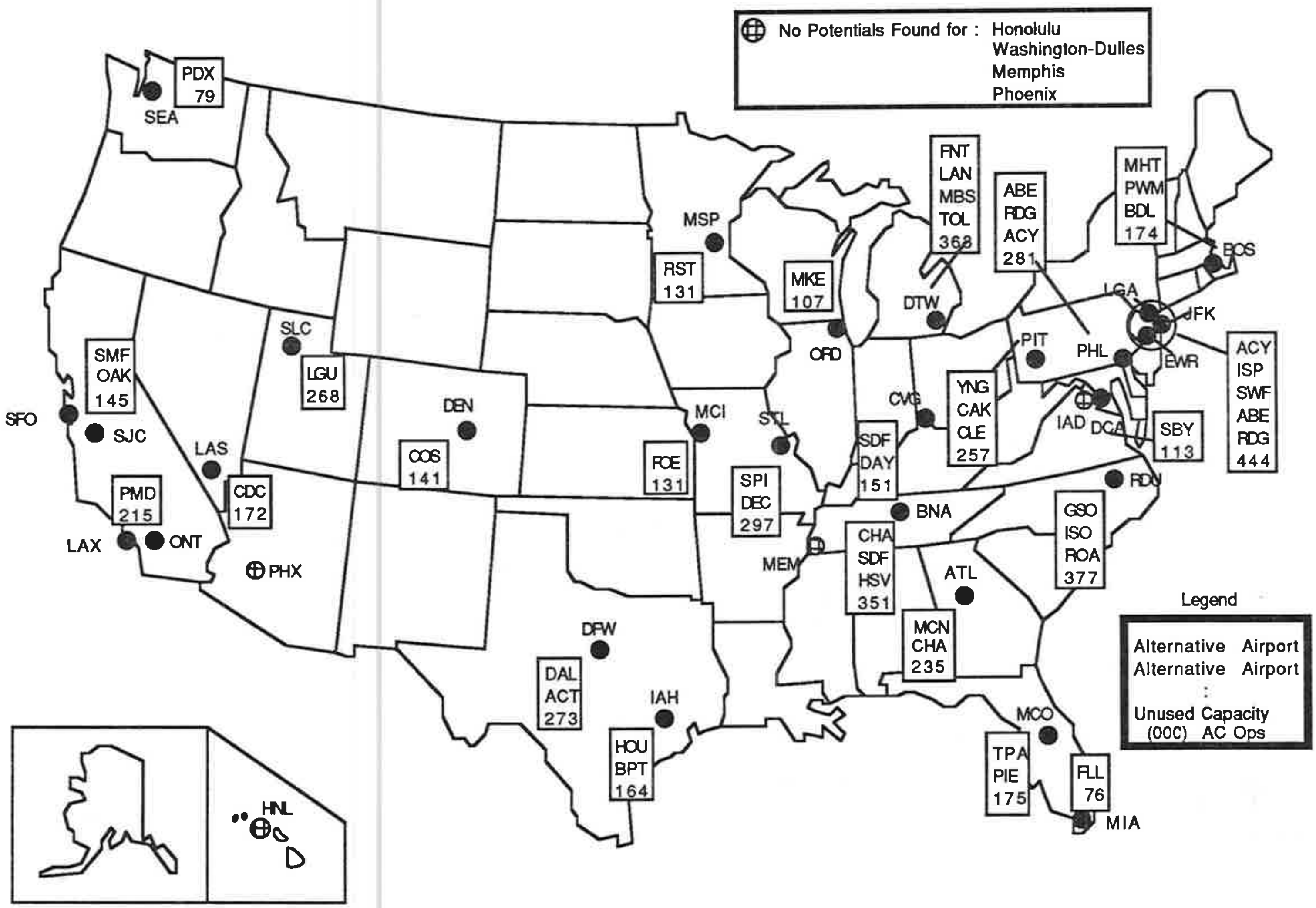


FIGURE 2-3. POTENTIAL ALTERNATE AIRPORTS WITHIN 100 MILES OF AIRPORTS FORECAST TO EXCEED 20,000 HOURS OF ANNUAL AIRCRAFT DELAY IN 1996 EXCLUDING THOSE WITH PLANNED NEW RUNWAYS OR LARGE GA PERCENT

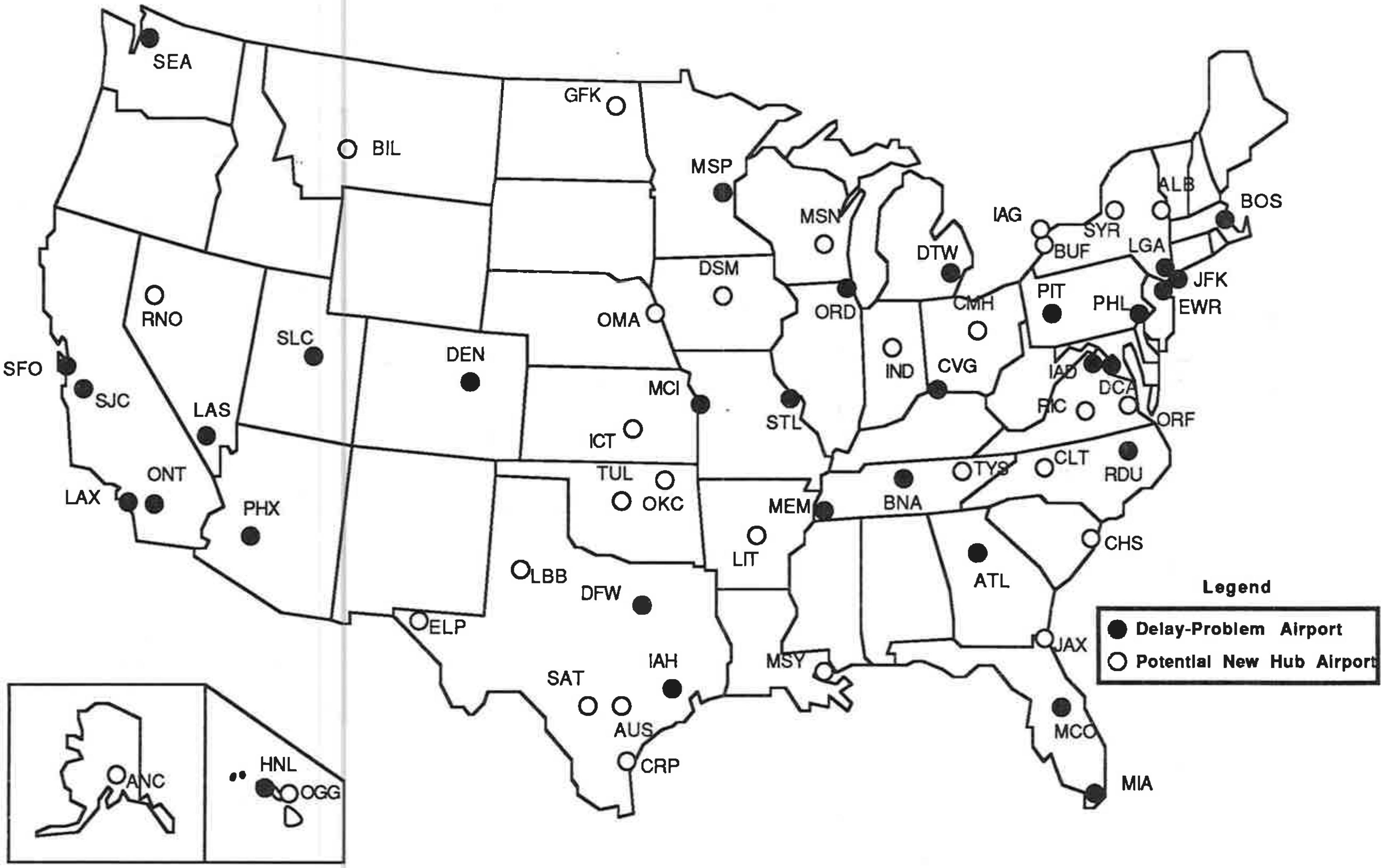


FIGURE 2-4. POTENTIAL NEW CONNECTING HUB AIRPORTS MORE THAN 100 MILES FROM DELAY-PROBLEM AIRPORTS AND HAVING DUAL IFR APPROACH

Table 2-7 summarizes selected information from Appendix D. It lists airports that are located within 100 miles of delay problem airports and have an "unused capacity" of at least 100,000 operations per year. "Unused capacity" is the number of additional aircraft operations that could be accommodated annually by the existing runway system without having significant delays. In most instances, the existing passenger, baggage, and airport servicing systems would have to be expanded to support the increased activity, but the runways are available.

TABLE 2-7. SCHEDULED SERVICE AIRPORTS WITH PRESENTLY UNDERUTILIZED CAPACITIES IN EXCESS OF 100,000 OPERATIONS PER YEAR

UNDERUTILIZED AIRPORT	POTENTIAL TO RELIEVE	UNUSED CAPACITY
Macon	Atlanta	152,000
Dayton	Cincinnati	110,000
Salisbury	Washington	113,000
Colorado Springs	Denver	141,000
Waco	Dallas/Ft. Worth	232,000
Saginaw	Detroit	145,000
Toledo	Detroit	104,000
Atlantic City	Newark New York	113,000
Beaumont	Houston	144,000
Palmdale	Los Angeles Ontario	215,000
Topeka	Kansas City	131,000
Rochester	Minneapolis	131,000
St. Petersburg	Orlando	136,000
Milwaukee	Chicago	107,000
Greensboro	Raleigh-Durham	151,000
Kinston	Raleigh-Durham	160,000
Sacramento	San Francisco San Jose	145,000
Decatur	St. Louis	229,000
Huntsville	Nashville	229,000

CHAPTER 3

PROCEDURAL AND TECHNOLOGICAL IMPROVEMENTS

As discussed in Chapter 1, the aircraft separation standards and procedures used under IFR reduce airport capacity relative to VFR, particularly with respect to arrivals. In some cases, the IFR capacity can be less than 50 percent of the VFR capacity. The lower IFR capacities result in more delays even if demand is unchanged. It is not surprising that roughly two-thirds of all delays lasting over 15 minutes occur during adverse weather conditions. 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 improving aircraft separation standards and procedures while still maintaining safety margins.

Two-thirds of all delays lasting over 15 minutes occur during adverse weather conditions.

One way in which IFR capacities can be increased is to permit 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. The applicability 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 separated by a sufficient distance to meet new separation standards.

Improving IFR longitudinal (in-trail) separation standards is another procedural method for increasing arrival capacity. The improvement in IFR longitudinal separations can apply at most airports. The FAA has recently authorized this procedure and it is being 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.

3.1 INDEPENDENT IFR APPROACHES TO CONVERGING RUNWAYS

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 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 that have recently implemented IFR converging approaches are Denver and Philadelphia.

Table 3-1 lists the 20 airports among the 50 major airports which are candidates for independent IFR converging approaches. Table 3-2 compares the current best configuration with potential independent converging approach IFR capacities at nine of those airports where the implementation of this procedure can be most beneficial.

Two airports--Denver and Philadelphia--have already implemented independent IFR converging approaches.

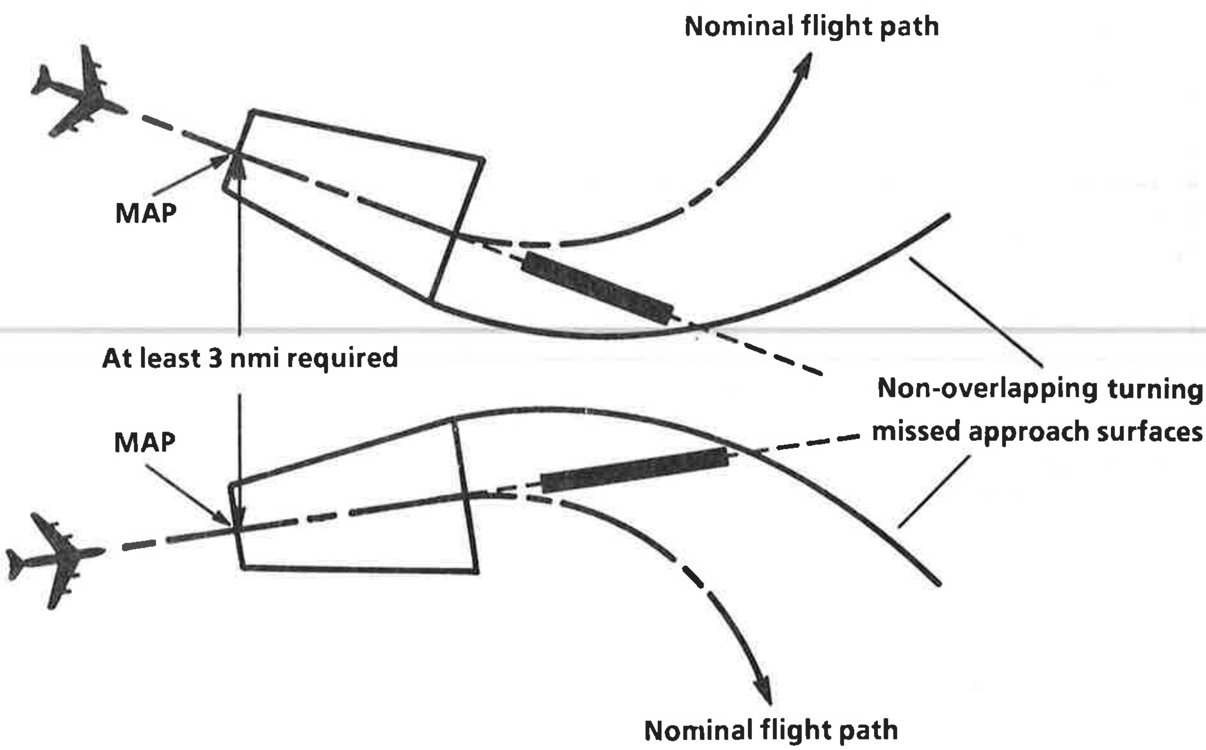


FIGURE 3-1. IFR APPROACHES TO CONVERGING RUNWAYS AUTHORIZED BY FAA ORDER 7110.98

TABLE 3-1. CANDIDATES FOR INDEPENDENT IFR CONVERGING APPROACHES AMONG THE 50 MAJOR AIRPORTS

Columbus, OH	Kansas City
Dayton	Memphis
Dallas-Ft. Worth	Miami
Detroit	Milwaukee
Newark	Oakland
Washington Dulles	Chicago O'Hare
Houston	Raleigh-Durham
Jacksonville	Salt Lake City
New York Kennedy	St. Louis
Las Vegas	Tampa

TABLE 3-2. SAMPLE IFR CAPACITIES FOR INDEPENDENT CONVERGING APPROACHES

Airport	Runway	Capacity (arrivals/hour)	
		Converging	Curr. Best
Newark	4R,11	50.6	25.3[1]
Jacksonville	25,31	51.0	25.5[1]
N.Y. Kennedy	13R,22L	51.4	41.7[2]
Kansas City	19,27	55.0	27.5[1]
Memphis	27,36L	49.2	35.2[2]
Oakland	27L,29	48.2	29.6[1]
Raleigh-Durham	5L,32	49.2	35.4[2]
Salt Lake City	14,16L	50.8	36.2[2]
St. Louis	24,30R	51.8	25.3[3]

[1] Single runway approaches.
[2] Dependent parallel approaches.
[3] Single runway, does not consider "sidestep" procedure used at STL.

3.2 DEPENDENT (ALTERNATING) IFR APPROACHES TO CONVERGING RUNWAYS

The objective of this project is to increase capacity by reducing the relatively high approach minima required by existing independent converging IFR approach procedures described in FAA Order 7110.98.

As in the independent approach case, the possibility of simultaneous missed approaches is the main concern. Two concepts are under development by FAA to enforce a minimum separation between aircraft landing on two converging runways to ensure safe separation in case both aircraft execute missed approaches. The aircraft alternate arrivals on the two runways so that a simultaneous missed approach cannot occur. Unlike the procedures described in the previous section, the streams are dependent, that is, aircraft flow in one stream affects aircraft flow in the other stream, especially when there are large speed differences between aircraft. Figure 3-2 shows the elements of this concept.

Preliminary results indicate that dependent approaches to converging runways can permit ceilings down to Category I minima (200 feet).

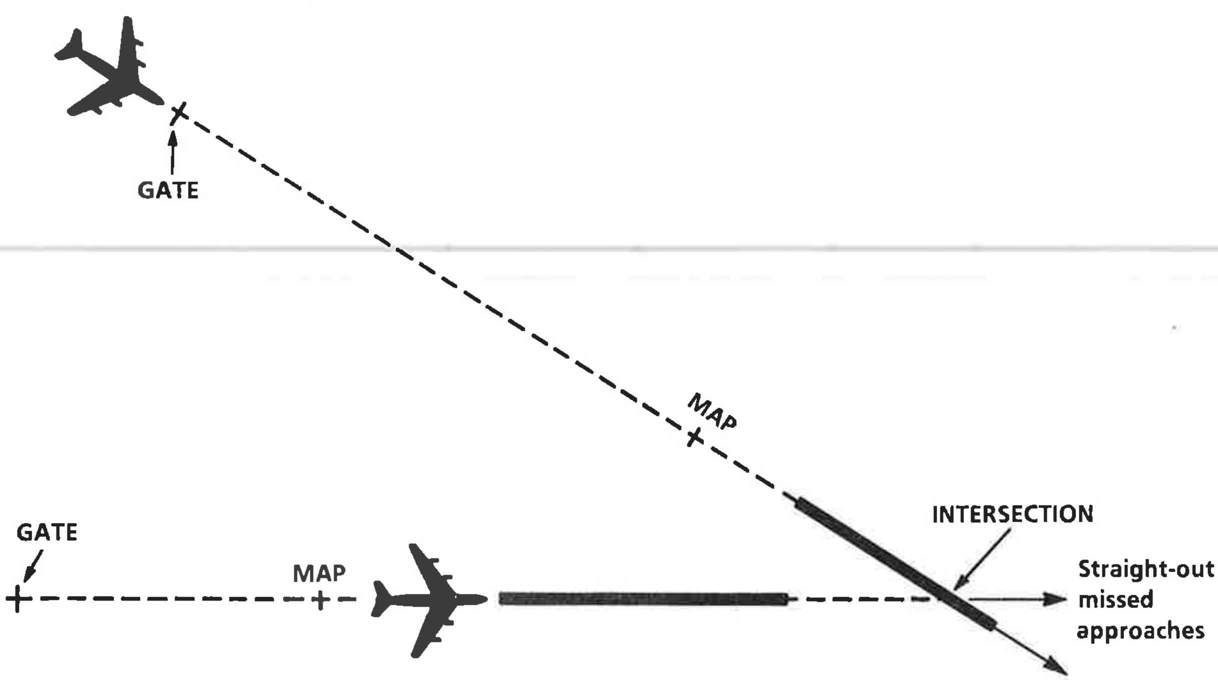


FIGURE 3-2. DEPENDENT (ALTERNATING) IFR APPROACHES TO CONVERGING RUNWAYS

Among the 50 major airports, are 18 candidates where dependent converging approaches may be possible. A program is underway to demonstrate this concept at Boston within the next two years. Figure 3-3 shows an example of how the concept would be applied at Boston.

Among the 50 major airports are 18 candidates where dependent converging approaches may be possible

Table 3-3 shows the estimated capacity increases at nine of these airports where implementation of this procedure can be most beneficial. Notice that the procedure will yield increases of about 20 percent in IFR capacity.

Dependent converging approach procedures will yield increases of about 20 percent in IFR capacity

TABLE 3-3. SAMPLE IFR CAPACITIES FOR DEPENDENT CONVERGING APPROACHES

Airport	Runway	Capacity (arrivals/hour)	
		Converging	Curr. Best
Nashville	2L,31	32.0	27.0
Boston	22L,27	38.0	26.0
Cleveland	5R,36	33.0	28.0
Wash. National	33,36	32.3	26.3
Denver	17L,26L	39.0	25.5[4]
Newark	4R,11	30.3	25.3
N.Y. La Guardia	4,31	31.5	26.5
San Francisco	1R,10L	30.2	25.2
St. Louis	24,30L	30.9	25.9

[4] Single runway when weather conditions do not permit dual independent approaches

3.3 IMPROVED INDEPENDENT PARALLEL IFR APPROACHES

Currently, the separation between parallel runways must be at least 4,300 feet for simultaneous independent IFR operations. The FAA is actively pursuing ways to improve 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. This may permit an increase of 10-15 operations per hour under IFR. The flexibility inherent to 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 aircraft on the other, and this causes a significant loss in capacity when the aircraft speeds are different.

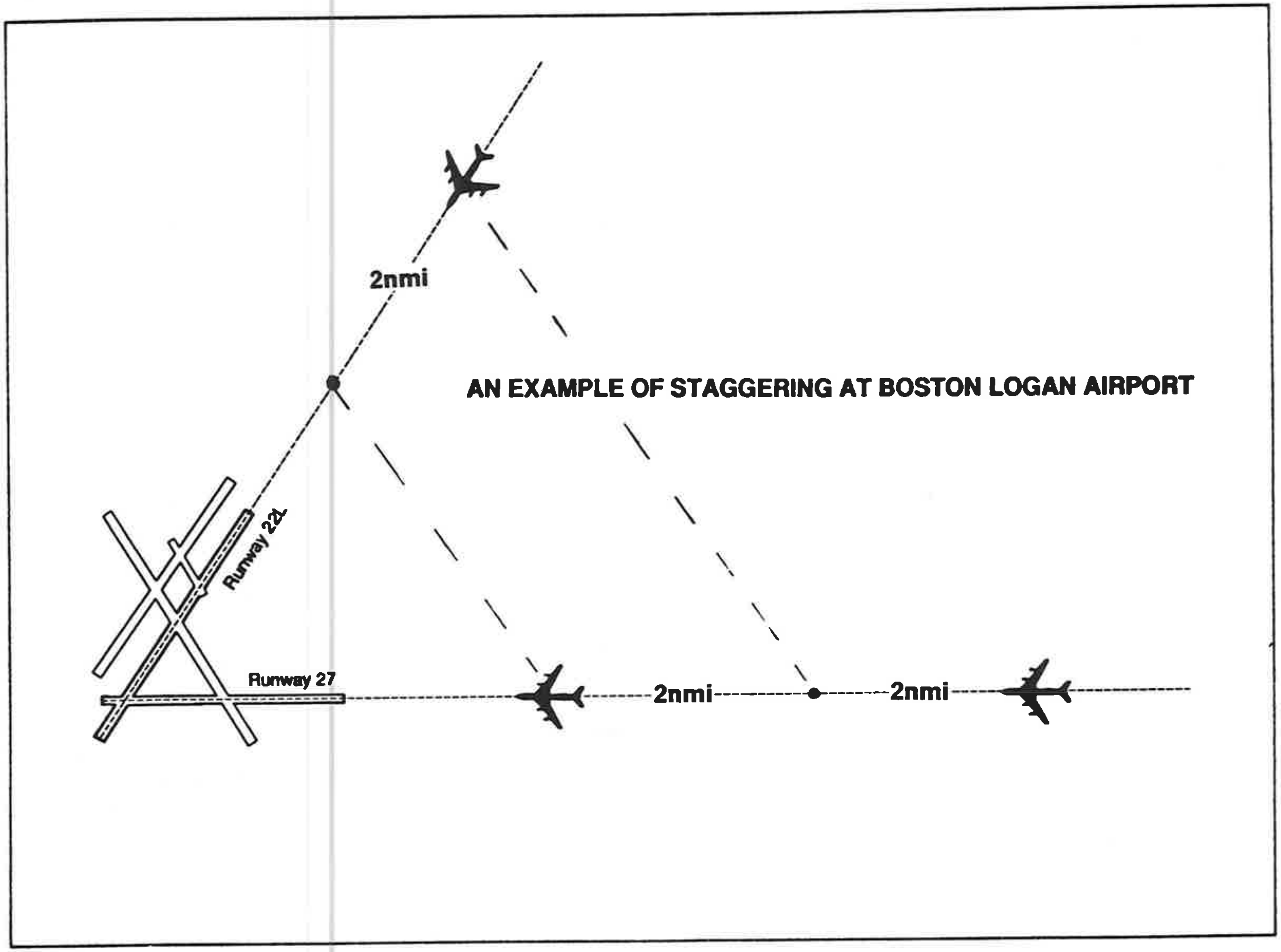


*FIGURE 3-3. CONCEPT OF STAGGERED APPROACHES TO CONVERGING RUNWAYS

The FAA is currently developing new surveillance systems that will permit such spacing reductions between parallel runways. During 1988, demonstrations will begin using two prototype quick-scan systems. One surveillance system, Mode S ATC Radar Beacon System - Monopulse Processing System (AMPS), will be tested at Memphis, while the other, a phased-array system, will be tested at Raleigh-Durham. Figure 3-4 shows the schedule for the development of these two systems.

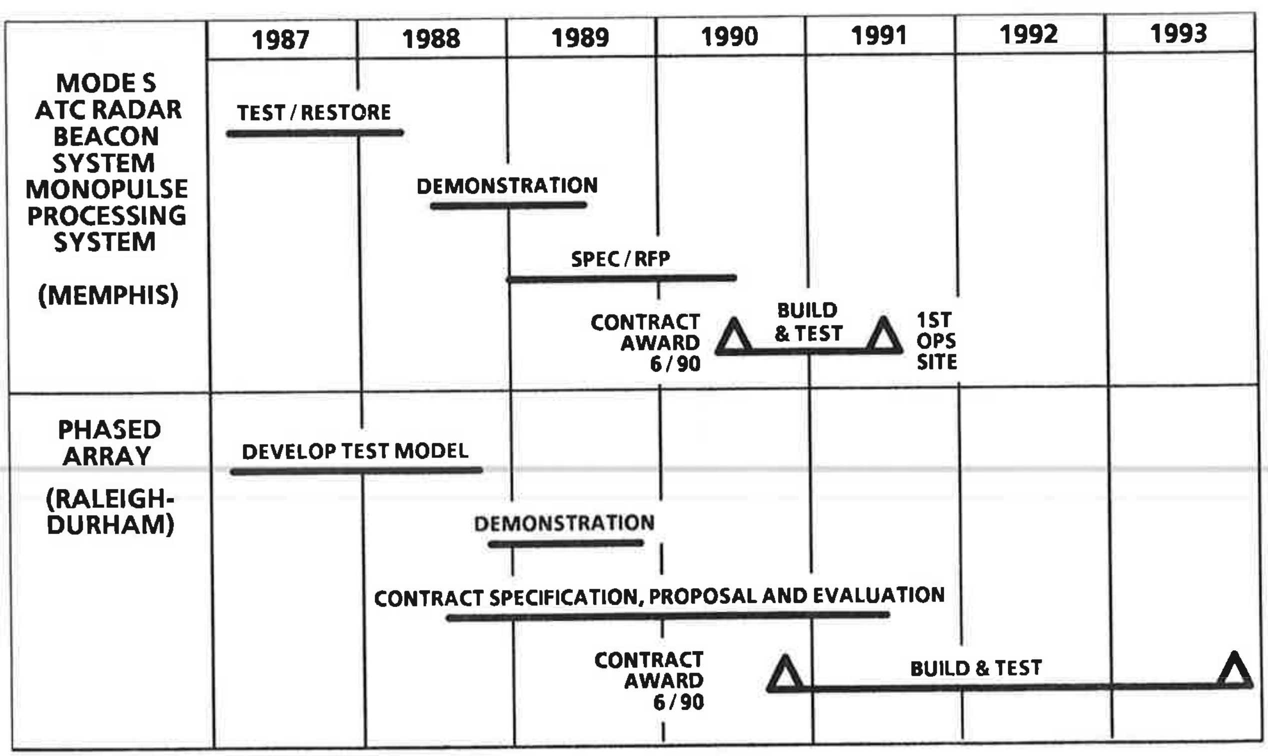


FIGURE 3-4. PARALLEL AND CONVERGING RUNWAY MONITOR PROJECT SCHEDULES

Ten of 50 major airports have parallel runways with spacing between 3,000 and 4,300 feet

Ten of 50 major airports have parallel runways with spacings between 3,000 and 4,300 feet. It is likely that all of these airports would implement independent IFR operations if the spacing standard were reduced to 3,000 feet. Estimated capacity increases at these airports are shown in Table 3-4.

TABLE 3-4. IFR CAPACITIES FOR INDEPENDENT IFR PARALLEL APPROACHES

Airport	Runway	Spacing	Capacity (arrivals/hour)	
			Parallel	Curr. Best
Baltimore[5]	10L,10R	3500′	52.0	37.0
Detroit	3C,3L	3800′	50.2	36.6[6]
Houston Intcontl.[5]	8L,8R	3500′	76.2[7]	50.8
Memphis	36L,36R	3400′	49.2	35.2
Minneapolis	11L,11R	3380′	49.2	35.5
N.Y. Kennedy	4L,4R	3000′	51.4	41.7
Portland	28L,28R	3100′	52.6	35.5
Phoenix	8L,8R	3400′	48.4	34.6
Raleigh-Durham	5L,5R	3500′	49.2	35.4
Salt Lake City	16L,16R	3500′	50.8	6.2

[5] Considers a new runway not yet built.

[6] Best current capacity for runways 3L and 3C. Capacity of runways 3L and 3R is 50.2 arrivals per hour.

[7] As part of triple IFR approaches.

3.4 DEPENDENT IFR APPROACHES TO PARALLEL RUNWAYS USING 1.5-NMI DIAGONAL SEPARATION

Existing rules require that the separation between parallel runways be at least 2,500 feet for dependent IFR operations with 2.0-nautical miles (nmi) 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; this 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 an improvement in the 2.0-nmi diagonal separation between aircraft. Recent studies show that this diagonal separation could be safely changed to 1.5-nmi. Figure 3-5 shows the elements of this concept. Improvements below 2,500 feet for runway separation will only be feasible when solutions to wake vortex hazards are developed. The FAA is currently developing test procedures for dependent parallel operations with 1.5-nmi diagonal separations and selecting sites for demonstrating these procedures.

Of the 50 major airports nine have existing parallel runways with spacings between runway pairs in the 2,500-4,300-foot range. Capacity increases are calculated in Table 3-5 where it is assumed that all of these airports would implement improved diagonal spacings under IFR.

Of the 50 major airports 9 have existing parallel runways with spacings between runway pairs in the 2,500 - 4,300 foot range

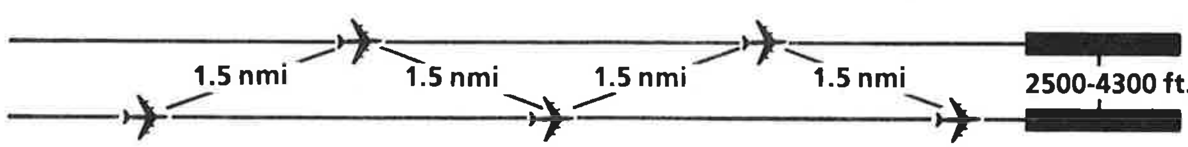


FIGURE 3-5. DEPENDENT PARALLEL APPROACHES WITH IMPROVED DIAGONAL SPACING

TABLE 3-5. IFR CAPACITIES FOR IMPROVED DEPENDENT IFR PARALLEL APPROACHES USING 1.5-NMI DIAGONAL SEPARATION

Airport	Runway	Spacing	Capacity (arrivals/hour)	
			Parallel[8]	Curr. Best
Columbus	10L,10R	2800′	40.3	34.8
Detroit	3C,3L	3800′	40.9	36.6
Memphis	36L,36R	3400′	40.3	35.2
Minneapolis	11L,11R	3380′	39.9	35.5
N.Y. Kennedy	4L,4R	3000′	45.4	41.7
Portland	28L,28R	3100′	40.4	35.5
Phoenix	8L,8R	3400′	39.9	34.6
Raleigh-Durham	5L,5R	3500′	40.5	35.4
Salt Lake City	16L,16R	3500′	41.2	36.2

[8] **Dependent parallels with 1.5-nmi diagonal separations.**

3.5 TRIPLE IFR APPROACHES

If triple operations were to be permitted in IFR, airports could achieve up to a 50 percent increase in capacity

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 with multiple departure 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 parallel runway or a favorably located converging runway may be used for a third arrival stream. If triple operations were to be permitted in IFR, airports could achieve up to a 50 percent increase in capacity. The airports listed all use triple arrival streams when possible (VFR), virtually eliminating arrival delays. Capacity increases are shown in Table 3-6.

As proposed in the Atlantic Task Force Report, triple approaches are currently being studied for application to the proposed new commuter runway complex at Atlanta.

TABLE 3-6. IFR CAPACITIES FOR TRIPLE APPROACHES

Airport	Runways	Capacity (arrivals/hour)	
		Triples	Current Best
Dallas-Ft. Worth	36L,35R,31R	79.5	53.0
Wash. Dulles	12,19R,19L	76.5	51.0
Chicago O'Hare	4R,9L,9R	81.0	54.0

3.6 SEPARATE SHORT IFR RUNWAYS

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. The multiple approach options covered in Chapter 3.1 - 3.5 can be applied to short runways, adding to an airport's IFR capacity for slower planes.

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. The benefits also have two components--an additional approach stream is added, doubling the arrival capacity, and aircraft are segregated by speeds, increasing the capacity of both new streams. In some cases, this can more than double the capacity. Ten airports that are potential candidates to use separate short runways are listed in Table 3-7.

TABLE 3-7. CANDIDATES FOR SEPARATE SHORT IFR RUNWAYS AMONG 50 MAJOR AIRPORTS

Albuquerque	New York La Guardia
Austin	Milwaukee
Baltimore	Ontario
Cincinnati	West Palm Peach
Indianapolis	San Antonio

3.7 IMPROVED IFR LONGITUDINAL SEPARATIONS

Air traffic control procedures include minimum longitudinal separation standards for aircraft in IFR approach streams. The separation distances vary from 2.5 to 6-nmi, 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. An improvement in the separation standard from 3.0 to 2.5 nautical miles between certain classes of aircraft has been recently approved for dry runway conditions and included in the FAA's terminal ATC procedures. While research work is going on to investigate properties of wake vortices that may permit reductions below 2.5-nmi, the solution to the wake vortex problem is not anticipated in the near- term.

Nineteen airports have either implemented improved in-trail separation or have requested authorization to do so

All airports will benefit from improvement of required longitudinal separations. Table 3-8 shows the list of 19 airports that have either implemented this procedure or have requested authorization to do so. Table 3-9 presents examples of capacity gains achieved with improved IFR longitudinal separations.

TABLE 3-8. AIRPORTS THAT HAVE IMPLEMENTED OR REQUESTED AUTHORIZATION FOR IFR APPROACHES WITH 2.5-NMI IN-TRAIL SEPARATIONS

Atlanta	New York Kennedy
Dallas - Ft. Worth	New York La Guardia
Nashville	Washington National
Charlotte	Newark
Tampa	Pittsburgh
Cincinnati	Norfolk
Los Angeles	Baltimore
Denver	Philadelphia
Boston	Washington Dulles
Orlando	

TABLE 3-9. SAMPLE IFR CAPACITIES WITH 2.5-NMI IN-TRAIL SEPARATIONS

Airport	2.5-nmi In-Trail	Current Best
Newark	26.9	25.3
Philadelphia	52.2	50.4
Dallas - Ft. Worth	53.2	53.0

3.8 TECHNOLOGICAL IMPROVEMENTS

The FAA Capacity Enhancement Program includes the development of a wide range of equipment and systems for terminal areas. These projects are cataloged in Appendix A. 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 the number of airports to which they apply. Some, such as Wind Shear Sensor Development and Mode S Data Link Applications Development, will apply at most airports, while others such as the quick-scan sensor system have their main impact at airports where there is the potential to use closely-spaced multiple approach streams.

The quick-scan sensor system will be demonstrated in 1988 (at Memphis and Raleigh-Durham), leading to the implementation of independent parallel IFR approaches at 3000-foot runway spacing, and of simultaneous IFR approaches to converging runways. Figure 3-6 depicts the system that will be demonstrated at Raleigh-Durham. New displays and visual aids, which will facilitate the implementation of procedures for dependent (alternating) approaches to converging runways, are also being developed.

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 threshold. One major near-term product of this program is a controller aid to permit dependent (alternating) approaches to non-parallel runways. These procedures will permit full IFR operations on two runways.

The FAA and NASA are working jointly on a proposal for the dynamic control of arrival aircraft. The concept is to automatically 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 time flight path. Aircraft would be provided with a 4-dimensional flight profile, including airspeed, route, time across a metering fix, and assigned altitude. This information would be provided to the controller and pilot. The aircraft's conformance with its profile would be monitored and adjustments made. On final approach, computer-aided fine-tuning maneuvers could be made to reduce the delivery error.

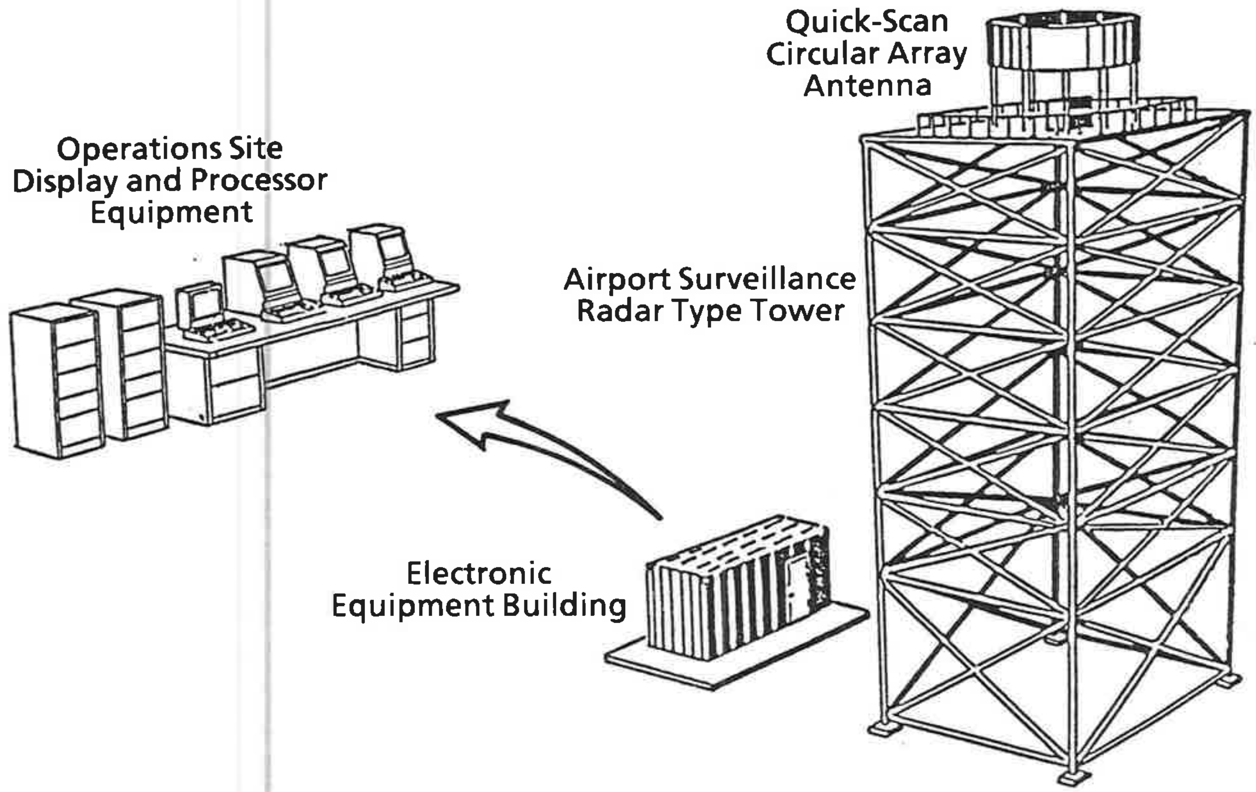


FIGURE 3-6. HIGH DATA RATE RUNWAY MONITOR SYSTEM

3.9 CAPACITY ENHANCEMENT PLANS FOR ROTORCRAFT AND TILTROTOR TECHNOLOGY

Rotorcraft and tiltrotor service, if allowed to operate at congested hub airports independently of fixed-wing traffic, could supplement or replace some of the service now offered by commuter carriers. The benefit of this is that these aircraft would operate from separate specialized landing pads/runways and in separate traffic patterns.

The Rotorcraft Master Plan issued in September 1987 describes special needs for the future of rotorcraft operation through the year 2000. The needs cited are:

1. Tiltrotor and helicopter feasibility studies building upon the experience gained in the recent study conducted by the Port Authority of New York and New Jersey (Port Authority) should be undertaken in other high-density markets;

2. Coordinated national government/industry policy encouraging research into civil applications of tiltrotor technology should be developed;

3. The National Airspace system should be enhanced to permit rotorcraft to employ their unique capabilities to the maximum extent, to provide for an adequate system of visual flight rules/instrument flight rules for heliports and vertiports, and to improve safety by upgrading criteria and applying advanced technology; and

4. Tiltrotor aircraft should receive certification including type, airworthiness, manufacturing and maintenance, facility and surveillance, and operations certification.

Two independently conducted studies, the joint FAA/NASA/DOD Civil Tiltrotor and Applications Study and the Port Authority VTOL Intercity Feasibility Study, have now been completed. They address the feasibility of tiltrotor technology in civilian configuration, primarily in scheduled airline service, although other kinds of service were also studied.

Both studies concluded that a civilian tiltrotor is feasible and, by operating out of urban vertiports with point-to-point service, can enhance capacity at major air carrier airports.

For example, the study conducted by the Port Authority estimated that from five to eight million passengers annually could use tilt-rotor service by the year 2000 in the Northeast Corridor, depending upon ticket costs, price sensitivity, and proximity of vertiports to the market centers.

In the year 2000, the New York/New Jersey Port Authority estimates there will be 120 million air travelers using their three major air carrier airports. The estimated VTOL market in the year 2000 is 5 to 8 million passengers

In the year 2000, the Port Authority estimates there will be 120 million air travelers using their three major air carrier airports in the New York/New Jersey Metropolitan Region. The estimated VTOL market in the year 2000 of 5 to 8 million passengers represents a potential diversion of 4.2 percent to 6.7 percent of the total passengers from these airports. When coupled with other initiatives, this percentage is significant from an airport capacity enhancement standpoint.

The National Plan of Integrated Airport Systems (NPIAS), issued in January 1988, projects the need for an increase to 65 heliports from the current total of seven at a cost of $84 million. Table J-1 in Appendix J lists the location and status of each of the 65 heliports. Figure 3-7 depicts the locations of the 65 heliports.

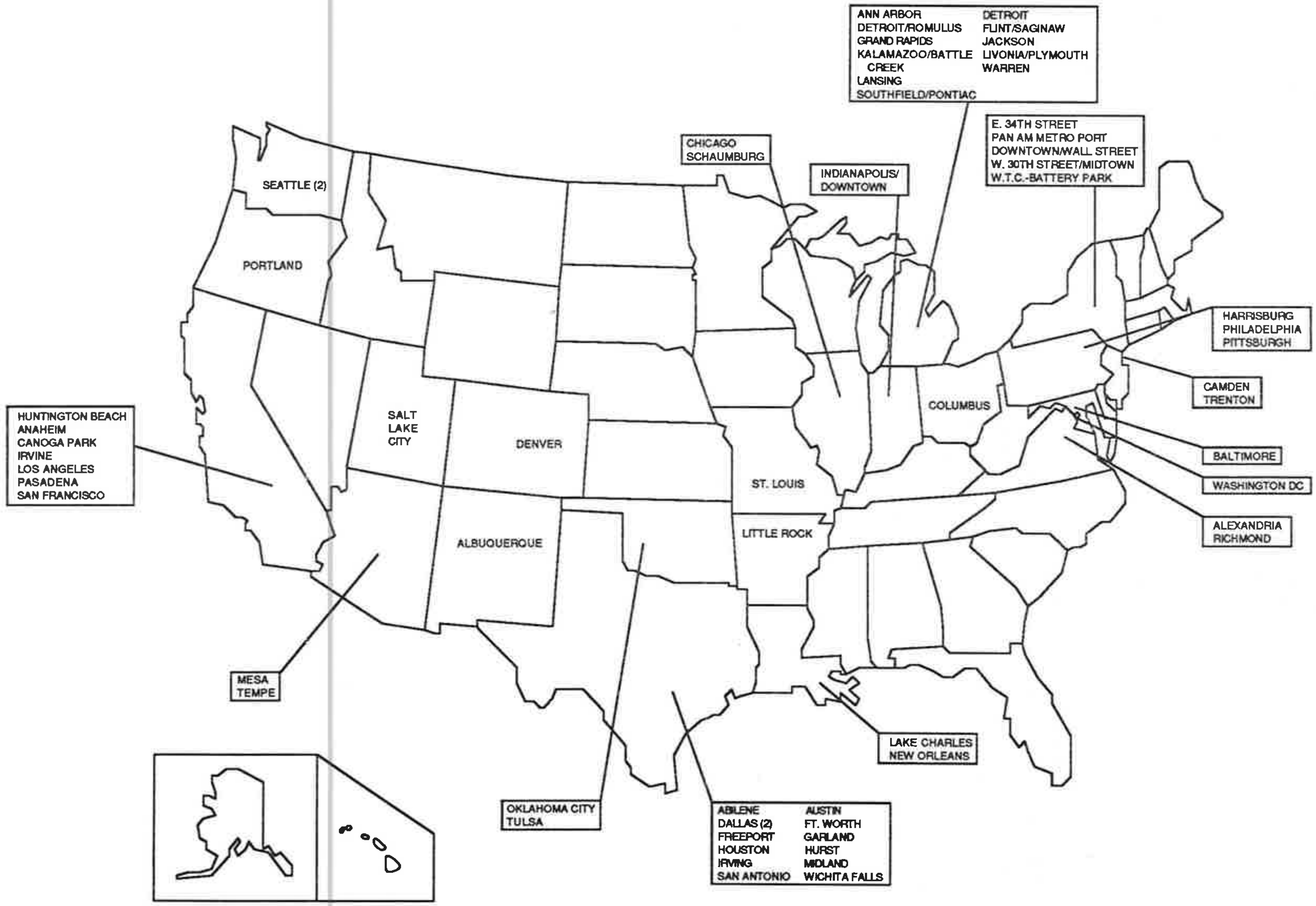


FIGURE 3-7. LOCATIONS OF 65 HELIPORTS IN 1986-1995 NATIONAL PLAN OF INTEGRATED AIRPORT SYSTEMS (NPIAS)

CHAPTER 4

AIRPORT CAPACITY PLANNING AND ANALYSIS

There is the potential for significant increases in capacity through the analysis of site-specific problems at individual airports. One site may have taxiway limitations causing congestion, another site may need new approach lighting to use a runway, and another may have airspace constraints because of nearby military operations. The FAA provides support for site-specific planning and analysis by developing analytical models, conducting large simulation studies at the FAA Technical Center, providing technical support to individual airport task forces, and making available comprehensive studies performed by consultants, research organizations, and universities.

4.1 AIRPORT CAPACITY ENHANCEMENT TASK FORCES

The FAA has a number of projects and programs that support capacity enhancement by employing analytical tools to quantify enhancement actions, thereby acting as a catalyst for their adoption. 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 of the airport sponsor and sponsor's master planning consultant, system users, industry groups, the airport control tower, the FAA regional and district offices, and the FAA Technical Center.

The Atlanta Task Force published its findings in 1987 which resulted in an action plan to achieve reductions in congestion

The Atlanta Hartsfield Task Force published its findings in 1987 resulting in an aggressive action plan to achieve reductions in congestion (see Appendix F). One of the major results was an initiative to plan and develop a new commuter runway complex south of the airport. If successful, this will provide separate access to the airport for the slower moving commuter aircraft, relieving congestion on the four major runways. The Task Force estimated that this would result in about 135,000 hours of annual delay savings in 1996. Other improvements recommended by the Atlanta Task Force are grouped in four categories:

- Airfield improvements: new concourses, hold pads, taxiways, and exits
- Facilities and equipment improvements: wake vortex avoidance and forecasting systems, NAVAIDS, terminal approach radar, lights, RVR, and ASDE
- Air traffic control operational improvements: improvements in arrival separations, and enhancement of traffic management procedures
- Airport user improvements: de-peaking of airline schedules within the hour

Annual delay savings for these improvements were estimated to range between 12,000 and 58,000 hours in 1996. Table F-1-2 shows these estimates in more detail.

The San Francisco Task Force also published its recommendations in 1987. Improvements for San Francisco International Airport were grouped into the same four categories used for Atlanta (see Appendix F):

- Airfield improvement: create holding areas, improve noise barriers, extend runways, construct a new runway, extend taxiways, and create a high speed exit
- Facilities and equipment improvements: install Microwave Landing Systems (MLS's)
- Air traffic control improvement: expand visual approach procedure, utilize an offset instrument approach, and use staggered IFR departures on close parallel runways
- User improvements: distribute traffic more evenly among the three San Francisco area airports, distribute traffic uniformly within the hour, and divert 50 percent of general aviation aircraft to reliever airports

The San Francisco Task Force also studied capacity improvements at Oakland and Sàn Jose International Airports.

For each improvement, both Task Forces--Atlanta and San Francisco--identified the type of action required, the time frame involved, and the responsible agency or group.

FAA is supporting eight task forces for airports at Miami, St. Louis, Detroit, Memphis, Boston, Phoenix, Salt Lake City, and Kansas City

Currently, FAA is supporting eight task forces for airports at Miami, St. Louis, Detroit, Memphis, Boston, Phoenix, Salt Lake City, and Kansas City. Each task force performs an in-depth study of an airport's current and anticipated capacity problems. It identifies the causes of delay and evaluates the delay reduction potential of options generally categorized as airport development items, air traffic control procedures, additional facilities and equipment, and user improvement. The result of this effort is an action plan that serves as a guide for improvements at the particular airport.

Ideally, the work of a task force should lead directly to implementation of improvements that otherwise might not have been considered. According to Atlanta's Task Force Action Plan, a large potential for capacity increase/delay reduction lie in developing a commuter/G. A. terminal and runway complex south of existing Runway 9R/27L. Subsequently, a working group of regional FAA experts was formed to evaluate means of implementing this improvement. To assist the working group in analyzing various runway configuration options, the ACPO is coordinating computer simulation support utilizing the resources of the MITRE Corporation and the FAA Technical Center. A modification of the quick-scan airport surveillance demonstration program at Raleigh-Durham is also planned incorporating potential triple IFR approaches at Atlanta.

4.2 ANALYTICAL MODELING AND SIMULATION

The FAA has developed and improved several computer based methods for analyzing airport capacity. All of these models are available for use by any airport planners or managers. The FAA's Airfield Capacity Model has been used extensively to provide the data for this report and as a basis for estimating the potential capacity gains from proposed research and development programs under consideration by FAA. The report summarized in Appendix B is an example of how the capacity model can provide insight into prioritizing development efforts.

Recently, the ACPO has encouraged the development and use of FAA's airspace and airport simulation model (SIMMOD) to study airspace problems around major terminal areas such as San Francisco and Boston. The SIMMOD model was used to assist in evaluating the FAA's East Coast and West Coast Plans for reorganizing the airspace.

The FAA is currently involved with the development of the Expanded East Coast Plan (EECP) which was begun in November 1987. The objective of this plan is to devise air traffic routings and procedures on the East Coast of the U. S. to make maximum use of airspace capacity, thus improving the efficiency of operations and reducing delay. SIMMOD is being used as a tool in identifying, evaluating, and analyzing potential plan options for the New England Region's portion of the EECP, in particular, Boston Center Air Traffic Operations. SIMMOD has already shown that the EECP will improve operations in the New England area. Boston Center Airspace Operations will be substantially more efficient with the proposed airspace routings and sectorization. Figure 4-1 shows an example of proposed improvements analyzed using SIMMOD. Preliminary results indicate aircraft flight time delay reductions will average 50 hours per day and (at $1,600 per hour) the savings in aircraft delay will exceed $80,000 per average day. The density of traffic in congested airspace sectors will be reduced under the new system, yielding reductions in controller workload and potential safety enhancements. Two of the busiest sectors in the current system will each experience more than a 40 percent reduction in average and peak traffic under the proposed system. Traffic will be more uniformly distributed than under the current system, with only five sectors having a peak aircraft count exceeding 15 aircraft under the proposed system compared to nine sectors under the current system.

Boston Center Airspace Operations aircraft flight time delay reductions will average 50 per day and the savings in aircraft delay will exceed $80,000 per average day

On the West Coast, SIMMOD has been applied to a study of terminal airspace procedures in the Los Angeles Basin. Work to study changes in the airspace between San Francisco and Los Angeles is continuing. In the Dallas Metroplex area, SIMMOD has been used to examine options for the redesign of the airspace and the interactions between the terminal and en route traffic flows.

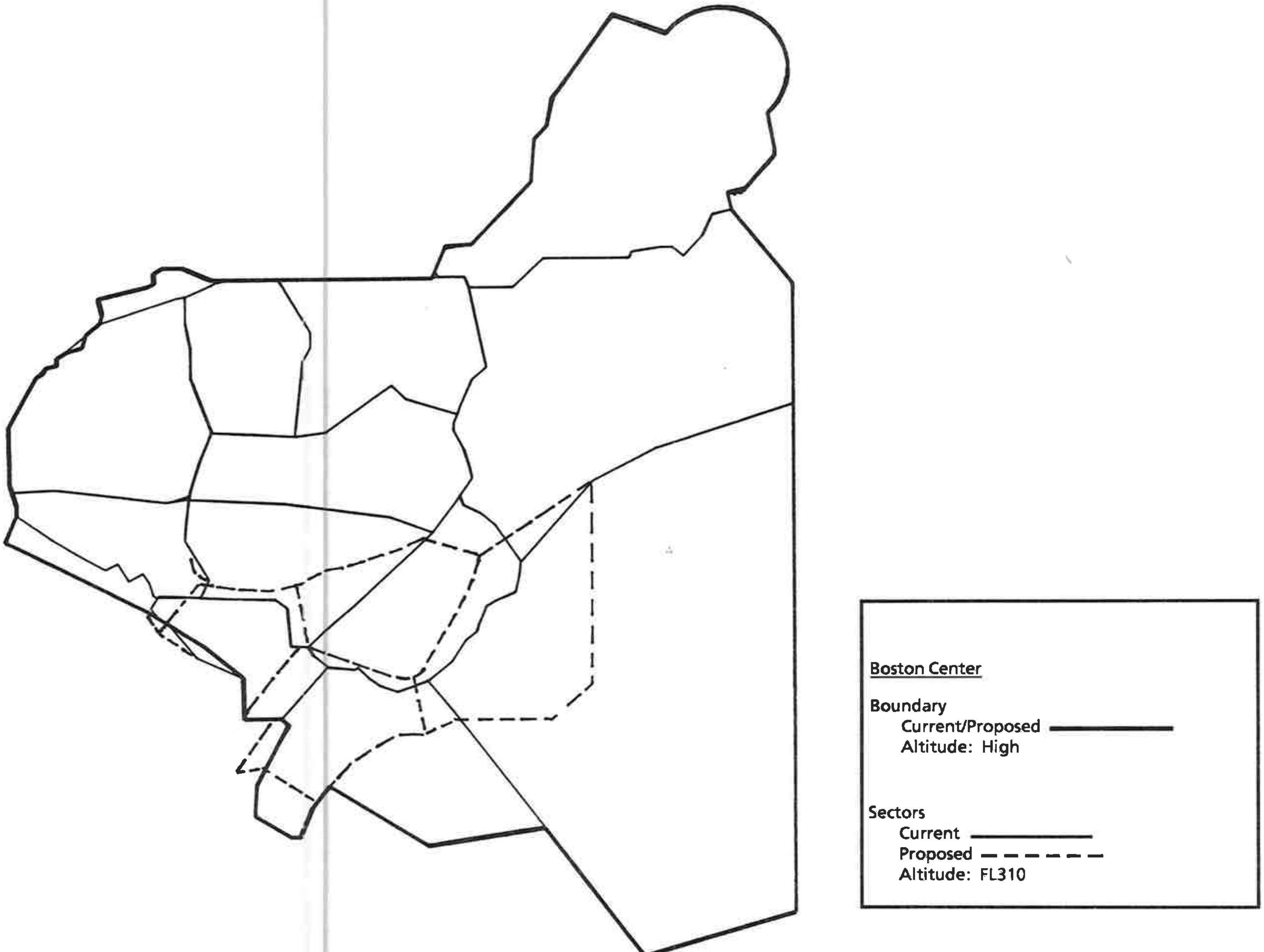


FIGURE 4-1. PROPOSED SECTOR CHANGES FOR THE BOSTON CENTER

The FAA has also undertaken the development of a long-term National Airspace System Performance Analysis Capability (NASPAC) that will apply the tools of operations research and computer modeling to the development, design, and management of the nation's airspace. This project will provide the FAA with a capability to address capacity problems in today's complex National Airspace System (NAS) and to objectively evaluate alternative solutions.

Two prototype models of NAS traffic flow and capacity are currently being developed as part of the NASPAC effort. The primary model is an event-driven simulation model that traces the progress of individual aircraft through a network of approximately 50 of the nation's busiest airports. This model will be capable of providing delay and utilization measures by time of day for individual airports, network segments, and the complete system, and also summary statistics for the entire network. The second model will use aggregated data (i.e., daily averages, non-aircraft-specific data) and will provide long-term delay and utilization statistics.

In addition to these models, the FAA Technical Center has facilities to simulate ATC operations at any airport. This capability has been used to conduct feasibility studies of new runway configurations, reduced spacing between parallel runway operation and other proposed changes in operations. Current efforts include studies of triple and quadruple arrival streams at Dallas (see Appendix C), improved diagonal spacing for dependent parallel operations and studies of independent parallel operations.

CHAPTER 5

CONCLUDING OBSERVATIONS

IMPACT '88 PLAN

In 1987, as part of an overall program of goals and objectives for 1988, the Administrator of the FAA, T. Allan McArtor, adopted the following "Impact '88" initiatives to exercise a leadership role in assisting state and local governments to build new airports and to expand and modernize existing airports:

- Target the areas of the country where the need for additional airport capacity is most critical over the next ten years.

- Implement a public education and public relations campaign, on several levels, designed to persuade and assist state and local governments and local business and community leaders to increase the capacity of the national system of airports, targeting areas of the country where there is a critical capacity need.

- Prioritize, according to the benefit to the national system, proposed capacity projects under the New Airport Capacity Development Program and the existing Airport Improvement Program, and fund each according to that priority list.

- Create a Future Airport Design Task Force to analyze the advanced civil aircraft technologies which will be available within the next 50 years and determine the design characteristics of future airports needed to accommodate those aircraft technologies.

- Complete development of a computer model which will enable planners to predict and demonstrate a network of airspace and airport capacity needs and assist planners in creating capacity-enhancing solutions for those needs.

- Establish Air Traffic Task Forces similar to the one which developed the Dallas-Fort Worth Metroplex Plan in other capacity-critical areas of the country so that airspace changes can be designed and implemented in parallel with airport capacity enhancements.

- Accelerate planning and development of relievers, vertiports, and the certification of tilt-rotorcraft.

- Establish a Federal Agency Roundtable of transportation and environmental agencies as well as the military services to deal with problems arising from airport development and airspace utilization.

Identification of the areas of the country where the need for additional airport capacity is most critical is included in this 1988 plan. Under the Airport and Airway Safety and Capacity Expansion Act of 1987, funding levels for Airport Improvement Program grants were authorized as follows:

FY	Authorization (Billion)
88	$1.7
89	1.7
90	1.7
91	1.8
92	1.8

Seventy-five percent of discretionary funds remaining after legislative minimums and entitlements carry-over is reserved for use at primary airports and their relievers for capacity, safety, security, and noise projects. The legislation requires the FAA to develop capacity project criteria based on a project's overall effect on national system capacity, its cost/benefit ratio, and the financial commitment of the sponsor.

The itemization for FY88 is as follows:

Total Program Level ($000)	1268.7
Primary Airports	571.2
Cargo	38.1
Alaska Supplemental	11.8
States	152.2
Subtotal	773.3
Noise	126.9
Relievers	126.9
Commercial Service	31.7
System Planning	6.3
Capacity/Safety/Noise	102.0
Carryover Entitlements	67.6
Remaining Discretionary	34.0
Subtotal Discretionary	495.4

The Airport and Airway Safety and Capacity Expansion Act of 1987 also provided for new airport capacity initiatives. The Act stated:

> "The conferees direct the FAA to undertake increased research and development activities directed toward technologically advancing the design, construction, safety, maintenance, and operation of airports. In this light, the conferees establish a minimum authorization of $25 million in 1988, 1989, and 1990 for airport capacity research and development programs. A report from the FAA on compliance with this provision is required after each fiscal year."

SUMMARY

Of the 32 airports forecast to exceed 20,000 hours of annual aircraft delay in 1996 in the absence of airport improvements, nine have new runways either under construction or included in approved airport layout plans

Of the remaining forecast delay-problem airports, eleven are prospective candidates for the quick-scan airport surveillance systems under development which can improve both parallel runway and converging runway capacity.

Of the forecast delay-problem airports, five have in excess of 25 percent general aviation operations and have one or more reliever airports with unused capacity. It is assumed that a natural diversion of general aviation operations will occur over time as the relatively uncrowded reliever airports become an attractive option.

Several forecast delay-problem airports do not have new runways planned, and have less than 25 percent general aviation operations. Likewise, anticipated technological improvements for capacity increases, such as the quick-scan airport surveillance systems, have limited application at some of the forecast delay-problem airports. Even so, it can be assumed that some market-based solutions to airport capacity delays may apply at airports where these other options are unavailable.

As forecast delay-problem airports become more congested, passengers may tend to make connecting flights through other airports, and airlines can be expected to expand service in ways that would accommodate this trend. This phenomenon may account for the relatively slow growth in operations of 1.7 percent at the "22 pacing" in 1987. See Table 5-1. This compares to a systemwide increase in operations of 3.6 percent.

Airlines may be expected to create additional "mini-hubs" as delays grow at traditional connecting hub airports. From past trends, airports require a stable existing traffic base, good geographical location, dual approach capability, and an expandable airport capacity to be selected by airlines as connecting hubs of the future. Dozens of existing airports with excess capacity exhibit these qualities.

Assuming that connecting passengers will tend toward less congested airports in the future, there may still be a problem of forecast delay-problem airports accommodating local passengers.

TABLE 5-1. A COMPARISON OF AIR TRAFFIC OPERATIONS BETWEEN 1986 AND 1987 AT 22 SELECTED AIRPORTS

AIRPORT	TOTAL OPERATIONS 1987	TOTAL OPERATIONS 1986	PERCENT CHANGE 1986-1987
Atlanta-Hartsfield	796,600	787,272	101
Boston-Logan	441,175	423,538	104
Chicago-O'Hare	791,695	794,921	100
Cleveland-Hopkins	219,954	231,610	95
Dallas/Ft. Worth	623,240	575,997	108
Denver-Stapleton	520,905	523,388	100
Detroit Metropolitan	403,428	413,750	98
Fort Lauderdale	224,206	222,460	101
Houston Intercntnl.	303,557	291,820	104
Kansas City Int'l.	204,675	208,184	98
Las Vegas-McCarran	383,759	364,548	105
Los Angeles Int'l.	665,515	577,907	115
Miami International	360,290	351,201	103
Minneapolis Int'l.	383,969	398,856	96
La Guardia	363,645	366,250	99
John F. Kennedy	317,769	320,188	99
Newark Int'l.	376,874	412,204	91
Greater Pittsburgh	375,062	366,440	102
Philadelphia Int'l.	419,091	378,728	111
St. Louis-Lambert	418,782	457,353	92
San Francisco Int'l.	462,175	433,865	107
Washington Nat'l.	325,052	325,356	100
TOTALS	9,381,418	9,225,836	101.7

Source: National Airspace Performance Reporting System.

In that light, many forecast delay-problem airports have alternate airports in the general area with excess capacity as discussed in Chapter 2.3 (see Figure 2-3).

Depending on population growth and direction and surface transportation, it could be assumed that some "local" passengers will be accommodated at the "alternate hub" airports.

The American flying and shipping public has expressed a demand for low fares. Low fares are made possible by the volume and consolidation that airline hubbing allows. There is, therefore, a trade-off between air fares and delay/congestion. Air fares must be considered when weighing the total quality of air service. Total fare savings to the flying and shipping public have been estimated to exceed $10 billion per year.[2]

THE FUTURE

The FAA will continue to participate in local initiatives to create new capacity through airport development projects. The FAA will continue to develop new systems and equipment to increase airport and airspace capacity. The FAA will continue to sponsor and co-sponsor new planning initiatives such as computer model applications and airport capacity task forces.

Historically, airport development is primarily dependent on local initiative. The creation of new connecting hub airports has been a marketing decision of individual airlines.

Local airport operator initiatives and airline initiatives must continue, in concert with FAA programs, to maximize airport capacity and the future quality of aviation services.

---

[2] Marvin Kosters, American Enterprise Institute, 3/19/86.

APPENDIX A. PROJECT DESCRIPTIONS OF CURRENT FAA CAPACITY IMPROVEMENT PROJECTS

APPENDIX A. PROJECT DESCRIPTIONS OF CURRENT FAA CAPACITY IMPROVEMENTS PROJECTS

This Appendix presents detailed descriptions of the capacity enhancement projects that currently make up the Airport Capacity Enhancement Program. 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, project identification data, and the telephone number of the responsible FAA office. To facilitate locating a particular project description, the projects are listed by title and project number in Table A-1.

TABLE A-1. LISTING OF AIRPORT CAPACITY ENHANCEMENT PROJECTS

No.	Project Title
AIRPORT CONSTRUCTION AND EXPANSION	
1.1	Airport Improvement Program (AIP)
1.2	Airport Design and Configuration Improvements
1.3	Enhanced All-Weather Ground Operations Capability
1.4	Pavement Strength, Durability, and Repair
AIRSPACE CONTROL PROCEDURES	
2.1	Independent IFR Approaches to Converging Runways
2.2	Dependent IFR Approaches to Converging Runways
2.3	Independent Parallel IFR Approaches
2.4	Dependent Parallel IFR Approaches
2.5	Triple IFR Approaches
2.6	IFR Approaches to Separate Short Runways
2.7	IFR Approaches with 2.5-nmi In-Trail Separation
ADDITIONAL EQUIPMENT AND SYSTEMS	
3.1	Instrument Landing System (ILS)
3.2	Weather Radar Program
3.3	Wind Shear Detection/Sensor Development (LLWAS)
3.4	Weather Sensor Implementation/Upgrade
3.5	Terminal Doppler Weather Radar
3.6	Wake Vortex Avoidance Forecasting
3.7	Advanced Traffic Management System
3.8	Terminal Radar Enhancements
3.9	Airport Surface Detection Equipment (ASDE-3)
3.10	Mode S Data Link Applications Development
3.11	MLS/ILS Based Surveillance Systems (MILSS)
3.12	Terminal ATC Automation
CAPACITY PLANNING STUDIES	
4.1	Airport Capacity Enhancement Task Forces
4.2	Airport Capacity and Delay Models
4.3	Environmental Programs

1. AIRPORT CONSTRUCTION AND EXPANSION

1.1 AIRPORT IMPROVEMENT PROGRAM (AIP)

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

The Airport Improvement Program (AIP) is one of four major programs supported by the Airport and Airway Trust Fund. Established in 1970 under the Airport and Airway Development Act, this fund is the mechanism for federal funding of airport and airway improvements.

The goal of the AIP 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, acquisition of land, and conduct of airport planning task forces. A new runway, for instance, can increase the capacity of an airport by as much as 100 percent.

The current AIP program is authorized by the Airport and Airway Improvement Act of 1982 as amended by the Airport and Airway Safety and Capacity Expansion Act of 1987. The act provides assistance for airport planning and development through funding from the Airport and Airway Trust Fund. The Act also authorizes funds for noise compatibility planning and for carrying out noise compatibility programs. The following amounts for the AIP have been authorized since 1982:

	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	$1,025.0 million
1988:	$1,700.0 million	$1,268.7 million

AIP funds are distributed in accordance with provisions contained in the 1987 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 3,700 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: Planning (APP-400) J. Mottley, 202-267-3451
Grants In Aid (APP-500) L. Johnson, 202-267-3831
Community and Environmental Needs (APP-600)
L. Pickard, 202-267-3263

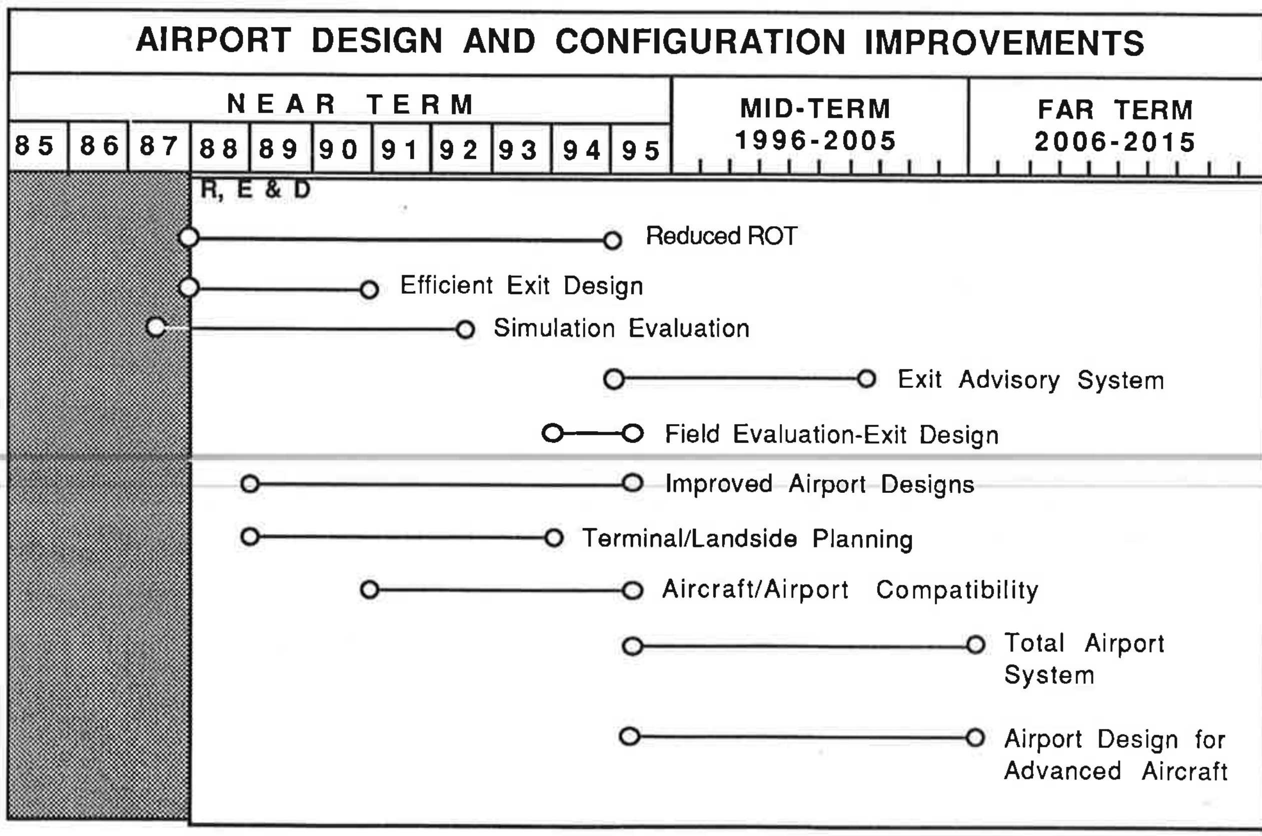
1.2 AIRPORT DESIGN AND CONFIGURATION IMPROVEMENTS

IMPACT ON AIRPORT CAPACITY: **INCREASE CAPACITY AND REDUCE DELAYS THROUGH IMPROVED AIRPORT AND TERMINAL DESIGNS AND CONFIGURATIONS, AND EFFICIENT GROUND MOVEMENT**

This project will investigate various concepts for improving airport efficiency, increasing capacity, and reducing delays to aircraft and passengers through improved airside and landside designs and configurations. Simulation techniques will be utilized to optimize runway exit locations and geometry. Concepts and designs will be related to runway occupancy times and exit speeds to assure compatibility with improved in-trail separation, other advances in air traffic control procedures, and airline equipment and passenger comfort considerations.

Improved guidelines for planning and estimating space requirements for high volume passenger terminal buildings will be developed to assist planners, engineers, and architects. Emphasis will be on terminals suitable for high-peak hubbing operations.

Mid-term and far-term projects will concentrate on airport system designs and analysis techniques that are consistent with future aircraft and aircraft control systems. In particular, new airport designs will accommodate advanced aircraft and the more highly automated systems that will permit aircraft to exit runways at higher speeds and provide guidance to terminal areas with reduced controller workloads and greater safety.



PROJECT MANAGER: H. Tomita (AES-310), 202-267-8697
RE&D PROJECT: 10.3
F&E PROJECT: None
SMART SHEET NO: 10020

1.3 ENHANCED ALL-WEATHER GROUND OPERATIONS CAPABILITY

IMPACT ON AIRPORT CAPACITY: **INCREASE CAPACITY BY ENHANCING SAFETY AND EFFICIENCY OF ALL-WEATHER GROUND OPERATIONS**

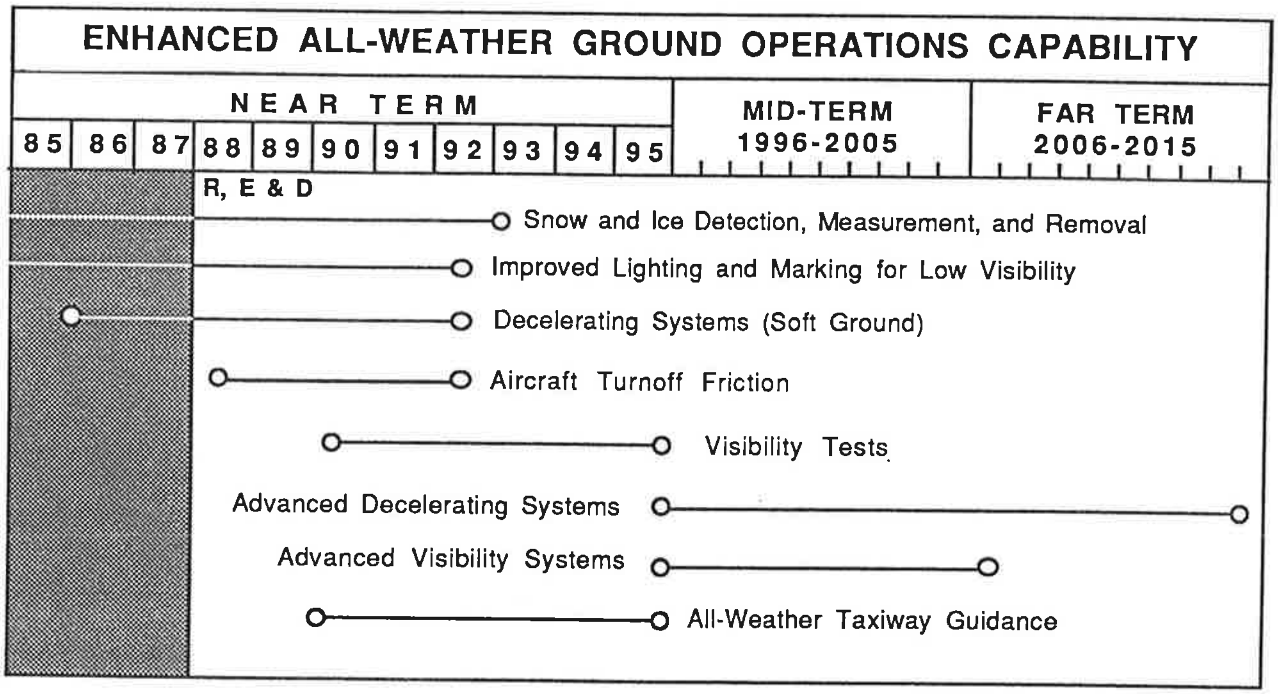
The goal of this project is to enhance all-weather ground operations capabilities by providing (1) improved daytime/nighttime visibility and guidance for use under low visibility conditions, (2) a system for all-weather ground movement guidance to aircraft and support vehicles in very low to zero visibilities, and (3) a ground performance advisory system to provide pilots with needed information on runway conditions during all-weather operations.

Improved lighting and visual aids will be developed for the landing environment down to restricted visibility conditions. These aids will include improved visual signs and markings, distance-to-go markers, and other advanced systems for guiding aircraft both ways between apron and runway. Lighting and visual aids unique to STOL and VTOL aircraft facilities will also be developed. New concepts for lighting and its energy sources, as well as self-contained systems requiring little or no maintenance, will be investigated.

Because taxiing of aircraft to the terminal after landing and back to the runway for takeoff is not always possible under low visibility conditions and movement of ground vehicles is hampered, a system is needed to accurately guide aircraft and ground vehicles during severely restricted visibility. After all-weather operational requirements are determined, alternative system concepts will be developed and assessed. Prototype equipment will be developed and tested and performance specifications will be written. The final product of this activity will be the functional description of an airport surface guidance system that will be a component of the Airport Surface Traffic Automation (ASTA) concept.

Fundamental studies on ground friction will be conducted to provide inputs to the exit advisory system to be developed under Project 1.2. These studies will address the effects on aircraft braking and lateral forces of tire parameters, pavement characteristics, runway profiles, and drainage in an effort to set their limits for high-speed runway exit designs. New sensors for detecting and measuring the thicknesses of water, slush, snow, and ice on runways, as well as improved methods of removing these substances, will be developed. A method for predicting aircraft braking and takeoff performance under adverse weather conditions, as well as for informing pilots of potential hazards, will also be developed.

The products produced by this project will include research reports and design criteria, computer programs and user guides, specifications and procedures manuals, a technical basis for Federal Aviation Regulations Part 139 rule making, and lighting standards for airports.



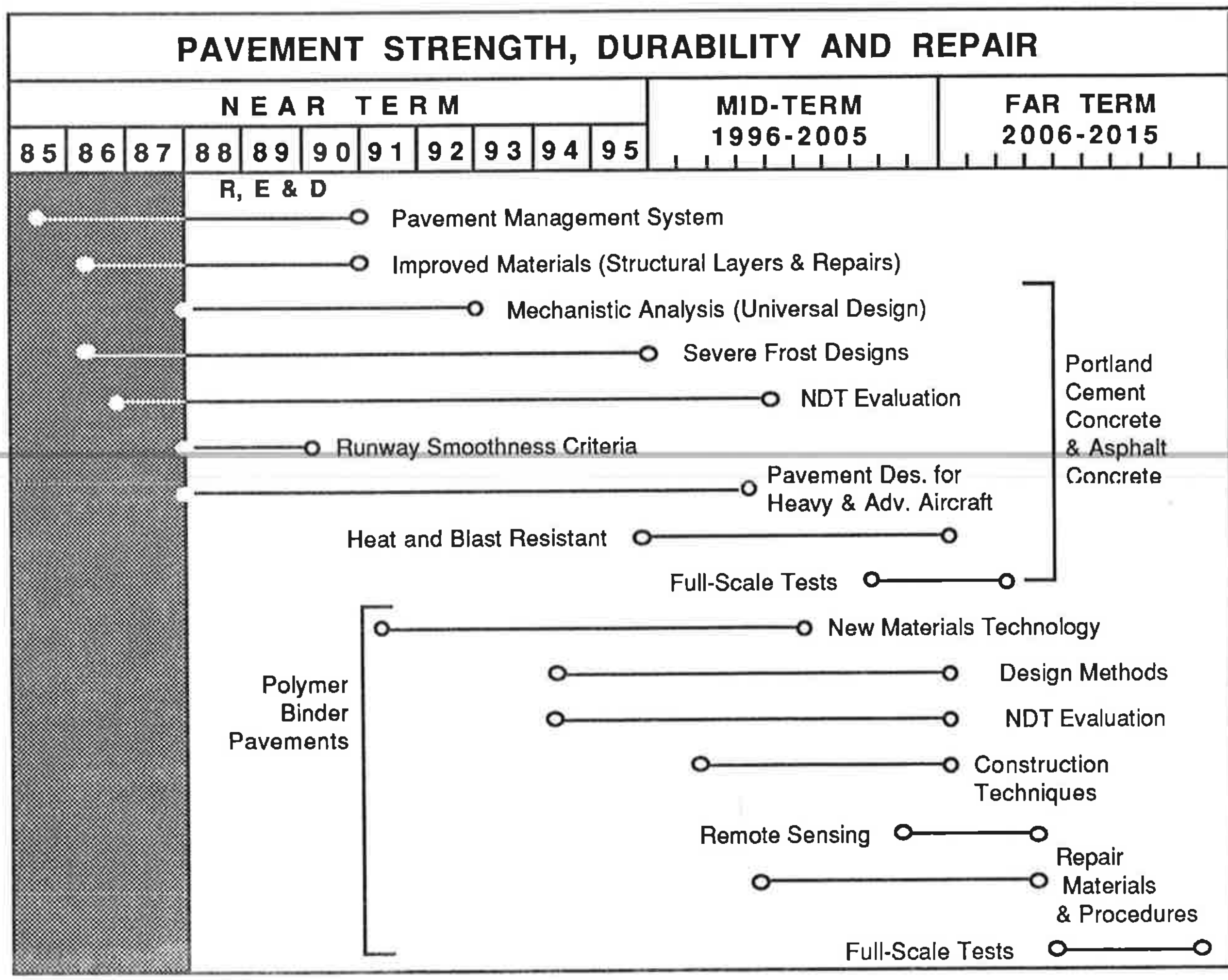
PROJECT MANAGER: H. Tomita (AES-310), 202-267-8697
RE&D PROJECT: 10.2
F&E PROJECT: None
SMART SHEET NO: 10030
10042
10046

1.4 PAVEMENT STRENGTH, DURABILITY, AND REPAIR

IMPACT ON AIRPORT CAPACITY: **INCREASE CAPACITY BY DEVELOPING MORE DURABLE AIRPORT PAVEMENT MATERIALS THAT REDUCE REQUIREMENTS FOR REPAIR**

This project will develop new cost-effective techniques and methods to enhance the strength and durability of materials used as airport pavement components. In parallel with the development of better pavement materials, improved analytical techniques for pavement design and evaluation will be formulated. Design methods for pavements in cold regions will be developed that minimize the effects of frost heave and thaw weakening. Pavement designs based on these new analytical techniques will be compared to the conventional designs, and the most promising technique will be used to design the test sections discussed above. In addition to improving current methods of nondestructive structural testing, evaluation, and rehabilitation, this project will develop remote sensing techniques for inspecting pavement and detecting defects. Pavements require periodic repair to maintain an acceptable level of performance. Repair procedures will be developed for new pavement materials, including pavements for cold regions. Adhesion of repair materials will be improved and faster- curing repair materials will be developed to provide longer-lasting repair. The use of improved pavement coatings, sealants, and man-made fabrics in pavement repair will be explored. A pavement management system will be developed to provide an efficient and economical program of pavement maintenance and rehabilitation.

The products of this project include; technical reports and procedures manuals, computer programs and user guides, test methods and nondestructive testing (NDT) equipment, and guidelines and criteria for pavement design, construction, and maintenance.



PROJECT MANAGER:	H. Tomita, AES-310 (202) 267-8697
RE&D PROJECT:	10.1
F&E PROJECT:	None
SMART SHEET NO:	10010

2. AIRSPACE CONTROL PROCEDURES

2.1 INDEPENDENT IFR APPROACHES TO CONVERGING RUNWAYS

IMPACT ON AIRPORT CAPACITY: **INCREASE CAPACITY BY ALLOWING INDEPENDENT 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 been able to conduct these approaches in IFR weather, but only through the application of visual separation. To increase IFR capacity, modified and improved surveillance data are needed that will permit these operations with lower weather minimums that do not rely on visual separation techniques.

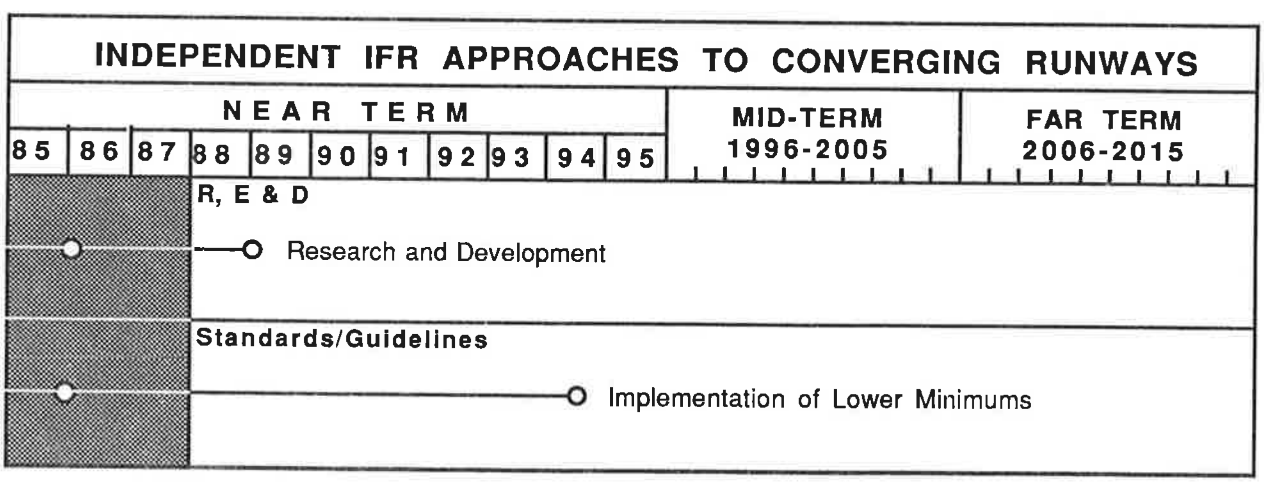
The goal of this project is to increase the number of airports and runways that are able to use independent procedures. If successful, independent converging approach operations may be implemented at more than 30 of the busiest airports. This will significantly improve capacity at these airports during IFR weather conditions.

Denver-Stapleton and Philadelphia Airports have implemented Simultaneous Converging Instrument Approaches in accordance with FAA Order 7110.98. This order describes the "TERPS + 3" criteria used to provide separation between aircraft to the missed approach point and then visual separation is provided to the runway. Methods for reducing or eliminating the visual separation requirement will be evaluated upon continued successful application of these procedures. Dallas-Ft. Worth is also developing procedures for simultaneous converging instrument approaches.

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



PROJECT MANAGER: R. Gausman (ATO-320), 202-267-9339
RE&D PROJECT: 3.7
F&E PROJECT: None
SMART SHEET NO. None

REMARKS/NOTES: Tests are scheduled at Memphis and Raleigh-Durham Airports in 1988 to evaluate the use of precision beacon radar systems for simultaneous independent approaches to parallel runways separated by less than 4,300 feet. Subsequent test phases are scheduled to evaluate the suitability of utilizing these radar systems for monitoring approaches to converging runways.

2.2 DEPENDENT IFR APPROACHES TO CONVERGING RUNWAYS

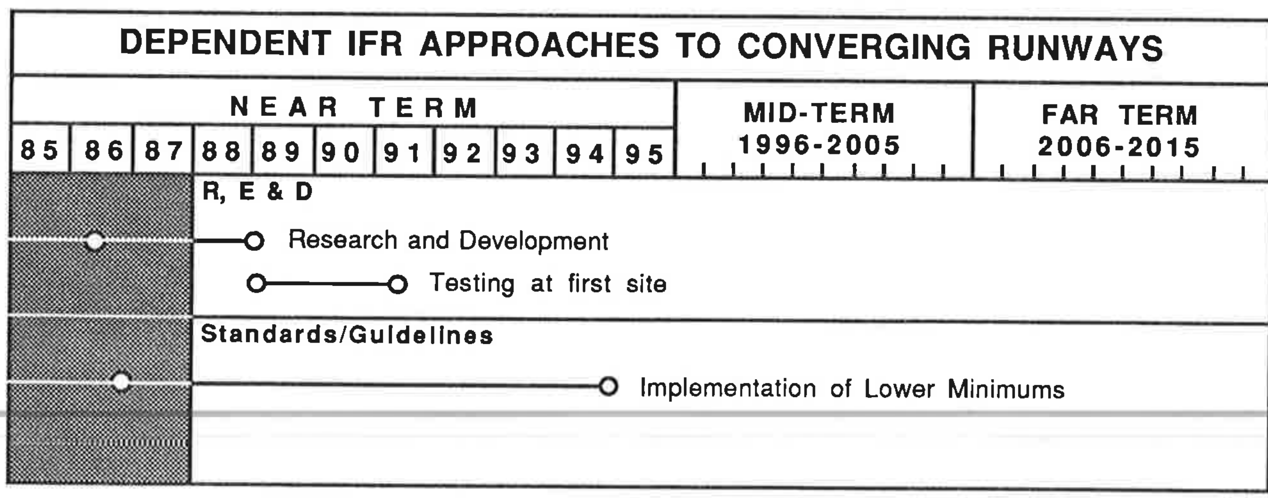
IMPACT ON AIRPORT CAPACITY: **INCREASE CAPACITY BY ALLOWING DEPENDENT CONVERGING APPROACHES THAT DO NOT RELY ON VISUAL SEPARATION TECHNIQUES AND CAN BE USED DURING PERIODS OF LOWER CEILINGS AND VISIBILITY**

The goal of this project is to reduce the relatively high approach minima required by existing independent converging instrument approach procedures. The high minima are caused by the requirement that the missed approach Terminal Instrument Procedures (TERPS) obstacle clearance surfaces do not overlap and that missed approach points be separated by at least 3 miles (TERPS + 3 criteria). By developing and implementing procedures that eliminate the risk of simultaneous missed approaches, minima can be reduced. The concept is to prevent simultaneous missed approaches by enforcing a minimum time of separation between alternating arrivals to the two runways.

Several concepts are being considered to ensure minimum separation between aircraft conducting IFR approaches on converging runways. Aircraft may be separated by means of a time-stagger that takes into account aircraft speeds and lengths of runways. Aircraft may also be separated by a distance-stagger that considers only runway geometry and TERPS surfaces.

Initial investigations indicate that dependent approaches to converging runways can achieve Category I ILS minima. Total IFR arrival capacity will be greater than that for a single runway but less than that attainable under independent converging approaches.

A demonstration of the new procedure is planned for 1988-89.



PROJECT MANAGER: R. Gausman (ATO-320), 202-267-9339
RE&D PROJECT: 3.7
F&E PROJECT: None
SMART SHEET NO. None

2.3 INDEPENDENT PARALLEL IFR APPROACHES

IMPACT ON AIRPORT CAPACITY: **INCREASE CAPACITY BY INCREASING NUMBER OF AIRPORTS QUALIFYING FOR INDEPENDENT PARALLEL APPROACHES DURING INSTRUMENT WEATHER CONDITIONS**

The goal of this project is to develop monitoring equipment and ATC procedures that will enable independent streams of aircraft to land on parallel runways separated by 3000 to 4300 feet during instrument weather conditions.

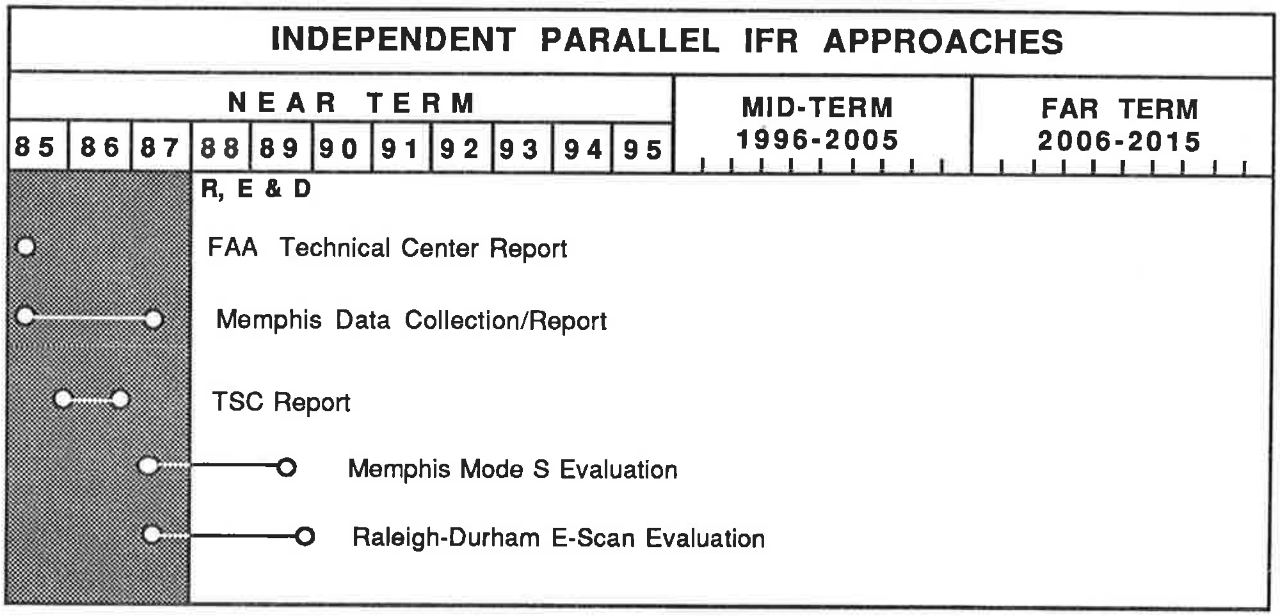
Independent parallel approaches have been successfully used since 1963. The original requirement that runways be separated 5000 feet was reduced to 4300 feet in 1974. A further reduction to 3000 feet, subject to specific conditions, has been recommended by the Industry Task Force on Airport Capacity Improvement and Delay Reduction. The reduction to 3000 feet at qualifying airports would significantly reduce the delays by enabling simultaneous independent closely-spaced parallel operations during instrument weather conditions.

A previous study suggested that independent operation of parallel runways separated by at least 3400 feet can be safely conducted where a sensor with a 2- milliradian (mrad) azimuth precision and a 2-second update rate is used to detect blunders. The study also indicated that a sensor providing a 1-mrad/1- second update capability is required for 3000-foot parallel runway separations.

A simulation of the proposed reduced runway separation was completed at the FAA Technical Center in 1984. A real-time data collection effort using a precision approach radar was conducted at Memphis during 1985 and 1986. A study was performed by the Transportation Systems Center in 1986 to determine the optimum sensor to demonstrate the capability to monitor aircraft on closely spaced parallels. Two systems were selected for evaluation. A Mode S-Sensor (Low Data Rate) with back-to-back antennas will be installed at Memphis. An ATCRBS based system (High Data Rate) with an electronically scanned antenna and using TCAS blunder logic will be evaluated at Raleigh-Durham where the faster update rate will be required.

MILESTONE SCHEDULE:

	Scheduled Completion	Revised Scheduled Completion	Actual Completion
FAA Technical Center Report	10/84		
Memphis Data Collection Report	2/87		
TSC Sensor Options Report	12/86		
Memphis Mode S Evaluation		6/89	
Raleigh-Durham Evaluation		11/89	



PROJECT MANAGER: D. Hodgkins (APS-303), 202-264-8411
RE&D PROJECT: 6.3
F&E PROJECT: None
SMART SHEET NO. None

2.4 DEPENDENT PARALLEL IFR APPROACHES

IMPACT ON AIRPORT CAPACITY:	**INCREASE CAPACITY AT QUALIFYING AIRPORTS BY ALLOWING DEPENDENT PARALLEL IFR APPROACHES USING 1.5-NMI DIAGONAL SEPARATION**

The goal of this project is to permit IFR approaches to be conducted on parallel runways separated by 2500 feet or more with improved diagonal separation. Currently, parallel, instrument landing system-equipped runways separated by a minimum of 2500 feet can conduct approaches provided that a minimum diagonal separation of 2 miles is maintained between aircraft on adjacent approach paths. Recent studies by FAA and the aviation industry have shown that this diagonal can safely be changed to 1.5 miles with a significant increase in IFR capacity. An effort is underway to simulate these procedures using the facilities at the FAA Technical Center in Atlantic City, New Jersey.

A demonstration of the new procedure is planned for 1988-1990.

PROJECT MANAGER:	R. Gausman (ATO-320), 202-267-9339
RE&D PROJECT:	3.7
F&E PROJECT:	None
SMART SHEET NO.	None

2.5 TRIPLE IFR APPROACHES

IMPACT ON AIRPORT CAPACITY: **INCREASE CAPACITY BY ENABLING TRIPLE ARRIVAL STREAMS DURING INSTRUMENT WEATHER CONDITIONS**

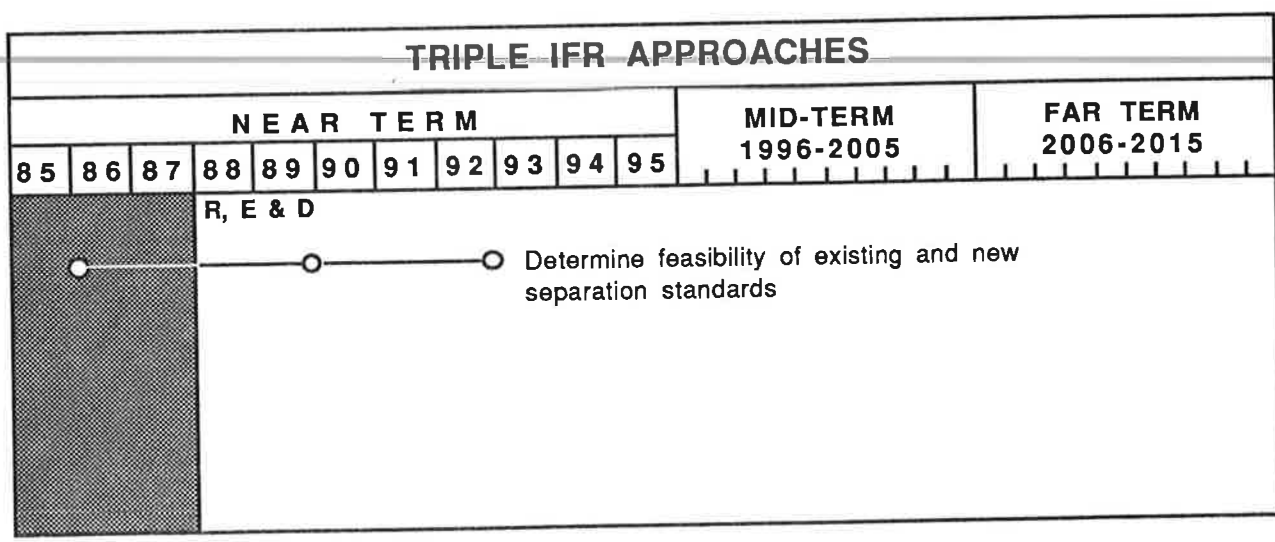
Currently, triple approaches are used at some airports when visibility conditions are at least three miles. The goal of this project is to develop IFR procedures that will permit triple arrival streams during periods of reduced visibility. This effort will involve an investigation of surveillance and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

The principal benefit from triple approaches will be obtained using separate short runways. This will permit separate access for smaller, slower aircraft 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.

A simulation of IFR triple approaches is planned at the FAA Technical Center in 1988.

MILESTONE SCHEDULE:

	Scheduled Completion	Revised Scheduled Completion	Actual Completion
Requirement for Instrument Approaches to Triple Parallel Runways			7/81
Determine Feasibility of Triple Approach Procedures - Existing Separation Standards	1988		
Determine Feasibility of Triple Approach Procedures - New Separation Standards	Not Scheduled		



PROJECT MANAGER:	R. Gausman (ATO-320), 202-267-9339
RE&D PROJECT:	3.7
F&E PROJECT:	None
SMART SHEET NO:	None

2.6 IFR APPROACHES TO SEPARATE SHORT RUNWAYS

IMPACT ON AIRPORT CAPACITY:	**INCREASE CAPACITY BY ALLOWING SLOWER AIRCRAFT TO USE IFR APPROACHES TO SHORT RUNWAYS IN CONJUNCTION WITH SIMULTANEOUS IFR APPROACHES TO LONG RUNWAYS**

The goal of this project is to evaluate the potential for multiple IFR approaches to airports that include instrumented, short runways and to implement these procedures where there is a benefit.

Airports sometimes have runways that are suitable for use by smaller, slower aircraft but too short for regular use by faster jets. These runways are used under VFR but not IFR because of restrictions placed on multiple approach operations when visibility is limited. The multiple approach options covered in Projects 2.1 through 2.5 can be applied to short runways, adding to an airport's IFR capacity for smaller, slower planes. Generally the benefits of this approach will be evaluated as part of the relevant multiple approach concept covered in Projects 2.1 through 2.5. Potential benefits from use of short runways will be evaluated in this project.

PROJECT MANAGER:	R. Gausman (ATO-320), 202-267-9339
RE&D PROJECT:	3.7
F&E PROJECT:	None
SMART SHEET NO:	None

2.7 IFR APPROACHES WITH 2.5-NMI IN-TRAIL SEPARATION

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

The capacity of a single runway is constrained during instrument operations by longitudinal separation standards which define required separation between successive aircraft on approach. The current separation standard between large aircraft is three nautical miles.

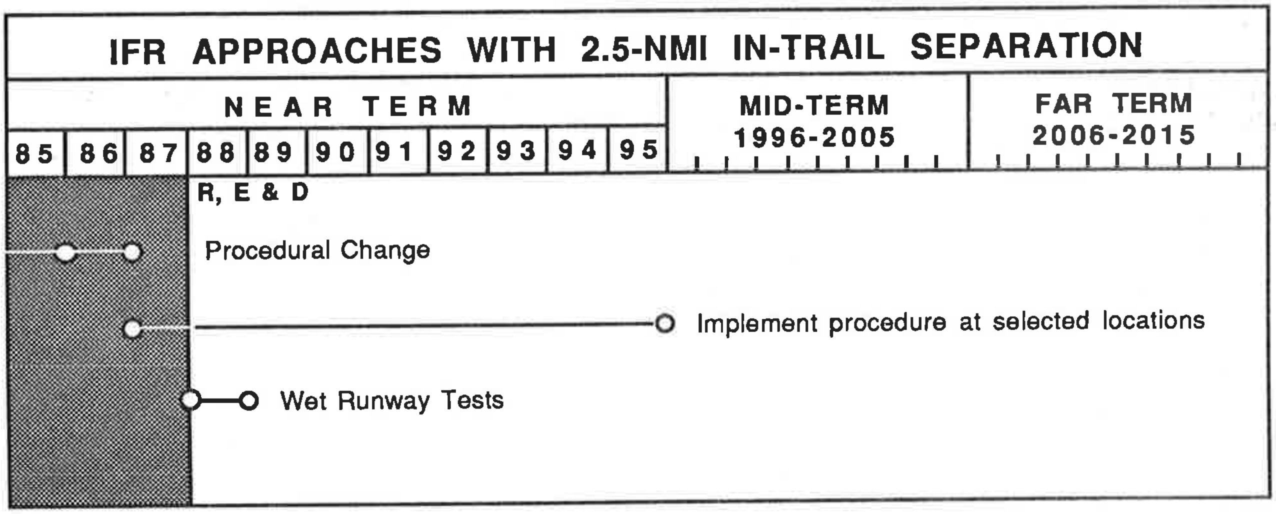
According to the Air Traffic Controllers Handbook, the minimum separation may be changed to 2.5 miles after the trailing aircraft has passed the final approach fix. Presently, heavy aircraft and the B-757 are excluded and runways must be clear and dry. At the end of 1987, 19 locations have implemented this procedure and six additional locations are considering it. Comments from ATC facilities indicate that the procedure works well.

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 for this improvement, its current runway occupancy times are required to average 50 seconds or less.

Next, FAA will evaluate extending the procedure to wet runways. Dallas-Ft. Worth and Atlanta have tentatively been selected as test locations. Before proceeding, wet runway occupancy time data must be collected and the average time determined to be 50 seconds or less. Weather minima for the wet runway demonstration will be 500 foot ceiling and two miles visibility.

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
Implement Procedure at Selected Locations	1987		1987
Wet Runway Test Plan	1988		1987



PROJECT MANAGER: R. Gausman (ATO-320), 202-267-9339
RE&D PROJECT: None
F&E PROJECT: None
SMART SHEET NO: None

3. ADDITIONAL EQUIPMENT AND SYSTEMS

3.1 INSTRUMENT LANDING SYSTEM (ILS)

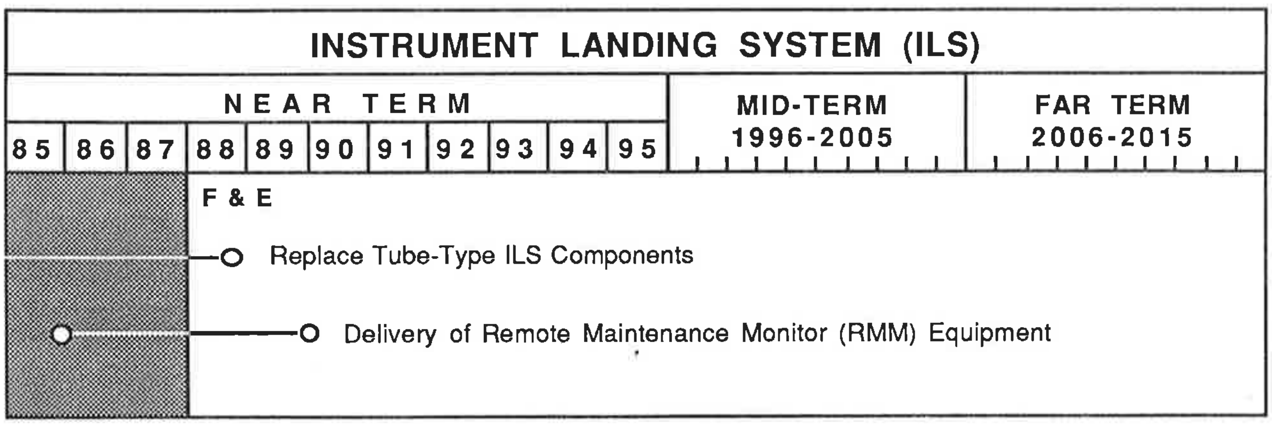
IMPACT ON AIRPORT CAPACITY: **PREVENT ANY LOSSES IN IFR CAPACITY DURING THE TRANSITION FROM ILS TO MLS**

The Instrument Landing System (ILS) has been the backbone of instrument landing operations for more than 30 years. During the transition from the ILS to the new microwave landing system (MLS), 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, which results in greater reliability.

MILESTONE SCHEDULE:

	Scheduled Completion	Revised Scheduled Completion	Actual Completion
ILS - Replace Tube-Type	10/88		12/87
ILS Remote Maintenance Monitor Equipment (RMM)	10/88	4/89	



PROJECT MANAGER: Frank Roepcke (APS-440), 202-267-8518
RE&D PROJECT: None
F&E PROJECT: Ground-Air 6
SMART SHEET NO: 24060

3.2 WEATHER RADAR PROGRAM

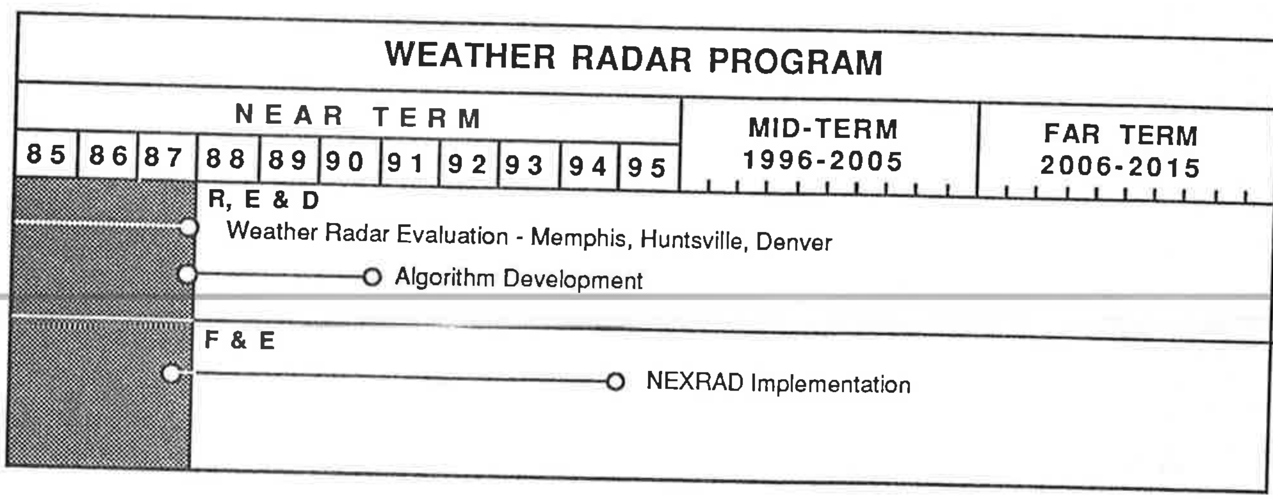
IMPACT ON AIRPORT CAPACITY: **REDUCE WEATHER-RELATED DELAYS THROUGH USE OF MORE EFFICIENT ROUTES MADE POSSIBLE BY IMPROVED WEATHER RADARS**

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. This includes furnishing 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 may be able to reduce weather- related delay while also enhancing safety.

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.

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			



PROJECT MANAGER: Don Johnson (APS-310), 202-267-8573
RE&D PROJECT: 7.1
F&E PROJECT: Ground-Air 16
SMART SHEET NO: 24160

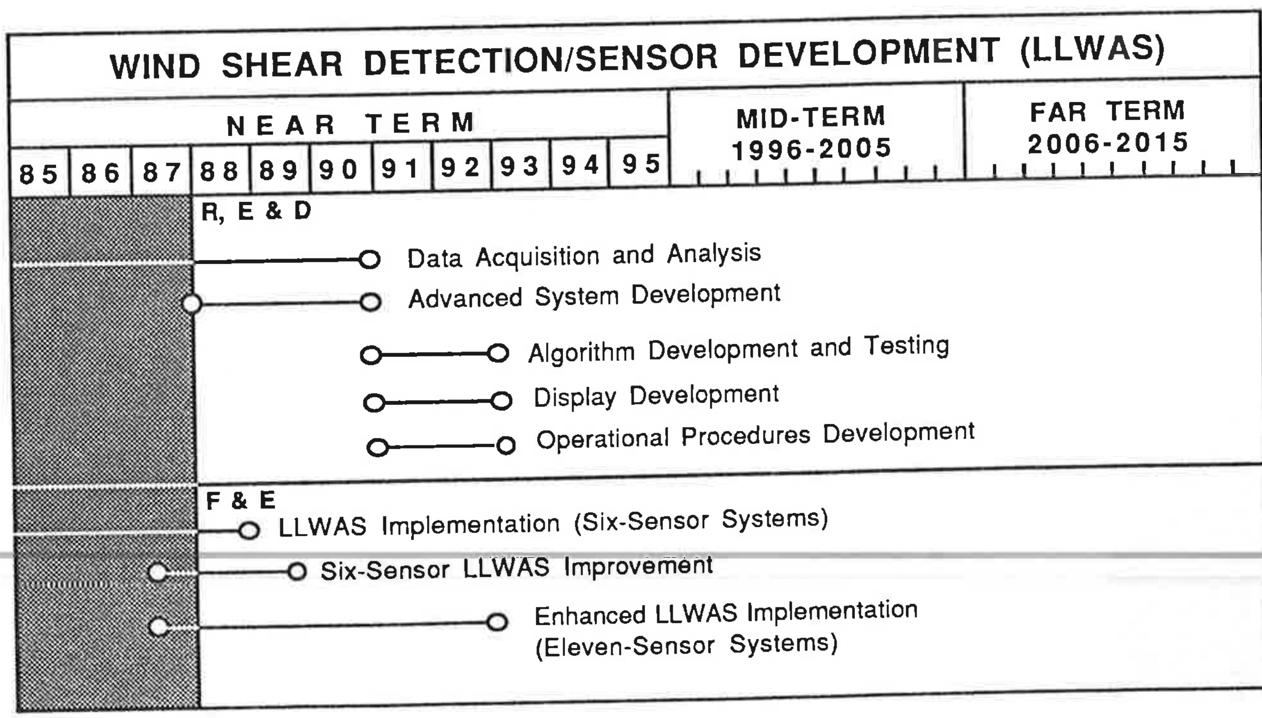
3.3 WIND SHEAR DETECTION/SENSOR DEVELOPMENT (LLWAS)

IMPACT ON AIRPORT CAPACITY: **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 6-Sensor Systems Installed	7/87	2/88	



PROJECT MANAGER: Craig Goff (APM-640), 202-267-8659
RE&D PROJECT: 7.3
SMART SHEET NO: 23120
F&E PROJECT: Flight Services-12

3.4 WEATHER SENSOR IMPLEMENTATION/UPGRADE

IMPACT ON AIRPORT CAPACITY: **INCREASE CAPACITY BY PROVIDING LOWER MINIMA AT ADDITIONAL AIRPORTS THUS REDUCING WEATHER-RELATED CONSTRAINTS**

The goal of these projects is to upgrade and modernize weather observation equipment in the NAS. The Automated Weather Observing Systems (AWOS) will provide observations updated every minute for approximately 700 airports. The Runway Visual Range (RVR) project will modernize existing equipment and establish new locations thus permitting lower landing approach minima.

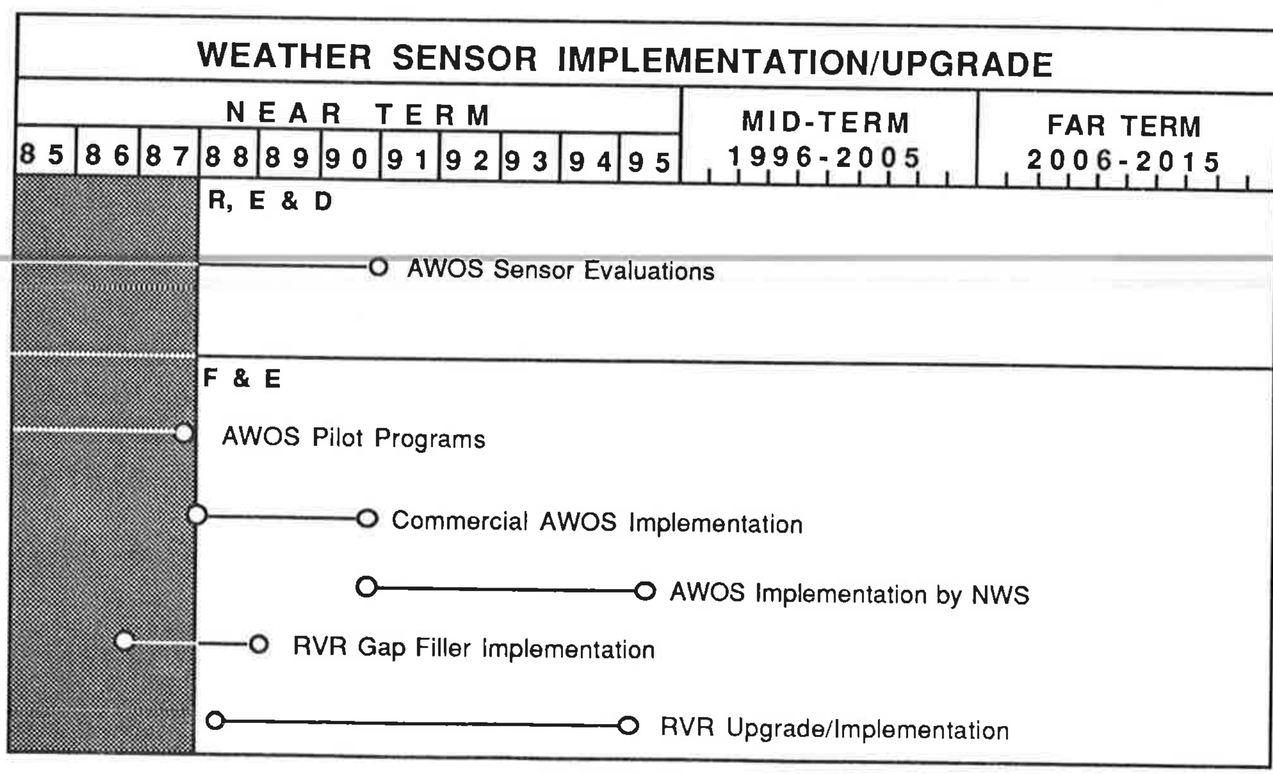
AWOS will obtain aviation critical airport weather data and allow its dissemination directly to pilots via computer generated voice.

A demonstration program for AWOS was successfully completed in July 1984. The acquisition of production AWOS equipment will be accomplished through a joint national procurement with the National Weather Service. Implementation of these systems by NWS for nontowered airports will begin in early 1991 and be completed in 1992. Post 1992 requirements for 304 towered airports and FSS locations where the FAA currently takes surface observations will also be met by the NWS supplier.

FAA requirements prior to the NWS program deliveries will be met through an acquisition of commercial off-the-shelf equipment. One hundred sixty systems will be installed starting in early 1989 through 1990.

A new RVR System, employing advanced technology, will provide an inherent capability to satisfy Category I through Category IIIC landing minima requirements. This will be fielded to replace all existing RVR equipment which are maintenance intensive and employ outdated technology. The project will also provide new generation equipment for establishment at qualifying facilities.

The RVR gap filler project will provide RVR equipment identical to the latest generation equipment now in the field and will satisfy urgent regionally identified requirements, pending receipt of new generation RVR equipment.



PROJECT MANAGER:	RVR: Frank Roepcke (APS-440), 202-267-8518 AWOS: Ken Kraus (APS-550), 202-267-8676
RE&D PROJECT:	None
SMART SHEET NO:	7011
F&E PROJECT:	AWOS Flight-Services 9 RVR Ground-Air 8
SMART SHEET NO:	23090 24080

3.5 TERMINAL DOPPLER WEATHER RADAR

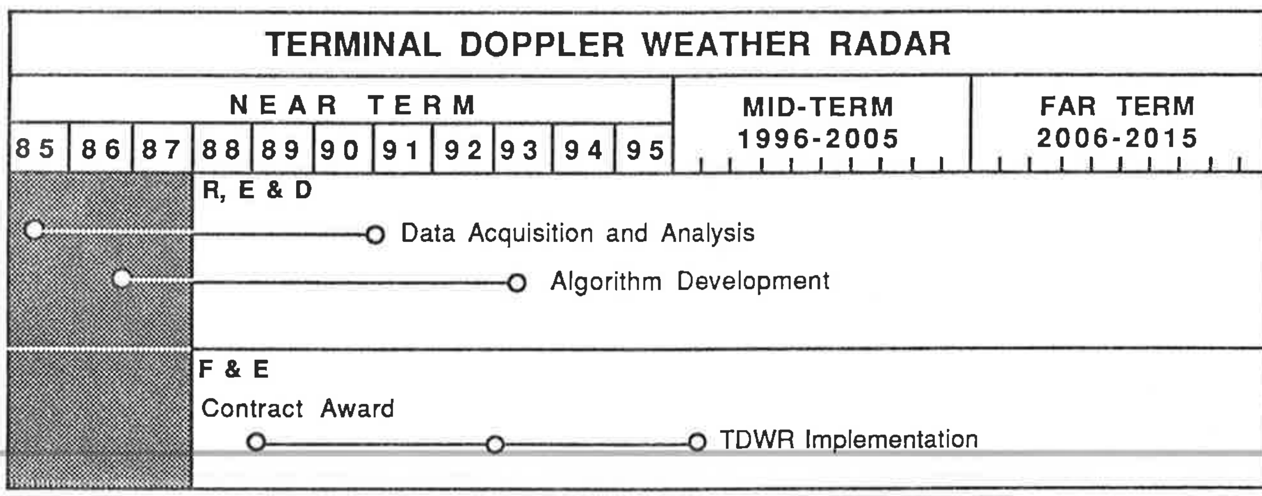
IMPACT ON AIRPORT CAPACITY: **INCREASE CAPACITY BY IMPROVING DETECTION AND IDENTIFICATION OF DANGEROUS WINDSHEAR IN TERMINAL ENVIRONMENT**

Terminal Doppler Weather Radar (TDWR) will be developed for the detection of hazardous weather in terminal airspace, similar to NEXRAD in the en route airspace. This radar will be deployed at major airports that experience frequent occurrences of hazardous wind shear conditions and severe thunderstorms. For example, technical specifications for scanning of radar products, ground clutter suppression, and controller-display interface, will be developed.

Research will be continued on microburst-type wind shear detection and prediction by Doppler radar techniques. Data will be acquired for different elevation angles, scan techniques, precipitation levels, and environments. Wind field patterns and signal levels will be analyzed to determine signatures of dangerous wind shear events. Algorithms will be developed to identify the hazard locations and characteristics, and to provide guidelines for controller and pilot actions.

This project will produce detection and identification algorithms for wind shear and other hazardous weather, specifications and operational guidelines for TDWR, and a wind shear detection system.

MILESTONES:



PROJECT MANAGER: D. Johnson (APM-310), 202-267-8573
RE&D PROJECT: 7.2
F&E PROJECT: Ground-Air 18
SMART SHEET NO: 24180 (7020)

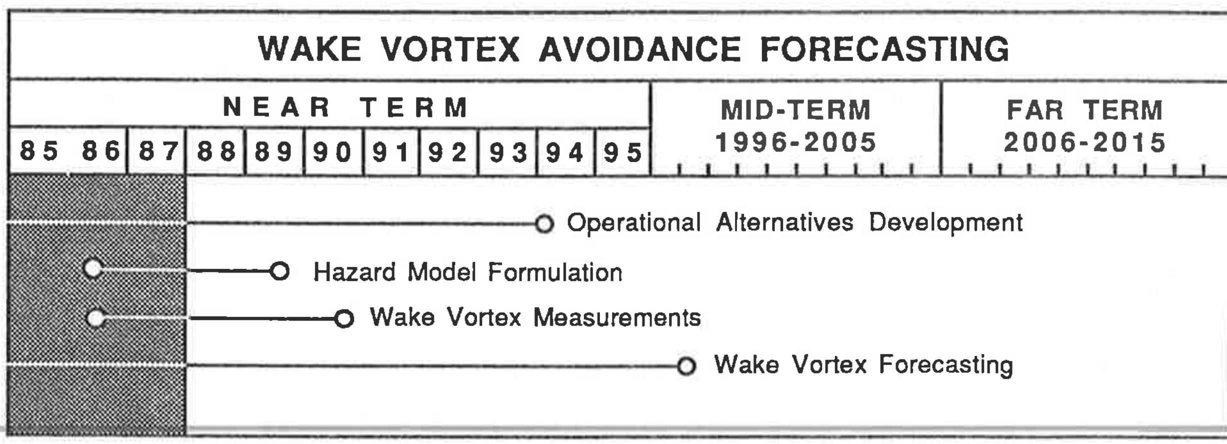
3.6 WAKE VORTEX AVOIDANCE FORECASTING

IMPACT ON AIRPORT CAPACITY: **INCREASE CAPACITY BY ADOPTING SEPARATION STANDARDS AND PROCEDURES THAT MORE ACCURATELY REFLECT WAKE VORTEX HAZARD**

The goal of this project is to improve current methods of avoiding wake vortex encounters. This will be possible by adopting general separation standards and procedures that more accurately reflect the actual hazard, and by adapting the separations to the real-time duration of the hazard.

In this project, ways of classifying aircraft for wake vortex purposes will be examined. Wake vortex data on new aircraft types will be collected. Possible operational alternatives will be examined in light of current wake vortex knowledge and available technology, such as MLS, for aircraft guidance. Wake vortex computer models for aircraft classification and hazard avoidance will be developed. Wake vortex data currently not available will be collected, including data on high-altitude and parallel runways. The evaluation of onboard wake vortex detection systems and advanced wake vortex avoidance systems will be conducted.

The products of this project include wake vortex computer models for aircraft classification and hazard avoidance, a report on wake vortex classification of aircraft, a wake vortex hazard model, wake vortex hazard model software and associated report, a wake vortex behavior data report, recommendations for improved procedures and standards, report on onboard wake vortex systems evaluation, and a report on advanced wake vortex avoidance systems evaluation.



PROJECT MANAGER: J. O'Neill (ACT-330), 609-484-4458
RE&D PROJECT: 11.5
SMART SHEET NO:
F&E PROJECT: None

3.7 ADVANCED TRAFFIC MANAGEMENT SYSTEM

IMPACT ON AIRPORT CAPACITY: **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 develop operational procedures, processing capabilities, and required interfaces. This will enable the ATC system to monitor air traffic demand on saturable resources such as airports, fixes, and sector airspaces. It will also predict and identify imbalances between demand and capacity, and to provide traffic management specialists with tools for efficiently and safely utilizing available system capacity based on demand.

The Traffic Management System (TMS) has two components: (1) the Central Flow Control Function (CFCF) and (2) local Traffic Management Units (TMUs).

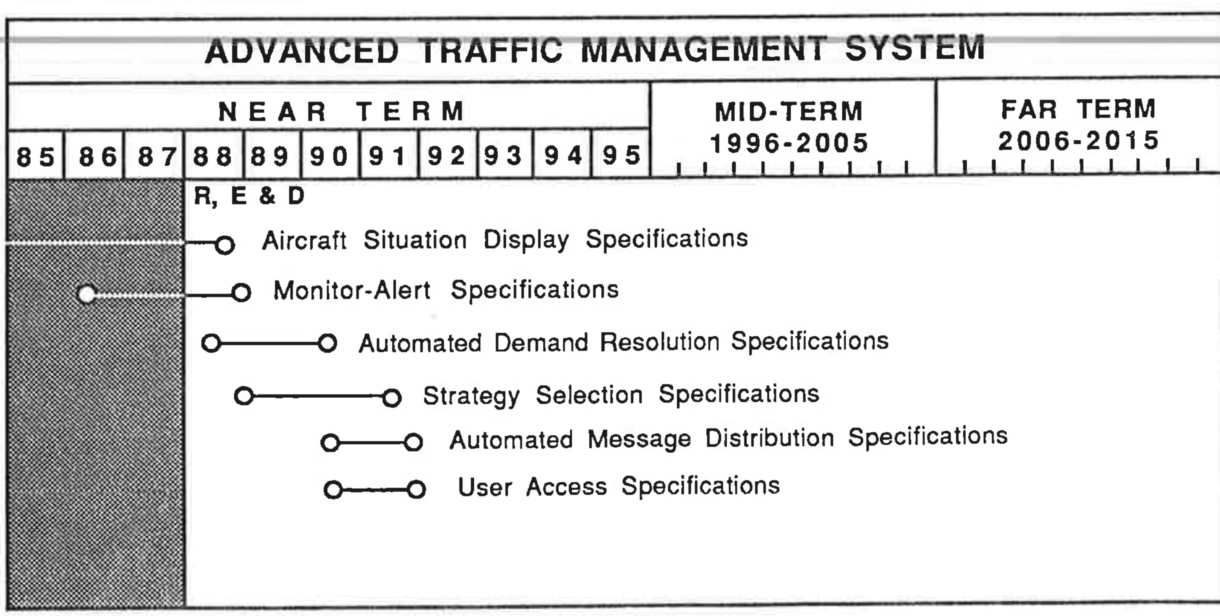
The following functions will be developed by ATMS; the aircraft situation display is a real-time display of all IFR and selected VFR aircraft positions. The monitor-alert function will maintain an accurate data base containing the current status of all IFR and selected VFR air traffic. The Automated Demand Resolution Function, possibly a knowledge-based system within CFCF, will automatically provide traffic management alternatives for resolving identified imbalances between demand and capacity. These alternatives may include reroutings, flow rate adjustments, or ground delays. They will enable the traffic management specialist or, in the long term, an automation function to select a particular traffic flow strategy that will best achieve the desired overall system performance. The algorithms for this function will be evaluated through air traffic simulations and field tests.

The strategy selection function executes the selected strategy by determining the impacted facilities. It tailors appropriate directives, and transmits them to the proper flow management positions in the en route and terminal facilities.

The automated message distribution function will provide automated distribution of flow management directives to other FAA facilities based on the demand resolution strategy selected.

The ATMS will also include: definition of system performance indices, performance analysis function, direct user access to TMS information, and oceanic traffic management.

MILESTONE SCHEDULE:



PROJECT MANAGER:	L. Mosher (AES-320), 202-267-9855
RE&D PROJECT:	3.1
F&E PROJECT:	Enroute-6
SMART SHEET NO:	21060

3.8 TERMINAL RADAR ENHANCEMENTS

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

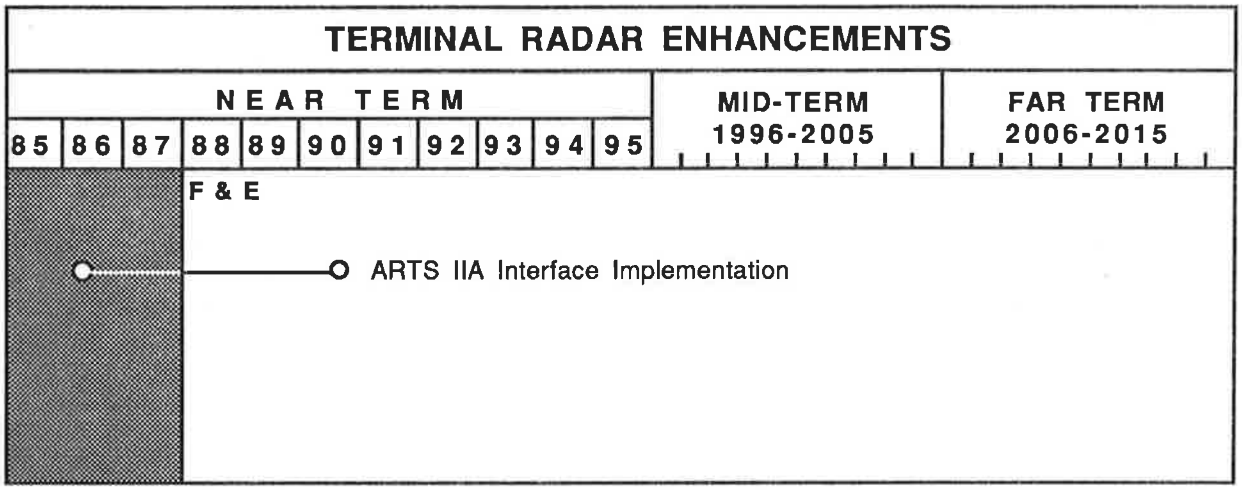
The goal of this program is to provide development and support for the Automated Radar Terminal System (ARTS). This will ensure that its availability, reliability, and capacity remain acceptable as demand increases. The ARTS will continue to provide the computer resources for the terminal area ATC until 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 data link. Improvements in terminal automation systems will refine terminal conflict alert algorithms. This will 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 S Sensor interface requirements	FY 1987		
ARTS IIA - Factory Acceptance completed	11/19/86		12/87
ARTS IIA - ACT-100 Integration	1/14/87		12/87
ARTS IIA - APS-160 Shakedown Test	1/16/87	2/88	
ARTS IIA - First Operational Readiness demonstration	4/1/87	4/88	
ARTS IIA - First System delivered	12/4/87	2/88	
ARTS IIA - Last System delivered	1/7/88	1/89	



PROJECT MANAGER: Bob Voss (AAP-320), 202-267-8349
RE&D PROJECT: None
F&E PROJECT: Terminal-9
SMART SHEET NO: 22090

REMARKS/NOTES: Terminal ATC facilities are being upgraded under the current NAS Plan. The Automated Radar Terminal System (ARTS) IIA 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.

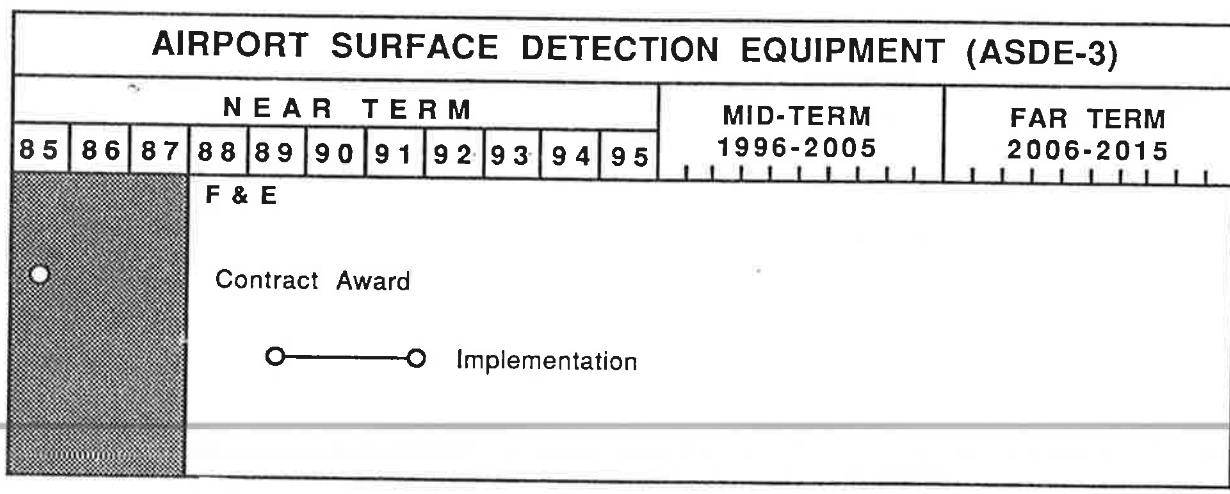
3.9 AIRPORT SURFACE DETECTION EQUIPMENT (ASDE-3)

IMPACT ON AIRPORT CAPACITY:	**REDUCE DELAY BY EXPEDITING 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 almost 30 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 reduces delay and increases safety. The radar operating frequency of ASDE-2 is characteristically absorbed and deflected by precipitation. The resulting cluttered plan view display makes the detection of surface vehicle movement more difficult. Improving the monitoring of such vehicle movement may result in an improvement in capacity under IFR conditions.

MILESTONE SCHEDULE:

	Scheduled Completion	Revised Scheduled Completion	Actual Completion
Contract Award (30 systems)			9/85
Establish 17 Systems	9/88	10/90	
Replace 13 ASDE-2 Systems	3/90	8/91	



PROJECT MANAGER:	Don Johnson (APS-310), 202-267-8573
F&E PROJECT:	Ground-Air 14
SMART SHEET NO:	24140
RE&D PROJECT:	None

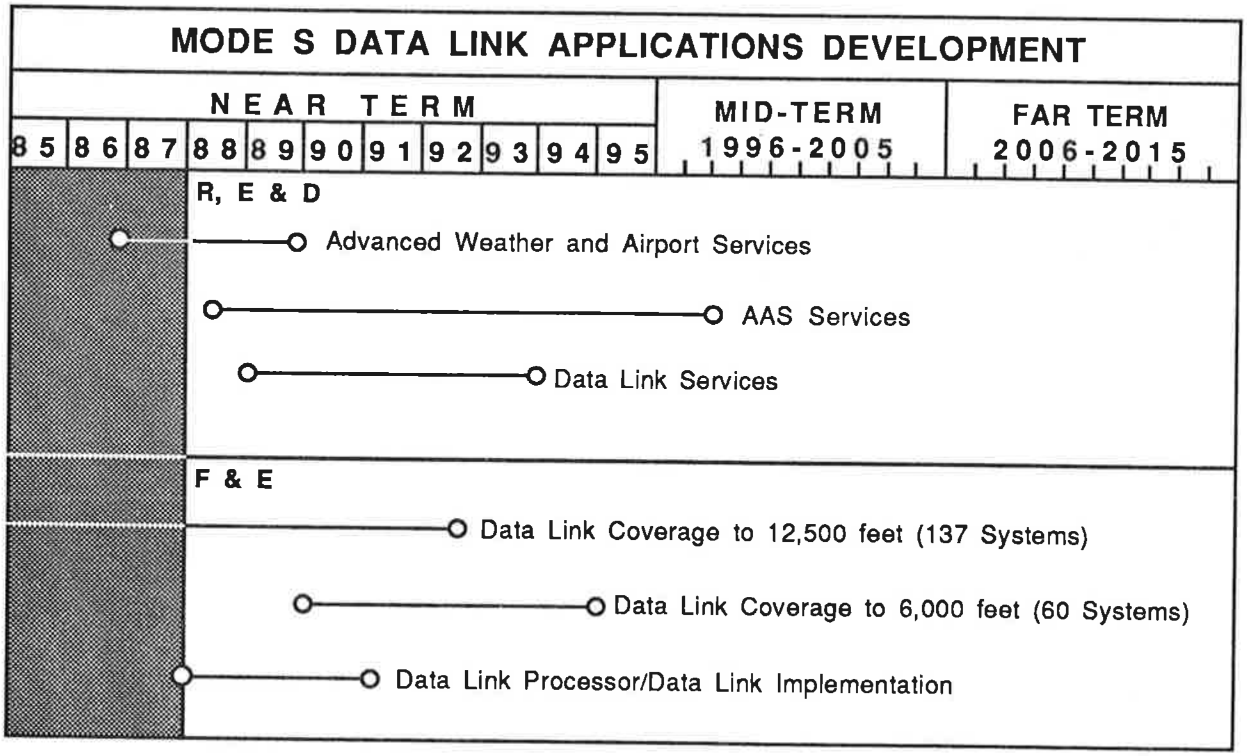
3.10 MODE S DATA LINK APPLICATIONS DEVELOPMENT

IMPACT ON AIRPORT CAPACITY: **INCREASE CAPACITY 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 digital 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 Mode S systems) FY 1983, FY 1984, FY 1985			10/5/84
Contract Award (60 Mode S systems)	3/90		
RTCA-SC 142 Develop Minimum Operational Performance Specifications (MOPS) for Mode-S Data Link	FY 1987	1988	
Delivery of First of 137 Mode S Systems	FY 1989	4/89	
Delivery of first Weather Communications Processor (WCP) to ARTCC	FY 1990		
Delivery of Last of 137 Mode S Systems	FY 1992	1/92	



PROJECT MANAGER: J. Fee (APS-330), 202-267-3193
E. Mandel (APS-520), 202-267-8637

RE&D PROJECT: 4.8 7.7

SMART SHEET NO: 4080 7070

F&E PROJECT: Flight-Services 5 Ground-Air 12

SMART SHEET NO: 23050 27800

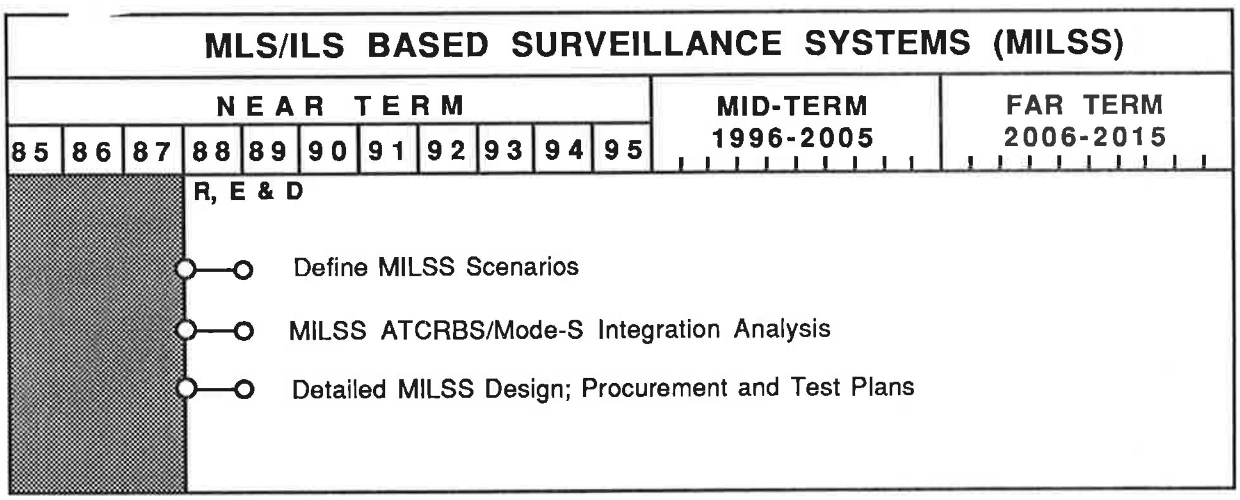
3.11 MLS/ILS BASED SURVEILLANCE SYSTEMS (MILSS)

IMPACT ON AIRPORT CAPACITY: INCREASE CAPACITY AT AIRPORTS WITH CLOSELY SPACED PARALLELAND CONVERGING RUNWAYS BY USE OF MLS-BASED APPROACH MONITOR AND INSTRUMENT LANDING SYSTEM

The Microwave Landing System (MLS) will be evaluated for use as a separate surveillance system for independent monitoring of the aircraft approach and go- around regions. Since MLS will eventually include all instrumented runways, it will be an ideal candidate for the independent surveillance task. There are a number of airborne and ground system configurations that can perform this surveillance function.

This project will demonstrate the feasibility of a MLS/ILS-based Surveillance System (MILSS). MLS-based surveillance system concepts and identified candidate MILSS configurations will be analyzed. Detailed MILSS implementation requirements identifying all necessary ATC system interfaces, functions, and procedures will be developed. Procurement of the MILSS components will be completed. An extensive MILSS field and flight test program will be conducted. Finally, testing and evaluation of the MILSS will be completed.

MILESTONES:



PROJECT MANAGER: J. Heurtley (ACP-6), 202-267-8747
TSC PROJECT: FA-8D9

3.12 TERMINAL ATC AUTOMATION

IMPACT ON AIRPORT CAPACITY: **REDUCE DELAYS BY AUTOMATING AIRCRAFT SEQUENCING AND SCHEDULING FLEXIBLE ARRIVAL AND DEPARTURE ROUTES**

The goal of Terminal ATC Automation (TACTA) is to develop automated planning, coordination, and traffic control aids. This will cause controllers to maximize use of terminal airspace, increase the efficiency of aircraft operations, and explore the potential for increasing productivity by incorporating time-based ATC concepts. It will develop and evaluate concepts for automation and information exchange to support precise scheduling and spacing of aircraft over predefined and user- preferred trajectories. It will also refine the controller/machine interface to reduce manual complex computations necessary for efficient traffic planning, and reduce controller/pilot workload by automating communications.

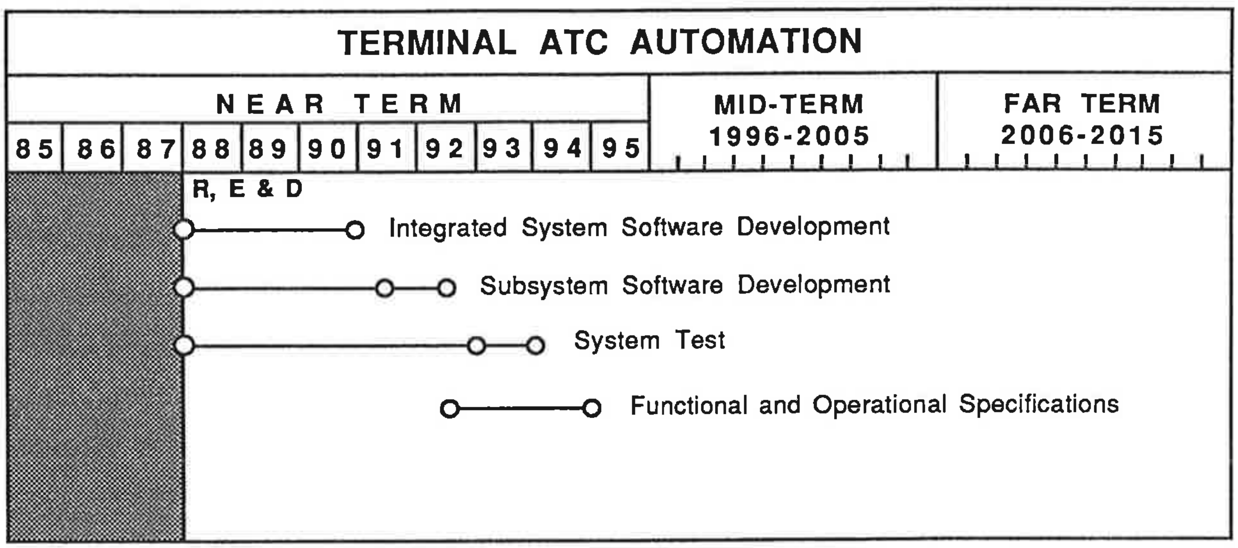
TATCA includes three specific functions. The first is, traffic planner/coordinator, a computer-resident traffic planning and coordination network that form the core of the initial automation package. ATC coordination will be facilitated by sharing the traffic plan and its associated data base among all relevant supervisory and control positions, as well as with the participating aircraft. Automation plan updates based on radar surveillance data will reflect changes in aircraft locations and speeds. Planning accuracy will be capable of enhancement as more accurate estimates of local winds aloft become available. An important feature of the traffic planner will be its ability to calculate efficient landing sequences. After an efficient, conflict- free landing sequence has been identified, aircraft must be controlled to achieve that sequence. Several alternatives will be considered. This research will focus on the exploitation of 4-dimensional (4D)-equipped aircraft, digital data link, advanced cockpit avionics, improved weather products, and AAS capability.

The second function, descent advisor, uses knowledge of winds to calculate where descent should begin and what speeds should be flown. This function will save fuel in VMC as well as IMC by allowing appropriately equipped aircraft to fly uninterrupted, fuel-efficient, conflict-free, and accurately timed descents from cruise altitude to the final approach fix.

The third function, final-spacing advisor, will suggest specific speed changes or turn-to-final commands for bringing the aircraft into compliance with the plan and for more precisely spacing aircraft on final approach. The converging approach delivery aid, a specific application of the final-spacing advisor, will assist controllers in feeding staggered approach streams to converging runways, thus allowing use of dependent converging approaches under IMC conditions.

Each of the above early candidate automation features will be evaluated by controllers in field evaluation testbeds. A simulation testbed will also be assembled to provide an early capability for simulating the performance of terminal automation aids that are characteristic of those specified for the AAS environment. Final full-scale evaluation of the automation will take place in a special terminal automation validation facility at the FAA Technical Center.

MILESTONE SCHEDULE:



PROJECT MANAGER:	M. Burgess (AES-301), 202-267-9840
RE&D PROJECT:	3.5
F&E PROJECT:	None
SMART SHEET NO:	3231

4. CAPACITY PLANNING STUDIES

4.1 AIRPORT CAPACITY ENHANCEMENT TASK FORCES

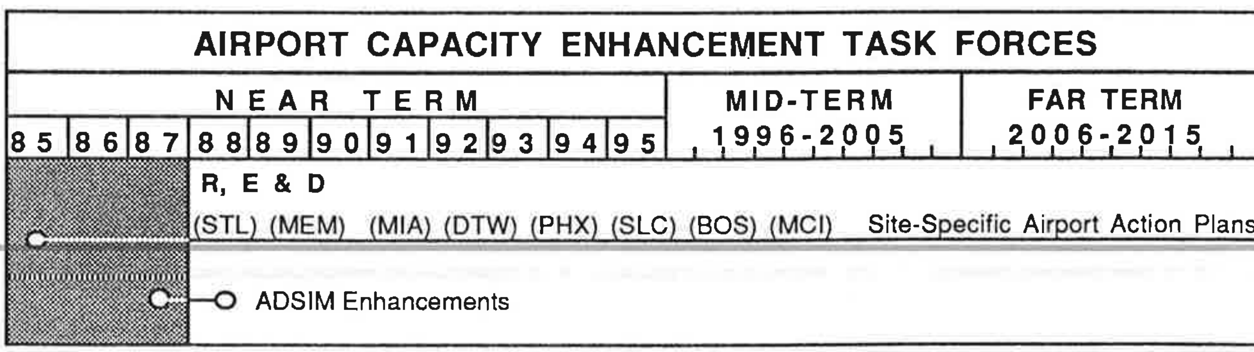
IMPACT ON AIRPORT CAPACITY: **DEVELOP PLANS FOR MEETING FUTURE CAPACITY NEEDS AT THE NATION'S BUSIEST AIRPORTS THROUGH AIRPORT/FAA/USER EFFORTS**

The FAA has a number of projects and programs that support capacity enhancement by employing analytical tools to quantify the benefits of various capacity enhancement actions, which acts as a catalyst for their adoption. Foremost among these projects are the airport capacity enhancement task forces which provide a means for the FAA to initiate or support planning activities at individual airports. These task forces include representatives of the airport sponsor, system users, industry groups, the airport control tower, and the FAA.

Each task force performs an in-depth study of an airport's current and anticipated capacity problems. It identifies the causes of delay and evaluates the delay reduction potential of options generally categorized as airport development items, air traffic control procedures, additional facilities and equipment, and user improvements. The result of this effort is an action plan that serves as a guide for improvements at the particular airport. Figure 4-1 shows the schedule of presently planned task forces.

Ideally, the work of a task force should lead directly to implementation of improvements that otherwise might not have been considered. The Atlanta Task Force reported that a large potential capacity increase and delay reduction would result from developing a commuter/G. A. terminal and runway complex south of existing Runway 9R/27L. Subsequently, a working group of regional FAA experts was formed to evaluate alternatives for implementing this improvement utilizing computer simulation support.

Each year task forces are initiated at some airports and completed at others. When completed, the FAA will provide for periodic review to update plans.



PROJECT MANAGER: R. Yatzeck (ACP-4), 202-267-8791
J. Vanderveer (ACT-310), 609-484-5645
RE&D PROJECT: 10.4
SMART SHEET NO: 10060
F&E PROJECT: None

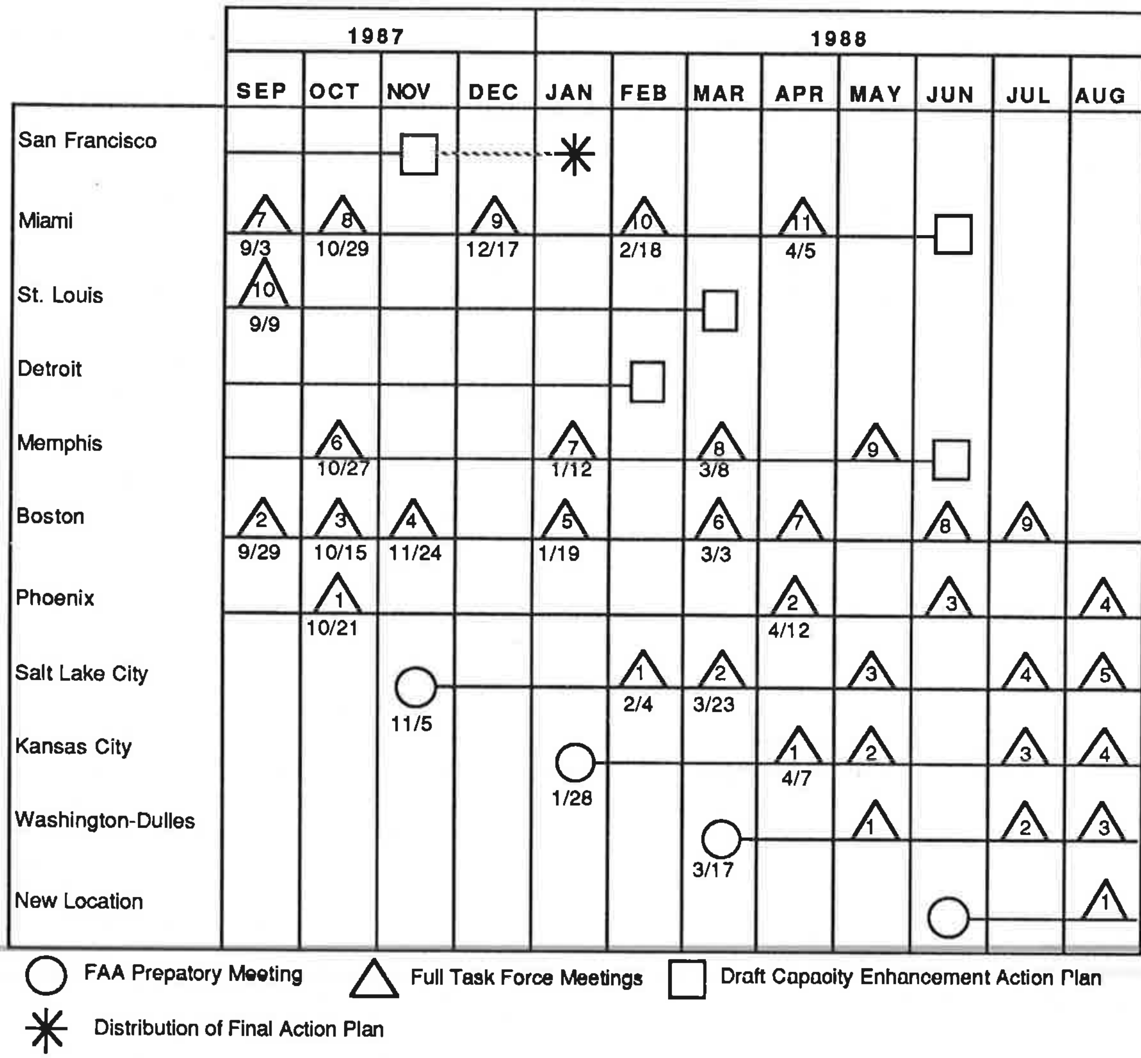


FIG 4-1. PROPOSED SCHEDULE OF PRESENTLY PLANNED TASK FORCES

4.2 AIRPORT CAPACITY AND DELAY MODELS

IMPACT ON AIRPORT CAPACITY: **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 developed by the Office of Environment and Energy to measure all time and fuel related impacts of ground and air operations; and the "Airport Machine," used to model surface traffic. The FAA has started the development of a fourth model, NASPAC, that will allow analysis of the National Airspace System.

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.

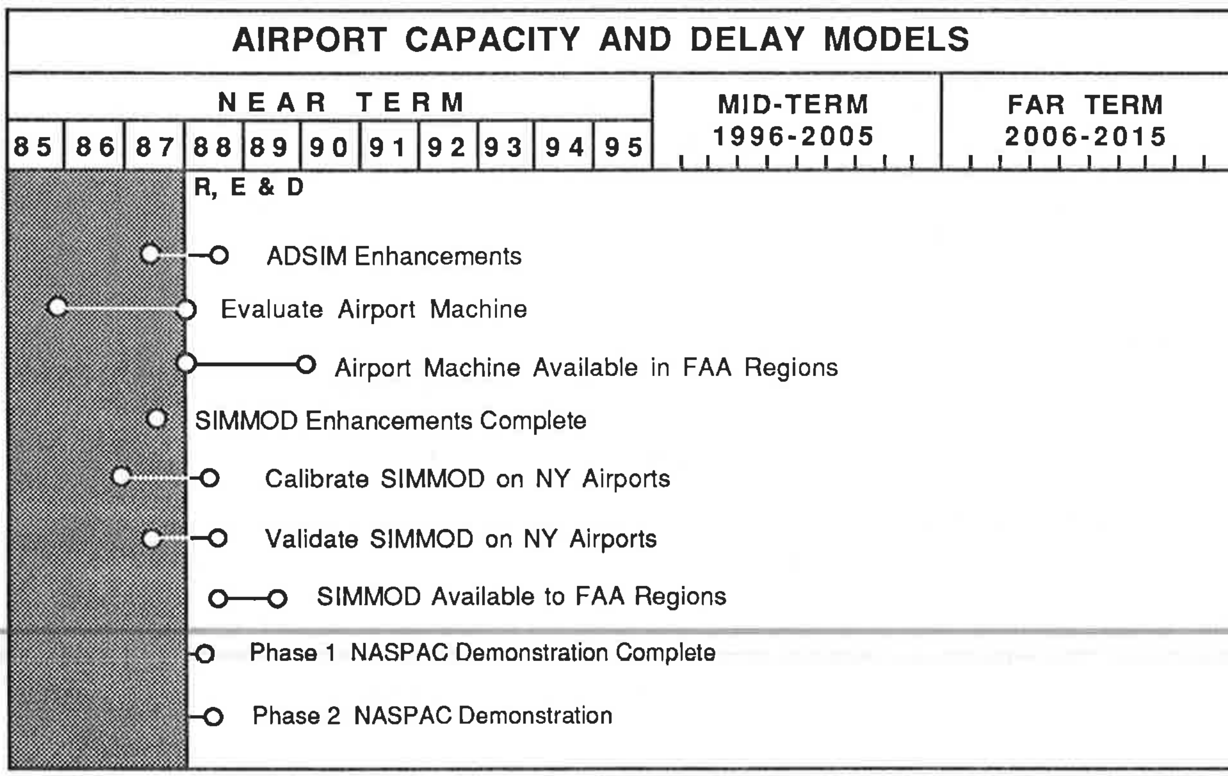
The SIMMOD Model is being prepared for use by airport consultants and airlines and eventually will be made available to analysts studying proposed airspace changes (routes, fixes, procedures, etc.) in complex terminal areas and en route and transitional airspace, for example, the West Coast Plan and the recently completed 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 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. When the validation process is completed, the model will be made available to regional FAA offices.

The National Airspace System Performance Analysis Capability, NASPAC, will apply operations research tools and computer modeling to the development, design and management of the nation's airspace. This model will provide delay and utilization statistics for the entire networks.

MILESTONE SCHEDULE:

	Scheduled Completion	Revised Scheduled Completion	Actual Completion
Evaluate Airport Machine at LGA (Joline)		1/88	
Airport Machine (Joline) application in FAA Regions		4/88	
SIMMOD			
Enhancements complete			9/87
Validate at New York Airport	3/87	5/88	
2 airspace simulations	9/87	10/88	
NASPAC			
Phase 1 model demonstration	1/88		1/88
Phase 2 model demonstration	9/88		



PROJECT MANAGER: D. Winer (AEE-200), 202-267-3534
J. Mottley (APP-400), 202-267-3451
J. Vanderveer (ACT-310), 609-484-5658

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

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

The goal of this program is to reduce the impact of environmental constraints on the growth of the national air transportation system. This goal holds true especially on airport capacity, by developing the methods, technology, and expertise to mitigate those environmental impacts.

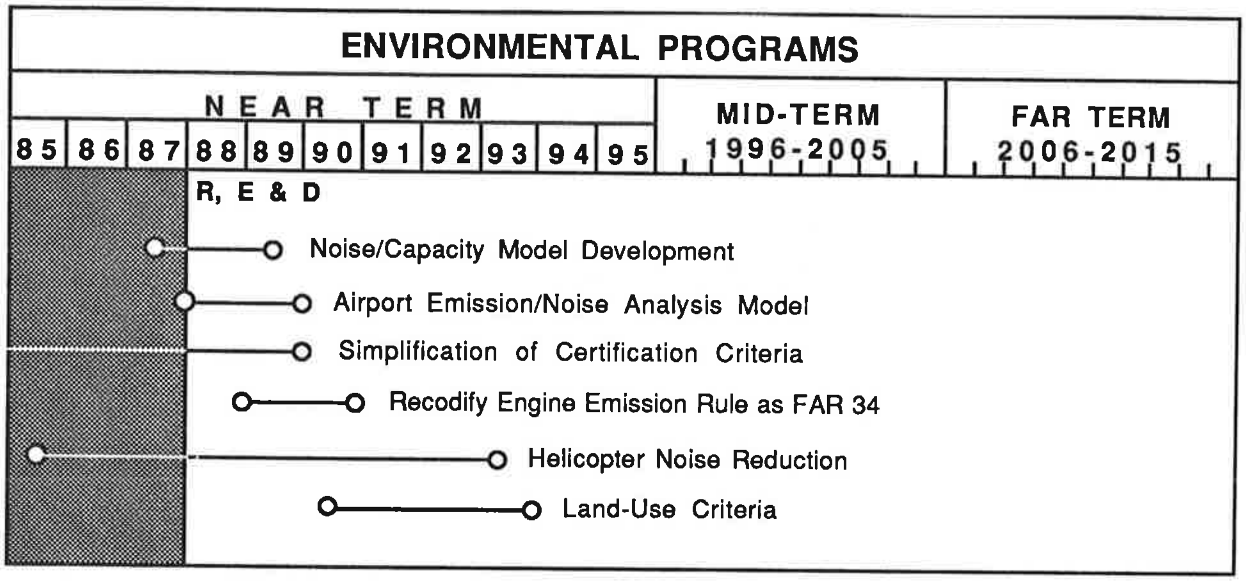
The foremost environmental constraint on the national air transportation system continues to be aircraft noise and local community actions taken for protection from that noise. Airport related noise currently affects several million people in the U. S. Noisy aircraft are gradually being phased out of service. Aircraft engine emissions have been largely controlled through coordinated government-industry efforts using both regulation and technology.

Ten percent of Federal matching grants will be spent for noise compatability projects. This could amount to as much as $870 million during the next five years assuming all authorized funds are appropriated. The FAA Part 150 Airport Noise Compatibility Planning Program continues to be the primary Federal program for guiding this noise mitigation effort. The FAA continually upgrades the Part 150 program.

Additional aircraft noise efforts include developing accurate information on the noise characteristics and appropriate Federal regulation to minimize aircraft noise emissions. FAR Part 36 aircraft noise certification standards are being revised. A heliport noise impact model has been developed by the FAA. FAA will continue to work closely with NASA and the aviation industry to evaluate noise control technology. A subcommittee of the Industry Task Force on Airport Capacity was requested by the FAA to make recommendations on phasing out older, noisier aircraft.

MILESTONE SCHEDULE:

	Scheduled Completion	Revised Scheduled Completion	Actual Completion
Recodify SFAR-27 as FAR Part 34	FY 1988		
Industry Task Force Recommendations	FY88		



PROJECT MANAGER:	R. Hixson-Noise (AEE-110), 202-267-3558 N. Krull-Pollution (AEE-30), 202-267--8933
RE&D PROJECT:	10.5
SMART SHEET NO:	11070
F&E PROJECT:	None

APPENDIX B. SUMMARY OF FAA REPORT ON POTENTIAL CAPACITY BENEFITS

APPENDIX B. SUMMARY OF FAA REPORT ON POTENTIAL CAPACITY BENEFITS

FAA Report, FAA-DL5-87-1, "Estimates of Potential Increases in Airport Capacity Through Improvements in Airport and Terminal Areas," presents the results of a study performed by the MITRE Corporation. This report estimates the potential increases in airfield capacity that might result from improvements in airfield and terminal-area operations. This study was conducted for the Federal Aviation Administration to better understand the expectations and limitations of airport capacity increases achievable through technical solutions. The focus of this study is not on how new technology results in operational improvements, but rather on how much of an operational improvement is necessary to increase capacity.

An analysis of the key operational parameters in today's airfield operations yields the following conclusions:

1. The greatest capacity increases come from the addition of new runways that are properly placed to allow additional independent arrival and/or departure streams, both under Visual Flight Rules (VFR) and under Instrument Flight Rules (IFR). The resulting increase in capacity is from 33 to 100 percent (depending on whether the baseline is a single, dual, or triple runway configuration).

2. While most of the time weather conditions support VFR operations, IFR operations must be used some of the time, resulting in decreased capacity due to the more restrictive rules on the use of available runways. Development of multiple approach concepts to permit simultaneous instrument approaches (where not currently allowed) increases IFR capacity by 44 to 100 percent. This (depending on whether the baseline is a single runway, two dependent, or two independent runways), significantly reduces the difference between IFR and VFR capacity.

3. Another area for significant increases in IFR capacity is reduction in separation minima during final approach. A reduction in the diagonal separation requirement from 2 nmi to 1 nmi for dependent parallel operations would increase capacity for that configuration by 25 percent. Reduction in the longitudinal separation requirements from 3 to 2 1/2 nmi (with a 1-nmi reduction in other wake vortex separation rules) would increase capacity by 15 percent.

4. Technical solutions that result in operational improvements--such as reduced variability in interarrival time and reduced runway occupancy times-- do not increase capacity as much as separation reductions. However, they still offer potential capacity increases of as much as 18 percent for VFR and 16 percent for IFR.

This study focuses on the capacity increases that can result from technical improvements to the ATC system, using the existing runways. Realistic upper limits on such increases are from 15 to 26 percent in VFR (depending on runway configuration and percent arrivals), and from 9 to 78 percent in IFR. In comparison, the addition of a new runway that allows an additional independent arrival and/or departure stream results in a 33 to 100 percent capacity increase (depending on whether the baseline is single,dual, or triple runway configuration). In VFR, this would require the construction of a new runway; in IFR, the increase could also come through development of multiple approach concepts, which can result in a 44 to 100 percent increase in IFR capacity (depending upon whether the baseline is a single runway, two dependent, or two independent runways). The greatest capacity increases come from the addition of a new runway, properly spaced to allow an additional independent arrival and/or departure stream.

While the capacity increase from technical ATC system improvements are not as large as those from the addition of new runways, they still represent a significant capacity gain. In addition, technical ATC system improvements that would allow operation of multiple independent IFR approach streams that are currently prohibited or operated only at very high weather minimums (such as converging and triple IFR approaches) would result in a significant decrease in the difference between the IFR and VFR capacities of particular runway configurations. The parameters that technical solutions must improve to provide the greatest increases in capacity vary as a function of percent arrivals, runway configuration, and weather conditions (VFR and IFR).

VFR Capacity. VFR operations today are characterized by pilot-maintained visual separations; it is not clear whether these can be reduced significantly over the long term. There are limitations in the ability of the controllers and pilots to achieve these levels consistently. In addition, runway occupancy time is a limitation, especially where arrivals and departures use the same runway(s). There is room to achieve some increases in VFR capacity through technical solutions that affect these factors. The parameters that have the greatest effect and the magnitude of the expected increases from reducing those parameters are:

- Arrivals-only capacity, 17-18 percent by reducing interarrival time variability by 50 percent.

- Departures-only capacity, 18 percent by reducing departure separations 14 to 20 percent.

- Mixed operations, 8-9 percent by reducing mean arrival ROT 11 to 17 percent.

IFR Capacity. IFR operations, as distinguished from VFR, are characterized by relatively large controller-maintained radar separations and procedures for avoiding collisions and wake vortices. Not only are there significantly larger separations under IFR for individual arrival streams, but also restrictions on the use of multiple arrival streams. The biggest impacts on IFR capacity will be from increasing the ability to operate multiple arrival streams.

The technical solutions that provide the greatest impact on IFR capacity are as follows:

- Multiple independent approach concepts, where applicable, which can increase capacity 44 to 100 percent depending on the previous "best" capacity.

- Reductions in the separation requirements between multiple dependent approaches, which can increase capacity by 25 percent.

- Reductions in the longitudinal separation standards, which can increase capacity 15 percent.

- Reduction in system variabilities, which can increase capacity by 12- 16 percent.

APPENDIX C. THE DALLAS/FORT WORTH METROPLEX AIR TRAFFIC SYSTEM PLAN

APPENDIX C. THE DALLAS/FORT WORTH METROPLEX AIR TRAFFIC SYSTEM PLAN

Problem

An analysis of air traffic demand for the period 1986-1996 indicates that growth in the Dallas-Fort Worth Center terminal area of 100 percent can be anticipated. Half of this increase is forecast to occur by 1991. The 1986 traffic count at DFW was 576,000 operations. The 1991 forecast for these two facilities (Dallas/Fort Worth Airport and Dallas/Fort Worth Center) is 863,000 operations and 1,480,000 operations respectively. The management of air traffic is about to be further complicated by the addition of three new airports, currently under construction, that are capable of accommodating large turbojet aircraft. The increased traffic demand and increased complexity of the local system have the potential to increase delays to the point that the stability and continued growth of aviation in this area are threatened.

Addressing the Problem

It became imperative that a plan be developed to expand the approach control airspace and increase the number of arrival/departure routes to accommodate the growth anticipated through the next 10 to 15 years. To initiate this process, a task force composed of air traffic experts from the DFW TRACON and the Fort Worth Center was formed. The task force defined a set of major problem areas, established goals and planning guidelines, and evaluated various options for designing a new system.

The task force defined six problem areas:

- Inadequate capacity of the en route airway system: existing operational limitations severely reduce efficiency and contribute to delays to arriving and departing traffic;

- Terminal airspace constraints: traffic volume and complexity have grown to the point that the limited size of the approach control airspace has become a constraint to efficient operations, particularly affecting arrival traffic;

- Military special operating areas: the existing military special operating areas restrict traffic transitting the high-density airspace;

- Inefficient handling of high performance turboprop aircraft: the existing procedure for handling these aircraft--routinely keeping them at low altitudes along with much slower traffic--creates a complex traffic situation and added workload, reducing handling capability at the positions working these aircraft;

- Traffic management: the existing metering system has served well over the years in managing arrival traffic to this area, but it has limitations that must be overcome to meet the demand forecast over the next 10 to 15 years; and

- Limited capability of the DFW ARTS II A system: the existing system in use at the DFW TRACON has limited track storage capacity necessitating procedural adjustments that are inefficient during peak periods.

The task force evaluated the present system and determined that if no changes are made to it, existing problems will become more complex with increasing demand over the next 10 years. The solution lay generally in segregating traffic by type and destination, in more strict regimentation of traffic flows through "fix balancing", in improved traffic management procedures, and in construction of additional runways.

The task force met with all major users, airport management representatives, and representatives of several local government agencies. Familiarization trips were made to Atlanta and Chicago to observe traffic management and the interface between center sectors feeding approach control and the terminal operation itself. The result of the experience gained and information gathered was a plan for enhancing the existing system to accommodate forecast demand through the next 10 to 15 years.

Solution

The principal points of the DFW Metroplex Air Traffic System Plan are as follows:

- Establish parallel arrival routes to DFW over all "cornerposts" regardless of flow (the use of parallel arrival routes is contingent upon runway availability and traffic demand requirements);
- Establish parallel arrival routes to satellite airports based on destination;
- Establish four turbojet departure routes--north, south, east, and west;
- Provide separate arrival and departure altitudes for a select group of high performance turboprop aircraft;
- Increase the arrival and departure capacity of DFW and satellite airports;
- Establish a 30 nmi TCA based on the DFW VORTAC;
- Develop a real-time traffic management system for the DFW terminal area;
- Develop procedures for four simultaneous ILS approaches; and
- Recommend that the DFW airport sponsor construct two new north/south runways (one east and one west of the existing parallel runways) to be used primarily by smaller commuter aircraft.

APPENDIX D. SELECTION OF ALTERNATE AIRPORTS TO REDUCE FORECAST AIRCRAFT DELAY

APPENDIX E. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

LEGEND

POTENTIAL OPERATIONS PER YEAR	Dependent (Dep.) IFR approach 200,000 Independent (Indep.) IFR approach 300,000 - If adequate groundside capacity is created, the runway layout could handle this volume with no delay.
UNUSED CAPACITY	An estimate of the number of aircraft operations that could be added to this runway configuration without incuring delays. (Negative number indicates airport is probably already incuring delays.)

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

ATLANTA (ATL) **HOURS OF DELAY: 103,260**

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000- 7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Columbus (CSG)	67	1	0			No	No		64,000	
Macon (MCN)	68	2	0	5/23(5)		Dep.	Yes	200,000	48,000	152,000
Chattanooga (CHA)	87	1	1		2L/20R(5)	Dep.	Yes	2000,000	119,000	81,000
Athens (AHN)	58							Not Selected for Evaluation		
Anniston (ANB)	70							Not Selected for Evaluation		
Gadsden (GAD)	84							Not Selected for Evaluation		

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

BOSTON (BOS) **HOURS OF DELAY: 46,700**

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000- 7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
New Bedford (EWB)	41	2	0	5/23(5)		No	Yes		103,000	
Hyannis (HYA)	52	1	0			No	No		182,000	
Providence (PVD)	42	0	2			Dep.	Yes	200,000	208,000	(8,000)
Manchester (MHT)	35	1	1	17R/35L(5)		Yes	Yes	200,000	156,000	44,000
Portland (PWM)	82	2	0			Dep.	Yes	200,000	111,000	89,000
Windsor Locks (BDL)	79	2	0			Dep.	Yes	200,000	159,000	41,000
Worcester (ORH)	39							Not Selected for Evaluation		

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

CHICAGO (ORD)

HOURS OF DELAY: 156,040

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Midway (MDW)	13	4	0			Dep.	Yes	200,000	220,000	(20,000)
Milwaukee (MKE)	57	1	2	1R/19L(5) 1L/19R(5)	7L/25R(5)	Indep.	Yes	300,000	193,000	107,000
Sterling-Rock Falls (SOI)	80							Not Selected for Evaluation		
Rockford (RFD)	58							Not Selected for Evaluation		
Meigs (CGX)	15							Not Selected for Evaluation		
Janesville (JVL)	63							Not Selected for Evaluation		

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

CINCINNATI (CVG) | **HOURS OF DELAY: 23,390**

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000- 7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Lexington (LEX)	63	0	1			No	No		116,000	
Louisvillle (SDF)	69	0	2			Dep.	Yes	200,000	159,000	41,000
Dayton (DAY)	61	0	3	6L/24R(5) 18/36(10)		Indep.	Yes	300,000	190,000	110,000

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

DALLAS/FT. WORTH INTERNATIONAL (DFW) — **HOURS OF DELAY: 90,060**

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000- 7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Dallas (DAL)	8	1	2			Indep.	Yes	300,000	259,000	41,000
Waco (ACT)	73	3	0			Indep.	Yes	300,000	68,000	232,000

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

DENVER (DEN)

HOURS OF DELAY: 158,250

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Colorado Springs (COS)	53	0	3		17L/35R(5)	Indep.	Yes	300,000	169,000	141,000

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

DETROIT (DTW)

HOURS OF DELAY: 57,660

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Flint (FNT)	48	0	2		9R/27L(5)	Dep.	Yes	200,000	139,000	61,000
Lansing (LAN)	67	1	1	10R/28L(5) 14/32(10)		Dep.	Yes	200,000	147,000	53,000
Saginaw (MBS)	85	1	1	14/32(5) 5L/23R(5) 14/32(10)	5R/23L(5)	Dep.	Yes	200,000	55,000	145,000
Detroit (DET)	19	1	0			No	No		169,000	
Toledo (TOL)	42	1	1		16/34(5)	Dep.	Yes	200,000	96,000	104,000
Jackson (JXN)	49							Not Selected for Evaluation		
Battle Creek (BTL)	85							Not Selected for Evaluation		

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

HONOLULU (HNL) **HOURS OF DELAY: 44,540**

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
No Alternate Airports on OAHU Island										

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

HOUSTON (IAH)

HOURS OF DELAY: 29,120

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000- 7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Houston (HOU)	19	2	2	17/35(5)		Indep.	Yes	300,000	280,000	20,000
Beaumont (BPT)	69	2	0	16/34(5)		Dep.	Yes	200,000	56,000	144,000
College Station (CLL)	68							Not Selected for Evaluation		

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

KANSAS CITY (MCI) **HOURS OF DELAY: 25,950**

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Topeka (FOE)	47	0	2			Dep.	Yes	200,000	69,000	131,000
Kansas City (MKC)	6							Not Selected for Evaluation		
Lawrence (3LA)	28							Not Selected for Evaluation		

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

LOS ANGELES (LAX) **HOURS OF DELAY: 61,920**

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Santa Ana (SNA)	31	1	0	1L/19R(5)		No	No		540,000	
Long Beach (LGB)	14	2	1			Indep.	Yes	300,000	397,000	(97,000)
Burbank (BUR)	17	2	0			Dep.	Yes	200,000	236,000	(36,000)
Santa Barbara (SBA)	75	1	0	7/25(5)		No	No		186,000	
Palm Springs (PSP)	99	0	1	12R/30L(5)	12L/30R(5)	No	No		101,000	
San Diego (SAN)	94	0	1			No	No		164,000	
Oxnard (OXR)	42							Not Selected for Evaluation		
Palmdale (PMD)	45	0	2			Indep.	Yes	300,000	85,000	215,000

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

LOS ANGELES (LAX) (Continued) **HOURS OF DELAY: 61,920**

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Los Angeles (Planned)								Unknown		
Los Angeles (Planned)								Unknown		
San Diego (Planned)								Unknown		

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

LAS VEGAS (LAS)

HOURS OF DELAY: 23,660

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Lake Havasu City (Planned)								Unknown		
Lake Havasu City (LHU)	104					No	No			
St. George (SGU)	97					No	No			
Cedar City (CDC)	143					Dep.	Yes	200,000	28,000	172,000

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

MEMPHIS (MEM) **HOURS OF DELAY: 26,950**

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Jackson TN (MKL)	61					No	No			
Tupelo (TUP)	76					No	No			

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

MIAMI (MIA)

HOURS OF DELAY: 41,530

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000- 7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Fort Lauderdale (FLL)	17	2	1			Indep.	Yes	300,000	224,000	76,000
West Palm Beach (PBI)	47	1	1	9L/27R(5)		Dep.	Yes	200,000	225,000	(25,000)
Marathon (MTH)	80							Not Selected for Evaluation		
Marco Island (MKY)	65							Not Selected for Evaluation		

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

MINNEAPOLIS-ST. PAUL (MSP)

HOURS OF DELAY: 43,680

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Rochester (RST)	71	1	1	2/20(5) 13L/31R(5)	13R/31L(5)	Dep.	Yes	200,000	69,000	131,000
Mankato (MKT)	48							Not Selected for Evaluation		
Eau Claire (EAU)	74							Not Selected for Evaluation		
Hayward (HYR)	101							Not Selected for Evaluation		

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

NASHVILLE (BNA) **HOURS OF DELAY: 23,470**

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000- 7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Chattanooga (CHA)	101	1	1			Dep.	Yes	200,000	119,000	81,000
Lexington (LEX)	152	0	1			No	No		116,000	
Louisville (SDF)	130	0	2			Dep.	Yes	200,000	159,000	41,000
Huntsville (HSV)	89	0	2			Indep.	Yes	300,000	71,000	229,000
Muscle Shoals (MSL)	93							Not Selected for Evaluation		

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

NEWARK (EWR) **HOURS OF DELAY: 67,110**

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Trenton (TTN)	38	1	0			No	No		181,000	
Atlantic City (ACY)	76	1	1			Dep.	Yes	200,000	87,000	113,000
Bader (AIY)	81	0	0			No	No		33,000	
Islip (ISP)	48	3	0	6/24(5) 15R/33L(10)	6R/24L(5)	Indep.	Yes	300,000	231,000	69,000
White Plains (HPN)	31	1	0		16R/34L(5)	No	No		212,000	
Newburgh (SWF)	49	1	1			Dep.	Yes	200,000	106,000	94,000
Poughkeepsie (POU)	57	1	0	6/24(5)		No	No		140,000	
Allentown (ABE)	58	1	1		6L/24R(5)	Dep.	Yes	200,000	117,000	83,000
Wilkes Barre (AVP)	77	1	0	4/22(5)		No	Yes		66,000	

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

NEWARK (EWR) (Continued)

HOURS OF DELAY: 67,110

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Reading (RDG)	83	2	0		13L/31R(5)	Dep.	Yes	200,000	115,000	85,000
Lancaster (LNS)	102	1	0			No	No		155,000	
New Haven (HVN)	67	1	0			No	No		143,000	
Belmar (BLM)	30							Not Selected for Evaluation		
East Hampton (HTO)	85							Not Selected for Evaluation		
Farmingdale (FRG)	34							Not Selected for Evaluation		
Bridgeport (BDR)	55							Not Selected for Evaluation		

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

NEW YORK KENNEDY (JFK)

HOURS OF DELAY: 43,770

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Trenton (TTN)	51	1	0			No	No		181,000	
Atlantic City (ACY)	79	1	1			Dep.	No	200,000	87,000	113,000
Bader (AIY)	82	0	0			No	No		33,000	
Islip (ISP)	31	3	0	6/24(5) 15R/33L(10)	6R/24L(5)	Indep.	Yes	300,000	231,000	69,000
White Plains (HPN)	27	1	0		16R/34L(5)	No	No		212,000	
Newburgh (SWF)	55	1	1			Dep.	Yes	200,000	106,000	94,000
Poughkeepsie (POU)	60	1	0	6/24(5)		No	No		140,000	
Allentown (ABE)	76	1	1		6L/24R(5)	Dep.	Yes	200,000	117,000	83,000
Wilkes Barre (AVP)	95	1	0	4/22(5)		No	No		66,000	

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

NEW YORK KENNEDY (JFK) (Continued)

HOURS OF DELAY: 43,770

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Reading (RDG)	100	2	0		13L/31R(5)	Dep.	Yes	200,000	115,000	85,000
Lancaster (LNS)	118	1	0			No	No		155,000	
New Haven (HVN)	55	1	0			No	No		143,000	
Belmar (BLM)	30	0	1			No	No			
East Hampton (HTO)	68							Not Selected for Evaluation		
Farmingdale (FRG)	17							Not Selected for Evaluation		
Bridgeport (BDR)	43							Not Selected for Evaluation		

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

NEW YORK LA GUARDIA (LGA) — **HOURS OF DELAY: 46,990**

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Trenton (TTN)	52	1	0			No	No		181,000	
Atlantic City (ACY)	86	1	1			Dep.	Yes	200,000	87,000	113,000
Bader (AIY)	90	0	0			No	No		33,000	
Islip (ISP)	34	3	0	6/24(5) 15R/33L(10)	6R/24L(5)	Indep.	Yes	300,000	231,000	69,000
White Plains (HPN)	18	1	0		16R/34L(5)	No	No		212,000	
Newburgh (SWF)	44	1	1			Dep.	Yes	200,000	106,000	94,000
Poughkeepsie (POU)	50	1	0	6/24(5)		No	No		140,000	
Allentown (ABE)	72	1	1		6L/24R(5)	Dep.	Yes	200,000	117,000	83,000
Wilkes Barre (AVP)	87	1	0	4/22(5)		No	No		66,000	

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

NEW YORK LA GUARDIA (LGA) (Continued) **HOURS OF DELAY: 46,990**

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Reading (RDG)	98	2	0		13L/31R(5)	Dep.	Yes	200,000	115,000	85,000
New Haven (HVN)	52	1	0			No	No		143,000	
Belmar (BLM)	57							Not Selected for Evaluation		
East Hampton (HTO)	70							Not Selected for Evaluation		
Farmingdale (FRG)	21							Not Selected for Evaluation		
Bridgeport (BDR)	40							Not Selected for Evaluation		

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

ONTARIO (ONT)

HOURS OF DELAY: 22,560

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Bakersfield (BFL)	112	1	0			No	No		115,000	
Palm Springs (PSP)	59	0	1	12R/30L(5)	12L/30R(5)	No	No		101,000	
San Diego (SAN)	81	0	1			No	No		164,000	
Santa Ana (SNA)	25	1	0	1L/19R(5)		No	No		540,000	
Burbank (BUR)	38	2	0	7/25(5)		Dep.	Yes	200,000	236,000	(36,000)
Long Beach (LGB)	30	2	1			Indep.	Yes	300,000	397,000	(97,000)
Oxnard (OXR)	79							Not Selected for Evaluation		
Inyokern (IYK)	96							Not Selected for Evaluation		
Palmdale (PMD)	40	0	2			Indep.	Yes	300,000	85,000	215,000

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

ORLANDO (MCO) **HOURS OF DELAY: 43,550**

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Daytona Beach DAB	47	0	1		6R/24L(5)	No	No		202,000	
Tampa (TPA)	69	1	2	18R/36L(5)		Indep.	Yes	300,000	261,000	39,000
Melbourne (MLB)	40	0	1	9L/27R(5)	9L/27R(5)	No	No		218,000	
St. Petersburg (PIE)	78	2	1	17L/35R(5)		Indep.	Yes	300,000	164,000	136,000
Ocala (OCF)	65							Not Selected for Evaluation		
Vero Beach (VRB)	63							Not Selected for Evaluation		

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

PHILADELPHIA (PHL)

HOURS OF DELAY: 41,690

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000- 7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Allentown (ABE)	51	1	1		6L/24R(5)	Dep.	Yes	200,000	117,000	83,000
Lancaster (LNS)	50	1	0			No	No		155,000	
Reading (RDG)	44	2	0		13L/31R(5)	Dep.	Yes	200,000	115,000	85,000
Harrisburg (MDT)	72	0	1			No	No		176,000	
Trenton (TTN)	31	1	0			No	No		181,000	
Atlantic City (ACY)	39	1	1			Dep.	Yes	200,000	87,000	113,000
Bader (AIY)	47	0	0			No	No		33,000	
Belmar (BLM)	54	0	1			No	No			
Wilmington (ILG)	20	3	0			Dep.	Yes	200,000	176,000	34,000

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

PHOENIX (PHX)

HOURS OF DELAY: 66,170

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Tuscon (TUS)	94	0	3	11L/29R(5) 11R/29L(5)	11R/29L(5)	Dep.	Yes	200,000	238,000	(38,000)
Lake Havasu City (Planned)	137							Unknown		

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

PITTSBURGH (PIT) — **HOURS OF DELAY: 24,490**

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Youngstown (YNG)	54	1	1		14L/32R(5)	Dep.	Yes	200,000	104,000	96,000
Akron (CAK)	61	3	0			Dep.	Yes	200,000	115,000	85,000
Cleveland (CLE)	91	3	1	5L/23R(5) 18/36(5)		Indep.	Yes	300,000	230,000	70,000
Cleveland (BKL)	90	2	0		NE/SW(5)	No	Yes		58,000	
Latrobe (LBE)	39							Not Selected for Evaluation		
Johnstown (JST)	63							Not Selected for Evaluation		
Franklin (FKL)	59							Not Selected for Evaluation		
Dubois (DUJ)	73							Not Selected for Evaluation		
Altoona (ALO)	88							Not Selected for Evaluation		

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

PITTSBURGH (PIT) (Continued) **HOURS OF DELAY: 24,490**

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Morgantown (MGW)	58							Not Selected for Evaluation		
Clarksburg (CKB)	74							Not Selected for Evaluation		

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

RALEIGH-DURHAM (RDU) | **HOURS OF DELAY: 21,610**

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
RDU Greensboro (GSO)	58	1	1	14/32(5)	5L/23R(5)	Indep.	Yes	300,000	149,000	151,000
Fayetteville (FAY)	53	0	1		3R/21L(5)	No	No		68,000	
Kinston (ISO)	67	2	0			Dep.	Yes	200,000	40,000	160,000
Lynchburg (LYH)	85	1	0			No	No		68,000	
Roanoke (ROA)	107	2	0			Dep.	Yes	200,000	134,000	66,000
Winston-Salem (INT)	71							Not Selected for Evaluation		
Greenville (PGY)	69							Not Selected for Evaluation		
Rocky Mount (RWI)	43							Not Selected for Evaluation		
Southern Pines (SOP)	47							Not Selected for Evaluation		

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

SALT LAKE CITY (SLC) — **HOURS OF DELAY: 30,260**

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000- 7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Logan (LGU)	59	3	0			Indep.	Yes	300,000	32,000	268,000

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

SAN JOSE (SJC) **HOURS OF DELAY: 24,320**

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Fresno (FAT)	105	0	1			No	No		201,000	
Monterey (MRY)	48	1	0		10L/28R(5)	No	No			
Stockton (SCK)	45	0	1		11L/29R(5)	No	No			
Oakland (OAK)	26	2	1			Indep.	Yes	300,000	371,000	(71,000)
Sacramento (SMF)	81	0	2		16L/24R(5)	Indep.	Yes	300,000	155,000	145,000
South Lake Tahoe (TVL)	129	0	1			No	No		39,000	
Merced (MCE)	73							Not Selected for Evaluation		
Modesto (MOD)	45							Not Selected for Evaluation		
Santa Rosa (STS)	80							Not Selected for Evaluation		

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

SAN FRANCISCO (SFO)

HOURS OF DELAY: 58,960

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Oakland (OAK)	9	2	1			Indep.	Yes	300,000	371,000	(71,000)
Monterey (MRY)	67	1	0		10L/28R(5)	No	No		99,000	
Stcckton (SCK)	58	0	1		11L/29R(5)	No	No		129,000	
Sacramento (SMF)	73	0	2		16L/24R(5)	Indep.	Yes	300,000	155,000	145,000
Santa Rosa (STS)	56							Not Selected for Evaluation		
Modesto (MOD)	67							Not Selected for Evaluation		

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

SEATTLE (SEA) **HOURS OF DELAY: 24,060**

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000- 7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Yakima (YKM)	92	0	1			No	No		94,000	
Bellingham (BLI)	90	1	0			No	No		42,000	
Portland (PDX)	102	0	3			Indep.	Yes	300,000	221,000	79,000
Wenatchee (EAT)	85							Not Selected for Evaluation		
Eastsound (S17)	79							Not Selected for Evaluation		

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

ST. LOUIS (STL) **HOURS OF DELAY: 59,910**

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Columbia (COU)	81	1	0			No	No		50,000	
Springfield (SPI)	69	2	1			Dep.	Yes	200,000	116,000	84,000
Decatur (DEC)	91	3	0			Indep.	Yes	300,000	71,000	229,000
Jefferson City (JEF)	80							Not Selected for Evaluation		
Mt. Vernon (MVN)	82							Not Selected for Evaluation		
Carbondale (MDH)	87							Not Selected for Evaluation		
Marion MWA)	95							Not Selected for Evaluation		

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

WASHINGTON DULLES (IAD) — **HOURS OF DELAY: 55,310**

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Charlottesville (CHO)	67	1	0			No	No		62,000	
Baltimore (BWI)	39	1	2			Dep.	Yes	200,000	283,000	(83,000)
Hagerstown (HGR)	48					No	No			
Stauton/ Harrisonburg	78					No	No			

POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1996

WASHINGTON NATIONAL (DCA) — **HOURS OF DELAY: 28,800**

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS (YR)		POTENTIAL: DUAL APPROACH WITH PRESENT RUNWAYS		POTENTIAL: OPERATIONS/ YEAR	1986 OPERATIONS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Charlottesville (CHO)	79	1	0			No	No		62,000	
Salisbury (SBY)	78	2	0	14/32(5)		Dep.	Yes	200,000	77,000	113,000
Baltimore (BWI)	25	1	2			Dep.	Yes	200,000	283,000	(83,000)
Hagerstown (HGR)	62					No	No			

APPENDIX F. ACTION PLANS - WILLIAM B. HARTSFIELD ATLANTA INTERNATIONAL AIRPORT AND SAN FRANCISCO INTERNATIONAL AIRPORT

APPENDIX F-1. ACTION PLAN FOR WILLIAM B. HARTSFIELD ATLANTA INTERNATIONAL AIRPORT

RECOMMENDED ACTIONS

Based on the data developed in this study, the Atlanta Task Force recommends the 15 improvements listed in the Action Plan (Table F-1-1).

The proposed recommendations for increasing airport capacity and reducing aircraft delays at ATL are categorized and discussed under the following four headings:

* Airfield Improvements.
* Facilities and Equipment Improvements.
* Air Traffic Control Operational Improvements.
* Airport User Improvements.

Airfield Improvements

1. International concourse. Construction of three of the seven additional gates is underway. Estimated 1987 cost - $20 million.

2. A fifth concourse. This will increase the number of gates from 138 to 173. If the additional concourse is constructed, it is expected that the airlines would add an additional 120 flights. It is estimated that there would be an annual savings in 1996 of $18 million based on reduced ramp congestion and the availability of additional gates. Estimated 1987 cost - $60 million.

   If the fifth concourse is built and no other improvements are made, the additional 120 flights on the existing runways will increase the annual delay by 176,000 hours and will generate additional delay costs of $264 million.

3. A commuter/general aviation terminal and runway complex south of R/W 9R/27L. This will permit commuters and general aviation aircraft to be segregated from other aircraft, generating a significant increase in VFR capacity. It will permit simultaneous instrument approaches to converging runways during weather conditions down to a specific IFR minimum, for example a ceiling of 800 ft. with visibility of two miles. Estimated 1987 cost - $100 million/estimated annual savings in 1996 - $202 million.

   Under the "do nothing" alternative, when weather conditions change from VFR to IFR, the model indicates that arrival delays will increase from 21.2 minutes (1991) demand) to 145 minutes. This delay will occur if no additional capacity is provided and all scheduled flights attempted to land at ATL.

   The construction of the south commuter complex will permit an additional 208 flights and also reduce the average arrival delay from 21.2 minutes to 13.4 minutes under VFR weather conditions. When the weather conditions change from VFR to IFR and if no flights are canceled, the model indicates that arrival delays will increase from 13.4 minutes to 226 minutes. When weather minimums are below 800 feet ceiling and two mile visibility, all of the flights will have to land on the existing runways. As a result of the additional 208 flights, the model indicated that average arrival delays for aircraft operating under IFR conditions will increase by 50 percent.

Airfield Improvements (Continued)

This improvement will provide a significant delay reduction under VFR conditions and only a small delay reduction under IFR conditions where the real capacity improvements are needed.

If a southside terminal is not built and the central terminal is used, annual savings will be reduced by $26 million but a potential derogation of safety might occur as a result of the increased runway crossings.

4. Three hold pads at the ends of departure runways. This will enable aircraft assigned controlled departure times to leave the ramp, taxi to the hold pad and depart at the appropriate time. This improvement will alleviate gate and ramp congestion and also provide the controller with greater flexibility. The pads will provide places to hold aircraft when departure times are changed so controllers would not have to hold entire departure queues. Estimated 1987 costs - $3.3 million.

5. Taxiway C parallel to and west of Taxiway D. This will permit two-way flow of traffic between the north and south runway complexes, relieve congestion on active taxiways and reduce delays. Currently, Taxiway D is the only taxi route between the north and south runway complexes. Estimated 1987 costs - $8 million.

6. Angled exits for commuter aircraft and widen fillets at exits to facilitate their use in either direction. These exits will reduce runway occupancy time for commuter aircraft and allow faster aircraft to land behind the commuters without making "S" turns, erratic speed adjustments or, in some cases, execute missed approaches. Overall benefit will be increased capacity. Cost for this action not available.

Facility and Equipment Improvements

The FAA has a long range plan to improve and enhance the entire United States Air Traffic Control System. The major improvements in this plan are needed immediately at ATL to increase capacity and reduce aircraft delays. The improvements needed now at ATL are:

7. Expedite development and implementation of wake vortex forecasting and avoidance systems. These systems will increase capacity by permitting reduced longitudinal spacing between aircraft when wake vortices present no hazards to following aircraft. Under current conditions, controllers cannot detect the presence of wake vortices. Therefore, to guard against these potential hazards, they maintain increased separations between aircraft.

8. Upgrade NAVAIDS and approach lights on R/W 26R and 27L to Category II. This will permit sustained capacity during periods of low visibility. Currently, controllers must reverse traffic flow from a westerly direction to an easterly direction when weather goes below CAT.I minimal. If this occurs during a peak arrival period, delays will increase at Atlanta and throughout the Air Traffic Control System. Estimated 1987 cost - $3.4 million.

9. Upgrade terminal approach radar. This could reduce controller workload and increase capacity by contributing to reduced separation standards. Estimated 1987 costs - $1.5 million.

10. Upgrade Runway Visual Range (RVR) systems to CAT IIIB and ICAO standards. This type of RVR will enable ATL to continue operations during extremely low visibility conditions. Estimated 1987 cost - 0.25 million.

Facility and Equipment Improvements (Continued)

11. Install Airport Surface Detection Equipment (ASDE) III radar with tracking capability. This will significantly improve airport ground operations during poor visibility and reduce congestion and delays. Estimated 1987 cost - $0.5 million.

12. Install touchdown zone lights on R/W 27L. These lights will lower landing minimums. Touchdown zone lights will permit the same landing minimums on R/W 27L as on R/W 26R. This will sustain capacity during bad weather by allowing two arrival streams to be maintained and thus eliminating the need to change landing directions. Estimated 1987 cost - $0.35 million.

Operational Improvements

13. Reduce arrival separations to 2.5-nmi between similar class, non-heavy aircraft. Reducing longitudinal separation on final approach from 3.0-nmi to 2.5-nmi for these aircraft will increase the arrival acceptance rate and reduce delays (Implemented February 2, 1987). Estimated annual savings in 1996 - $40 million.

14. Enhance traffic management procedures. The concept of traffic management is to control the movement of air traffic in a manner that will minimize delays for system users. Enhancing traffic management procedures will improve the flow of aircraft into and out of the airport. This would produce a maximum acceptance rate with a minimum delay resulting in increased capacity.

Airport User Improvements

15. De-peak airline schedules within the hour. More uniform scheduling for both arrivals and departures within the peak hours will produce a more orderly flow of traffic on the airport surface and reduce congestion. De- peaking offers great potential for immediate and sustained reduction of delays, provided flights are allowed to operate as scheduled by Central Flow Control Estimated annual savings in 1996 - $86.2 million.

TABLE F-1-1. RECOMMENDED IMPROVEMENTS FOR ATLANTA

IMPROVEMENTS	TYPE OF ACTION[1]	TIME FRAME[2]	RESPONSIBLE AGENCY
*<u>Airfield</u>			
(1) International concourse	Achievable	Near Term	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 Term	City
(5) Taxiway C parallel to and west of taxiway D	Achievable	Near Term	City
(6) Angled exits for commuter aircraft; widen fillets at exits to facilitate their use in either direction	Achievable	Near Term	City
*<u>Facilities and Equipment</u>			
(7) Expedite development and installation of wake vortex forecasting and avoidance systems	Systems Policy Change	Long Term	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 Term	FAA
(10) Upgrade RVR System to CAT IIIB and ICAO standards	Achievable	Near Term	FAA
(11) Install ASDE III with tracking	Achievable	Near Term	FAA

TABLE F-1-1. RECOMMENDED IMPROVEMENTS FOR ATLANTA (CONTINUED)

IMPROVEMENTS	TYPE OF ACTION[1]	TIME FRAME[2]	RESPONSIBLE AGENCY
(12) Install touchdown zone lights on R/W 27L	Achievable	Intermediate	City
*Operational Improvements			
(13) Reduce arrival separations to 2.5 nmi	Achievable	Near Term	FAA
(14) Enhance traffic management procedures	Achievable	Near Term	FAA
*User Improvements			
(15) De-peak airline schedules within the hour	Major Policy	Near Term	Airlines

[1] Types of Action: Achievable - Changes or improvements for which benefits have been clearly identified, on which action may already be underway, and which do not require a major policy change by any of the Task Force organizations. Major Policy Change - A change in procedure or operational regulation which 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 in terms of 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 which requires detailed research and evaluation by the Federal Aviation Administration.

[2] Time Frame: Improvement available and producing benefits by 1991 (near term), 1996 (intermediate term) or beyond 1996 (far term).

TABLE F-1-2. ANNUAL DELAY SAVINGS FOR RECOMMENDED ATLANTA IMPROVEMENT

IMPROVEMENTS	SAVINGS[1] 1986	1991	1996
AIRFIELD			
(2) FIFTH CONCOURSE			
Hours (Thousands)		17.1	12.3
Dollars (Millions)		25.7	18.4
(3) COMMUTER/GA TERMINAL AND RUNWAY[2] COMPLEX SOUTH OF RUNWAY 9R/27L			
Hours (Thousands)		119.4	134.7
Dollars (Millions)		179.1	202.1
*Facilities and Equipment			
(7) EXPEDITE DEVELOPMENT AND INSTALLATION OF WAKE FORTEX FORECASTING AND AVOIDANCE SYSTEMS			
Hours (Thousands)	112.7[3]		
Dollars (Millions)	169.1		
*Operational			
(13) REDUCE ARRIVAL SEPARATIONS TO 2.5 NM			
Hours (Thousands)	24.1	26.0	26.5
Dollars (Millions)	36.2	38.9	39.8
*User Improvements			
(15) DE-PEAK AIRLINE SCHEDULES WITHIN THE HOUR			
Hours (Thousands)	47.7	53.6	57.5
Dollars (Millions)	71.6	80.5	86.2

[1] Non additive

[2] Savings computed for weather conditions above 800 ft. ceiling and 2 mile visibility.

[3] Extrapolated from 1980 Task Force Study.

[4] Assumes no new commuter complex on south side.

APPENDIX F-2. ACTION PLAN FOR SAN FRANCISCO INTERNATIONAL AIRPORT

RECOMMENDED IMPROVEMENTS

1. Create holding areas near R/W 10 L/R. Aircraft waiting for gates currently must wait in the taxiway and ramp areas near active runways or in the terminal area. This creates congestion and causes delays for taxiing aircraft and blocked exits off active runways. A holding area near R/W 10 L/R would relieve this congestion and enable aircraft to reach an open gate without taxiing across active runways.

2. Improve noise barrier on R/W 1R. Aircraft departing R/W 1R can't apply full thrust until 600 ft. down the runway because the jet blast would impact freeway traffic. Consequently, all long haul aircraft are prevented from using R/W 1R and must use R/W 28, increasing their taxi time an average five minutes. An improved barrier would reduce delays 1,400 hr./yr. and save $2.6 million annually.

3. Extend R/W 10 L/R. Extending R/W 19 L/R would move the takeoff point from R/W 1 L/R much closer to the intersection of R/W 28 L/R used for arrivals. This would enable controllers to clear aircraft for takeoffs more easily and require less spacing for arrivals. Alternatively, it would permit two departures on each runway instead of the one that now can be accommodated between arrivals on R/W 28. Moreover, when R/W 10 and 19 are active, non-heavy aircraft arriving on R/W 19 could hold short of R/W 10. Benefits would be an annual reduction of 31,500 hr. in delay, reducing cost by more than $57 million.

   It should be noted that extension or construction of any runways into the bay will require in depth environmental studies and approvals. Moreover in the case of R/W 19 at SFO, the touchdown point must be carefully relocated so as not to interfere with the ILS glidepath to OAK R/W 11.

4. Extend R/W 28 L/R. This would permit independent operations of R/W 28 arrivals and R/W departures when a non-heavy jet is arriving on R/W 28 with a hold short of R/W 1. The extension of R/W 28 would move the departure end (R/W 10) close to the intersection with R/W 19, thereby facilitating departures on R/W 10. This would reduce delays by 83,700 hr./yr. and save over $151 million/yr. in delay costs.

5. Construct independent parallel approach runways 4,300 ft. north of R/W 28R. Independent parallel runways, at least 4,300 ft. north of R/W 28R, would substantially reduce IFR delays at SFO, provided the design didn't significantly reduce departures. The new runway complex should also be located east of R/W 1 L/R to permit simultaneous landings on the new, parallel runways and takeoffs and R/W 1 L/R.

   Delays would be reduced 36,900 hr./yr. and savings would amount to $67million/yr. However, the task force couldn't agree on justification for this recommendation due to its great expense and the fact that Oakland is under utilized and could handle increased SFO traffic.

6. Extend taxiway C to threshold of R/W 10L. This would permit separate departure queues for R/W 10R and 10L. It would also facilitate taxiing from and to the west end of the airport.

7. Create high speed exit from R/W 10L between taxiways L and P. The task force recommends completion of this project and quick funding by FAA if sought by the Airport Authority, which is currently evaluating the project

8. Extend taxiway T to taxiway B or A. Also currently under consideration by the Airport Authority, this project should be completed and quickly funded by FAA is requested by the Airport Authority, according to the task force.

9. Expand visual approach. On many days between May and September, when there are clear skies and unlimited visibility on approach, ceilings over the airport are below minimum vectoring altitude of 2,100 ft. Under these conditions, which occur approximately 90 hr./yr., ATC regulations prevent controllers from vectoring aircraft for simultaneous approaches to R/W 28R and 28L. Thus, aircraft must hold for a full instrument approach in VFR conditions incurring approximately 1,450 hr./yr. of aircraft delay resulting in $7.6 million/yr. of increased operating costs. Ironically, controllers could use the simultaneous approach if SFO didn't have a weather reporting service as required by the ATC handbook.

10. Offset instrument approach. The close spacing between R/W 28L and 28R does not permit simultaneous approaches when the ceiling is below 3,500 ft. Providing a parallel ILS approach offset 4,300 ft. from the present approach to R/W 28L would allow simultaneous approaches to be conducted when the ceiling is between 1,500 and 3,500 ft. and visibility is five miles or more. These conditions occur approximately 5% of the time. This improvement would reduce delays by more than 9,200 hr./yr. and save more than $17 million/yr. in operating costs.

11. Use staggered 1-mile divergent IFR departures from R/W 10L/10R. FAA should develop routes and procedures, if possible, that would permit staggered divergent IFR departures from R/W 10L/10R. During the 1.4% of the time aircraft takeoff from R/W 10 under current IFR procedures, significant delays result. These procedures would reduce delays by 6,775 hr./yr. and operating costs by $12.5 million/yr.

12. Install an MLS on R/W 28 and 19. An MLS on R/W 28 would provide precision guidance that could be used to support simultaneous offset or canted approaches to R/W 28 and allow shoreline IFR departures. Its flexibility might also be useful in developing better noise abatement approaches.

    An MLS on R/W 19 could facilitate final approach intercepts in mid-Bay during uncrowded time periods, thereby reducing final approach vectoring. Installation of an MLS would save 27,000 hr./yr. in delays and $49 million/yr. in operating costs. It would also facilitate the vertical separation of approaches to SFO R/W 19 and IFR approaches to OAK R/W 11. This could enhance the combined capacity of the two airports.

13. Taxi aircraft across runways instead of towing. Most airlines now tow aircraft across active runways to maintenance and test areas. Towed aircraft are slower than taxiing aircraft; take longer to cross active runways, and consequently, often block exits off active runways and increase runway occupancy time for arriving aircraft.

14. Distribute SFO traffic more evenly among SFO, SJC, and OAK. Because SFO is the pacing airport, traffic there gets preference during certain periods, aggravating delays at OAK and SJC. The task force believes a more even distribution of traffic among the three Bay Area airports would reduce delays and save a significant amount of money. If the traffic increase for San Francisco were diverted to Oakland, for example, it would produce a savings of $93 million/yr. and reduce delays by 53,000 hours annually.

15. Distribute traffic more uniformly within the hour. Redistributing traffic more uniformly within the hour would reduce SFO delays by more than 6,100 hr./yr. and operating costs by $11.5 million/yr.

16. Divert 50% GA traffic to reliever airports. This action also would reduce delays at SFO by 9,500 hr./yr. and operating costs by $17.6 million/yr. But again the task force couldn't agree on its justifications.

TABLE F-2-1. RECOMMENDED IMPROVEMENTS FOR SAN FRANCISCO

IMPROVEMENTS	ANNUAL SAVINGS[1] ($ MILLIONS/ HOURS, THS.)	TYPE ACTION[2]	TIME FRAME[3]	RESPONSIBLE GROUP
• Airfield				
1. Create holding areas near R/W 10 L/R, 1R and 28R	---/---[4]	Achievable	Near Term	Airport
2. Improve noise barrier for R/W 1R	$2.6/1.4	Achievable	Near Term	Airport
3. Extend R/W 19L/R	$57.1/31.5	Master Plan	Far Term	Airport
4. Extend R/W 28L/R	$151.7/83.7	Master Plan	Far Term	Airport
5. Construct independent, parallel R/W 28	$67.0/36.9	Master Plan	Far Term	Airport
6. Extend taxiway C to threshold R/W 10L	---/---[4]	Achievable	Near Term	Airport
7. Create high speed exit from R/W 10L between taxiways L and P	---/---[4]	Achievable	Near Term	Airport
8. Extend taxiway T to taxiway B or A	---/---[4]	Achievable	Near Term	Airport
• Air Traffic Control Improvements				
9. Expand visual approach procedure	$7.6/4.2	Achievable	Near Term	FAA
10. Offset instrument approach to R/W 28R	$17.1/9.2	Achievable	Near Term	FAA
11. Use staggered, 1-mile divergent IFR departures on R/W 10L/R	$12.5/6.8	Achievable	Near Term	FAA
• Facilities and Equipment				
12. Install Microwave Landing System (MLS) on R/W 28 and 19	$12.5/6.8	Achievable	Near Term	FAA
• User Improvements				
13. Taxi aircraft across active runways instead of towing	---/---[4]	Achievable	Near Term	Carriers
14. Distribute airline traffic more evenly among three airports	$93.0/53.0	Major Policy	Near Term	Carriers
15. Distribute traffic uniformly within the hour	$11.5/6.2	Major Policy	Near Term	Carriers
16. Divert 50% general aviation aircraft to reliever airports	$17.6/9.5	Major Policy	Near Term	Airport

- Improvements Considered But Not Recommended
  1. Construct angled high speed exit for R/W 1; Cost couldn't be justified.
  2. Convert taxiways to STOL runways; Not operational advantageous.
  3. Reduce IFR spacing; Not operationally feasible.

[1] For year implemented (in 1986 dollars).

[2] Types of Action: Achievable - changes or improvements for which benefits have been clearly identified, on which action may already be underway, and which do not require a major policy change by any of the participating Task Force organizations. Major Policy Change - a change in procedure or operational regulation which 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 evaluation in terms of its environmental and economic consequences by groups outisde the task force. System Policy Change - changes that must be implemented concurrently system-wide due to their scope and that require detailed evaluation and research by the Federal Aviation Administration.

[3] Time Frame: Near Term - 1991; Intermediate Term - 1996; Far Term - beyond 1996.

[4] Savings: Figures not available because computer models were not used to simulate effect of the improvement.

APPENDIX G. CAPACITY RELATED AIP GRANTS

G-1 AIP FUNDED CAPACITY RELATED PROJECTS

G-2 COMBINED FY86 & FY87 CAPACITY RELATED GRANTS TO 50 MAJOR AIRPORTS

G-3 COMBINED FY86 & FY87 CAPACITY RELATED GRANTS TO RELIEVER AIRPORTS OF 50 MAJOR AIRPORTS

TABLE G-1 AIP FUNDED CAPACITY RELATED PROJECTS

Runway Construction
Runway Extension
Runway Improvements
Taxiway Construction
Taxiway Extension
Taxiway Improvements
Apron Construction
Apron Expansion
Apron Improvements
Medium/High Intensity Runway Lighting
Rehabilitate Runway Lighting
Runway Centerline Lighting
Rehabilitate Taxiway Lighting
Miscellaneous Lighting Improvements
Instrument Approach Aid
Visual Approach Aid
Miscellaneous NAVAIDS Improvements
Weather Reporting Equipment
Terminal Building Expansions
Terminal Building Improvements
Land for Approaches
Land for Development
Land for Noise Control
Miscellaneous Airport Land

TABLE G-2. COMBINED FY86 & FY87 CAPACITY RELATED GRANTS TO 50 MAJOR AIRPORTS. *

RANK	AIRPORT	CITY	PROJECT	GRANTS($)
1	O'HARE INTERNATIONAL	CHICAGO	RUNWAY IMPROVEMENTS TAXIWAY IMPROVEMENTS RUNWAY LIGHTING MISC. LIGHTING IMPROVEMENTS TOTAL	4,000,000 1,100,000 750,000 1,500,000 7,350,000
2	HARTSFIELD / ATLANTA INTERNATIONAL	ATLANTA	LAND FOR NOISE CONTROL	20,571,428
3	DALLAS - FORT WORTH INTERNATIONAL	DALLAS - FORT WORTH	TAXIWAY CONSTRUCTION	8,100,000
4	NEWARK INTERNATIONAL	NEWARK	TAXIWAY IMPROVEMENTS TAXIWAY EXTENSIONS RUNWAY LIGHTING REHABILITATE TAXIWAY LIGHTING TOTAL	2,000,000 7,984,214 1,000,000 292,600 11,276,814
5	SAN FRANCISCO INTERNATIONAL	SAN FRANCISCO	-------	- 0 -
6	LOS ANGELES INTERNATIONAL	LOS ANGELES	RUNWAY IMPROVEMENTS TAXIWAY IMPROVEMENTS RUNWAY LIGHTING MISC. LIGHTING IMPROVEMENTS LAND FOR NOISE CONTROL TOTAL	7,000,000 4,554,125 330,250 998,250 3,920,000 16,802,625
7	LA GUARDIA	NEW YORK	TAXIWAY EXTENSION TAXIWAY CONSTRUCTION APRON CONSTRUCTION APRON EXPANSION MISC. LIGHTING IMPROVEMENTS TERMINAL BUILDING EXPANSION TOTAL	3,060,000 1,800,000 1,420,000 4,161,538 740,828 5,000,000 16,182,366
8	STAPLETON INTERNATIONAL	DENVER	TAXIWAY CONSTRUCTION APRON CONSTRUCTION APRON IMPROVEMENTS APRON EXPANSION MISC. LIGHTING IMPROVEMENTS TOTAL	5,130,420 8,058,945 1,080,085 2,308,690 32,234 16,610,374
9	LAMBERT - ST. LOUIS INTERNATIONAL	ST. LOUIS	APRON IMPROVEMENTS MISC. LIGHTING IMPROVEMENTS LAND FOR NOISE CONTROL TOTAL	3,787,639 375,000 14,763,658 18,926,297
10	LOGAN INTERNATIONAL	BOSTON	RUNWAY IMPROVEMENTS TAXIWAY CONSTRUCTION TAXIWAY IMPROVEMENTS MISC. LIGHTING IMPROVEMENTS APRON CONSTRUCTION TOTAL	2,104,072 4,535,940 851,358 388,197 3,139,134 11,018,701
11	KENNEDY INTERNATIONAL	NEW YORK	TERMINAL BLDG IMPROVEMENTS RUNWAY IMPROVEMENTS TAXIWAY IMPROVEMENTS REHABILITATE TAXIWAY LIGHTING MISC. LIGHTING IMPROVEMENTS TOTAL	1,700,000 7,500,000 1,500,000 83,003 1,817,655 12,100,658

* RANKED BY TOTAL 1986 AIR CARRIER DELAY (SDRS)

TABLE G-2. COMBINED FY86 & FY87 CAPACITY RELATED GRANTS TO 50 MAJOR AIRPORTS. *

RANK	AIRPORT	CITY	PROJECT	GRANTS($)
12	MIAMI INTERNATIONAL	MIAMI	RUNWAY CONSTRUCTION TAXIWAY CONSTRUCTION MISC. NAVAIDS IMPROVEMENTS TERMINAL BLDG IMPROVEMENTS TOTAL	6,037,799 3,774,501 206,115 318,286 10,336,701
13	MINNEAPOLIS - ST. PAUL INTERNATIONAL	MINNEAPOLIS - ST. PAUL	TAXIWAY CONSTRUCTION TAXIWAY IMPROVEMENTS APRON CONSTRUCTION APRON IMPROVEMENTS RUNWAY IMPROVEMENTS TERMINAL BLDG IMPROVEMENTS MISC. LIGHTING IMPROVEMENTS VISUAL APPROACH AIDS TOTAL	468,750 822,400 648,750 593,939 6,525,000 308,750 93,750 150,000 9,691,389
14	DETROIT METROPOLITAN	DETROIT	TAXIWAY CONSTRUCTION TAXIWAY EXTENSION APRON CONSTRUCTION APRON EXPANSION TOTAL	8,314,245 1,353,185 4,477,718 4,354,255 18,499,403
15	WASHINGTON NATIONAL	WASHINGTON	--------	- 0 -
16	PHOENIX SKY HARBOR	PHOENIX	TAXIWAY CONSTRUCTION TAXIWAY IMPROVEMENTS TAXIWAY EXTENSION MISC. LIGHTING IMPROVEMENTS LAND FOR NOISE CONTROL TOTAL	7,537,164 693,131 493,350 287,468 8,487,790 17,498,903
17	HONOLULU INTERNATIONAL	HONOLULU	RUNWAY IMPROVEMENTS TAXIWAY CONSTRUCTION TAXIWAY IMPROVEMENTS APRON CONSTRUCTION TOTAL	325,287 2,082,350 2,914,063 7,050,840 12,372,540
18	GREATER PITTSBURGH INTERNATIONAL	PITTSBURGH	RUNWAY IMPROVEMENTS APRON CONSTRUCTION MISC. LIGHTING IMPROVEMENTS TOTAL	1,415,000 2,741,523 1,485,000 5,641,523
19	PHILADELPHIA INTERNATIONAL	PHILADELPHIA	RUNWAY IMPROVEMENTS TAXIWAY CONSTRUCTION APRON CONSTRUCTION TOTAL	55,089 100,000 10,695,022 10,850,111
20	MEMPHIS INTERNATIONAL	MEMPHIS	RUNWAY IMPROVEMENTS TAXIWAY CONSTRUCTION TAXIWAY IMPROVEMENTS APRON IMPROVEMENTS TOTAL	152,034 1,899,000 81,167 25,615 2,157,916
21	SEATTLE - TACOMA INTERNATIONAL	SEATTLE	TAXIWAY CONSTRUCTION LAND FOR NOISE CONTROL TOTAL	746,499 10,576,000 11,322,499
22	HOUSTON INTERCONTINENTAL	HOUSTON	RUNWAY IMPROVEMENTS TAXIWAY CONSTRUCTION APRON CONSTRUCTION REHABILITATE RUNWAY LIGHTING TOTAL	2,640,332 269,000 3,480,000 1,756,600 8,145,932

*** RANKED BY TOTAL 1986 AIR CARRIER DELAY (SDRS)**

TABLE G-2. COMBINED FY86 & FY87 CAPACITY RELATED GRANTS TO 50 MAJOR AIRPORTS. *

RANK	AIRPORT	CITY	PROJECT	GRANTS($)
23	SALT LAKE CITY INTERNATIONAL	SALT LAKE CITY	RUNWAY IMPROVEMENTS	2,000,000
			TAXIWAY CONSTRUCTION	2,587,060
			TAXIWAY IMPROVEMENTS	2,999,069
			APRON IMPROVEMENTS	3,297,697
			MISC. LIGHTING IMPROVEMENTS	70,000
			LAND FOR NOISE CONTROL	3,514,269
			TOTAL	14,468,095
24	LAS VEGAS - McCARRAN INTERNATIONAL	LAS VEGAS	TAXIWAY IMPROVEMENTS	1,320,568
			LAND FOR DEVELOPMENT	3,000,000
			LAND FOR NOISE CONTROL	7,611,106
			TOTAL	11,931,674
25	KANSAS CITY INTERNATIONAL	KANSAS CITY	TAXIWAY CONSTRUCTION	60,000
			TAXIWAY IMPROVEMENTS	562,500
			APRON IMPROVEMENTS	832,500
			LAND FOR DEVELOPMENT	390,000
			TOTAL	1,845,000
26	SAN DIEGO INTERNATIONAL	SAN DIEGO	RUNWAY CONSTRUCTION	2,316,199
			TAXIWAY CONSTRUCTION	1,734,901
			TAXIWAY IMPROVEMENTS	577,433
			APRON IMPROVEMENTS	8,454,945
			RUNWAY LIGHTING	221,769
			MISC. LIGHTING IMPROVEMENTS	114,638
			TERMINAL BLDG IMPROVEMENTS	45,000
			TOTAL	13,419,885
27	ORLANDO INTERNATIONAL	ORLANDO	RUNWAY CONSTRUCTION	6,956,323
			TAXIWAY CONSTRUCTION	5,340,811
			LAND FOR NOISE CONTROL	5,674,841
			TOTAL	17,971,975
28	DULLES INTERNATIONAL	WASHINGTON	-------	- 0 -
29	PORT COLUMBUS INTERNATIONAL	COLUMBUS	RUNWAY IMPROVEMENTS	1,615,000
			TAXIWAY IMPROVEMENTS	680'000
			APRON EXPANSION	4,024,524
			LAND FOR NOISE CONTROL	2,434,380
			TOTAL	8,753,904
30	SAN JOSE INTERNATIONAL	SAN JOSE	TAXIWAY EXTENSION	2,142,501
			APRON EXPANSION	2,255,862
			LAND FOR APPROACHES	130,200
				4,503,807
			TOTAL	9,032,370
31	CLEVELAND - HOPKINS INTERNATIONAL	CLEVELAND	TAXIWAY CONSTRUCTION	2,996,691
			TAXIWAY IMPROVEMENTS	2,123,250
			INSTRUMENT APPROACH AID	131,250
				5,499,302
			TOTAL	10,750,493
32	BALTIMORE - WASHINGTON INTERNATIONAL	BALTIMORE	RUNWAY IMPROVEMENTS	3,450,563
			TAXIWAY CONSTRUCTION	587,303
			TAXIWAY EXTENSION	4,729,908
			APRON IMPROVEMENTS	500,00
			APRON EXPANSION	4,656,602
			REHABILITATE RUNWAY LIGHTING	1,798,156
			LAND FOR APPROACHES	2,703,299
			LAND FOR NOISE CONTROL	8,167,082
			TOTAL	26,592,913

*** RANKED BY TOTAL 1986 AIR CARRIER DELAY (SDRS)**

TABLE G-2. COMBINED FY86 & FY87 CAPACITY RELATED GRANTS TO 50 MAJOR AIRPORTS. *

RANK	AIRPORT	CITY	PROJECT	GRANTS($)
33	NASHVILLE METROPOLITAN	NASHVILLE	RUNWAY IMPROVEMENTS	1,169,196
			RUNWAY EXTENSION	230,700
			TAXIWAY CONSTRUCTION	2,265,898
			TAXIWAY IMPROVEMENTS	392,267
			TAXIWAY EXTENSION	230,700
			APRON CONSTRUCTION	3,871,229
			RUNWAY LIGHTING	83,694
			MISC. LIGHTING IMPROVEMENTS	528,061
			MISC. NAVAIDS IMPROVEMENTS	184,567
			TOTAL	8,956,312
34	TAMPA INTERNATIONAL	TAMPA	RUNWAY IMPROVEMENTS	116,000
			TAXIWAY CONSTRUCTION	206,000
			TAXIWAY IMPROVEMENTS	38,000
			APRON CONSTRUCTION	1,885,773
			TERMINAL BUILDING EXPANSION	1,406,436
			TOTAL	3,652,209
35	DAYTON INTERNATIONAL	DAYTON	RUNWAY EXTENSION	645,000
			TAXIWAY IMPROVEMENTS	187,500
			APRON IMPROVEMENTS	262,500
			INSTRUMENT APPROACH AID	42,425
			LAND FOR DEVELOPMENT	1,408,709
			MISC. AIRPORT LAND	533,610
			TOTAL	3,079,744
36	PORTLAND INTERNATIONAL	PORTLAND	TAXIWAY CONSTRUCTION	1,348,893
			TAXIWAY IMPROVEMENTS	166,660
			APRON CONSTRUCTION	1,461,300
			APRON EXPANSION	2,388,395
			TOTAL	5,365,248
37	ONTARIO INTERNATIONAL	ONTARIO	TAXIWAY CONSTRUCTION	1,772,498
			TAXIWAY IMPROVEMENTS	3,141,723
			REHABILITATE RUNWAY LIGHTING	165,750
			MISC. LIGHTING IMPROVEMENTS	114,000
			TOTAL	5,193,971
38	ALBUQUERQUE INTERNATIONAL	ALBUQUERQUE	RUNWAY IMPROVEMENTS	1,593,000
			TAXIWAY CONSTRUCTION	1,080,000
			TOTAL	2,673,000
39	CINCINNATI MUNICIPAL	CINCINNATI	RUNWAY IMPROVEMENTS	1,487,000
			TAXIWAY CONSTRUCTION	157,700
			TOTAL	1,644,700
40	METROPOLITAN OAKLAND INTERNATIONAL	OAKLAND	MISC. LIGHTING IMPROVEMENTS	84,620
			MISC. AIRPORT LAND	30,000
			TOTAL	114,620
41	SAN ANTONIO INTERNATIONAL	SAN ANTONIO	TAXIWAY CONSTRUCTION	210,000
			APRON CONSTRUCTION	4,659,040
			MISC. LIGHTING IMPROVEMENTS	370,000
			TOTAL	5,239,040
42	BRADLEY INTERNATIONAL	WINDSOR LOCKS	TAXIWAY CONSTRUCTION	1,271,250
43	GENERAL MITCHELL INTERNATIONAL	MILWAUKEE	TAXIWAY CONSTRUCTION	1,707,750
			APRON IMPROVEMENTS	942,963
			TOTAL	2,650,713
44	INDIANAPOLIS INTERNATIONAL	INDIANAPOLIS	APRON EXPANSION	1,002,279

*** RANKED BY TOTAL 1986 AIR CARRIER DELAY (SDRS)**

TABLE G-2. COMBINED FY86 & FY87 CAPACITY RELATED GRANTS TO 50 MAJOR AIRPORTS. *

RANK	AIRPORT	CITY	PROJECT	GRANTS($)
45	NEW ORLEANS INTERNATIONAL	NEW ORLEANS	MISC. NAVAIDS IMPROVEMENTS	350,000
46	RALEIGH - DURHAM	RALEIGH	TAXIWAY CONSTRUCTION	1,032,342
			APRON CONSTRUCTION	4,161,415
			MISC. LIGHTING IMPROVEMENTS	196,500
			TOTAL	5,390,257
47	WEST PALM BEACH INTERNATIONAL	WEST PALM BEACH	TAXIWAY CONSTRUCTION	443,000
			APRON CONSTRUCTION	1,206,746
			LAND FOR NOISE CONTROL	3,246,400
			TOTAL	4,896,146
48	AUSTIN MUELLER MUNICIPAL	AUSTIN	RUNWAY IMPROVEMENTS	1,077,000
			TAXIWAY CONSTRUCTION	341,292
			TAXIWAY IMPROVEMENTS	1,512,530
			APRON CONSTRUCTION	1,710,300
			APRON IMPROVEMENTS	210,000
			APRON EXPANSION	810,500
			TOTAL	5,661,622
49	JACKSONVILLE INTERNATIONAL	JACKSONVILLE	TAXIWAY CONSTRUCTION	1,926,337
			TAXIWAY IMPROVEMENTS	3,756,570
			TERMINAL BLDG IMPROVEMENTS	147,300
			TOTAL	5,830,207
50	SACRAMENTO METROPOLITAN	SACRAMENTO	RUNWAY CONSTRUCTION	2,316,199
			TAXIWAY CONSTRUCTION	1,734,901
			TAXIWAY EXTENSION	344,634
			APRON CONSTRUCTION	1,227,563
			RUNWAY LIGHTING	887,018
			MISC. LIGHTING IMPROVEMENTS	379,910
			TOTAL	6,890,225

*** RANKED BY TOTAL 1986 AIR CARRIER DELAY (SDRS)**

TABLE G-3. COMBINED FY86 & FY87 CAPACITY RELATED GRANTS TO RELIEVER AIRPORTS*

AIRPORT RELIEVED: CHICAGO O'HARE

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
AURORA MUNICIPAL	AURORA	APRON IMPROVEMENTS APRON EXPANSION LAND FOR DEVELOPMENT TOTAL	934,069 95,001 92,693 1,121,763
DUPAGE COUNTY	CHICAGO / WEST CHICAGO	APRON IMPROVEMENTS APRON EXPANSION REHABILITATE RUNWAY LIGHTING MISC. LIGHTING IMPROVEMENTS TOTAL	1,297,503 36,954 62,640 125,163 1,522,260
PAL-WAUKEE	CHICAGO/ WHEELING	APRON CONSTRUCTION LAND FOR APPROACHES LAND FOR DEVELOPMENT TOTAL	864,000 684,000 11,860,169 13,408,169
WAUKEGAN MEMORIAL	WAUKEGAN	TAXIWAY IMPROVEMENTS REHABILITATE TAXIWAY LIGHTING TOTAL	618,550 62,000 680,550

AIRPORT RELIEVED: ATLANTA - HARTSFIELD INTERNATIONAL

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
COBB COUNTY - McCOLLUM FIELD	MARIETTA	LAND FOR APPROACHES	39,126
DEKALB - PEACHTREE	ATLANTA	RUNWAY EXTENSION TAXIWAY EXTENSION RUNWAY LIGHTING MISC. LIGHTING IMPROVEMENTS TOTAL	857,549 527,582 16,717 18,260 1,420,108
FULTON COUNTY-BROWN FIELD	ATLANTA	REHABILITATE TAXIWAY LIGHTING MISC. LIGHTING IMPROVEMENTS TOTAL	50,553 9,948 60,501
GWINNET COUNTY - BRISCOE FIELD	LAWRENCEVILLE	RUNWAY CONSTRUCTION LAND FOR DEVELOPMENT TOTAL	4,112,099 3,882,252 7,994,351

*** OF 50 MAJOR AIRPORTS, RANKED BY TOTAL 1986 AIR CARRIER DELAY (SDRS)**

AIRPORT RELIEVED: DALLAS - FORT WORTH INTERNATIONAL

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
DENTON MUNICIPAL	DENTON	TAXIWAY CONSTRUCTION APRON CONSTRUCTION TOTAL	148,450 54,000 202,450
FORT WORTH - MEACHAM	FORT WORTH	MISC. LIGHTING IMPROVEMENTS	45,000
LANCASTER	LANCASTER	RUNWAY CONSTRUCTION TAXIWAY CONSTRUCTION APRON IMPROVEMENTS APRON EXPANSION TOTAL	1,104,505 421,510 248,000 478,210 2,252,225
McKINNEY MUNICIPAL	McKINNEY	RUNWAY CONSTRUCTION LAND FOR DEVELOPMENT INSTRUMENT APPROACH AID TOTAL	1,374,200 825,800 860,000 3,060,000
SOUTH FORT WORTH (NEW)	FORT WORTH	RUNWAY CONSTRUCTION TAXIWAY CONSTRUCTION APRON CONSTRUCTION RUNWAY LIGHTING MISC. LIGHTING IMPROVEMENTS LAND FOR DEVELOPMENT TOTAL	1,663,250 2,181,531 286,753 57,457 23,980 87,750 4,300,721
REDBIRD	DALLAS	RUNWAY EXTENSION TAXIWAY EXTENSION TOTAL	3,222,000 1,281,807 4,503,807

AIRPORT RELIEVED: NEWARK INTERNATIONAL

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
ESSEX COUNTY	CALDWELL	TAXIWAY CONSTRUCTION APRON CONSTRUCTION TOTAL	563,940 346,670 910,610
MORRISTOWN MUNICIPAL	MORRISTOWN	TAXIWAY IMPROVEMENTS	748,977
TETERBORO	TETERBORO	RUNWAY IMPROVEMENTS	1,665,946

AIRPORT RELIEVED: SAN FRANCISCO INTERNATIONAL

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
SAN CARLOS	SAN CARLOS	MISC. LIGHTING IMPROVEMENTS	66,600
HALF MOON BAY	HALF MOON BAY	APRON CONSTRUCTION	202,500

AIRPORT RELIEVED: LOS ANGELES INTERNATIONAL

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
EL MONTE	EL MONTE	APRON CONSTRUCTION APRON IMPROVEMENTS MISC. LIGHTING IMPROVEMENTS TOTAL	40,000 202,950 5,000 247,950
HAWTHORNE	HAWTHORNE	APRON IMPROVEMENTS APRON CONSTRUCTION TOTAL	777,570 20,000 797,570

AIRPORT RELIEVED: DENVER STAPLETON INTERNATIONAL

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
JEFFERSON COUNTY	DENVER	RUNWAY EXTENSIONS	563,940
		TAXIWAY IMPROVEMENTS	346,670
		TAXIWAY EXTENSIONS	910,610
		APRON IMPROVEMENTS	425,000
		RUNWAY LIGHTING	53,000
		MISC. LIGHTING IMPROVEMENTS	103,000
		MISC. NAVAIDS IMPROVEMENTS	355,500
		TOTAL	2,325,000
CENTENNIAL	DENVER	RUNWAY IMPROVEMENTS	626,000
		TAXIWAY CONSTRUCTION	113,480
		TAXIWAY IMPROVEMENTS	1,578,481
		APRON CONSTRUCTION	50,000
		APRON IMPROVEMENTS	886,980
		REHAB. RUNWAY LIGHTING	116,200
		MISC. LIGHTING IMPROVEMENTS	305,542
		LAND FOR DEVELOPMENT	274,000
		TOTAL	3,950,683
FRONT RANGE	DENVER	TAXIWAY CONSTRUCTION	50,000
		APRON CONSTRUCTION	450,000
		HIGH INTENSITY RUNWAY LGHTNG.	144,703
		INSTRUMENT APPROACH AID	912,240
		LAND FOR APPROACHES	571,466
		LAND FOR DEVELOPMENT	193,500
		TOTAL	2,321,909

AIRPORT RELIEVED: ST. LOUIS - LAMBERT INTERNATIONAL

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
SPIRIT OF ST. LOUIS	ST. LOUIS	RUNWAY IMPROVEMENTS	766,082
		TAXIWAY IMPROVEMENTS	522,151
		APRON IMPROVEMENTS	60,000
		REHABILITATE RUNWAY LIGHTING	90,000
		TOTAL	1,438,233

AIRPORT RELIEVED: BOSTON LOGAN INTERNATIONAL

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
HANSCOM FIELD	BEDFORD	MISC. LIGHTING IMPROVEMENTS	451,716
BEVERLY MUNICIPAL	BEVERLY	RUNWAY IMPROVEMENTS	87,900
		APRON IMPROVEMENTS	57,680
		APRON CONSTRUCTION	269,100
		TOTAL	414,680

AIRPORT RELIEVED: MIAMI INTERNATIONAL

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
OPA LOCKA	MIAMI	APRON IMPROVEMENTS	1,039,308

AIRPORT RELIEVED: MINNEAPOLIS - ST. PAUL INTERNATIONAL

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
SOUTH ST. PAUL MUNICIPAL	SOUTH ST. PAUL	TAXIWAY CONSTRUCTION TAXIWAY EXTENSION VISUAL APPROACH AID LAND FOR APPROACHES TOTAL	150,300 156,600 39,600 85,500 432.000
ST. PAUL DOWNTOWN - HOLMAN FIELD	ST. PAUL	RUNWAY EXTENSION TAXIWAY CONSTRUCTION TAXIWAY EXTENSION RUNWAY LIGHTING MISC. LIGHTING IMPROVEMENTS VISUAL APPROACH AID TOTAL	545,506 677,612 218,636 32,287 275,903 125,020 1,874,964

AIRPORT RELIEVED: DETROIT METROPOLITAN

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
WILLOW RUN	DETROIT	RUNWAY IMPROVEMENTS TAXIWAY IMPROVEMENTS TOTAL	2,136,290 984,769 3,121,059
GROSSE ILE MUNICIPAL	DETROIT	TAXIWAY IMPROVEMENTS APRON IMPROVEMENTS TOTAL	100,000 785,000 885,000
MONROE CUSTER	MONROE	APRON IMPROVEMENTS APRON EXPANSION MISC. LIGHTING IMPROVEMENTS LAND FOR APPROACHES TOTAL	5,000 368,000 8,000 95,000 476,000
OACKLAND - PONTIAC	PONTIAC	RUNWAY IMPROVEMENTS TAXIWAY IMPROVEMENTS APRON IMPROVEMENTS LAND FOR DEVELOPMENT TOTAL	117,500 98,700 233,500 170,300 600,000

AIRPORT RELIEVED: WASHINGTON NATIONAL

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
HYDE FIELD	CLINTON, MD	TAXIWAY CONSTRUCTION LAND FOR APPROACHES TOTAL	211,183 1,322,207 1,533,390
MONTGOMERY COUNTY AIRPARK	GAITHERSBURG, MD	TAXIWAY IMPROVEMENTS APRON CONSTRUCTION APRON IMPROVEMENTS TOTAL	1,343,229 243,000 486,000 2,072,229
LEESBURG MUNICIPAL	LEESBURG, VA	RUNWAY IMPROVEMENTS RUNWAY EXTENSION TAXIWAY EXTENSION APRON IMPROVEMENTS RUNWAY LIGHTING MISC. NAVAIDS IMPROVEMENTS LAND FOR DEVELOPMENT LAND FOR APPROACHES TOTAL	176,400 760,950 159,550 526,116 67,500 18,000 93,600 909,101 2,711,217
MANASSAS MUNICIPAL	MANASSAS, VA	TAXIWAY CONSTRUCTION APRON IMPROVEMENTS TOTAL	344,525 315,000 659,525

AIRPORT RELIEVED: PHOENIX SKY HARBOR INTERNATIONAL

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
CHANDLER MUNICIPAL	CHANDLER	LAND FOR DEVELOPMENT	6,000,000
GLENDALE MUNICIPAL	GLENDALE	APRON CONSTRUCTION MISC. LIGHTING IMPROVEMENTS LAND FOR DEVELOPMENT TOTAL	381,709 195,801 196,667 774,177
GOODYEAR MUNICIPAL	GOODYEAR	RUNWAY IMPROVEMENTS TAXIWAY IMPROVEMENTS TOTAL	744,360 39,176 783,536
FALCON FIELD	MESA	TAXIWAY IMPROVEMENTS REHABILITATE RUNWAY LIGHTING TOTAL	195,199 341,475 536,674
DEER VALLEY	PHOENIX	RUNWAY EXTENSION TAXIWAY CONSTRUCTION TAXIWAY EXTENSION RUNWAY LIGHTING VISUAL APPROACH AID TOTAL	500,000 125,000 325,000 35,000 80,000 1,065,000
SCOTTSDALE MUNICIPAL	SCOTTSDALE	APRON CONSTRUCTION RUNWAY LIGHTING MISC. LIGHTING IMPROVEMENTS TOTAL	554,629 23,813 108,627 687,069

AIRPORT RELIEVED: GREATER PITTSBURGH INTERNATIONAL

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
BEAVER COUNTY	BEAVER	TAXIWAY IMPROVEMENTS	155,400
		APRON CONSTRUCTION	200,000
		APRON IMPROVEMENTS	150,000
		LAND FOR APPROACHES	102,000
		TOTAL	607,400
BUTLER COUNTY	BUTLER	APRON EXPANSION	246,320
		LAND FOR APPROACHES	90,000
		TOTAL	336,320
ROSTRAVER	MONONGAHELA	RUNWAY IMPROVEMENTS	306,000
		TAXIWAY IMPROVEMENTS	217,000
		APRON IMPROVEMENTS	83,600
		TOTAL	606,600
WASHINGTON COUNTY	WASHINGTON	RUNWAY EXTENSION	1,080,000
		RUNWAY IMPROVEMENTS	266,000
		TAXIWAY CONSTRUCTION	420,000
		MISC. LIGHTING IMPROVEMENTS	31,000
		INSTRUMENY APPROACH AID	718,000
		TOTAL	2,515,000

AIRPORT RELIEVED: PHILADELPHIA INTERNATIONAL

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
CHESTER COUNTY	COATESVILLE	RUNWAY IMPROVEMENTS	84,010
		RUNWAY EXTENSION	706,840
		MISC. LIGHTING IMPROVEMENTS	70,600
		LAND FOR APPROACHES	181,440
		TOTAL	1,042,890
NEW GARDEN FLYING FIELD	TOUGHKENAMOM	LAND FOR APPROACHES	72,000
POTTSTOWN LIMERICK	POTTSTOWN	TAXIWAY CONSTRUCTION	450,000
BRANDYWINE	WEST CHESTER	APRON IMPROVEMENTS	283,296
		APRON EXPANSION	175,000
		MISC. LIGHTING IMPROVEMENTS	19,700
		TOTAL	477,996
SUMMIT AIRPARK	MIDDLETOWN, DE	APRON EXPANSION	373,206
		REHABILITATE RUNWAY LIGHTING	105,000
		MISC. LIGHTING IMPROVEMENTS	5,000
		TOTAL	483,206

AIRPORT RELIEVED: MEMPHIS INTERNATIONAL

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
GENERAL DEWITT SPAIN	MEMPHIS	RUNWAY IMPROVEMENTS	152,304
		TAXIWAY IMPROVEMENTS	81,167
		APRON IMPROVEMENTS	25,615
		TOTAL	259,086
CHARLES W. BAKER	MILLINGTON	RUNWAY IMPROVEMENTS	114,617
		TAXIWAY IMPROVEMENTS	59,284
		APRON IMPROVEMENTS	23,714
		TOTAL	197,615

AIRPORT RELIEVED: SEATTLE - TACOMA INTERNATIONAL

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
AUBURN MUNICIPAL	AUBURN	APRON CONSTRUCTION MISC. LIGHTING IMPROVEMENTS TOTAL	220,475 23,120 243,595
SNOHOMISH COUNTY/ PAINE FIELD	EVERETT	RUNWAY CONSTRUCTION TAXIWAY CONSTRUCTION TAXIWAY EXTENSION APRON CONSTRUCTION RUNWAY LIGHTING MISC. LIGHTING IMPROVEMENTS LAND FOR DEVELOPMENT TOTAL	466,524 333,212 1,576,800 500,000 150,000 180,000 81,000 2,787,536
BOEING FIELD	SEATTLE	TAXIWAY IMPROVEMENTS LAND FOR DEVELOPMENT TOTAL	669,694 958,985 1,628,679

AIRPORT RELIEVED: HOUSTON INTERCONTINENTAL

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
MONTGOMERY COUNTY	CONROE	RUNWAY IMPROVEMENTS TAXIWAY IMPROVEMENTS REHABILITATE RUNWAY LIGHTING INSTRUMENT APPROACH AID MISC. NAVAIDS IMPROVEMENTS TOTAL	515,600 236,200 48,200 745,000 15,000 1,560,000
LAPORTE MUNICIPAL	LAPORTE	TAXIWAY CONSTRUCTION APRON CONSTRUCTION TOTAL	245,810 101,780 347,590

AIRPORT RELIEVED: SALT LAKE CITY INTERNATIONAL

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
SALT LAKE CITY MUNICIPAL	SALT LAKE CITY	TAXIWAY CONSTRUCTION	129,000

AIRPORT RELIEVED: MCCARRAN INTERNATIONAL

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
NORTH LAS VEGAS AIR TERMINAL	LAS VEGAS	LAND FOR DEVELOPMENT	15,000,000

AIRPORT RELIEVED: KANSAS CITY INTERNATIONAL

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
DOWNTOWN	KANSAS CITY	RUNWAY IMPROVEMENTS	870,270
		TAXIWAY CONSTRUCTION	934,150
		TAXIWAY IMPROVEMENTS	804,100
		MISC. LIGHTING IMPROVEMENTS	307,000
		INSTRUMENT APPROACH AID	315,000
		TOTAL	3,230,520
RICHARDS - GEBAUR	KANSAS CITY	RUNWAY IMPROVEMENTS	1,808,532
		TAXIWAY IMPROVEMENTS	3,034,304
		TOTAL	4,842,836
MCCOMAS - LEE'S SUMMIT MUNICIPAL	LEE'S SUMMIT	RUNWAY IMPROVEMENTS	855,800
		TAXIWAY EXTENSION	451,200
		RUNWAY LIGHTING	74,131
		LAND FOR DEVELOPMENT	163,800
		TOTAL	1,544,931

AIRPORT RELIEVED: ORLANDO INTERNATIONAL

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
ORLANDO EXECUTIVE	ORLANDO	REHABILITATE RUNWAY LIGHTING	266,600
SANFORD	SANFORD	RUNWAY IMPROVEMENTS	497,000

AIRPORT RELIEVED: SAN JOSE MUNICIPAL

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
SOUTH COUNTY	SAN MARTIN	TAXIWAY CONSTRUCTION	965,000

AIRPORT RELIEVED: PORT COLUMBUS INTERNATIONAL

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
BOLTON FIELD	COLUMBUS	RUNWAY IMPROVEMENTS	395,500
		APRON IMPROVEMENTS	127,198
		MISC. LIGHTING IMPROVEMENTS	10,000
		MISC. NAVAIDS IMPROVEMENTS	67,752
		TOTAL	600,450
OHIO STATE UNIVERSITY	COLUMBUS	TAXIWAY CONSTRUCTION	547,912
		MISC. LIGHTING IMPROVEMENTS	90,000
		TOTAL	637,912

AIRPORT RELIEVED: CLEVELAND - HOPKINS INTERNATIONAL

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
LOST NATION MUNICIPAL	WILLOUGHBY	RUNWAY EXTENSION	833,000
		TAXIWAY IMPROVEMENTS	492,750
		TOTAL	2,019,250
			3,345,000
FREEDOM FIELD	MEDINA	LAND FOR DEVELOPMENT	1,035,000
		LAND FOR APPROACHES	555,733
		TOTAL	1,590,733

AIRPORT RELIEVED: BALTIMORE - WASHINGTON INTERNATIONAL

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
GLENN L. MARTIN STATE	BALTIMORE	TAXIWAY IMPROVEMENTS	90,000
		APRON IMPROVEMENTS	200,000
		MISC. NAVAIDS IMPROVEMENTS	313,712
		TOTAL	603,712
FREDERICK MUNICIPAL	FREDERICK	RUNWAY CONSTRUCTION	1,170,000

AIRPORT RELIEVED: TAMPA INTERNATIONAL

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
LAKELAND MUNICIPAL	LAKELAND	TAXIWAY IMPROVEMENTS APRON IMPROVEMENTS VISUAL APPROACH AID MISC. NAVAIDS IMPROVEMENTS TOTAL	377,290 205,735 12,120 17,460 612,605
ALBERT WHITTED	ST. PETERSBURG	TAXIWAY IMPROVEMENTS RUNWAY LIGHTING REHABILITATE RUNWAY LIGHTING MISC. LIGHTING IMPROVEMENTS VISUAL APPROACH AID TOTAL	103,116 110,130 126,414 25,884 22,792 388,336
VANDENBERG	TAMPA	RUNWAY IMPROVEMENTS TAXIWAY CONSTRUCTION TAXIWAY IMPROVEMENTS APRON CONSTRUCTION APRON IMPROVEMENTS APRON EXPANSION REHABILITATE RUNWAY LIGHTING MISC. LIGHTING IMPROVEMENTS VISUAL APPROACH AID LAND FOR DEVELOPMENT LAND FOR APPROACHES MISC. AIRPORT LAND TOTAL	375,127 421,266 252,900 48,443 44,014 185,177 49,835 24,282 8,200 522,812 193,059 573,350 2,698,465

AIRPORT RELIEVED: PORTLAND INTERNATIONAL

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
MULINO	MULINO	TAXIWAY EXTENSION RUNWAY LIGHTING TOTAL	690,000 180,000 870,000
PORTLAND - HILLSBORO	HILLSBORO	RUNWAY IMPROVEMENTS APRON CONSTRUCTION TOTAL	100,000 20,000 120,000

AIRPORT RELIEVED: ONTARIO INTERNATIONAL

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
RIALTO MUNICIPAL	RIALTO	TAXIWAY EXTENSION RUNWAY LIGHTING MISC. LIGHTING IMPROVEMENTS LAND FOR DEVELOPMENT LAND FOR APPROACHES TOTAL	145,000 75,000 75,00 2,500,000 500,000 3,295,000
RIVERSIDE MUNICIPAL	RIVERSIDE	RUNWAY IMPROVEMENTS LAND FOR DEVELOPMENT TOTAL	216,000 358,000 574,000

AIRPORT RELIEVED: ALBUQUERQUE INTERNATIONAL

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
DOUBLE EAGLE II	ALBUQUERQUE	TAXIWAY CONSTRUCTION APRON EXPANSION MISC. LIGHTING IMPROVEMENTS TOTAL	638,260 97,740 9,720 745,720

AIRPORT RELIEVED: OAKLAND INTERNATIONAL

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
HAYWARD AIR TERMINAL	HAYWARD	RUNWAY IMPROVEMENTS TAXIWAY IMPROVEMENTS TAXIWAY EXTENSION TOTAL	617,000 148,000 104,000 869,000
LIVERMORE MUNICIPAL	LIVERMORE	TAXIWAY EXTENSION LAND FOR APPROACHES TOTAL	0056,548 3,293,452 3,350,000
NAPA COUNTY	NAPA	TAXIWAY CONSTRUCTION TAXIWAY EXTENSION TOTAL	380,527 380,527 761,054

AIRPORT RELIEVED: SAN ANTONIO INTERNATIONAL

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
STINSON MUNICIPAL	SAN ANTONIO	RUNWAY IMPROVEMENTS APRON IMPROVEMENTS APRON EXPANSION TOTAL	418,000 691,930 459,000 1,568,930

AIRPORT RELIEVED: WINDSOR LOCKS BRADLEY

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
HARTFORD BRAINARD	HARTFORD	MISC. LIGHTING IMPROVEMENTS	128,700

AIRPORT RELIEVED: MILWAUKEE - MITCHELL FIELD

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
KENOSHA MUNICIPAL	KENOSHA	RUNWAY CONSTRUCTION TAXIWAY CONSTRUCTION APRON CONSTRUCTION RUNWAY LIGHTING MISC. LIGHTING IMPROVEMENTS INSTRUMENT APPROACH AID VISUAL APPROACH AID AIRPORT LAND TOTAL	1,877,900 1,400,900 731,300 111,500 192,000 440,000 51,490 2,000 4,807,090
HORLICK - RACINE	RACINE	LAND FOR APPROACHES	170,000
WAUKESHA COUNTY	WAUKESHA	RUNWAY IMPROVEMENTS TAXIWAY IMPROVEMENTS RUNWAY LIGHTING MISC. LIGHTING IMPROVEMENTS LAND FOR APPROACHES TOTAL	448,200 167,400 100,000 83,600 1,990,600 2,789,800

AIRPORT RELIEVED: INDIANAPOLIS INTERNATIONAL

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
EAGLE CREEK AIRPARK	INDIANAPOLIS	LAND FOR DEVELOPMENT	416,250
GREENWOOD MUNICIPAL	INDIANAPOLIS	RUNWAY IMPROVEMENTS	191,719
		RUNWAY LIGHTING	50,861
		MISC. LIGHTING IMPROVEMENTS	14,270
		MISC. NAVAIDS IMPROVEMENTS	9,420
		LAND FOR DEVELOPMENT	803,160
		LAND FOR APPROACHES	471,600
		TOTAL	1,541,030
INDIANAPOLIS TERRY	INDIANAPOLIS	RUNWAY IMPROVEMENTS	953,600
		REHABILITATE RUNWAY LIGHTING	172,200
		MISC. LIGHTING IMPROVEMENTS	43,800
		LAND FOR APPROACHES	202,000
		TOTAL	1,371,600
METROPOLITAN	INDIANAPOLIS	RUNWAY EXTENSION	730,900
		TAXIWAY IMPROVEMENTS	568,653
		APRON IMPROVEMENTS	44,022
		VISUAL APPROACH AID	30,000
		MISC. NAVAIDS IMPROVEMENTS	5,000
		LAND FOR DEVELOPMENT	728,303
		TOTAL	2,106,878

AIRPORT RELIEVED: NEW ORLEANS INTERNATIONAL

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
LAKEFRONT	NEW ORLEANS	RUNWAY IMPROVEMENTS	889,000
		RUNWAY EXTENSION	554,000
		TAXIWAY EXTENSION	218,000
		RUNWAY LIGHTING	198,000
		TOTAL	1,859,000
CBD HELIPORT	NEW ORLEANS	APRON IMPROVEMENTS	18,600
		MISC. LIGHTING IMPROVEMENTS	80,700
		MISC. NAVAIDS IMPROVEMENTS	15,000
		TOTAL	114,300
ST. JOHN PARISH (NEW)	RESERVE	RUNWAY CONSTRUCTION	574,000
		TAXIWAY CONSTRUCTION	38,000
		APRON CONSTRUCTION	187,000
		RUNWAY LIGHTING	69,000
		MISC. NAVAIDS IMPROVEMENTS	13,000
		TOTAL	881,000

AIRPORT RELIEVED: RALIEGH - DURHAM

RELIEVER AIRPORT	CITY	PROJECT	GRANTS ($)
PERSONS COUNTY (NEW)	ROXBORO	RUNWAY CONSTRUCTION	500,000
		RUNWAY LIGHTING	59,119
		LIGHTING IMPROVEMENTS	78,714
		VISUAL APPROACH AID	34,560
		TOTAL	672,393

APPENDIX H. AIRPORTS: ENPLANEMENTS & OPERATIONS LEVELS - CY 1986

H-1 **TOP 50 AIRPORTS RANKED BY 1986 TOTAL PASSENGER ENPLANEMENTS**

H-2 **TOP 50 TOWERED AIRPORTS RANKED BY 1986 AIRCRAFT OPERATIONS**

TABLE H-1. TOP 50 AIRPORTS RANKED BY 1986 TOTAL PASSENGER ENPLANEMENTS

RANK	AIRPORT	TOTAL ENPLANEMENTS (000s) [1]	PERCENT OF TOTAL [2]	CUMULATIVE PERCENT
1	CHICAGO O'HARE	26,106	6.0	6.0
2	ATLANTA HARTSFIELD	22,572	5.1	11.1
3	LOS ANGELES INTERNATIONAL	20,120	4.5	15.6
4	DALLAS - FORT WORTH	19,988	4.5	20.6
5	DENVER STAPLETON	16,787	3.7	23.8
6	NEWARK INTERNATIONAL	14,873	3.3	27.1
7	SAN FRANCISCO INTERNATIONAL	13,620	3.0	30.1
8	NEW YORK KENNEDY	13,269	2.9	33.0
9	NEW YORK LA GUARDIA	11,058	2.4	35.4
10	BOSTON LOGAN INTERNATIONAL	10,811	2.4	37.8
11	MIAMI INTERNATIONAL	10,752	2.4	40.2
12	ST. LOUIS INTERNATIONAL	10,205	2.3	42.5
13	HONOLULU INTERNATIONAL	9,023	2.0	44.5
14	DETROIT METROPOLITAN	8,880	1.9	46.4
15	MINNEAPOLIS - ST. PAUL	8,471	1.9	48.3
16	GREATER PITTSBURGH INTERNATIONAL	7,966	1.7	50.0
17	PHOENIX SKY HARBOR	7,840	1.7	51.7
18	SEATTLE - TACOMA INTERNATIONAL	7,066	1.5	53.2
19	HOUSTON INTERCONTINENTAL	7,036	1.5	54.7
20	WASHINGTON NATIONAL	6,960	1.5	56.2
21	PHILADELPHIA INTERNATIONAL	6,388	1.4	57.6
22	ORLANDO INTERNATIONAL	6,258	1.4	59.0
23	LAS VEGAS - McCARRAN	6,066	1.3	60.3
24	CHARLOTTE	5,999	1.3	61.6
25	SALT LAKE CITY	4,797	1.0	62.6
26	TAMPA INTERNATIONAL	4,775	1.0	63.6
27	SAN DIEGO INTERNATIONAL	4,606	1.0	64.6
28	MEMPHIS INTERNATIONAL	4,471	1.0	65.6
29	WASHINGTON DULLES INTERNATIONAL	4,442	1.0	66.6
30	BALTIMORE - WASHINGTON INTERNATIONAL	4,402	1.0	67.6
31	KANSAS CITY INTERNATIONAL	4,133	1.0	68.5

TABLE H-1. TOP 50 AIRPORTS RANKED BY 1986 TOTAL PASSENGER ENPLANEMENTS (CONTINUED)

RANK	AIRPORT	TOTAL ENPLANEMENTS (000s) [1]	PERCENT OF TOTAL [2]	CUMULATIVE PERCENT
32	FORT LAUDERDALE	3,931	0.9	69.4
33	HOUSTON HOBBY	3,730	0.8	70.2
34	CLEVELAND HOPKINS	3,322	0.7	70.9
35	NEW ORLEANS INTERNATIONAL	3,257	0.7	71.6
36	SAN JUAN INTERNATIONAL	2,936	0.6	72.2
37	SAN JOSE INTERNATIONAL	2,823	0.6	72.8
38	DALLAS LOVE FIELD	2,735	0.6	73.4
39	PORTLAND INTERNATIONAL	2,518	0.5	73.9
40	CINCINNATI	2,370	0.5	74.4
41	SAN ANTONIO INTERNATIONAL	2,325	0.5	74.9
42	NASHVILLE METROPOLITAN	2,280	0.5	75.4
43	DAYTON INTERNATIONAL	2,224	0.5	75.9
44	KAHULUI	2,211	0.5	76.4
45	ALBUQUERQUE INTERNATIONAL	2,179	0.5	76.9
46	INDIANAPOLIS INTERNATIONAL	2,129	0.5	77.4
47	ONTARIO INTERNATIONAL	2,071	0.5	77.9
48	WINDSOR LOCKS BRADLEY	2,068	0.5	78.4
49	WEST PALM BEACH INTERNATIONAL	2,058	0.5	78.9
50	SANTA ANA	1,997	0.4	79.3

1. INCLUDES U.S. CERTIFIED ROUTE CARRIERS, FORIEGN AIR CARRIERS, SUPPLEMENTALS, AIR COMMUTERS AND AIR TAXIS.
2. BASED ON 441 MILLION ENPLANEMENTS AT 543 AIRPORTS WITH 2,500 OR MORE ENPLANEMENTS IN 1986

TABLE H-2 TOP 50 TOWERED AIRPORTS RANKED BY 1986 AIRCRAFT OPERATIONS

RANK	AIRPORT	TOTAL OPERATIONS (000s) [1]	PERCENT OF TOTAL [2]	CUMULATIVE PERCENT
1	CHICAGO O'HARE INTERNATIONAL	794.4	1.3	1.3
2	ATLANTA HARTSFIELD INTERNATIONAL	787.4	1.3	2.6
3	LOS ANGELES INTERNATIONAL	580.1	1.0	3.6
4	DALLAS - FORT WORTH INTERNATIONAL	575.9	1.0	4.6
5	SANTA ANA	552.7	0.9	5.5
6	DENVER STAPLETON	524.8	0.9	6.4
7	VAN NUYS	477.6	0.8	7.2
8	ST. LOUIS - LAMBERT INTERNATIONAL	458.2	0.8	8.0
9	SAN FRANCISCO INTERNATIONAL	430.1	0.7	8.7
10	BOSTON LOGAN INTERNATIONAL	424.2	0.7	9.4
11	PHOENIX SKY HARBOR	416.6	0.7	10.1
12	NEWARK INTERNATIONAL	413.6	0.7	10.8
13	DETROIT METROPOLITAN	412.9	0.7	11.5
14	LONG BEACH	410.5	0.7	12.2
15	SEATTLE BOEING	404.4	0.7	12.9
16	MINNEAPOLIS - ST. PAUL INTERNATIONAL	399.5	0.7	13.7
17	PONTIAC	392.7	0.7	14.3
18	OAKLAND INTERNATIONAL	387.6	0.6	14.9
19	MEMPHIS INTERNATIONAL	382.1	0.6	15.5
20	PHILADELPHIA INTERNATIONAL	378.4	0.6	16.1
21	HONOLULU INTERNATIONAL	367.3	0.6	16.7
22	NEWARK LAGUARDIA	365.9	0.6	17.3
23	GREATER PITTSBURGH INTERNATIONAL	365.9	0.6	17.9
24	LAS VEGAS - McCARRAN INTERNATIONAL	364.9	0.6	18.5
25	CHARLOTTE	359.5	0.6	19.1
26	DENVER ARAPAHOE COUNTY	358.7	0.6	19.7
27	MIAMI INTERNATIONAL	351.2	0.6	20.3
28	SAN JOSE MUNICIPAL	350.5	0.6	20.9

TABLE H-2 TOP 50 TOWERED AIRPORTS RANKED BY 1986 AIRCRAFT OPERATIONS (CONTINUED)

RANK	AIRPORT	TOTAL OPERATIONS (000s) [1]	PERCENT OF TOTAL [2]	CUMULATIVE PERCENT
29	WASHINGTON NATIONAL	325.8	0.5	21.4
30	NEW YORK KENNEDY	316.9	0.5	21.9
31	TAMIAMI	316.9	0.5	22.4
32	HOUSTON INTERCONTINENTAL	297.8	0.5	22.9
33	ANCHORAGE MERRILL	296.3	0.5	23.4
34	FORT WORTH MEACHAM	289.8	0.5	23.9
35	BALTIMORE - WASHINGTON INTERNATIONAL	285.0	0.5	24.4
36	WASHINGTON DULLES INTERNATIONAL	284.6	0.5	24.9
37	NEW ORLEANS	280.1	0.4	25.3
38	HOUSTON HOBBY	277.9	0.4	25.7
39	SALT LAKE CITY INTERNATIONAL	276.5	0.4	26.1
40	HAYWARD	267.5	0.4	26.5
41	TETERBORO	264.1	0.4	26.9
42	SEATTLE TACOMA INTERNATIONAL	260.0	0.4	27.3
43	TAMPA INTERNATIONAL	253.3	0.4	27.7
44	CALDWELL	252.5	0.4	28.1
45	NASHVILLE METROPOLITAN	252.3	0.4	28.5
46	ATLANTA DEKALB	251.2	0.4	28.9
47	DALLAS LOVE FIELD	247.7	0.4	29.3
48	TORRANCE MUNICIPAL	243.4	0.4	29.7
49	CONCORD	241.9	0.4	30.1
50	COLUMBUS INTERNATIONAL	241.5	0.4	30.5

1. ALL DEPARTURES PERFORMED BY MILITARY, GENERAL AVIATION, AND AIR CARRIER AIRCRAFT.
2. BASED ON 59 MILLION OPERATIONS AT 399 FAA-OPERATED AIR TRAFFIC CONTROL TOWERS.

SOURCE: FAA AIR TRAFFIC ACTIVITY, 1986.

APPENDIX I AIRPORT DIAGRAMS

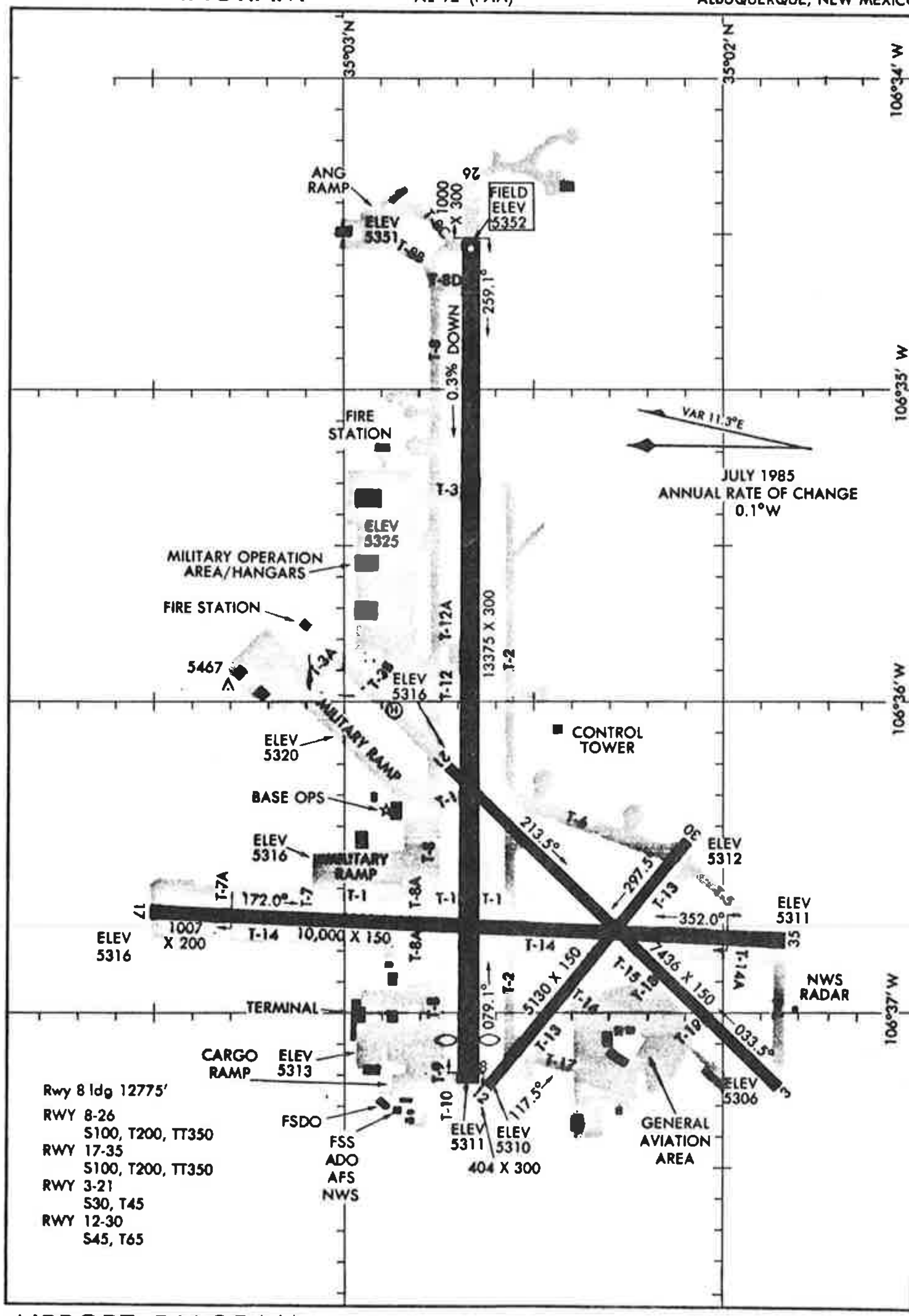
LISTING OF AIRPORT DIAGRAMS

87239

AIRPORT DIAGRAM

AL-12 (FAA)

ALBUQUERQUE INTERNATIONAL (ABQ)
ALBUQUERQUE, NEW MEXICO

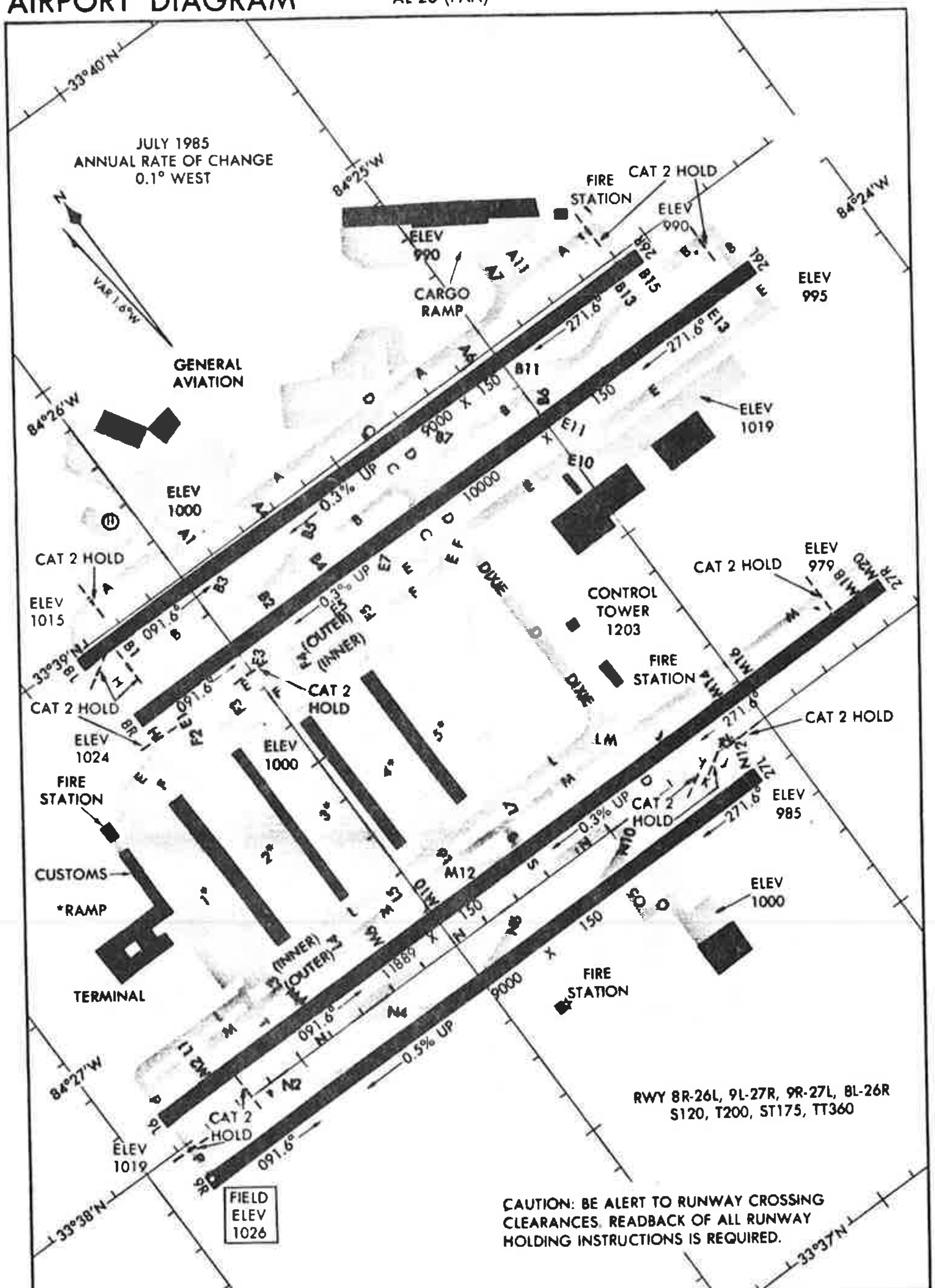


AIRPORT DIAGRAM

ALBUQUERQUE, NEW MEXICO
ALBUQUERQUE INTERNATIONAL (ABQ)

AIRPORT DIAGRAM ATLANTA/THE WILLIAM B. HARTSFIELD ATLANTA INTL (ATL)

AL-26 (FAA) ATLANTA, GEORGIA



AIRPORT DIAGRAM ATLANTA, GEORGIA

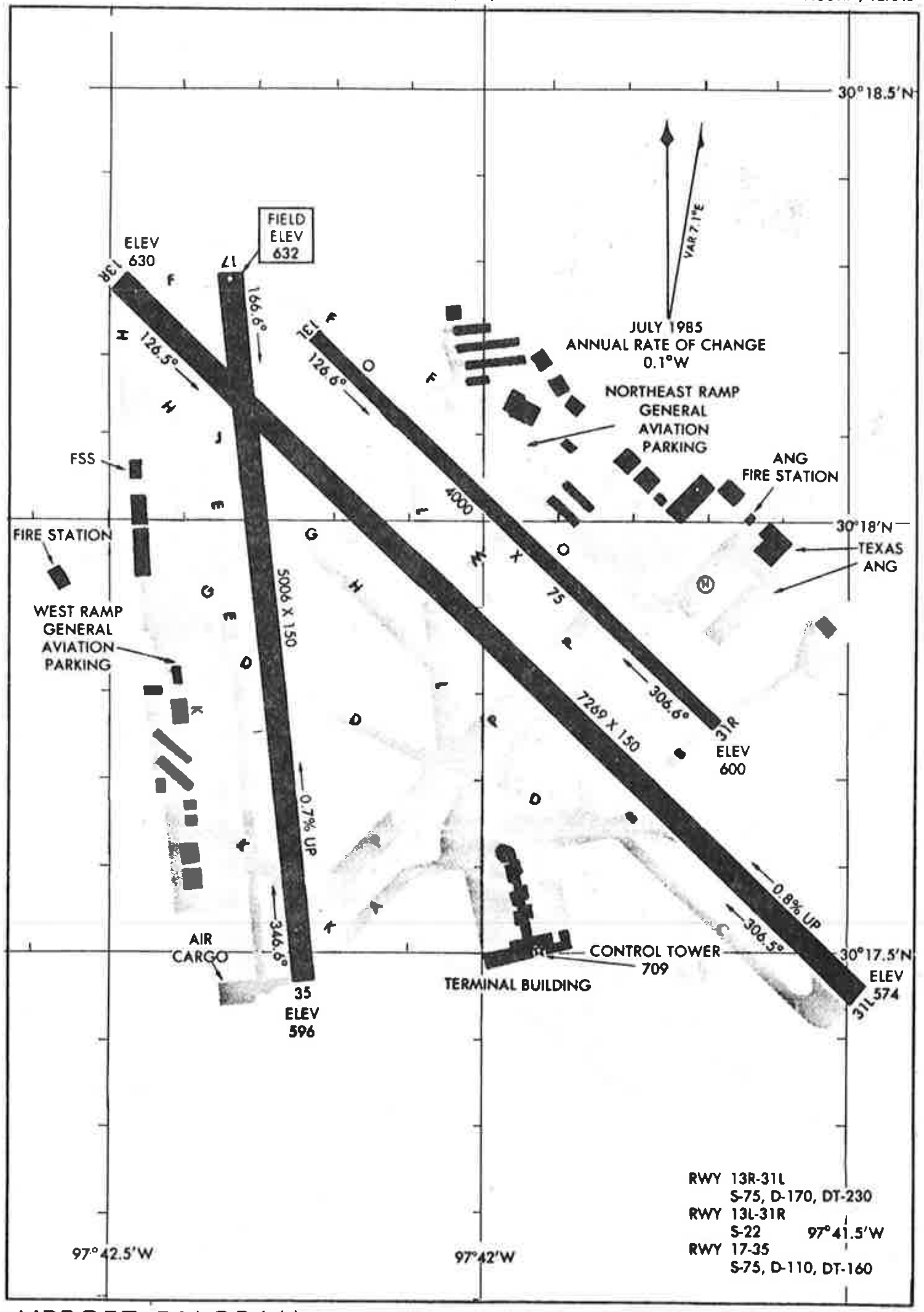
ATLANTA/THE WILLIAM B. HARTSFIELD ATLANTA INTL(ATL)

87239

AIRPORT DIAGRAM

AL-30 (FAA)

AUSTIN/ROBERT MUELLER MUNICIPAL (AUS)
AUSTIN, TEXAS



AIRPORT DIAGRAM

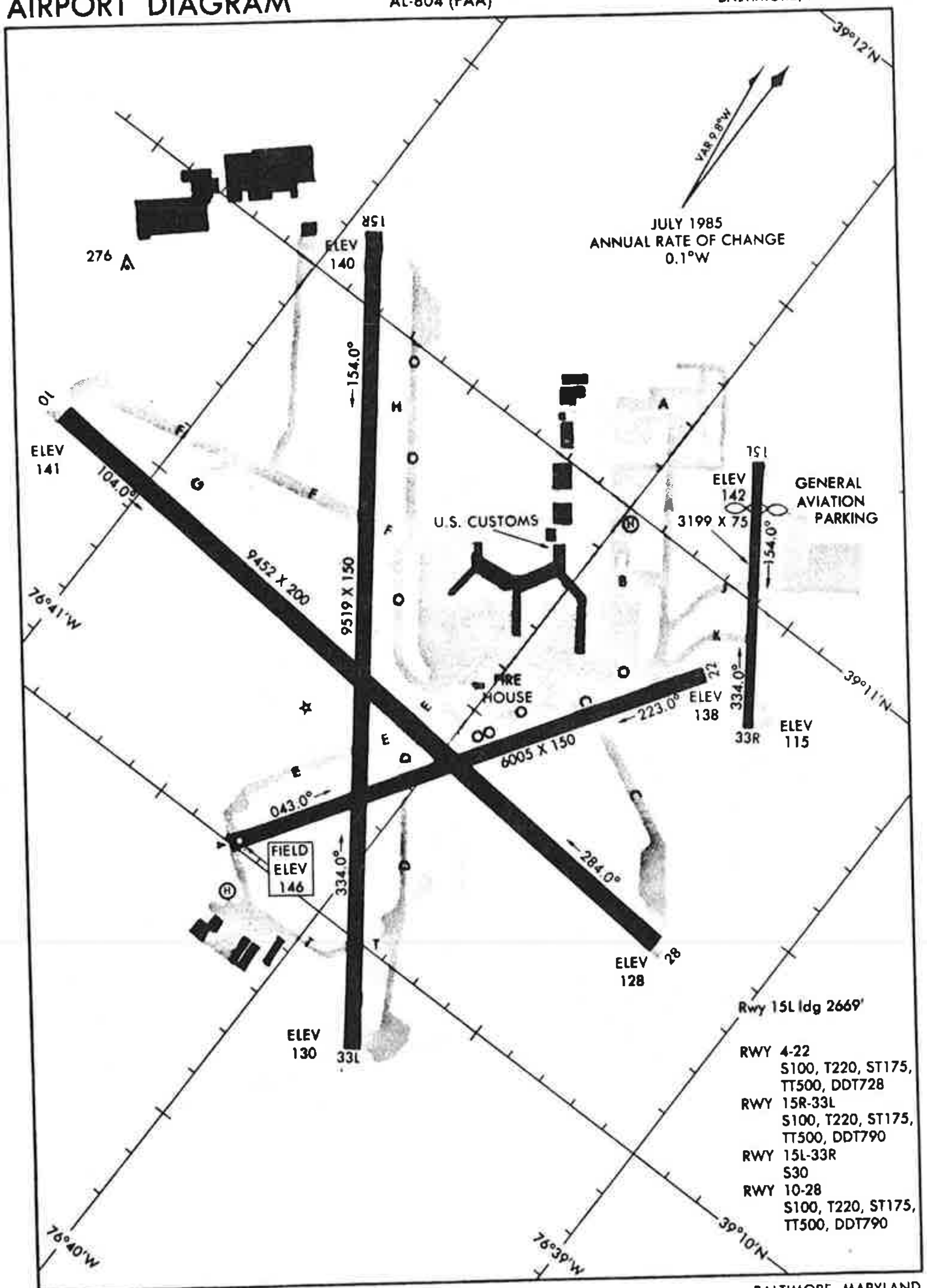
AUSTIN, TEXAS
AUSTIN/ROBERT MUELLER MUNICIPAL (AUS)

87239

AIRPORT DIAGRAM

AL-804 (FAA)

BALTIMORE-WASHINGTON INTL (BWI)
BALTIMORE, MARYLAND



BALTIMORE, MARYLAND

AIRPORT DIAGRAM

BALTIMORE-WASHINGTON INTL (BWI)

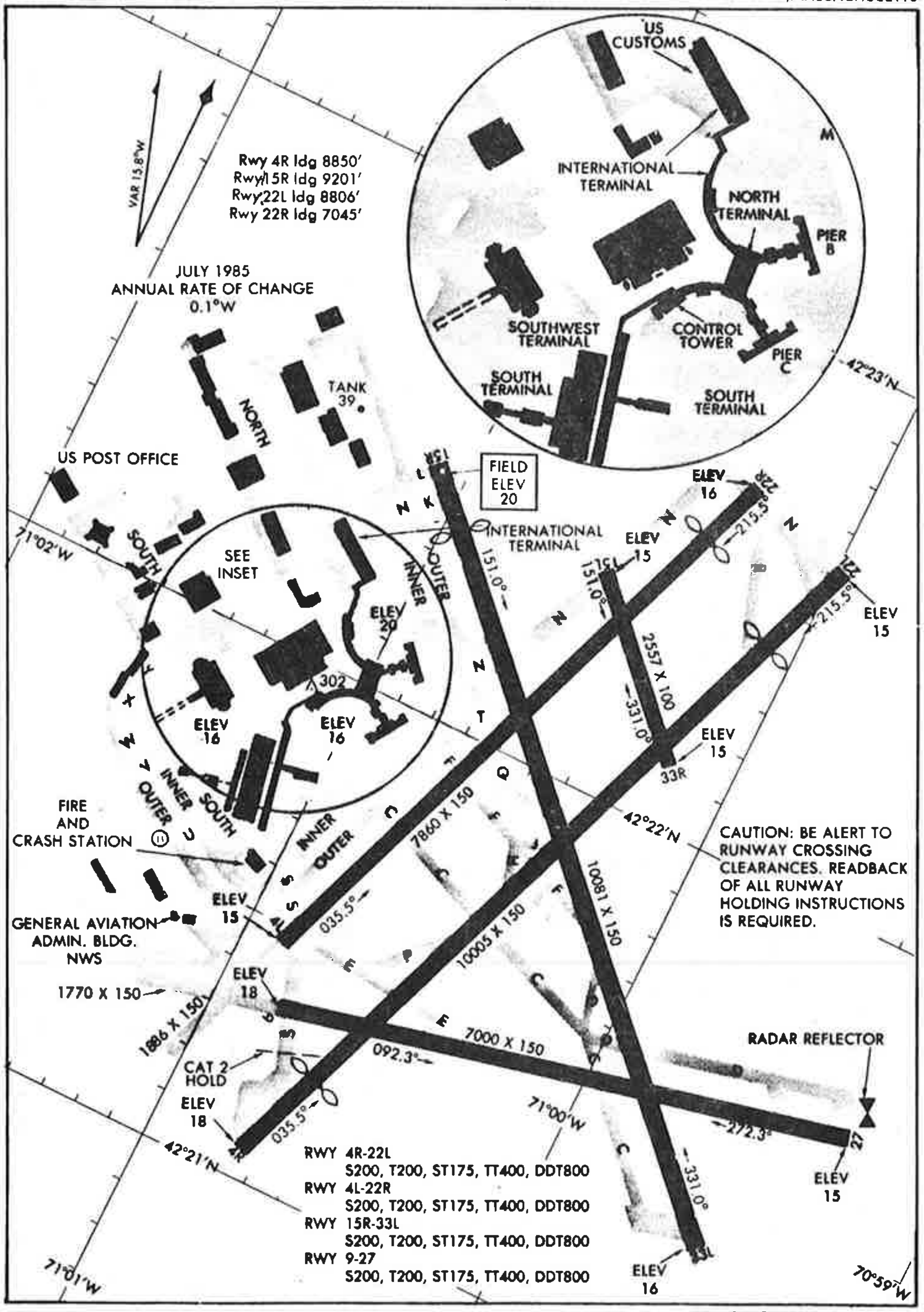
87295

AIRPORT DIAGRAM

BOSTON/GENERAL EDWARD LAWRENCE LOGAN INTL (BOS)

AL-58 (FAA)

BOSTON, MASSACHUSETTS



RWY 4R-22L
S200, T200, ST175, TT400, DDT800
RWY 4L-22R
S200, T200, ST175, TT400, DDT800
RWY 15R-33L
S200, T200, ST175, TT400, DDT800
RWY 9-27
S200, T200, ST175, TT400, DDT800

AIRPORT DIAGRAM

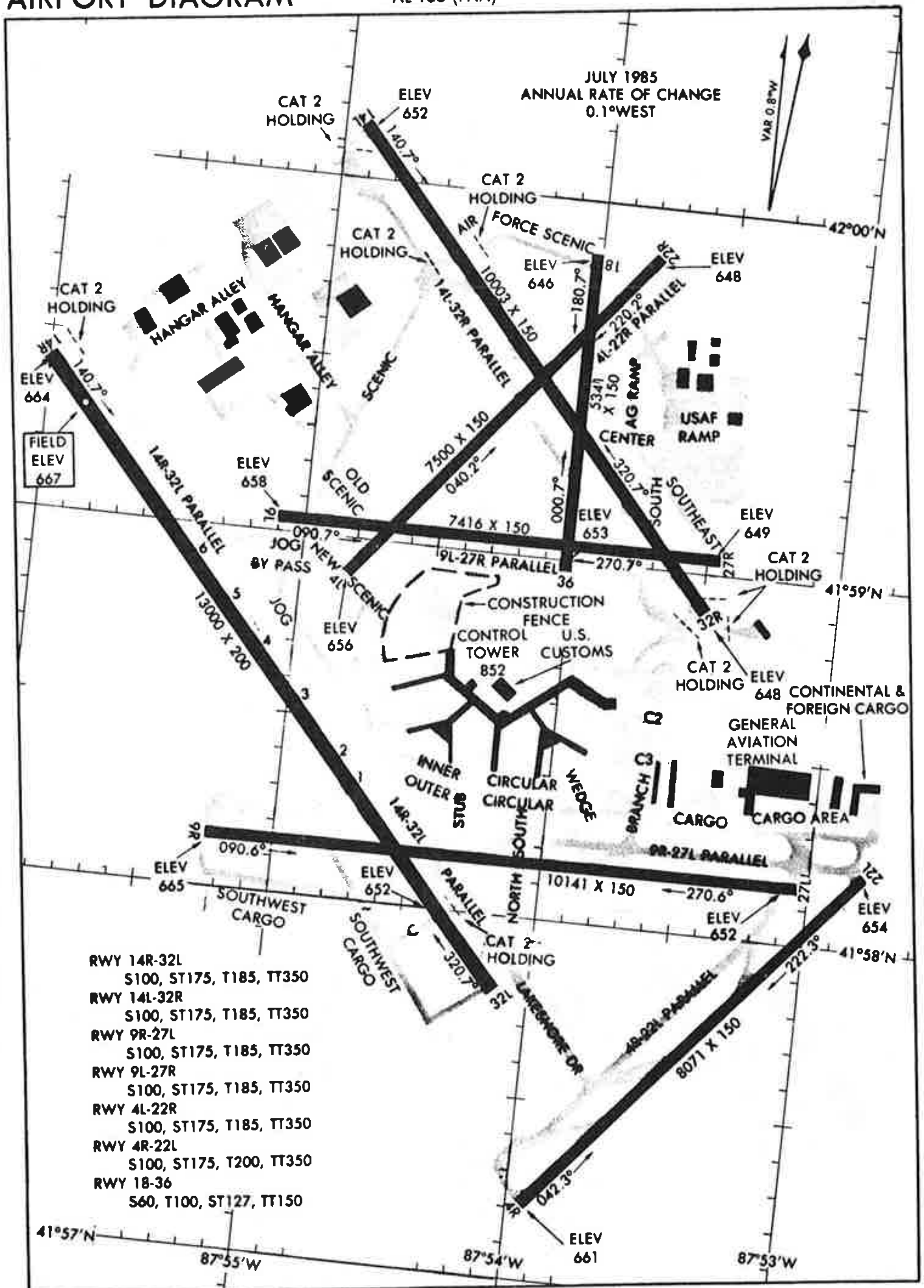
BOSTON, MASSACHUSETTS

BOSTON/GENERAL EDWARD LAWRENCE LOGAN INTL (BOS)

AIRPORT DIAGRAM

AL-166 (FAA)

CHICAGO-O'HARE INTL (ORD)
CHICAGO, ILLINOIS



AIRPORT DIAGRAM

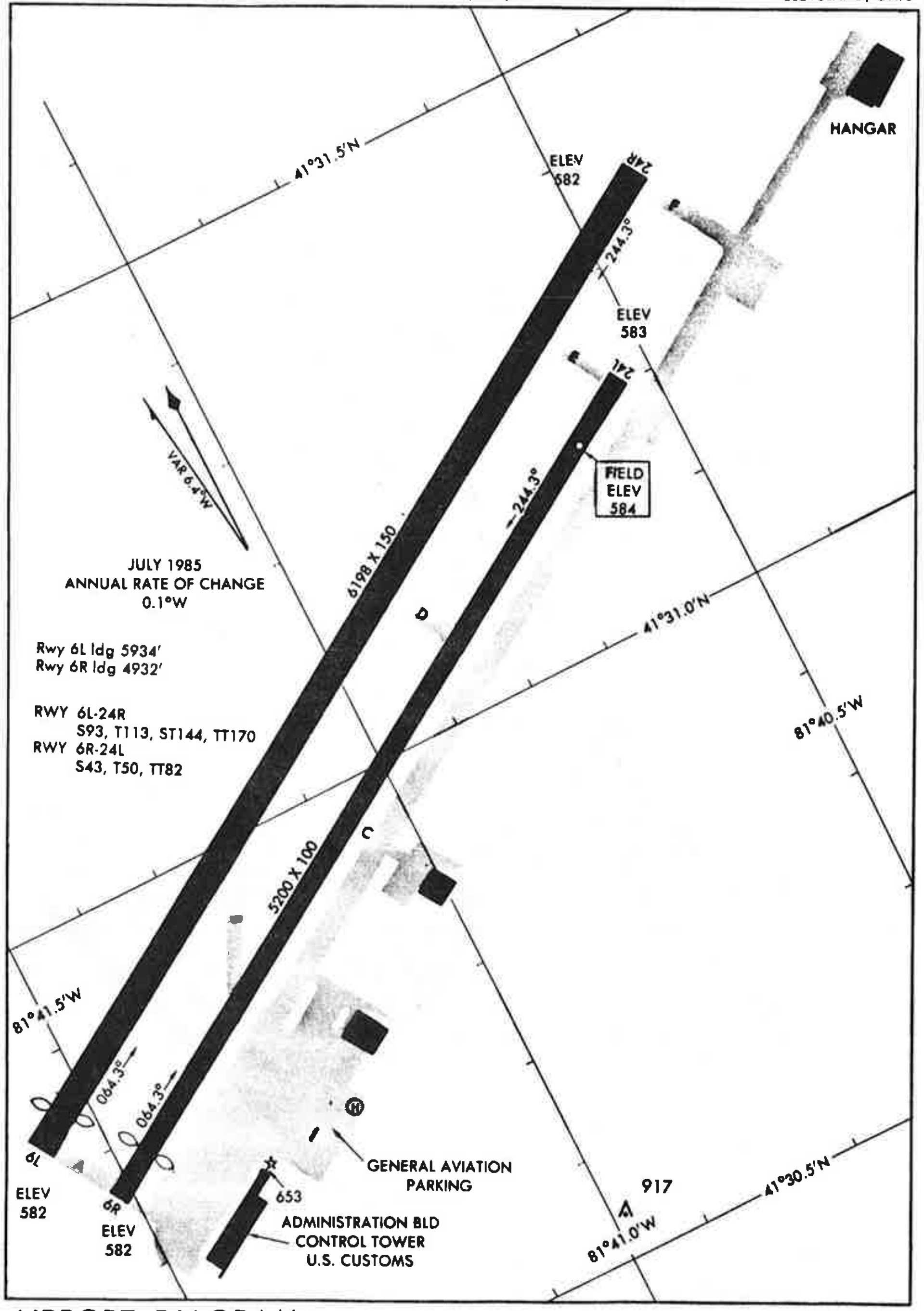
CHICAGO, ILLINOIS
CHICAGO-O'HARE INTL (ORD)

87295

AIRPORT DIAGRAM

AL-5370 (FAA)

CLEVELAND/BURKE LAKEFRONT (BKL)
CLEVELAND, OHIO



AIRPORT DIAGRAM

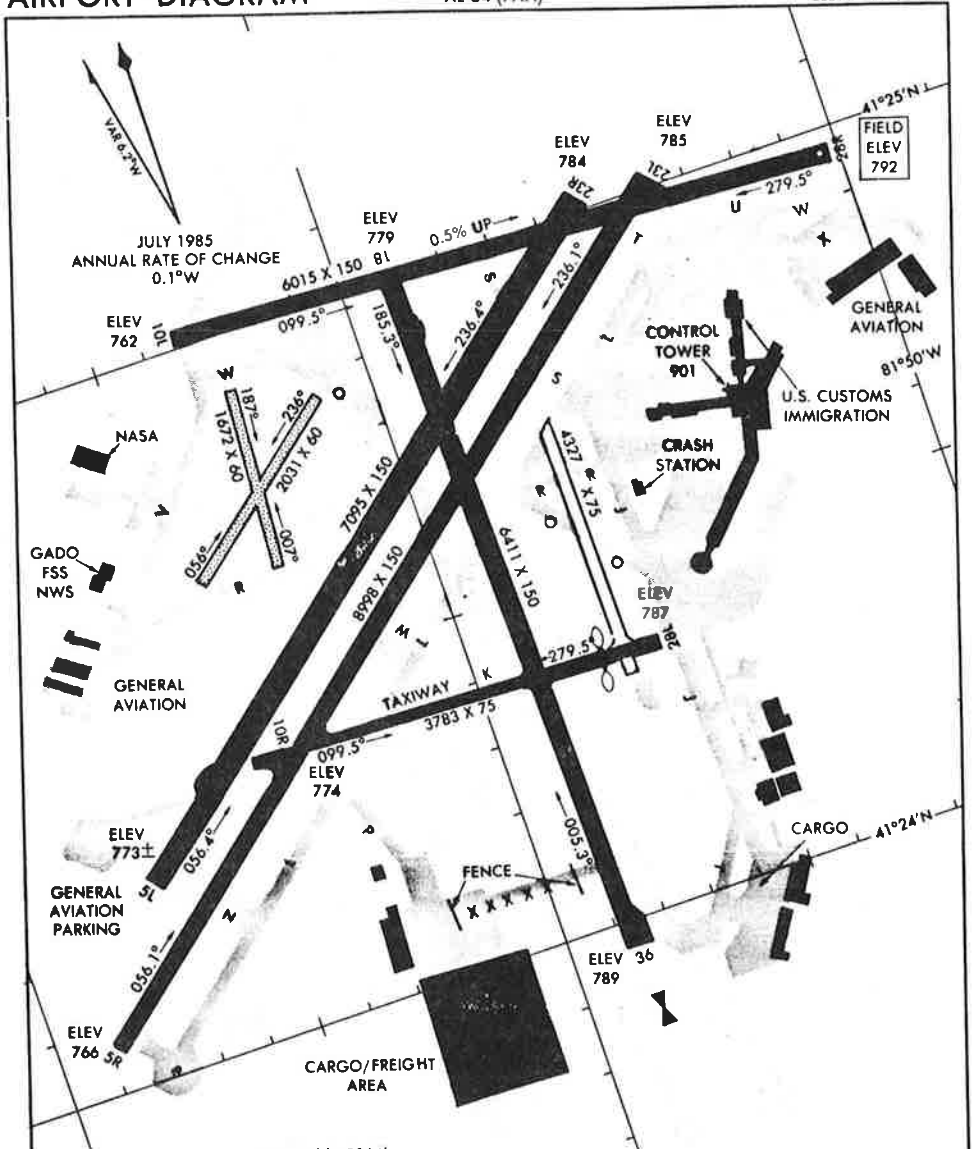
CLEVELAND, OHIO
CLEVELAND/BURKE LAKEFRONT (BKL)

87351

AIRPORT DIAGRAM

AL-84 (FAA)

CLEVELAND-HOPKINS INTL (CLE)
CLEVELAND, OHIO



Rwy 28L ldg 3264'

RWY 5R-23L, 18-36
S100, T170, ST175, TT287

RWY 5L-23R
S100, T155, ST175, TT260

RWY 10L-28R
S100, T147, ST175, TT230

RWY 10R-28L
S32

AIRPORT DIAGRAM

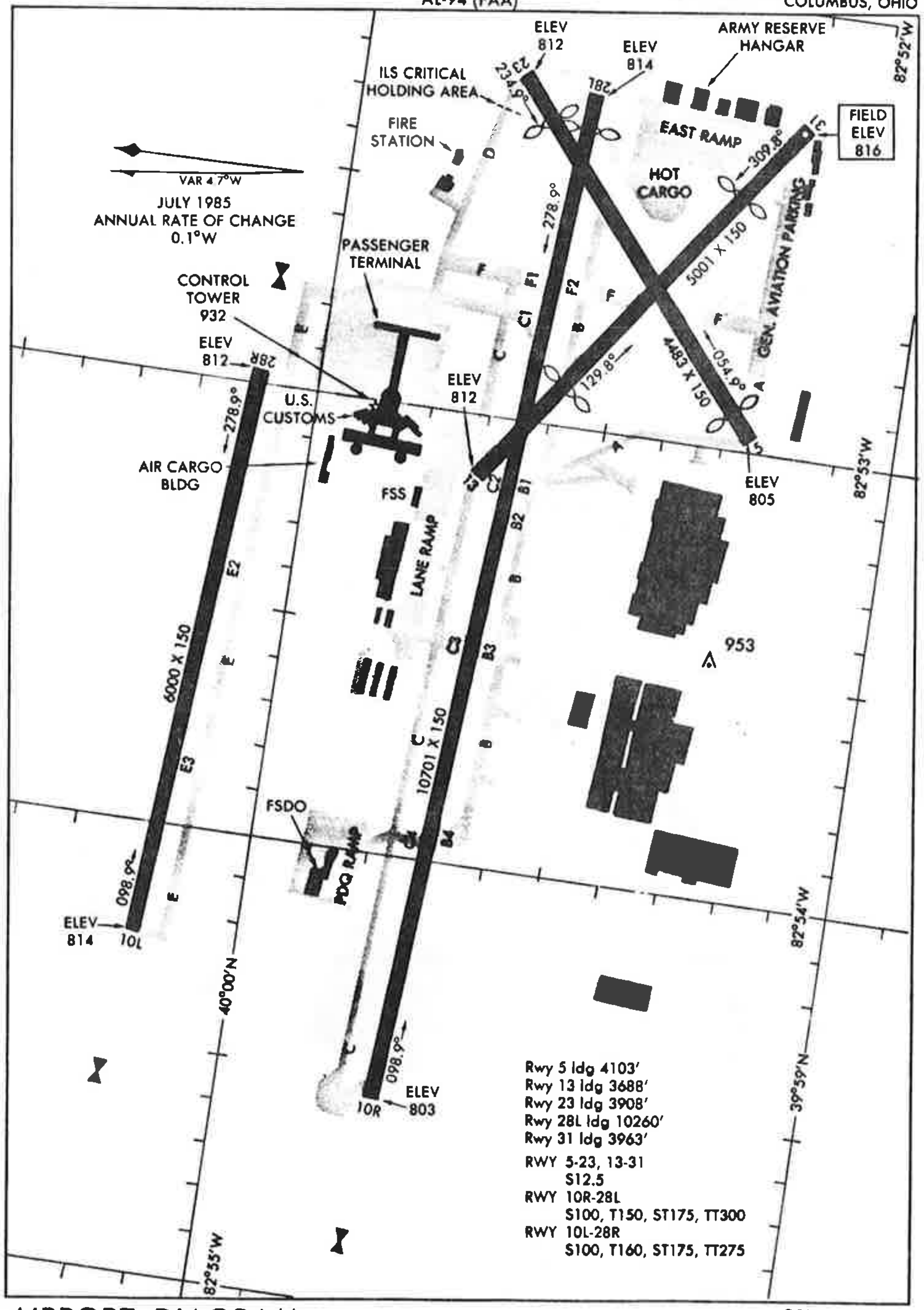
CLEVELAND, OHIO
CLEVELAND-HOPKINS INTL (CLE)

87239

AIRPORT DIAGRAM

AL-94 (FAA)

COLUMBUS/PORT COLUMBUS INTL (CMH)
COLUMBUS, OHIO



AIRPORT DIAGRAM

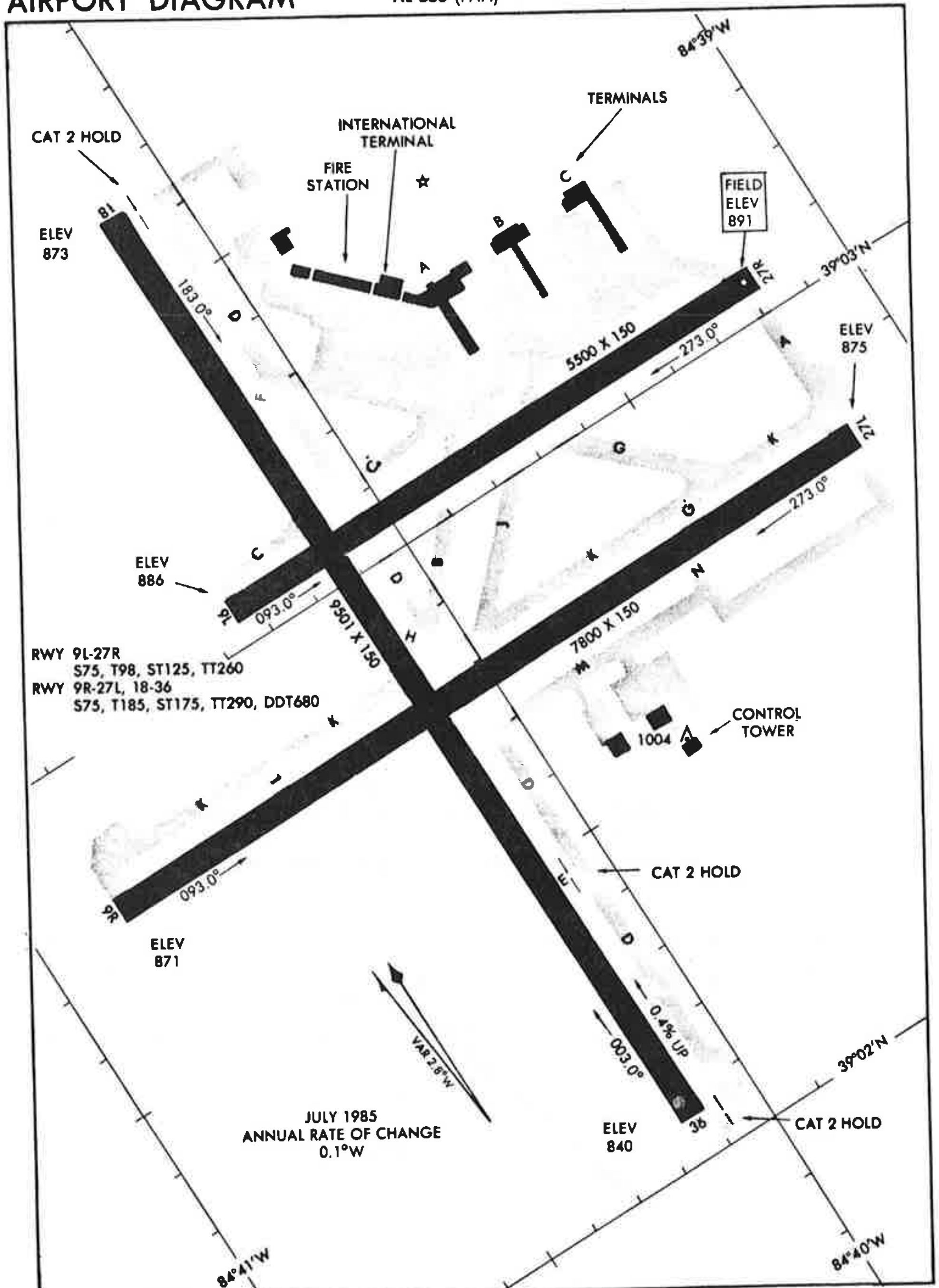
COLUMBUS, OHIO
COLUMBUS/PORT COLUMBUS INTL (CMH)

88042

AIRPORT DIAGRAM

AL-655 (FAA)

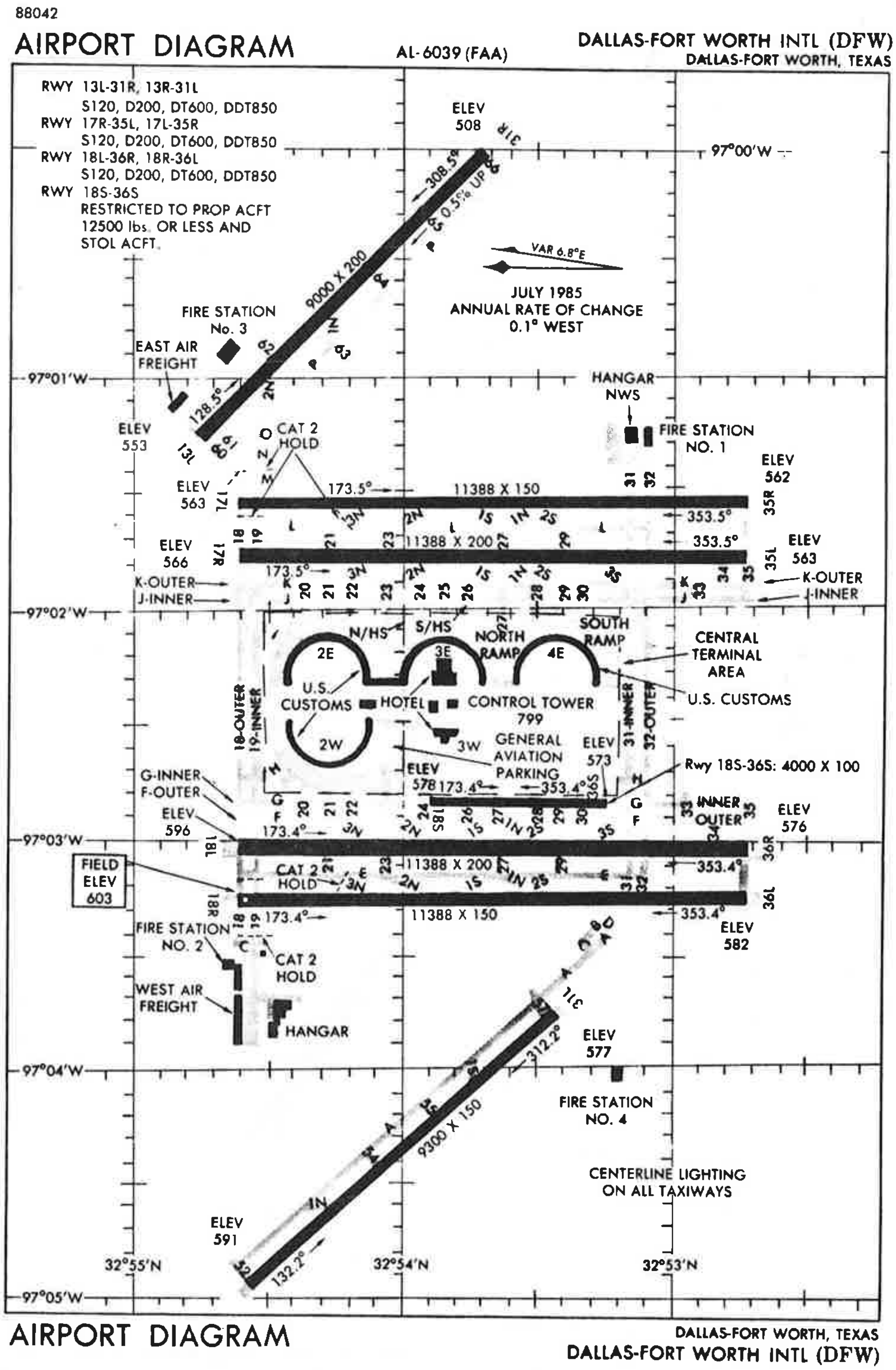
COVINGTON/GREATER CINCINNATI INTL (CVG)
COVINGTON, KENTUCKY



COVINGTON, KENTUCKY

AIRPORT DIAGRAM

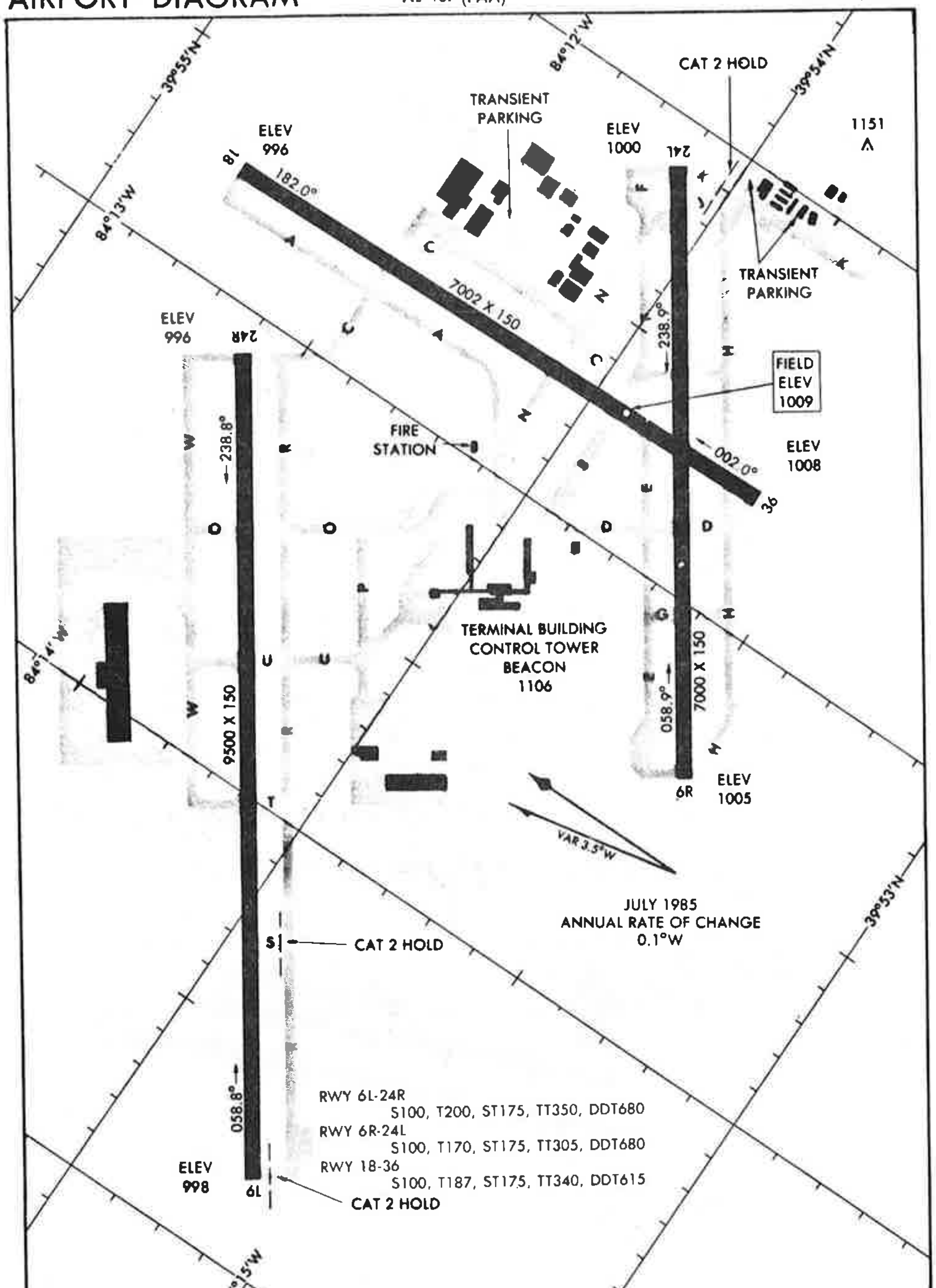
COVINGTON/GREATER CINCINNATI INTL (CVG)


88042
AIRPORT DIAGRAM
AL-6039 (FAA)
DALLAS-FORT WORTH INTL (DFW)
DALLAS-FORT WORTH, TEXAS
RWY 13L-31R, 13R-31L
S120, D200, DT600, DDT850
RWY 17R-35L, 17L-35R
S120, D200, DT600, DDT850
RWY 18L-36R, 18R-36L
S120, D200, DT600, DDT850
RWY 18S-36S
RESTRICTED TO PROP ACFT
12500 lbs. OR LESS AND
STOL ACFT.
ELEV 508
97°00'W
308.5°
0.5% UP
9000 X 200
VAR 6.8°E
JULY 1985
ANNUAL RATE OF CHANGE
0.1° WEST
FIRE STATION No. 3
EAST AIR FREIGHT
97°01'W
128.5°
HANGAR NWS
FIRE STATION NO. 1
ELEV 553
CAT 2 HOLD
ELEV 562
ELEV 563
173.5°
11388 X 150
353.5°
ELEV 566
11388 X 200
ELEV 563
K-OUTER
J-INNER
97°02'W
N/HS
S/HS
NORTH RAMP
SOUTH RAMP
CENTRAL TERMINAL AREA
2E
3E
4E
U.S. CUSTOMS
HOTEL
CONTROL TOWER 799
U.S. CUSTOMS
18-OUTER
19-INNER
31-INNER
32-OUTER
2W
3W
GENERAL AVIATION PARKING
ELEV 573
ELEV 578
173.4°
353.4°
Rwy 18S-36S: 4000 X 100
G-INNER
F-OUTER
INNER
OUTER
ELEV 576
ELEV 596
97°03'W
FIELD ELEV 603
CAT 2 HOLD
11388 X 200
353.4°
11388 X 150
ELEV 582
FIRE STATION NO. 2
CAT 2 HOLD
WEST AIR FREIGHT
HANGAR
312.2°
ELEV 577
97°04'W
FIRE STATION NO. 4
9300 X 150
CENTERLINE LIGHTING ON ALL TAXIWAYS
ELEV 591
132.2°
32°55'N
32°54'N
32°53'N
97°05'W
AIRPORT DIAGRAM
DALLAS-FORT WORTH, TEXAS
DALLAS-FORT WORTH INTL (DFW)

AIRPORT DIAGRAM

AL-107 (FAA)

DAYTON/JAMES M. COX-DAYTON INTL (DAY)
DAYTON, OHIO



AIRPORT DIAGRAM

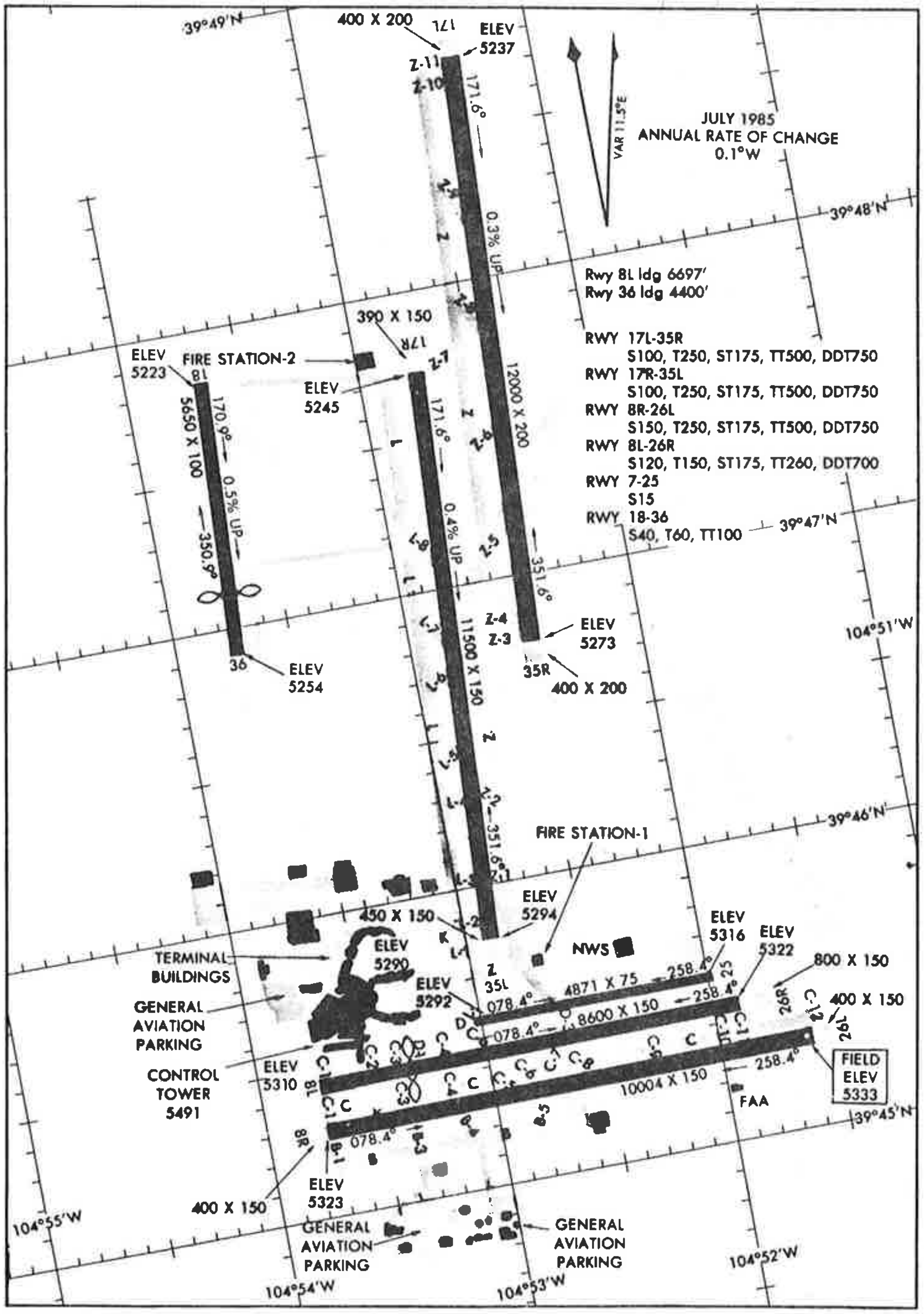
DAYTON, OHIO
DAYTON/JAMES M. COX-DAYTON INTL (DAY)

87239

AIRPORT DIAGRAM

AL-114 (FAA)

DENVER/STAPLETON INTL AIRPORT (DEN)
DENVER, COLORADO



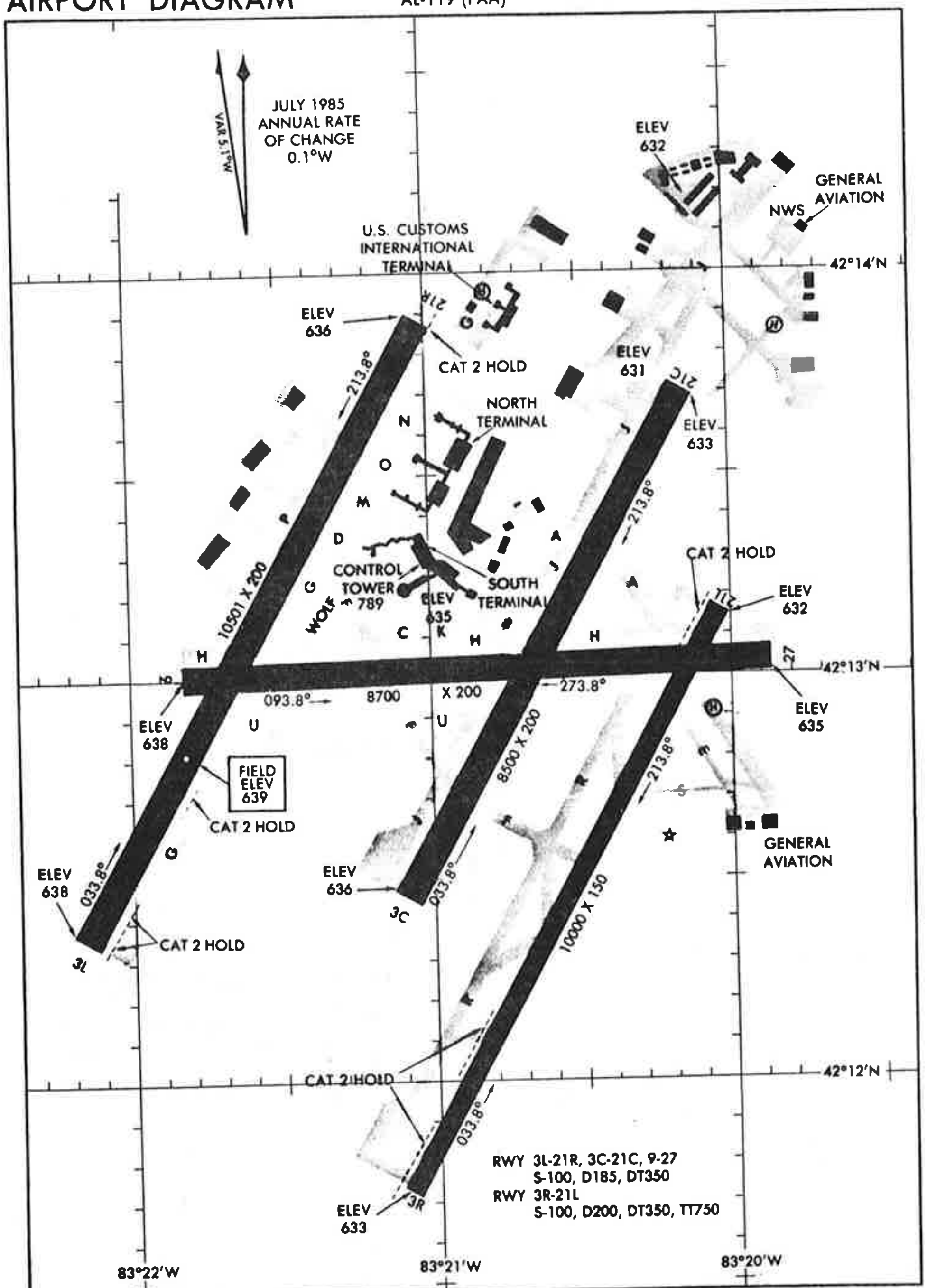
AIRPORT DIAGRAM

DENVER, COLORADO
DENVER/STAPLETON INTL AIRPORT (DEN)

88042

AIRPORT DIAGRAM

DETROIT METROPOLITAN WAYNE CO AIRPORT (DTW)
AL-119 (FAA)
DETROIT, MICHIGAN



AIRPORT DIAGRAM

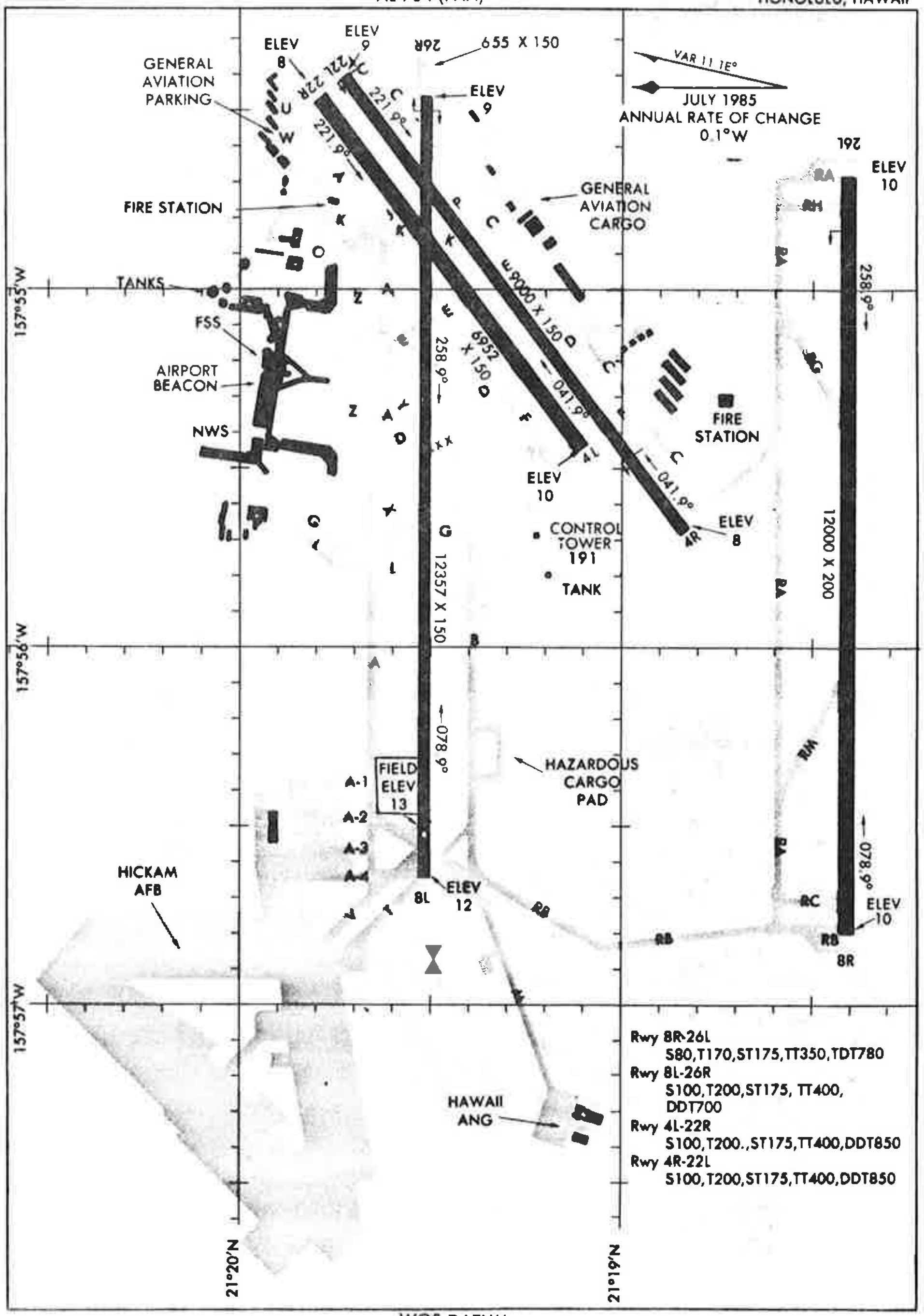
DETROIT, MICHIGAN
DETROIT METROPOLITAN WAYNE CO AIRPORT (DTW)

87323

AIRPORT DIAGRAM

AL-754 (FAA)

HONOLULU INTERNATIONAL (HNL)
HONOLULU, HAWAII



Rwy 8R-26L
S80,T170,ST175,TT350,TDT780
Rwy 8L-26R
S100,T200,ST175, TT400, DDT700
Rwy 4L-22R
S100,T200.,ST175,TT400,DDT850
Rwy 4R-22L
S100,T200,ST175,TT400,DDT850

WGS DATUM

AIRPORT DIAGRAM

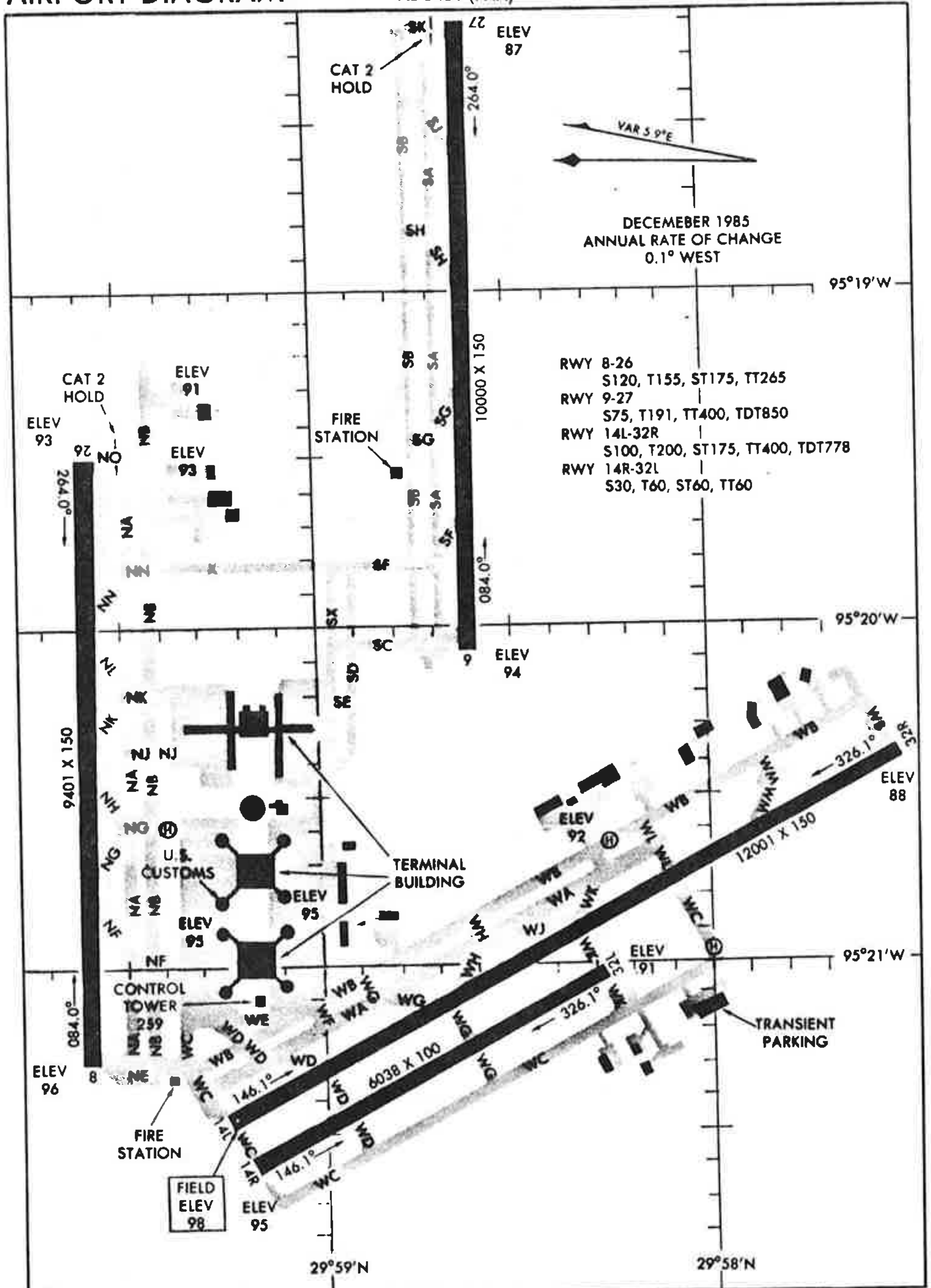
HONOLULU, HAWAII
HONOLULU INTERNATIONAL (HNL)

88042

AIRPORT DIAGRAM

AL-5461 (FAA)

HOUSTON INTERCONTINENTAL (IAH)
HOUSTON, TEXAS



HOUSTON, TEXAS

AIRPORT DIAGRAM

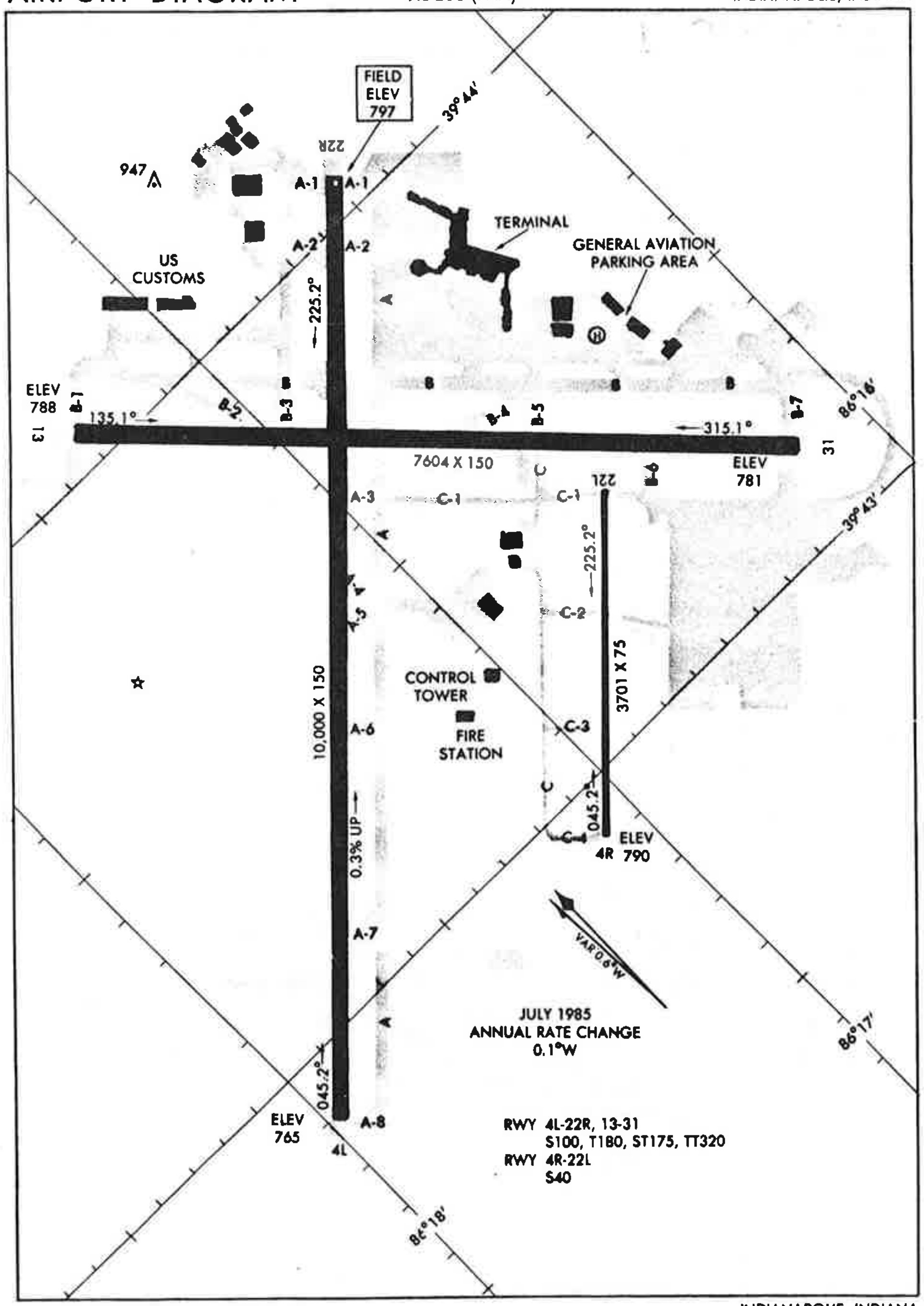
HOUSTON INTERCONTINENTAL (IAH)

87295

AIRPORT DIAGRAM

AL-203 (FAA)

INDIANAPOLIS INTERNATIONAL (IND)
INDIANAPOLIS, INDIANA



AIRPORT DIAGRAM

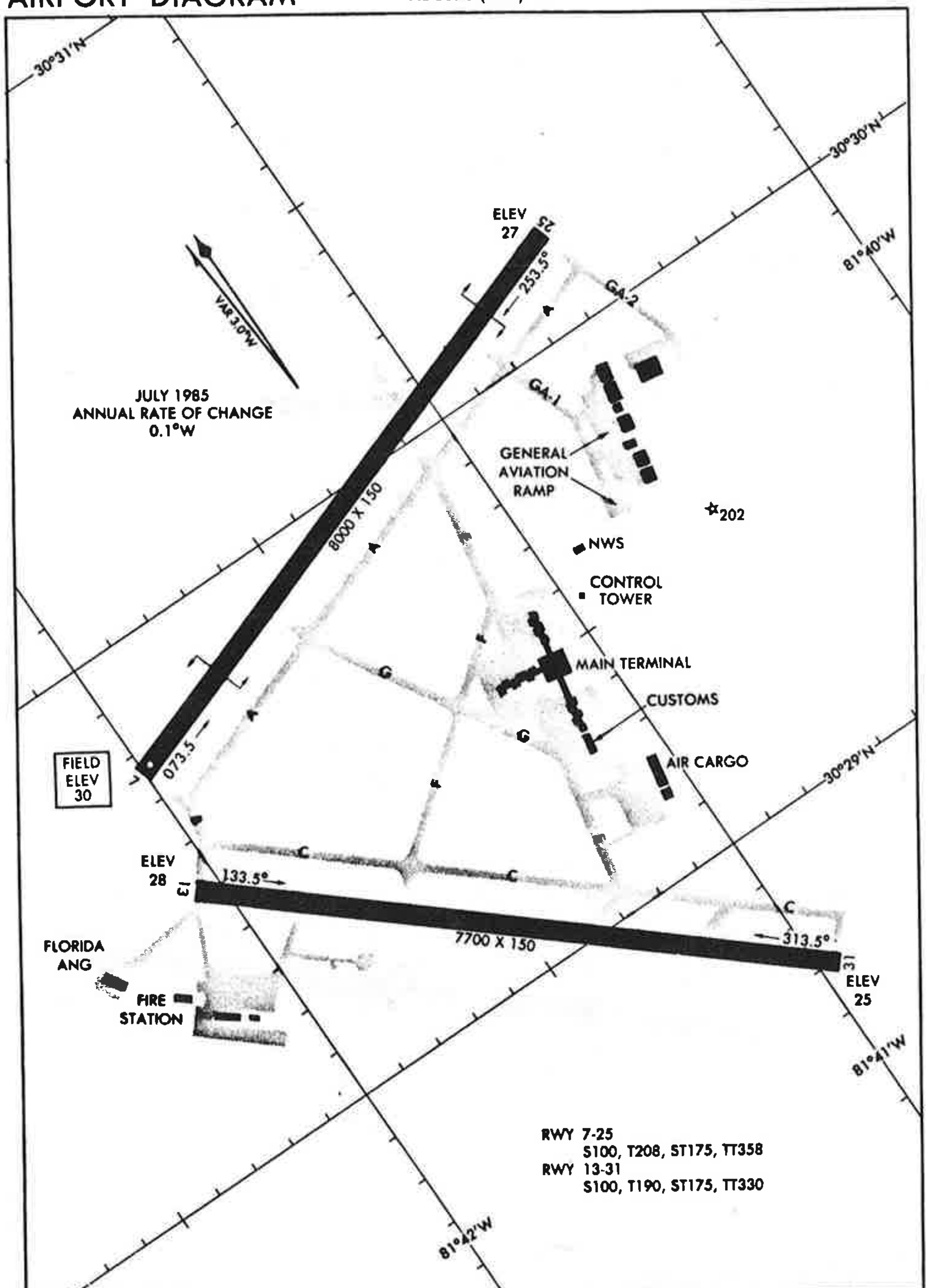
INDIANAPOLIS, INDIANA
INDIANAPOLIS INTERNATIONAL (IND)

87239

AIRPORT DIAGRAM

AL-5570 (FAA)

JACKSONVILLE INTL (JAX)
JACKSONVILLE, FLORIDA



AIRPORT DIAGRAM

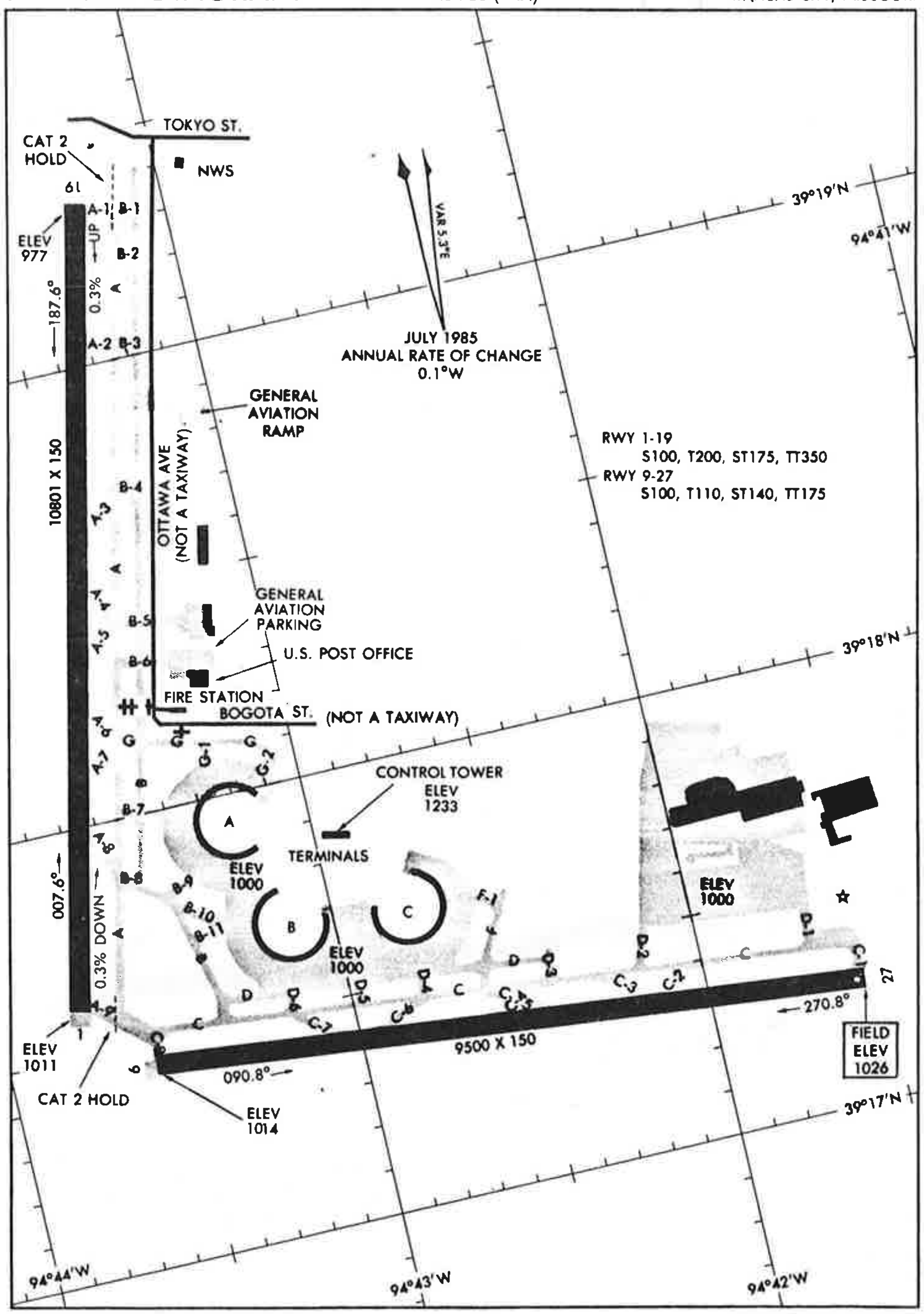
JACKSONVILLE, FLORIDA
JACKSONVILLE INTL (JAX)

87351

AIRPORT DIAGRAM

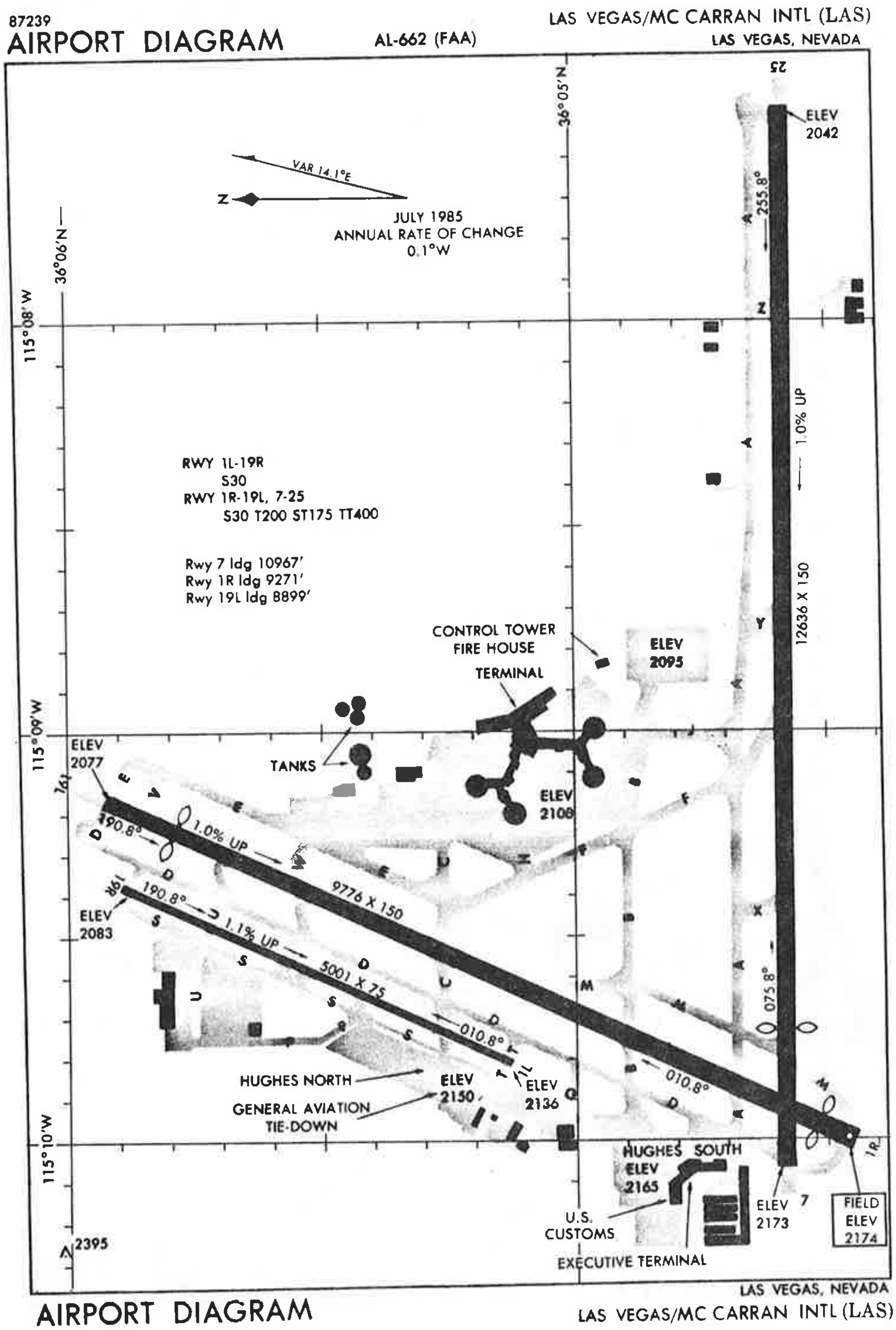
AL-780 (FAA)

KANSAS CITY INTERNATIONAL (MCI)
KANSAS CITY, MISSOURI



AIRPORT DIAGRAM

KANSAS CITY, MISSOURI
KANSAS CITY INTERNATIONAL (MCI)

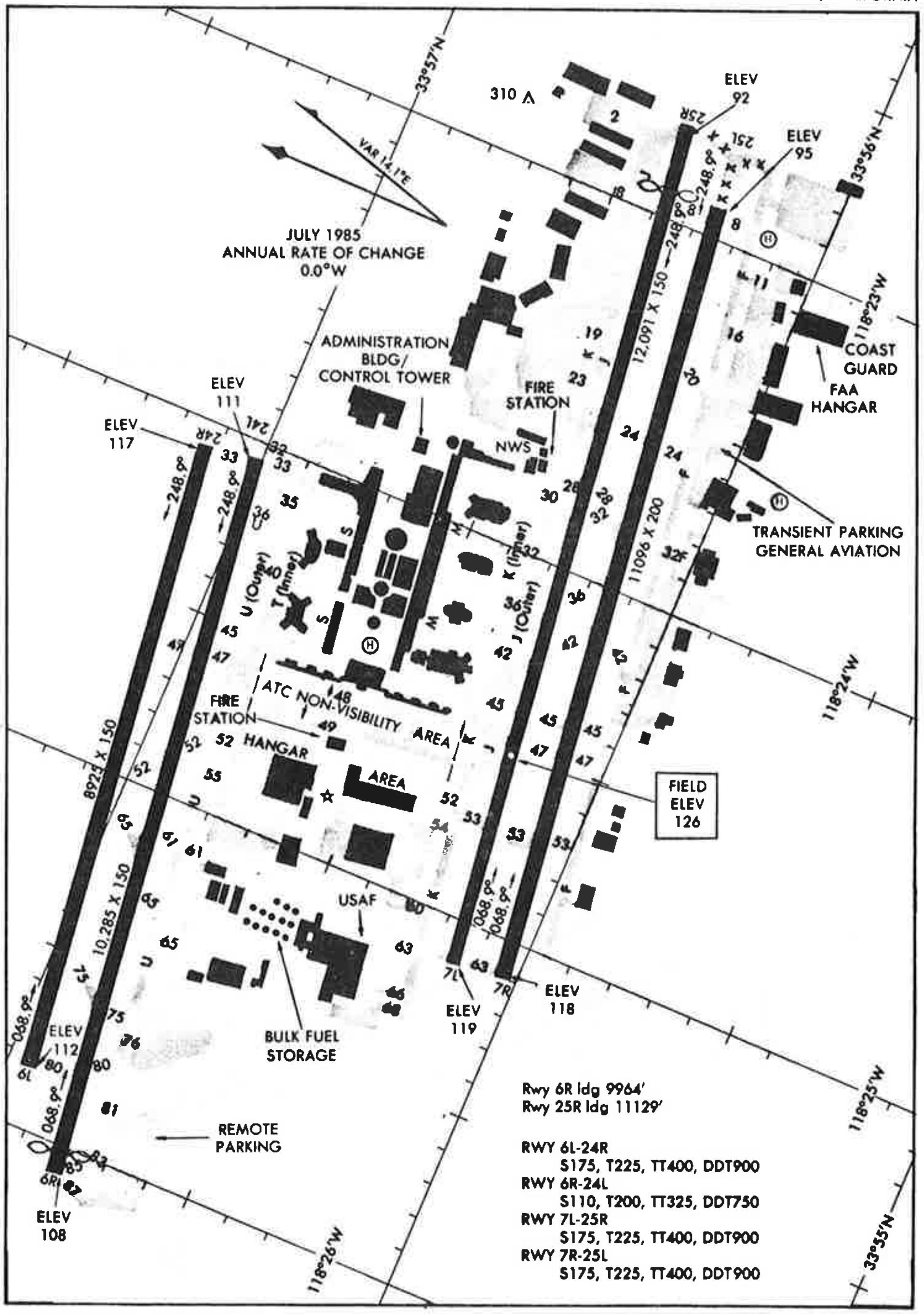


87239
AIRPORT DIAGRAM
AL-662 (FAA)
LAS VEGAS/MC CARRAN INTL (LAS)
LAS VEGAS, NEVADA
VAR 14.1°E
JULY 1985
ANNUAL RATE OF CHANGE
0.1°W
RWY 1L-19R
S30
RWY 1R-19L, 7-25
S30 T200 ST175 TT400
Rwy 7 ldg 10967'
Rwy 1R ldg 9271'
Rwy 19L ldg 8899'
ELEV 2042
1.0% UP
12636 X 150
255.8°
075.8°
CONTROL TOWER
FIRE HOUSE
TERMINAL
ELEV 2095
TANKS
ELEV 2077
ELEV 2108
190.8°
1.0% UP
9776 X 150
ELEV 2083
1.1% UP
5001 X 75
010.8°
HUGHES NORTH
GENERAL AVIATION TIE-DOWN
ELEV 2150
ELEV 2136
HUGHES SOUTH
ELEV 2165
U.S. CUSTOMS
EXECUTIVE TERMINAL
ELEV 2173
FIELD ELEV 2174
2395
36°05'N
36°06'N
115°08'W
115°09'W
115°10'W
AIRPORT DIAGRAM
LAS VEGAS, NEVADA
LAS VEGAS/MC CARRAN INTL (LAS)

AIRPORT DIAGRAM

AL-237 (FAA)

LOS ANGELES INTERNATIONAL (LAX)
LOS ANGELES, CALIFORNIA



AIRPORT DIAGRAM

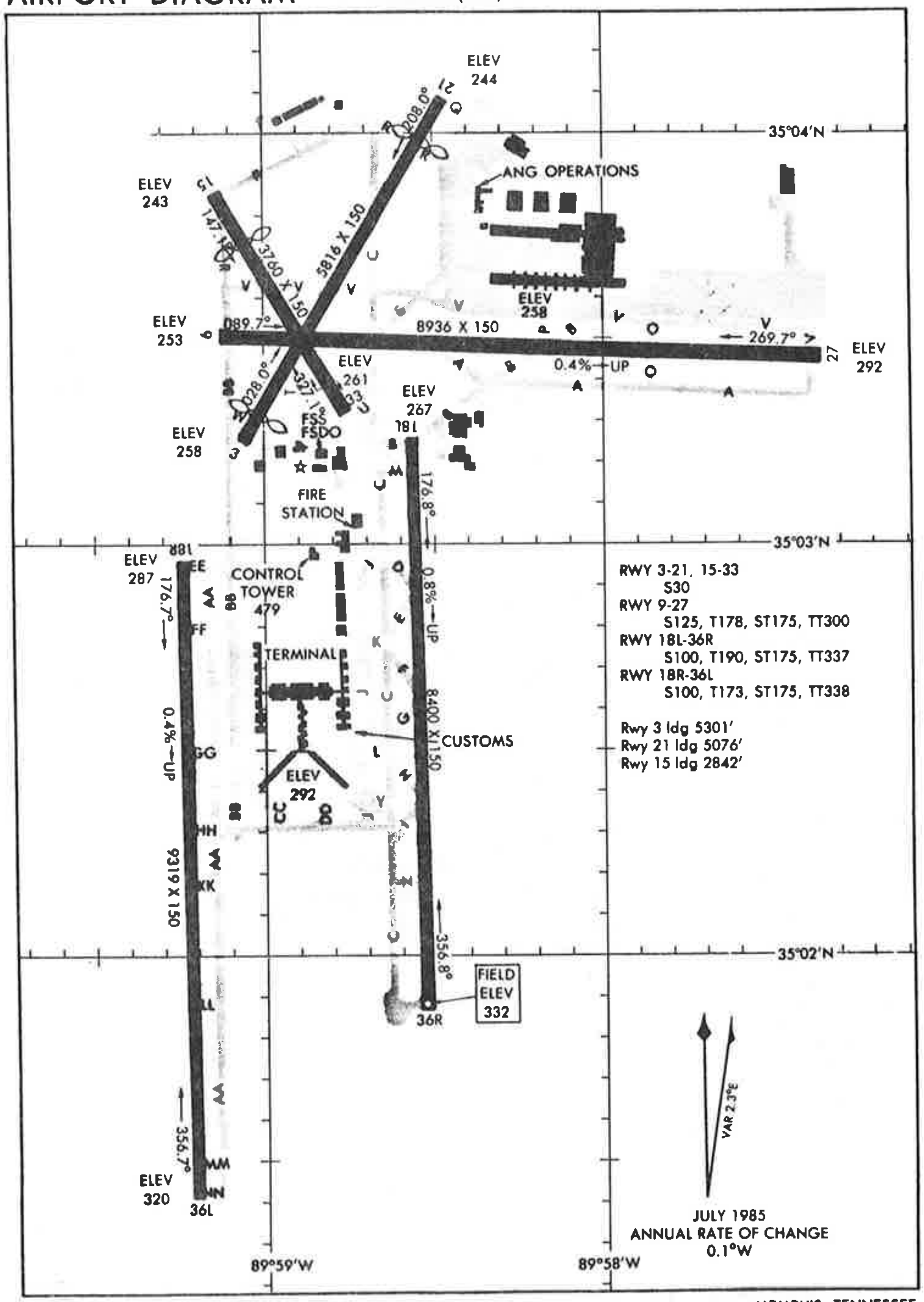
LOS ANGELES, CALIFORNIA
LOS ANGELES INTERNATIONAL (LAX)

87295

AIRPORT DIAGRAM

AL-253 (FAA)

MEMPHIS INTL AIRPORT (MEM)
MEMPHIS, TENNESSEE



AIRPORT DIAGRAM

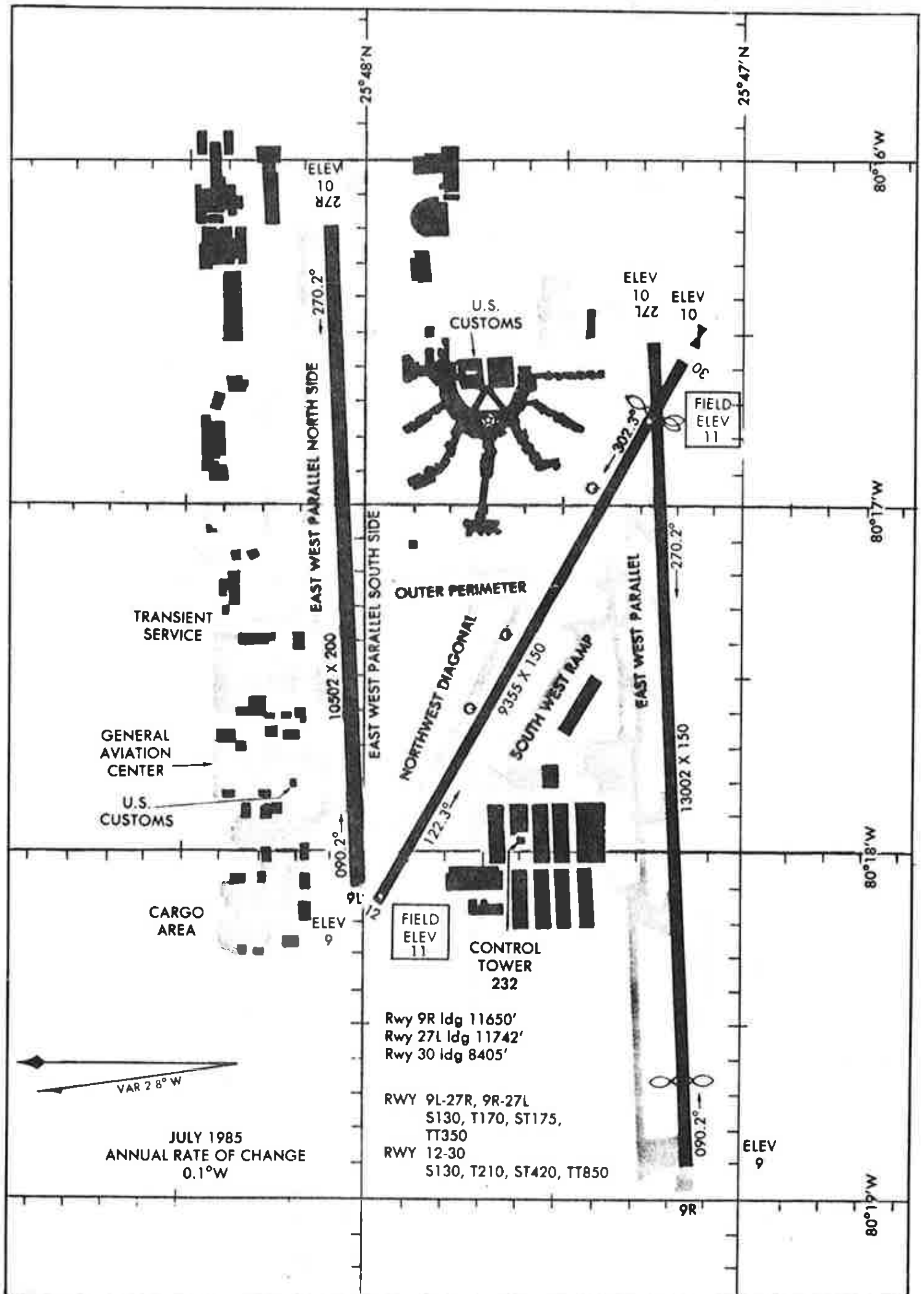
MEMPHIS, TENNESSEE
MEMPHIS INTL AIRPORT (MEM)

87295

AIRPORT DIAGRAM

AL-257 (FAA)

MIAMI INTERNATIONAL AIRPORT (MIA)
MIAMI, FLORIDA



AIRPORT DIAGRAM

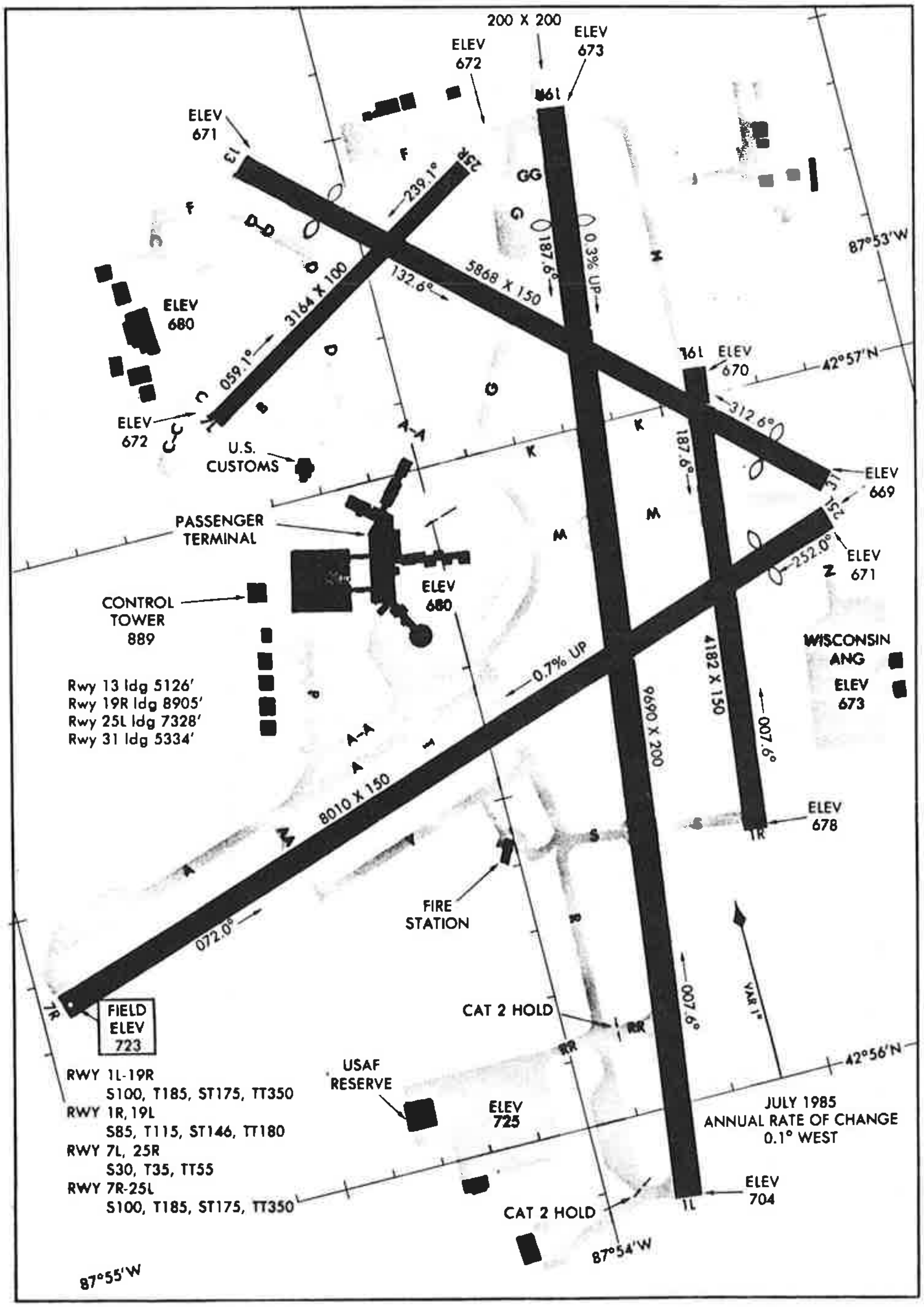
MIAMI, FLORIDA
MIAMI INTERNATIONAL AIRPORT (MIA)

87295

AIRPORT DIAGRAM

AL-262 (FAA)

MILWAUKEE/GENERAL MITCHELL INTL (MKE)
MILWAUKEE, WISCONSIN

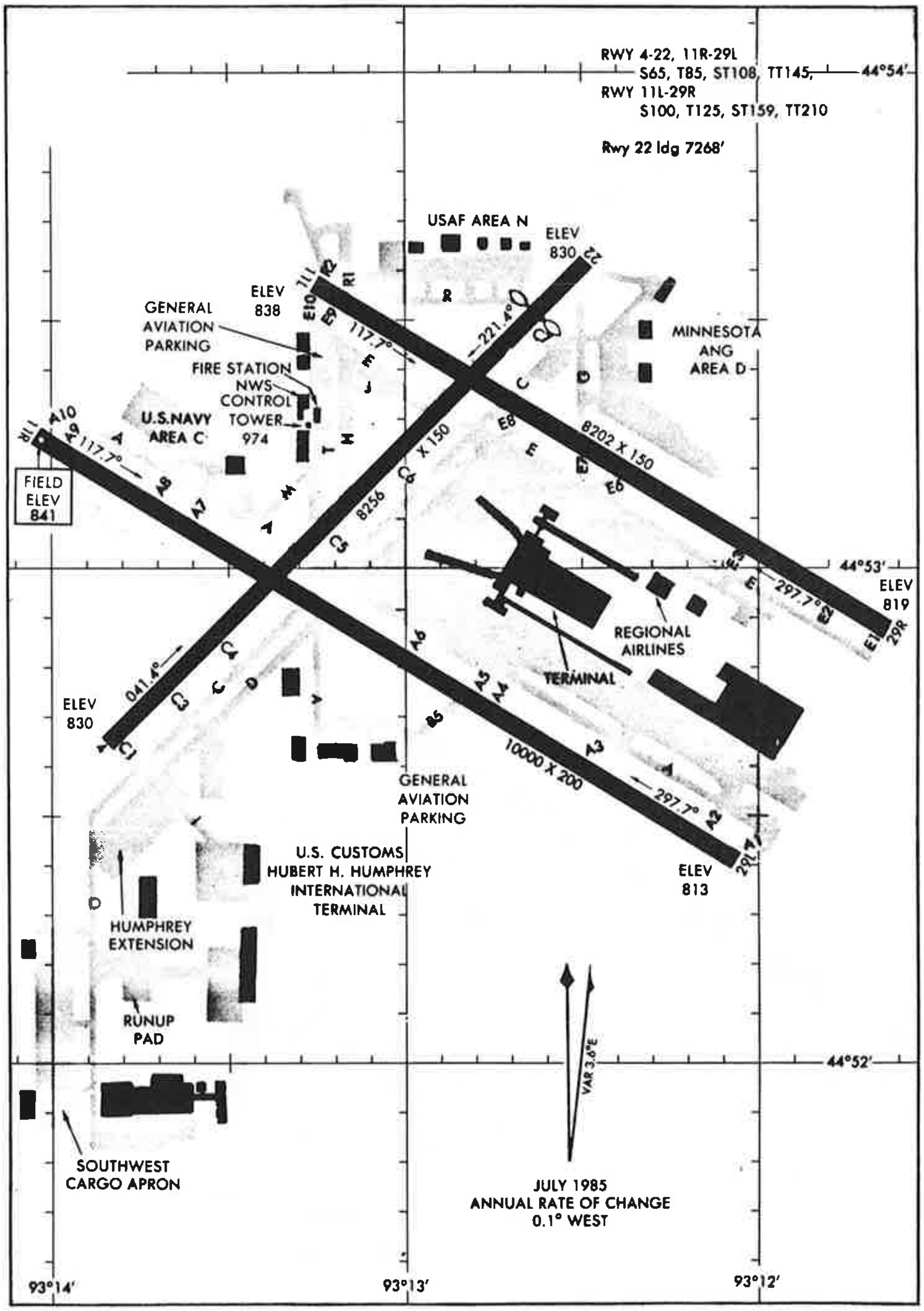


AIRPORT DIAGRAM

MILWAUKEE, WISCONSIN
MILWAUKEE/GENERAL MITCHELL INTL (MKE)

AIRPORT DIAGRAM

MINNEAPOLIS-ST PAUL INTL (WOLD-CHAMBERLAIN FIELD) (MSP)
AL-264 (FAA)
MINNEAPOLIS, MINNESOTA



AIRPORT DIAGRAM

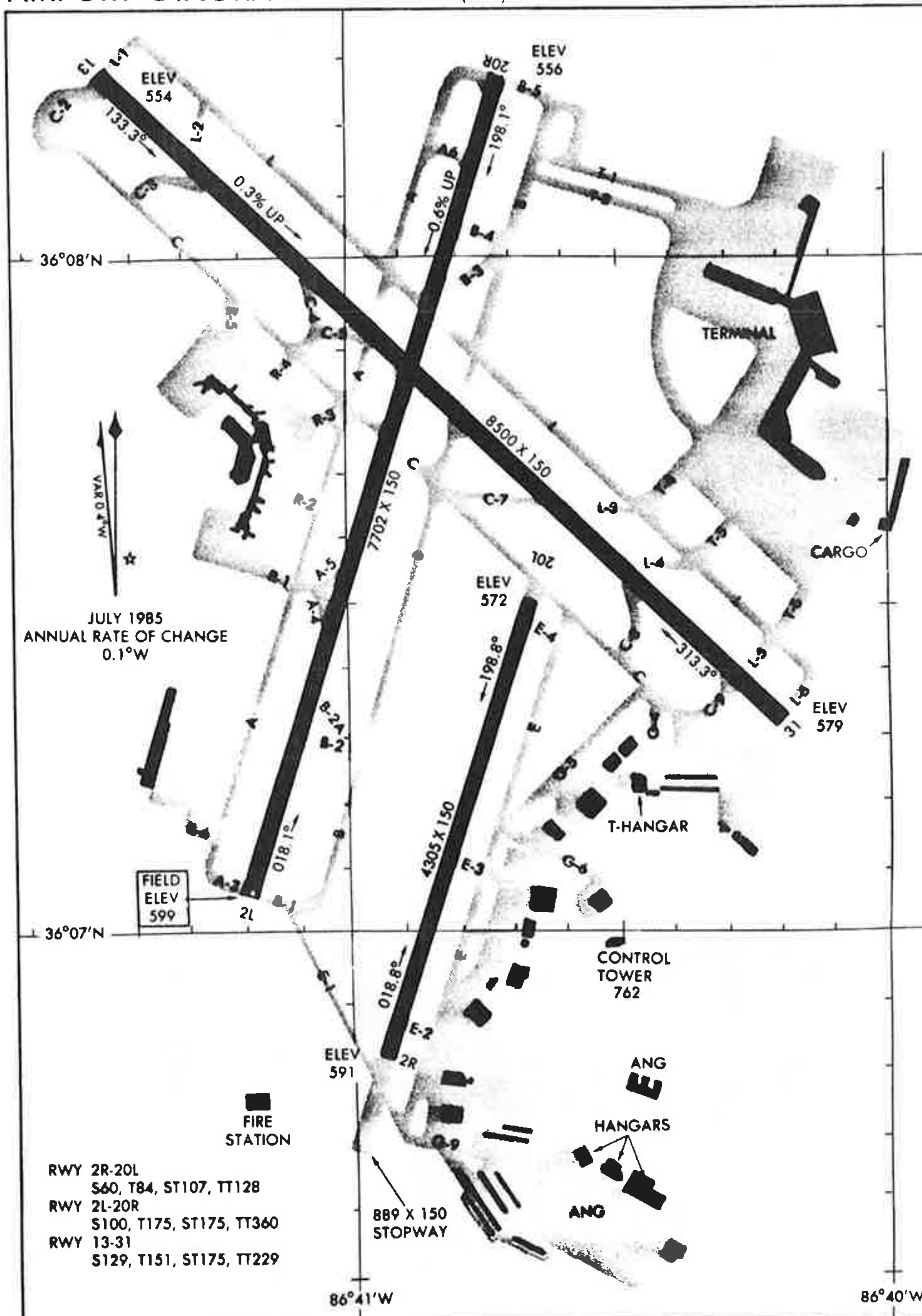
MINNEAPOLIS, MINNESOTA
MINNEAPOLIS-ST PAUL INTL (WOLD-CHAMBERLAIN FIELD) (MSP)

87295

AIRPORT DIAGRAM

AL-282 (FAA)

NASHVILLE METROPOLITAN (BNA)
NASHVILLE, TENNESSEE



AIRPORT DIAGRAM

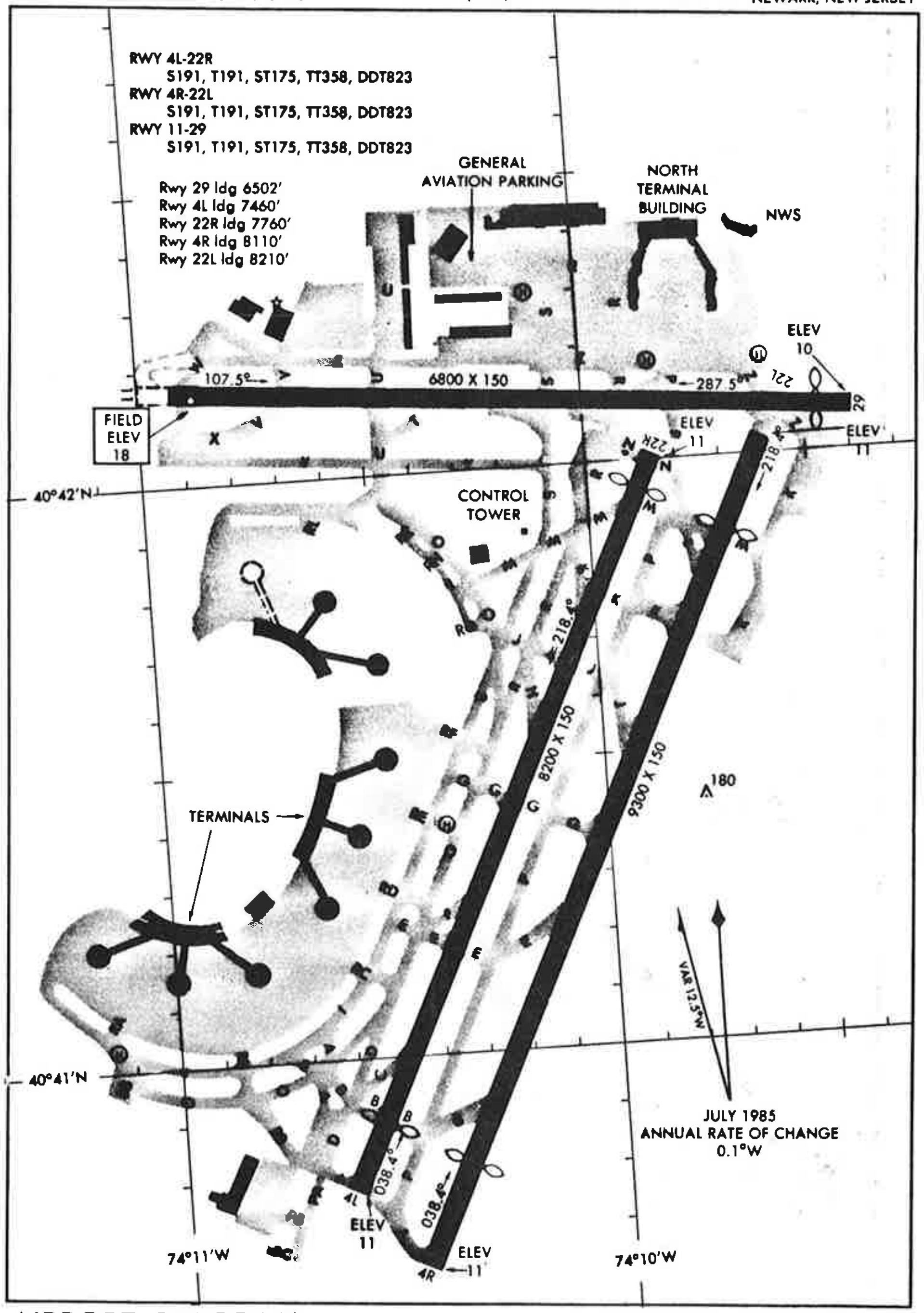
NASHVILLE, TENNESSEE
NASHVILLE METROPOLITAN (BNA)

87351

AIRPORT DIAGRAM

AL-285 (FAA)

NEWARK INTERNATIONAL (EWR)
NEWARK, NEW JERSEY



AIRPORT DIAGRAM

NEWARK, NEW JERSEY
NEWARK INTERNATIONAL (EWR)

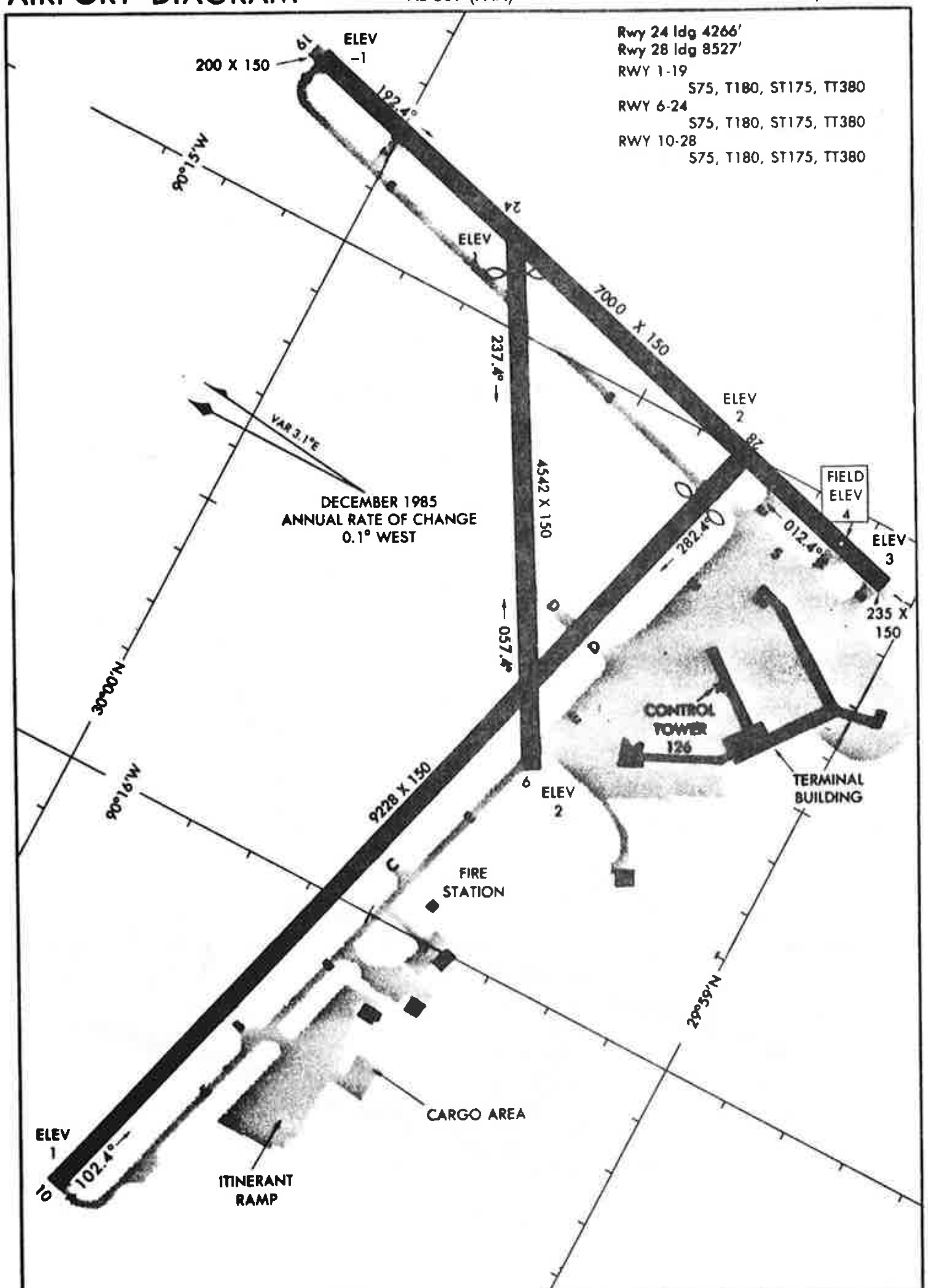
87239

AIRPORT DIAGRAM

AL-609 (FAA)

NEW ORLEANS INTL (MOISANT FIELD) (MSY)

NEW ORLEANS, LOUISIANA



AIRPORT DIAGRAM

NEW ORLEANS, LOUISIANA

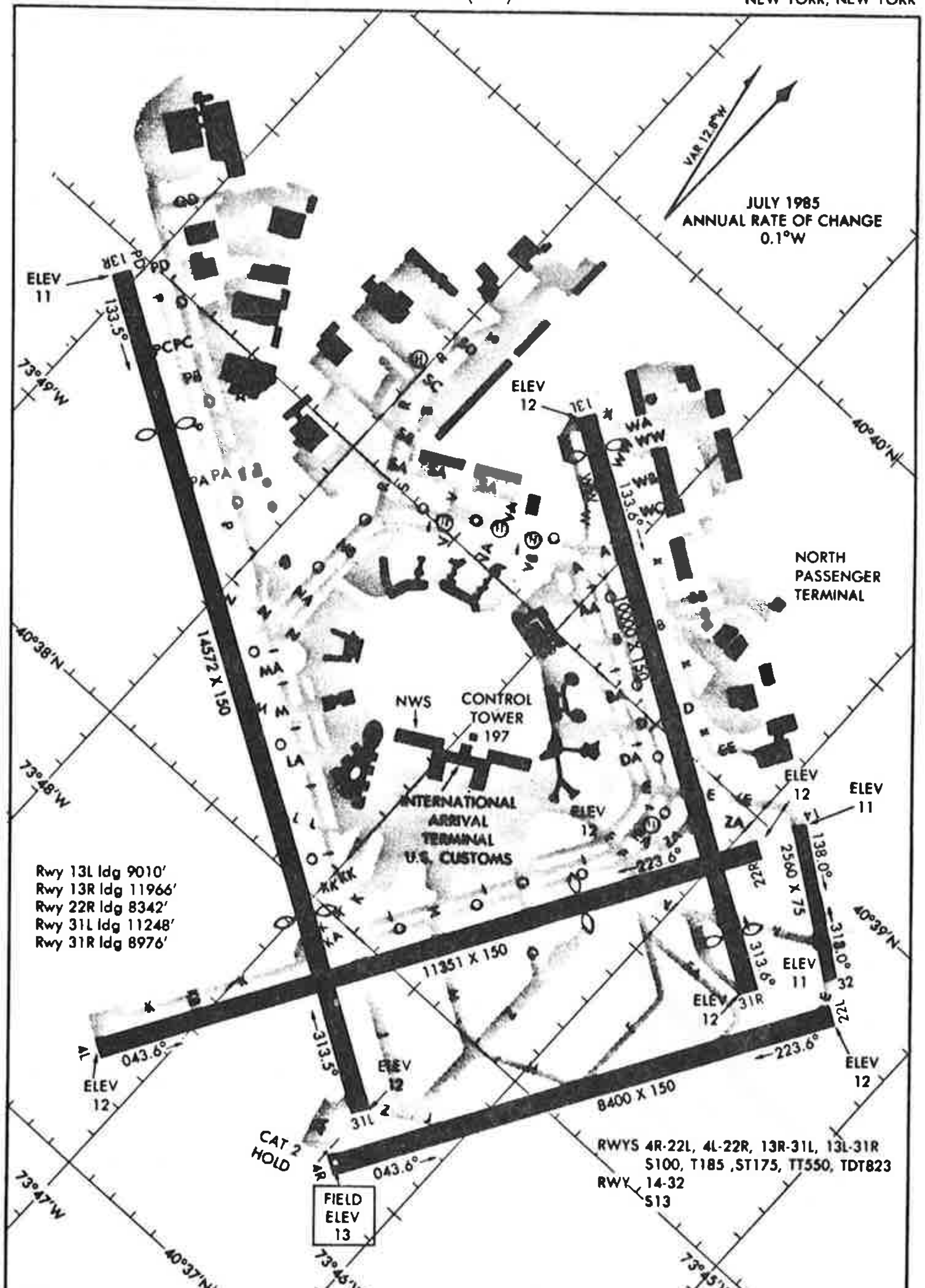
NEW ORLEANS INTL (MOISANT FIELD) (MSY)

87239

AIRPORT DIAGRAM

AL-610 (FAA)

NEW YORK/JOHN F. KENNEDY INTL (JFK)
NEW YORK, NEW YORK



AIRPORT DIAGRAM

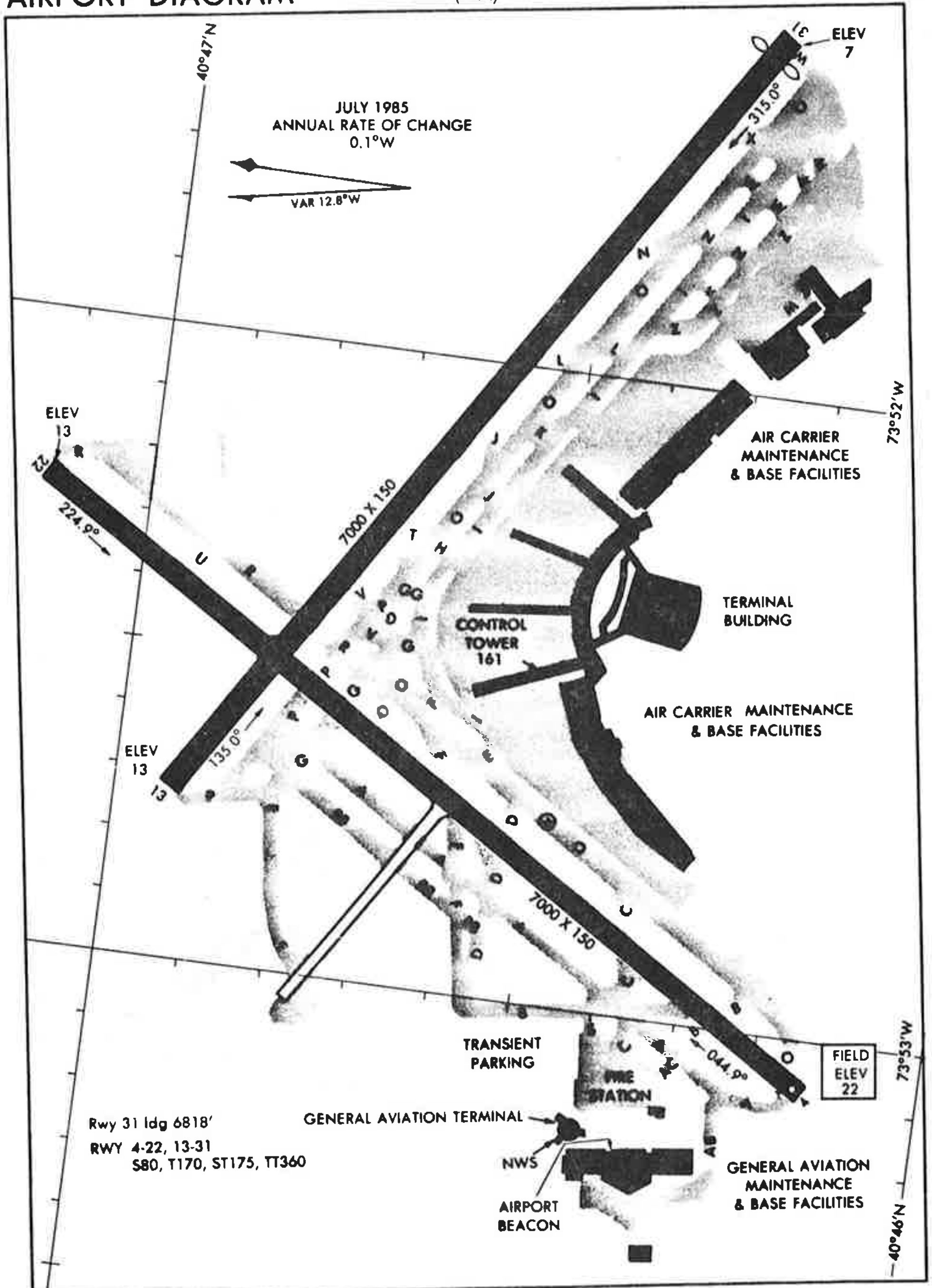
NEW YORK, NEW YORK
NEW YORK/JOHN F. KENNEDY INTL (JFK)

87239

AIRPORT DIAGRAM

AL-289 (FAA)

NEW YORK/LA GUARDIA (LGA)
NEW YORK, NEW YORK



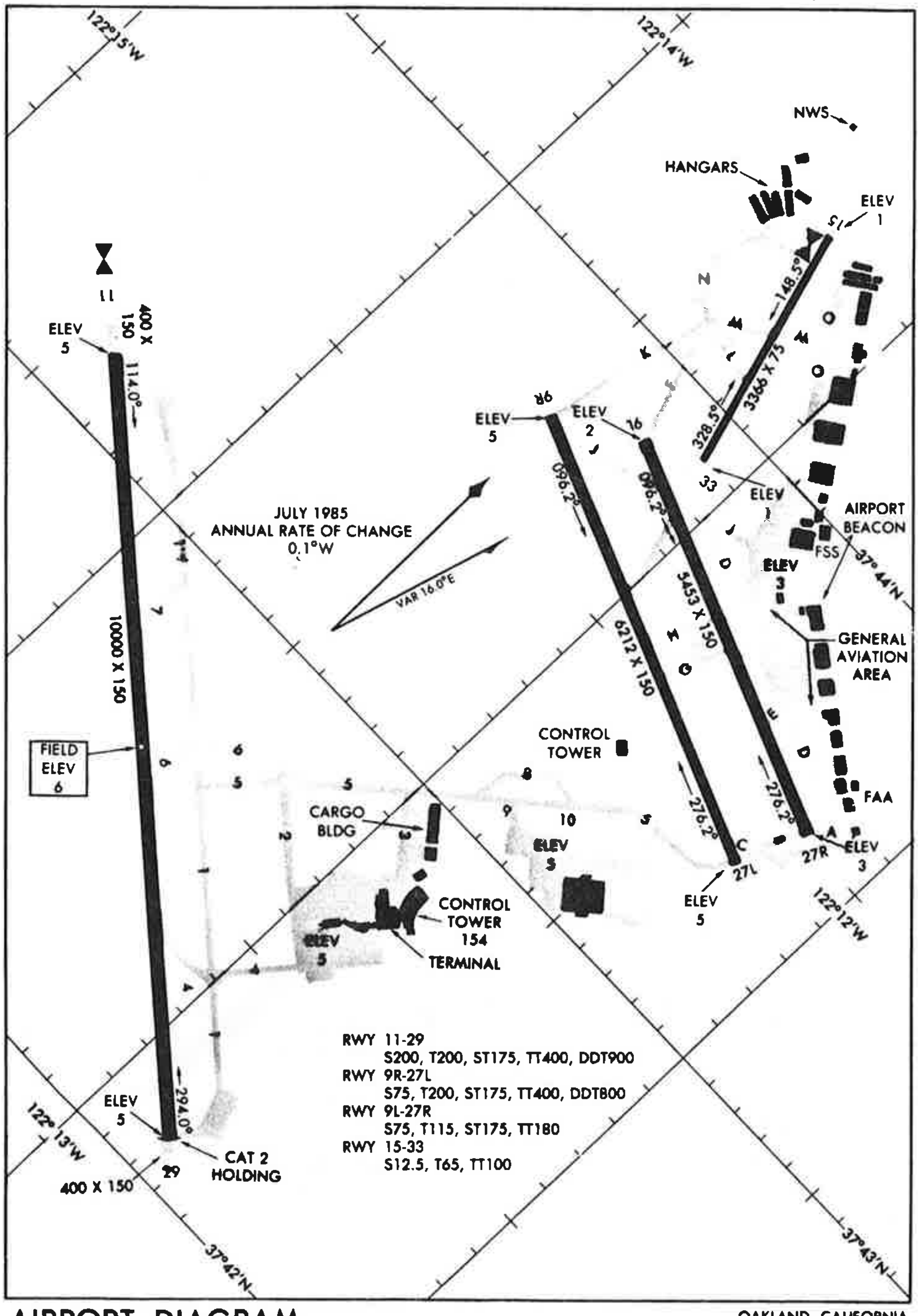
AIRPORT DIAGRAM

NEW YORK, NEW YORK
NEW YORK/LA GUARDIA (LGA)

87239

AIRPORT DIAGRAM

OAKLAND/METROPOLITAN OAKLAND INTL AIRPORT (OAK)
AL-294 (FAA)
OAKLAND, CALIFORNIA



RWY 11-29
S200, T200, ST175, TT400, DDT900
RWY 9R-27L
S75, T200, ST175, TT400, DDT800
RWY 9L-27R
S75, T115, ST175, TT180
RWY 15-33
S12.5, T65, TT100

AIRPORT DIAGRAM

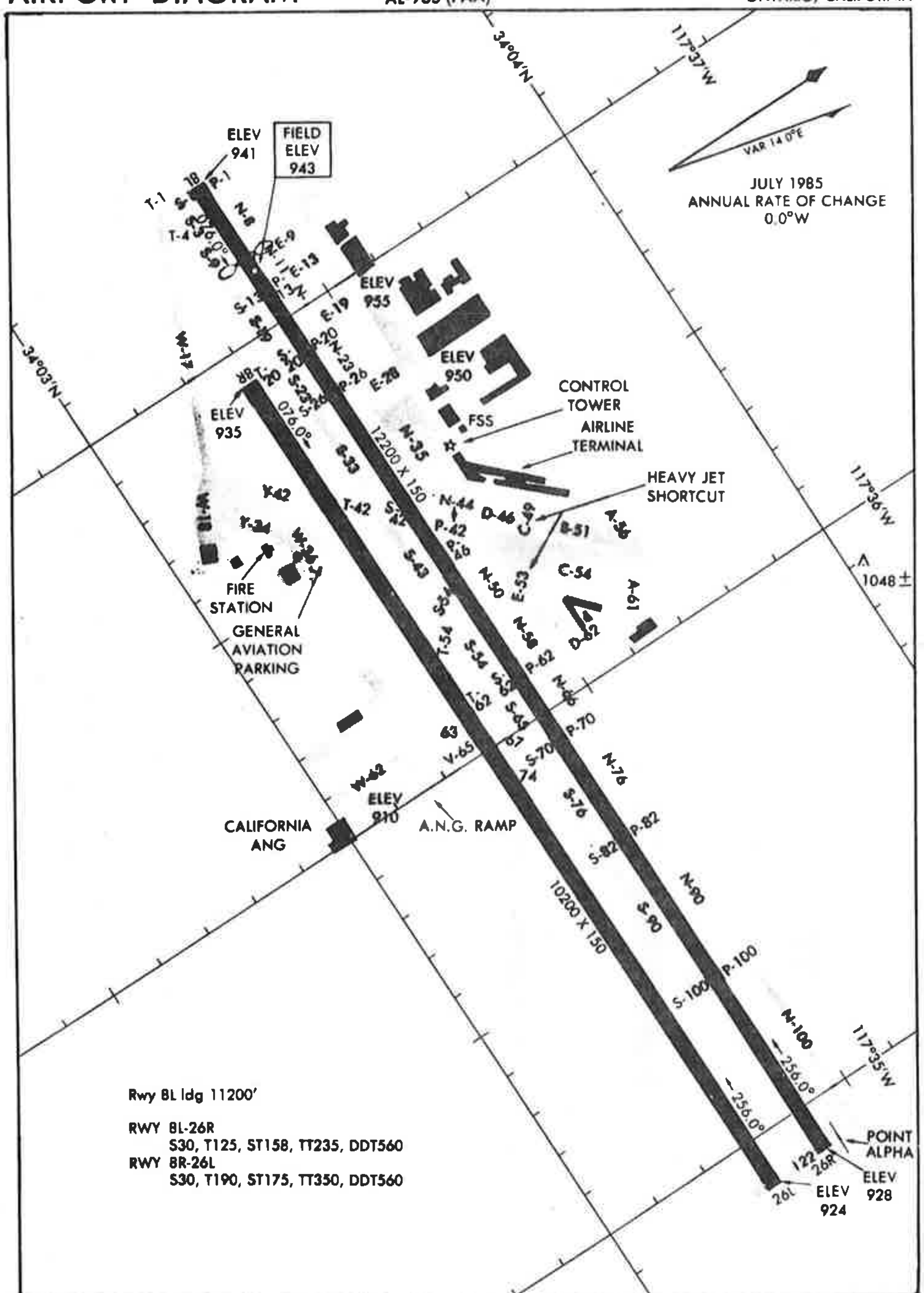
OAKLAND, CALIFORNIA
OAKLAND/METROPOLITAN OAKLAND INTL AIRPORT (OAK)

88014

AIRPORT DIAGRAM

AL-965 (FAA)

ONTARIO INTL AIRPORT (ONT)
ONTARIO, CALIFORNIA



AIRPORT DIAGRAM

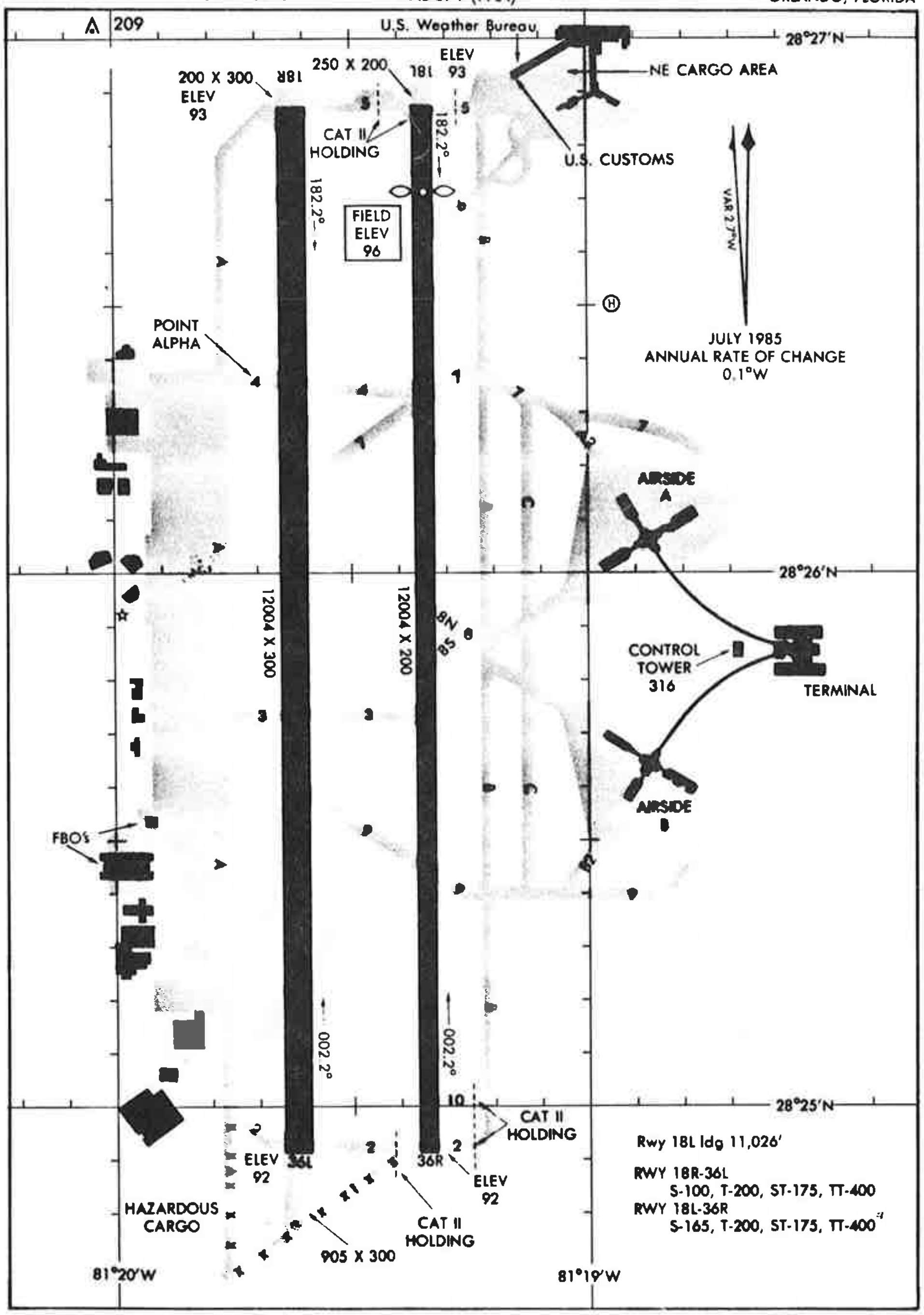
ONTARIO, CALIFORNIA
ONTARIO INTL AIRPORT (ONT)

87239

AIRPORT DIAGRAM

AL-571 (FAA)

ORLANDO INTL (MCO)
ORLANDO, FLORIDA



AIRPORT DIAGRAM

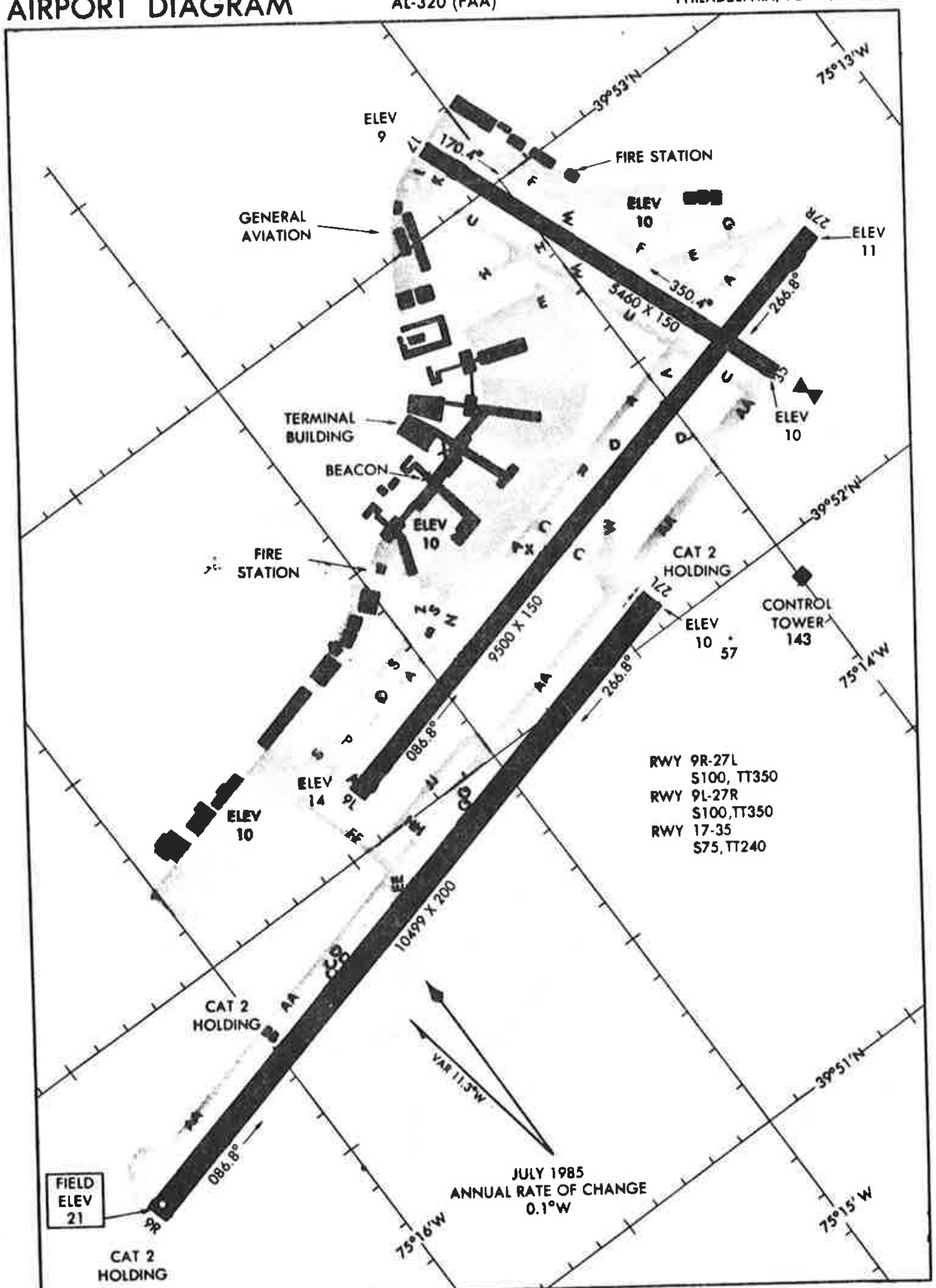
ORLANDO, FLORIDA
ORLANDO INTL (MCO)

87351

AIRPORT DIAGRAM

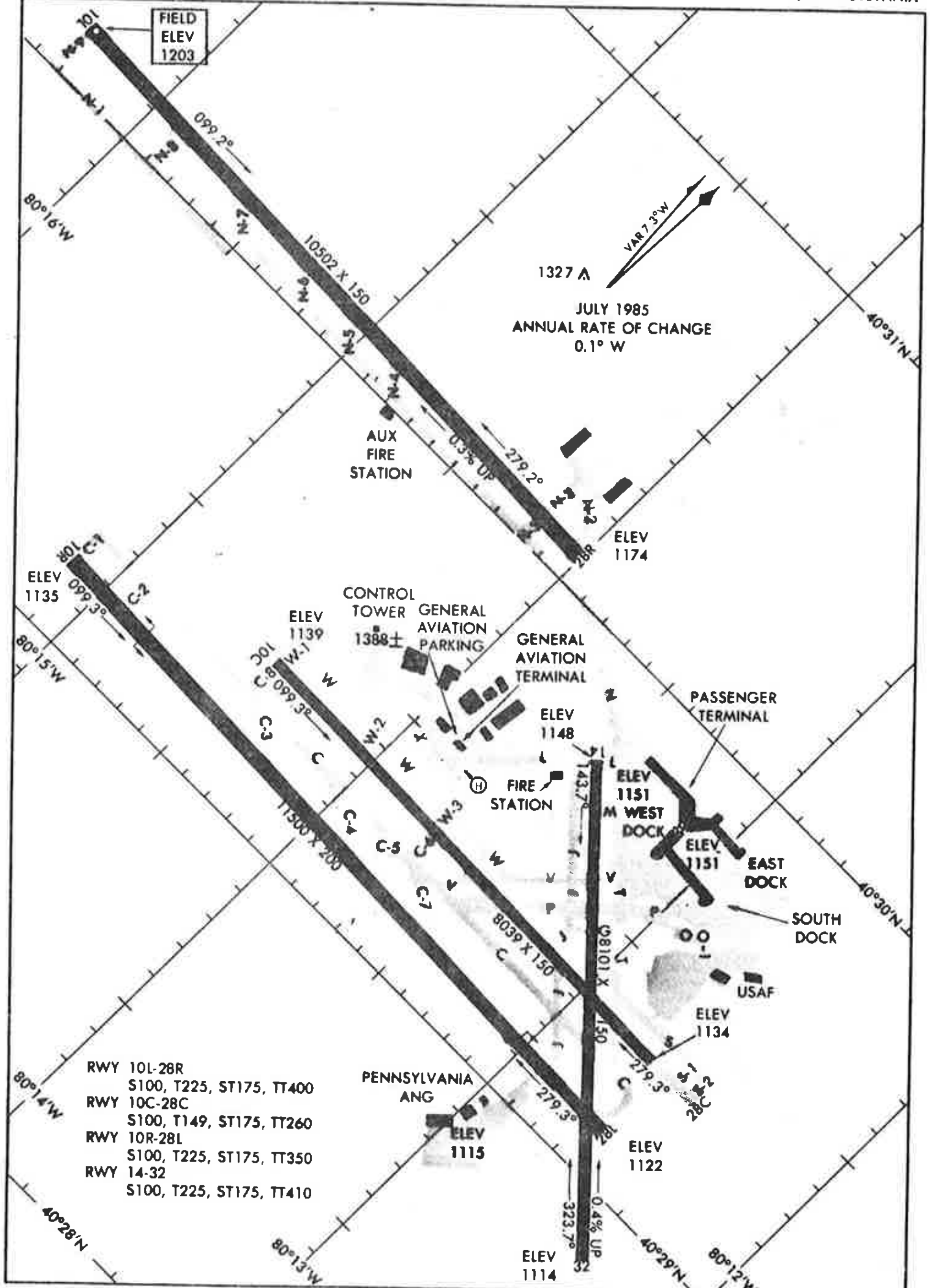
AL-320 (FAA)

PHILADELPHIA INTERNATIONAL (PHL)
PHILADELPHIA, PENNSYLVANIA



AIRPORT DIAGRAM

PHILADELPHIA, PENNSYLVANIA
PHILADELPHIA INTERNATIONAL (PHL)

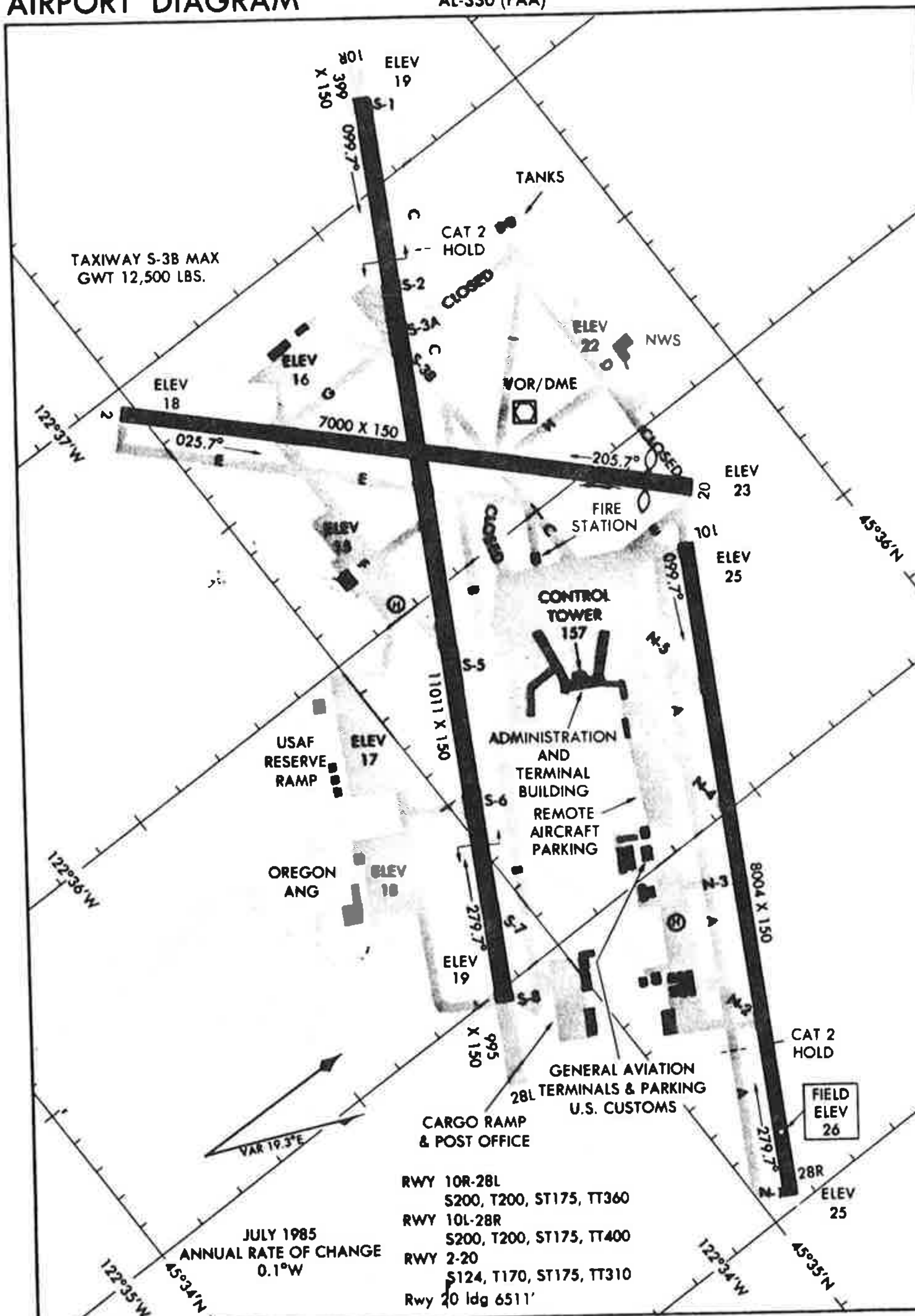

FIELD ELEV 1203
099.2°
10502 X 150
0.3% UP
279.2°
ELEV 1174
1327
VAR 7.3°W
JULY 1985
ANNUAL RATE OF CHANGE
0.1° W
AUX FIRE STATION
ELEV 1135
099.3°
ELEV 1139
CONTROL TOWER
1388±
GENERAL AVIATION PARKING
GENERAL AVIATION TERMINAL
ELEV 1148
PASSENGER TERMINAL
FIRE STATION
ELEV 1151
WEST DOCK
ELEV 1151
EAST DOCK
SOUTH DOCK
USAF
ELEV 1134
11500 X 200
8039 X 150
8101 X 150
143.7°
279.3°
PENNSYLVANIA ANG
ELEV 1115
ELEV 1122
323.7°
0.4% UP
ELEV 1114
80°16'W
80°15'W
80°14'W
80°13'W
80°12'W
40°31'N
40°30'N
40°29'N
40°28'N
RWY 10L-28R
S100, T225, ST175, TT400
RWY 10C-28C
S100, T149, ST175, TT260
RWY 10R-28L
S100, T225, ST175, TT350
RWY 14-32
S100, T225, ST175, TT410

88042

AIRPORT DIAGRAM

AL-330 (FAA)

PORTLAND INTERNATIONAL AIRPORT (PDX)
PORTLAND, OREGON



AIRPORT DIAGRAM

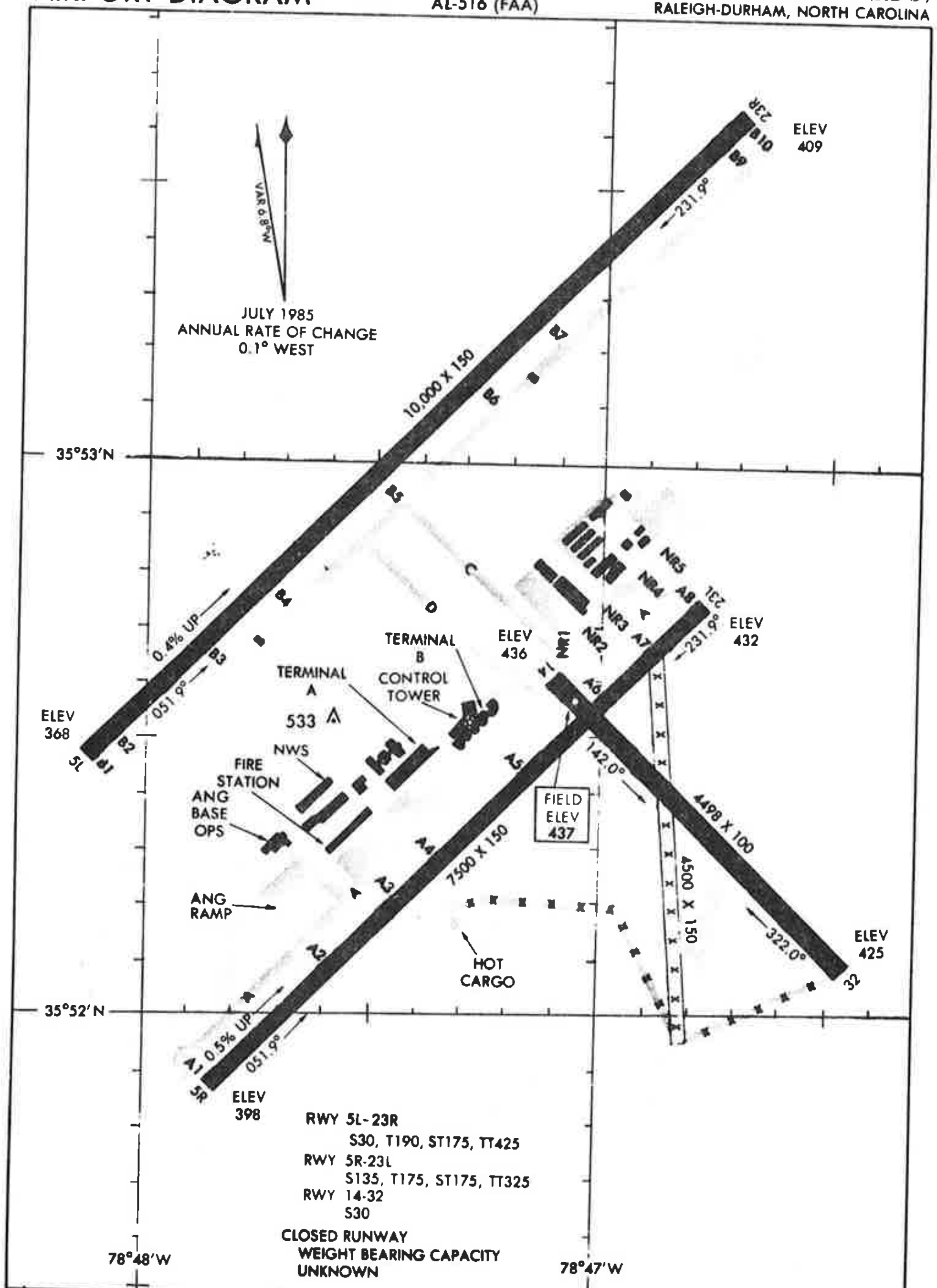
PORTLAND, OREGON
PORTLAND INTERNATIONAL AIRPORT (PDX)

87239

AIRPORT DIAGRAM

AL-516 (FAA)

RALEIGH-DURHAM (RDU)
RALEIGH-DURHAM, NORTH CAROLINA



AIRPORT DIAGRAM

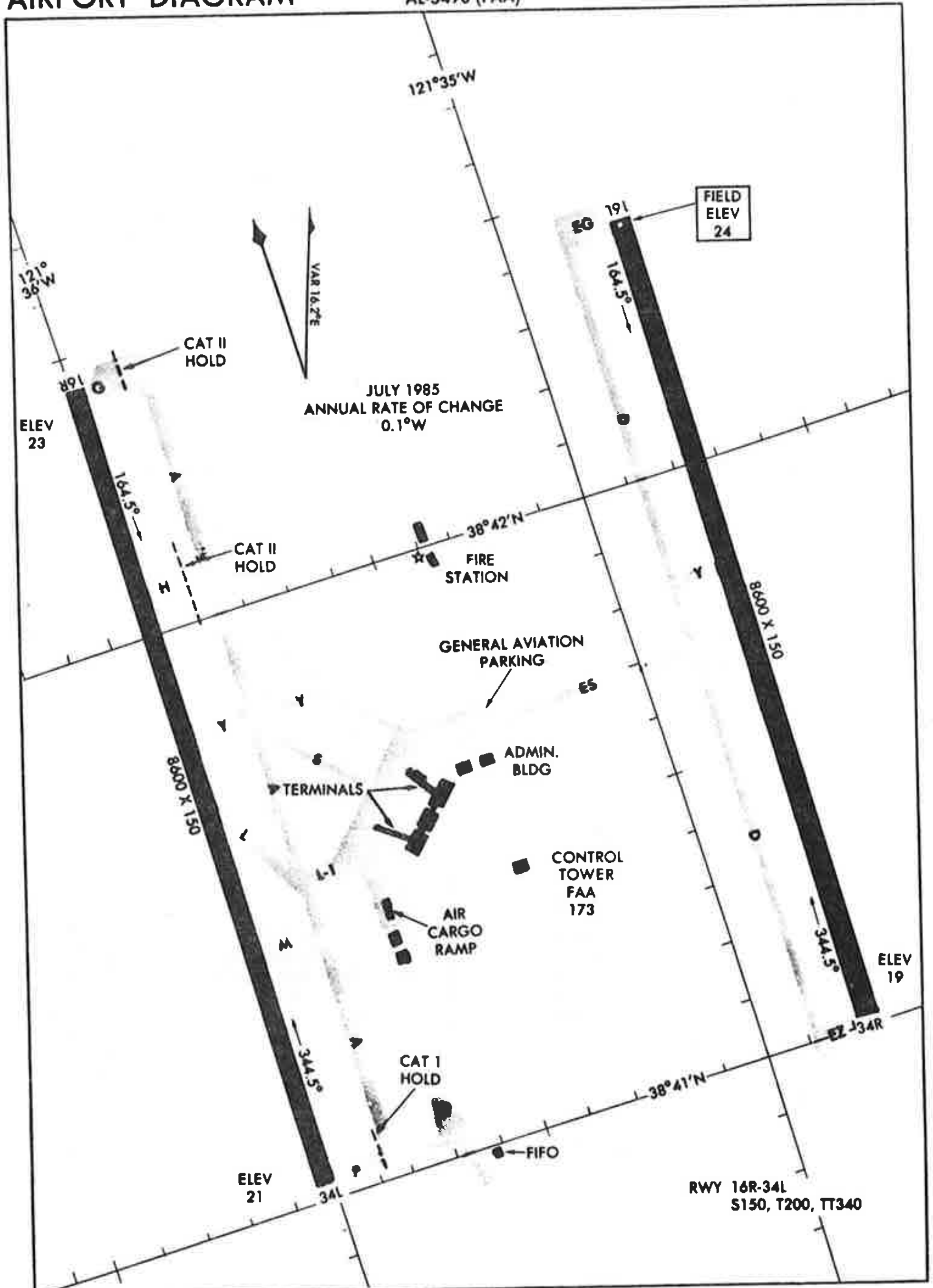
RALEIGH-DURHAM, NORTH CAROLINA
RALEIGH-DURHAM (RDU)

88070

AIRPORT DIAGRAM

AL-5490 (FAA)

SACRAMENTO METROPOLITAN AIRPORT (SMF)
SACRAMENTO, CALIFORNIA



AIRPORT DIAGRAM

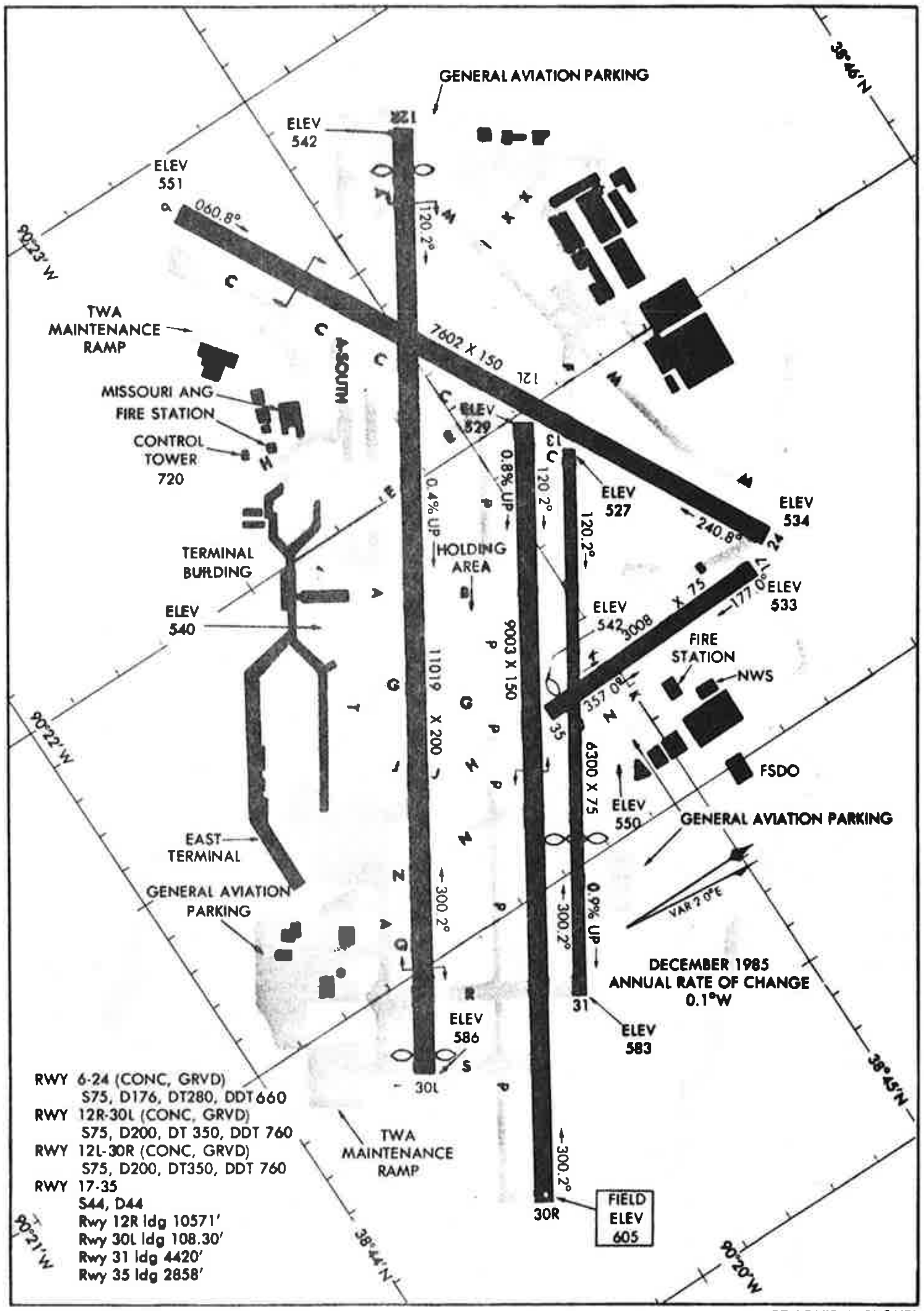
SACRAMENTO, CALIFORNIA
SACRAMENTO METROPOLITAN AIRPORT (SMF)

87351

AIRPORT DIAGRAM

AL-360 (FAA)

ST. LOUIS/LAMBERT-ST. LOUIS INTL (STL)
ST. LOUIS, MISSOURI



AIRPORT DIAGRAM

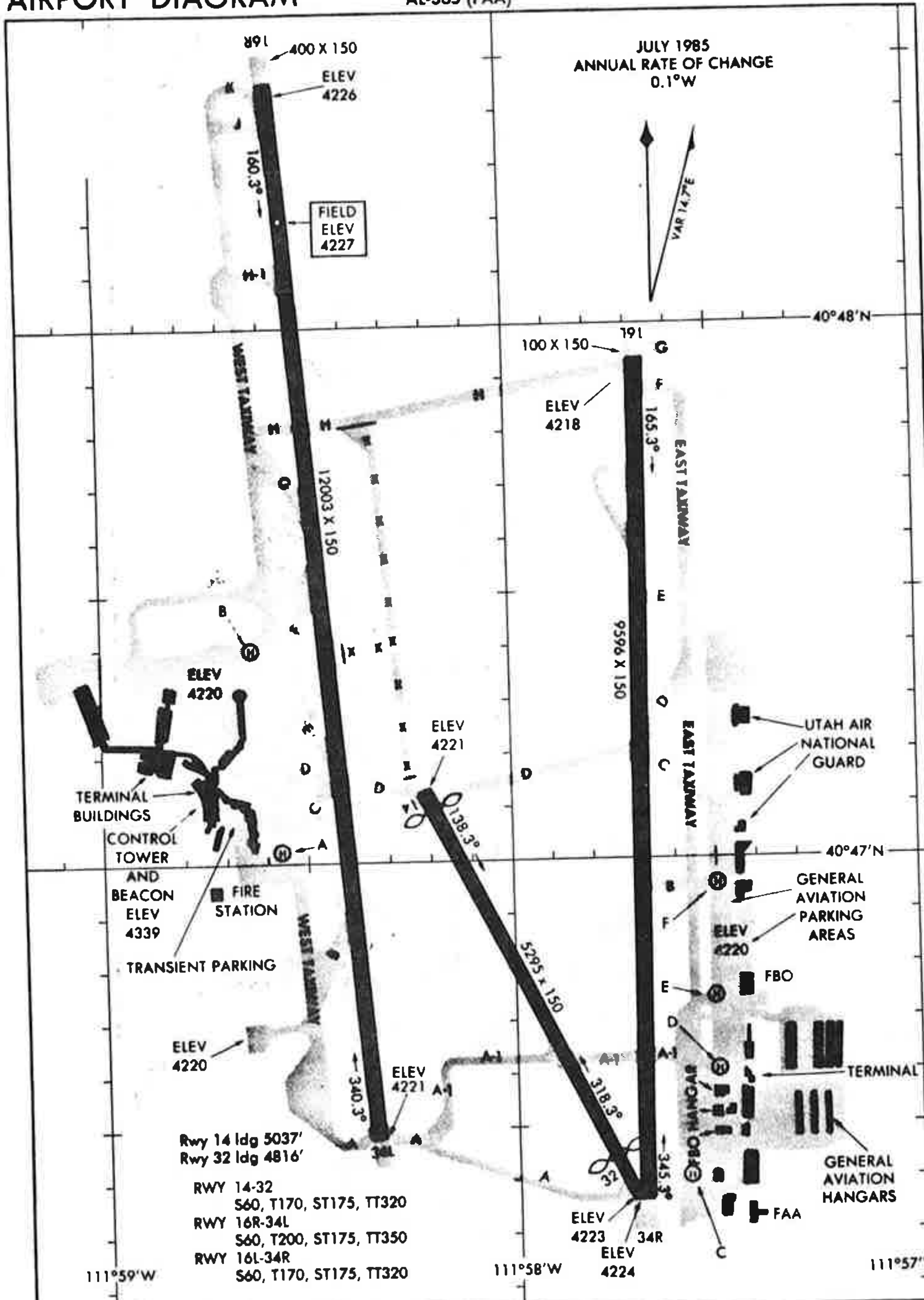
ST. LOUIS, MISSOURI
ST. LOUIS/LAMBERT-ST. LOUIS INTL (STL)

88014

AIRPORT DIAGRAM

AL-365 (FAA)

SALT LAKE CITY INTL (SLC)
SALT LAKE CITY, UTAH



AIRPORT DIAGRAM

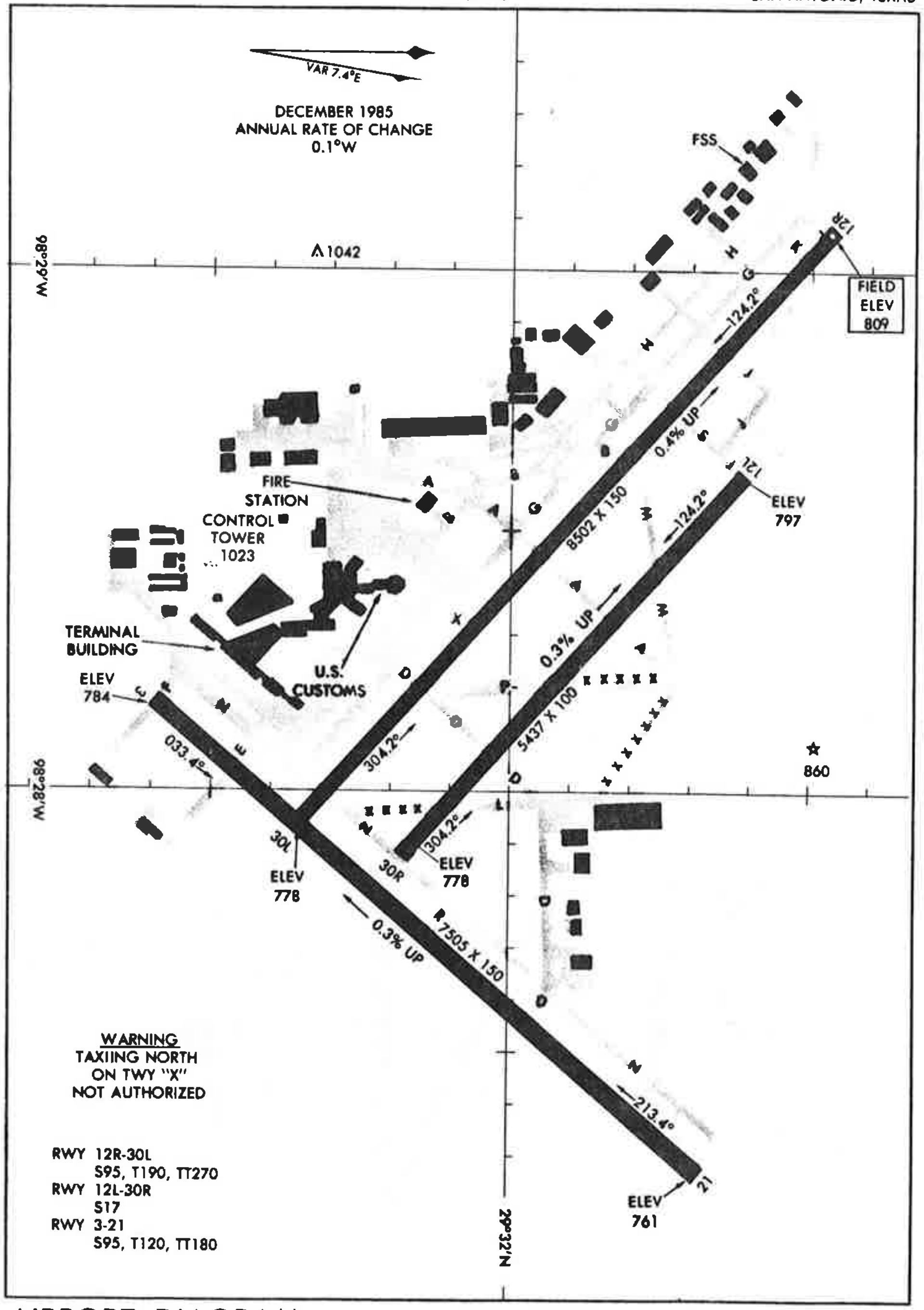
SALT LAKE CITY, UTAH
SALT LAKE CITY INTL (SLC)

88042

AIRPORT DIAGRAM

AL-369 (FAA)

SAN ANTONIO INTERNATIONAL (SAT)
SAN ANTONIO, TEXAS



AIRPORT DIAGRAM

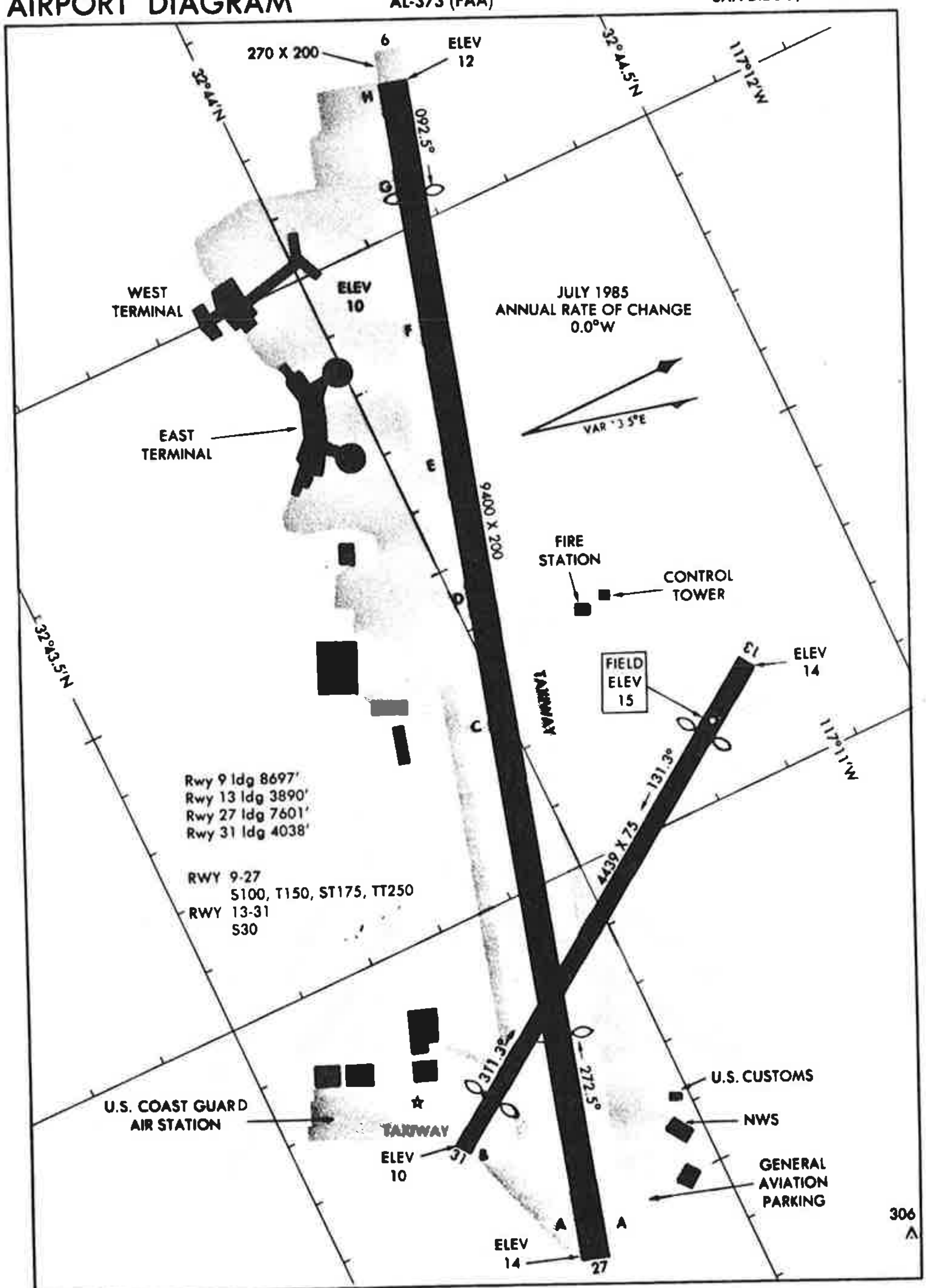
SAN ANTONIO, TEXAS
SAN ANTONIO INTERNATIONAL (SAT)

87295

AIRPORT DIAGRAM

AL-373 (FAA)

SAN DIEGO INTL-LINDBERGH FIELD (SAN)
SAN DIEGO, CALIFORNIA



AIRPORT DIAGRAM

SAN DIEGO, CALIFORNIA
SAN DIEGO INTL-LINDBERGH FIELD (SAN)

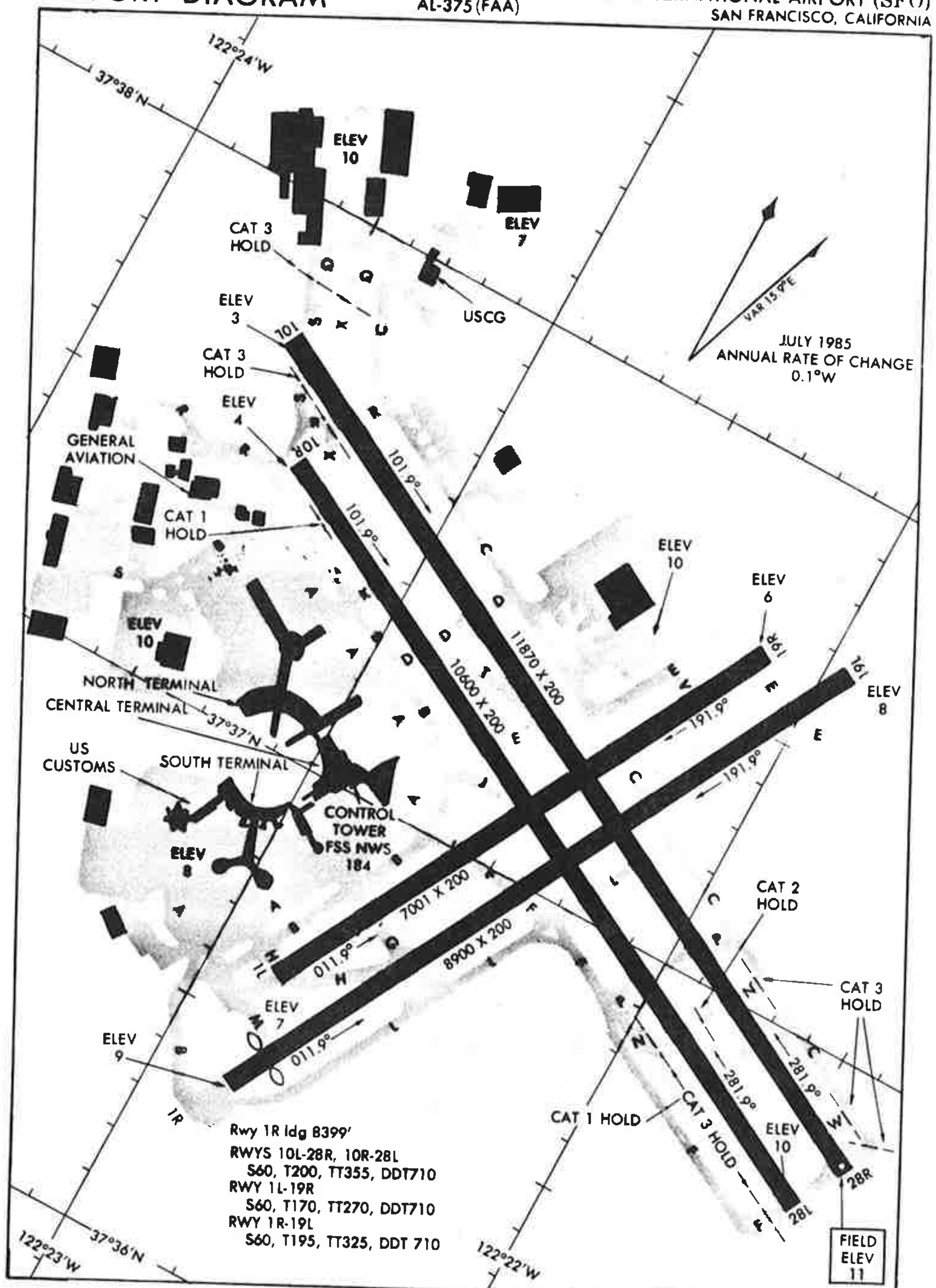
87239

AIRPORT DIAGRAM

AL-375 (FAA)

SAN FRANCISCO INTERNATIONAL AIRPORT (SFO)

SAN FRANCISCO, CALIFORNIA



AIRPORT DIAGRAM

SAN FRANCISCO, CALIFORNIA

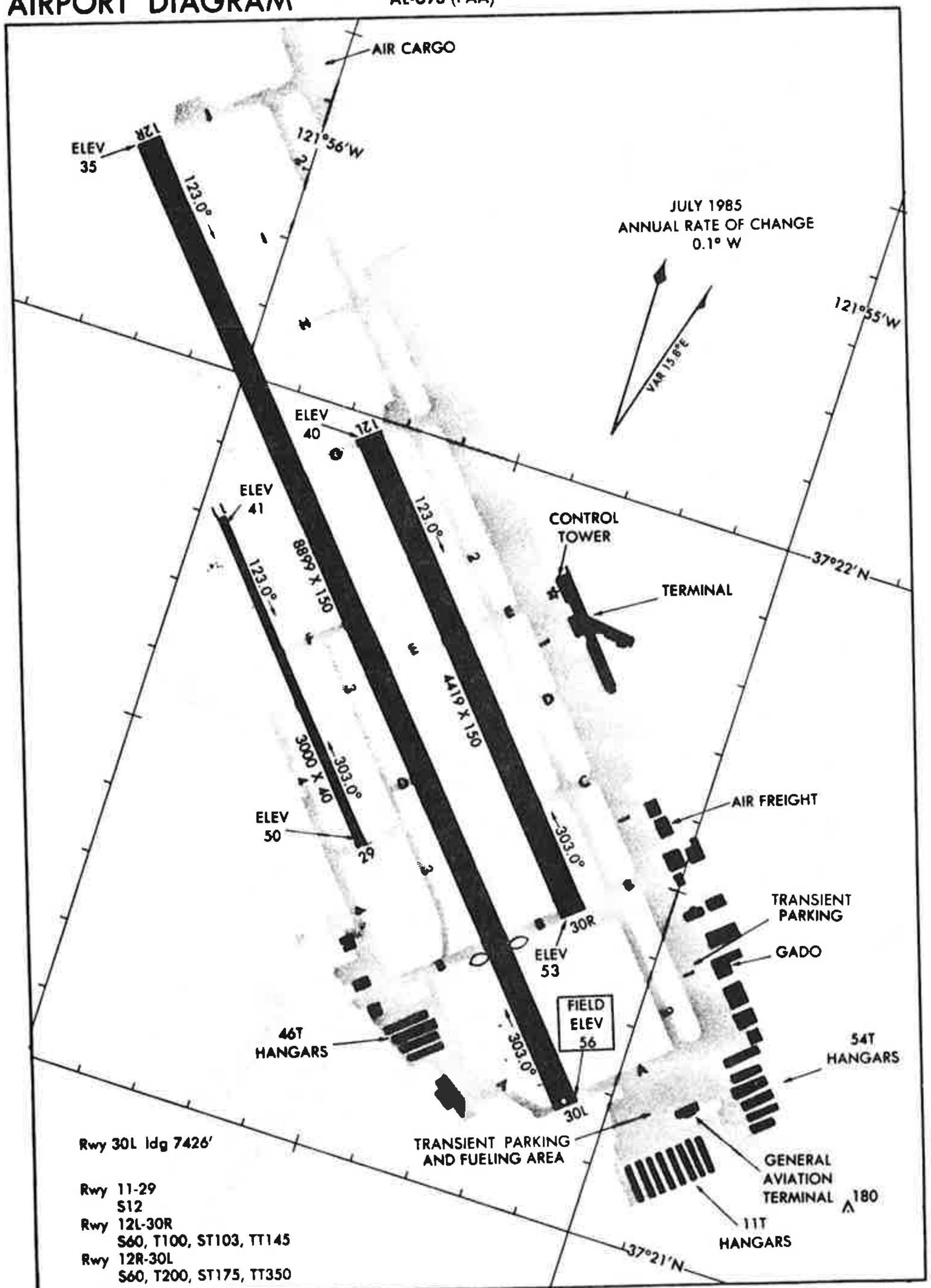
SAN FRANCISCO INTERNATIONAL AIRPORT (SFO)

87239

AIRPORT DIAGRAM

AL-693 (FAA)

SAN JOSE INTL AIRPORT (SJC)
SAN JOSE, CALIFORNIA



AIRPORT DIAGRAM

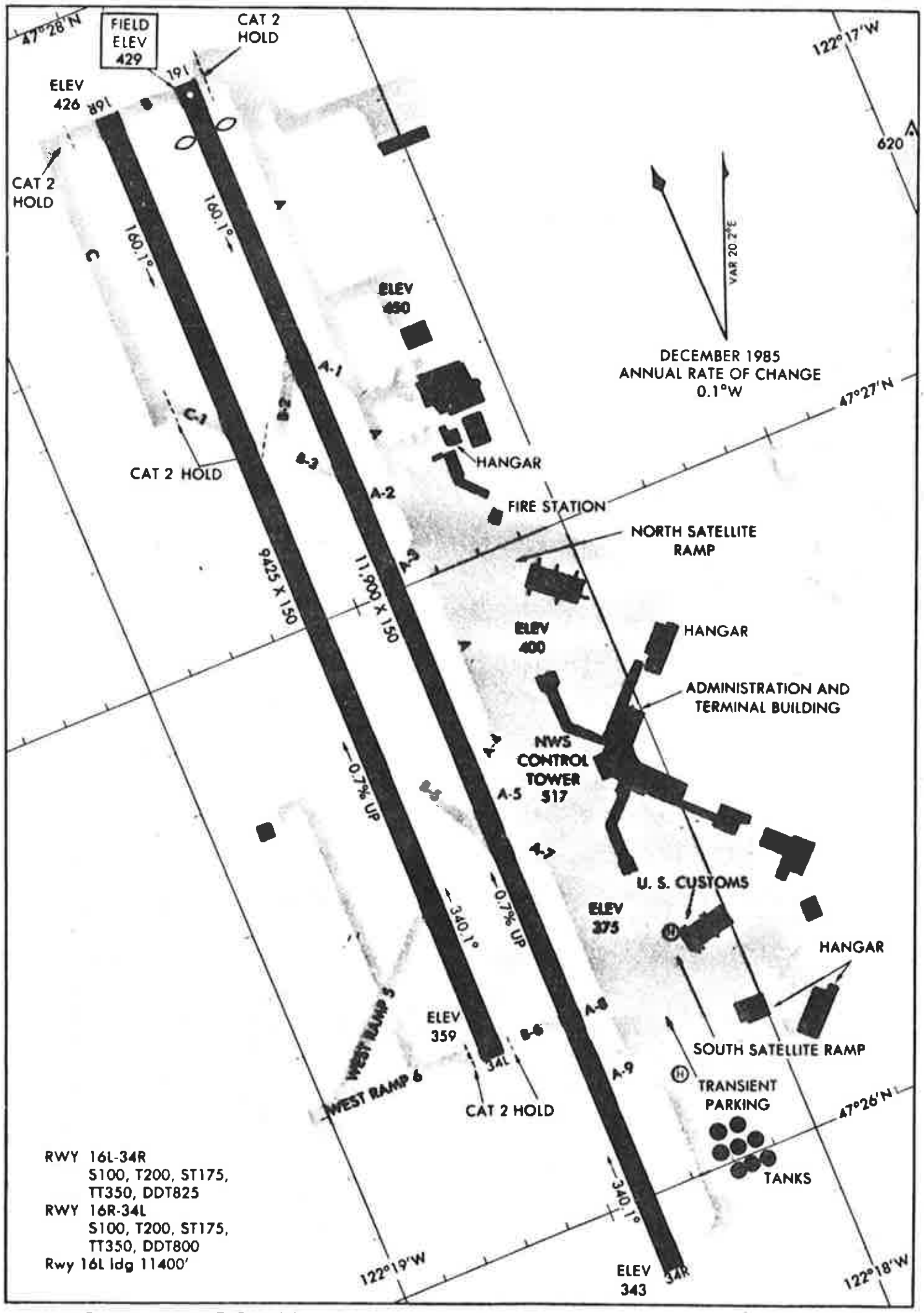
SAN JOSE, CALIFORNIA
SAN JOSE INTL AIRPORT (SJC)

87239

AIRPORT DIAGRAM

AL-582 (FAA)

SEATTLE-TACOMA INTL (SEA)
SEATTLE, WASHINGTON



AIRPORT DIAGRAM

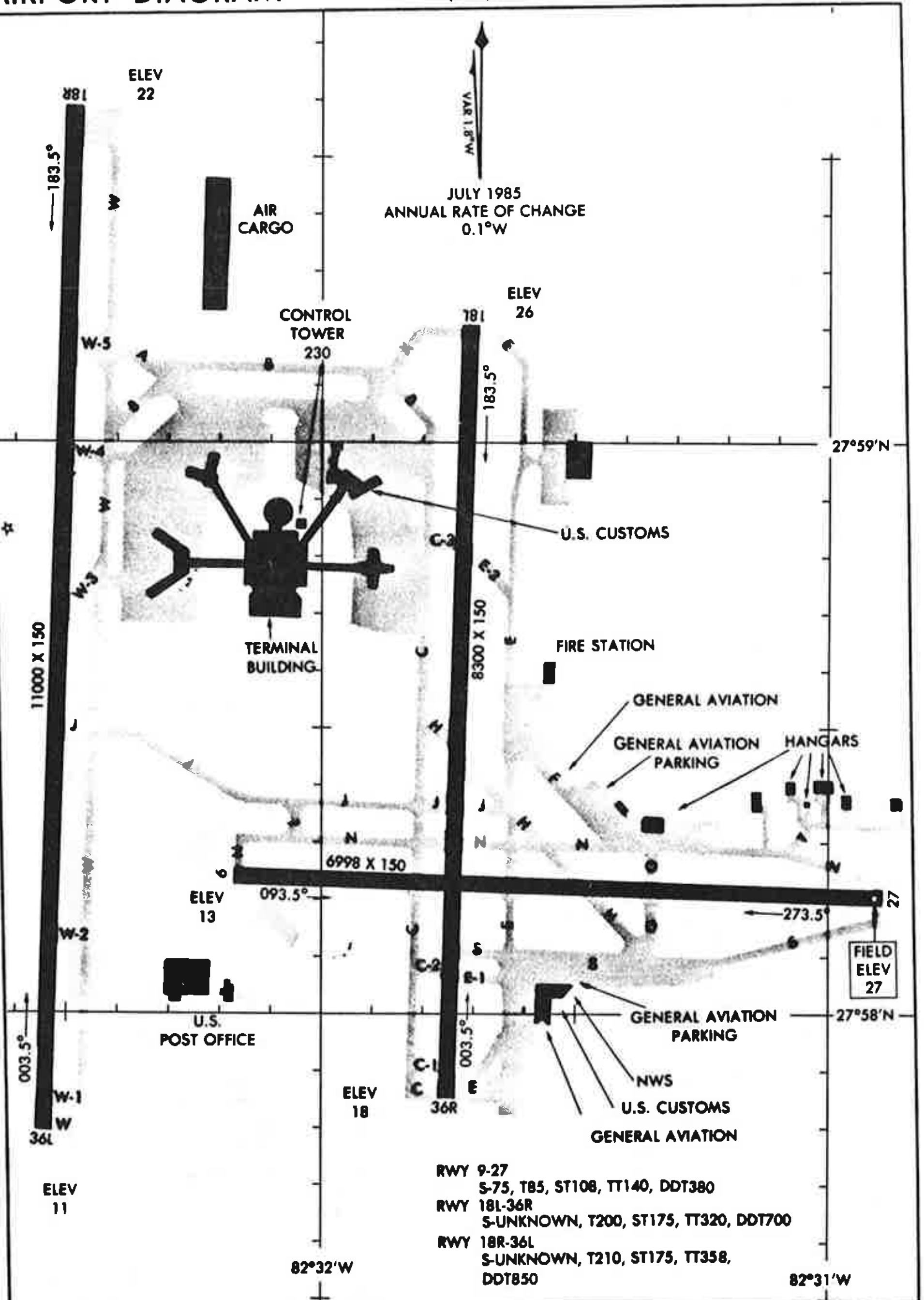
SEATTLE, WASHINGTON
SEATTLE-TACOMA INTL (SEA)

87351

AIRPORT DIAGRAM

AL-416 (FAA)

TAMPA INTL (TPA)
TAMPA, FLORIDA



AIRPORT DIAGRAM

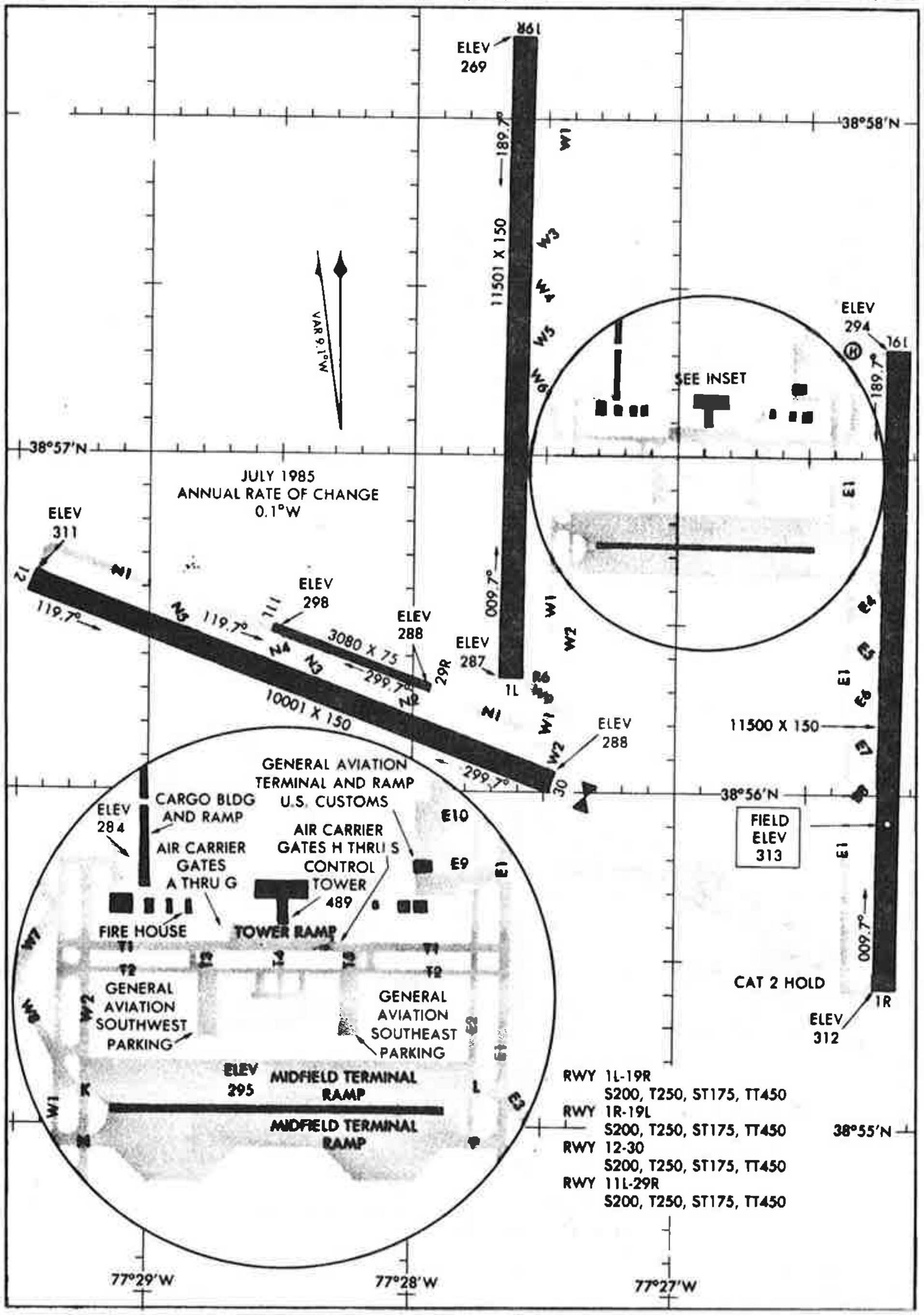
TAMPA, FLORIDA
TAMPA INTL (TPA)

87351

AIRPORT DIAGRAM

AL-5100 (FAA)

WASHINGTON /DULLES INTL (IAD)
WASHINGTON, D.C.



AIRPORT DIAGRAM

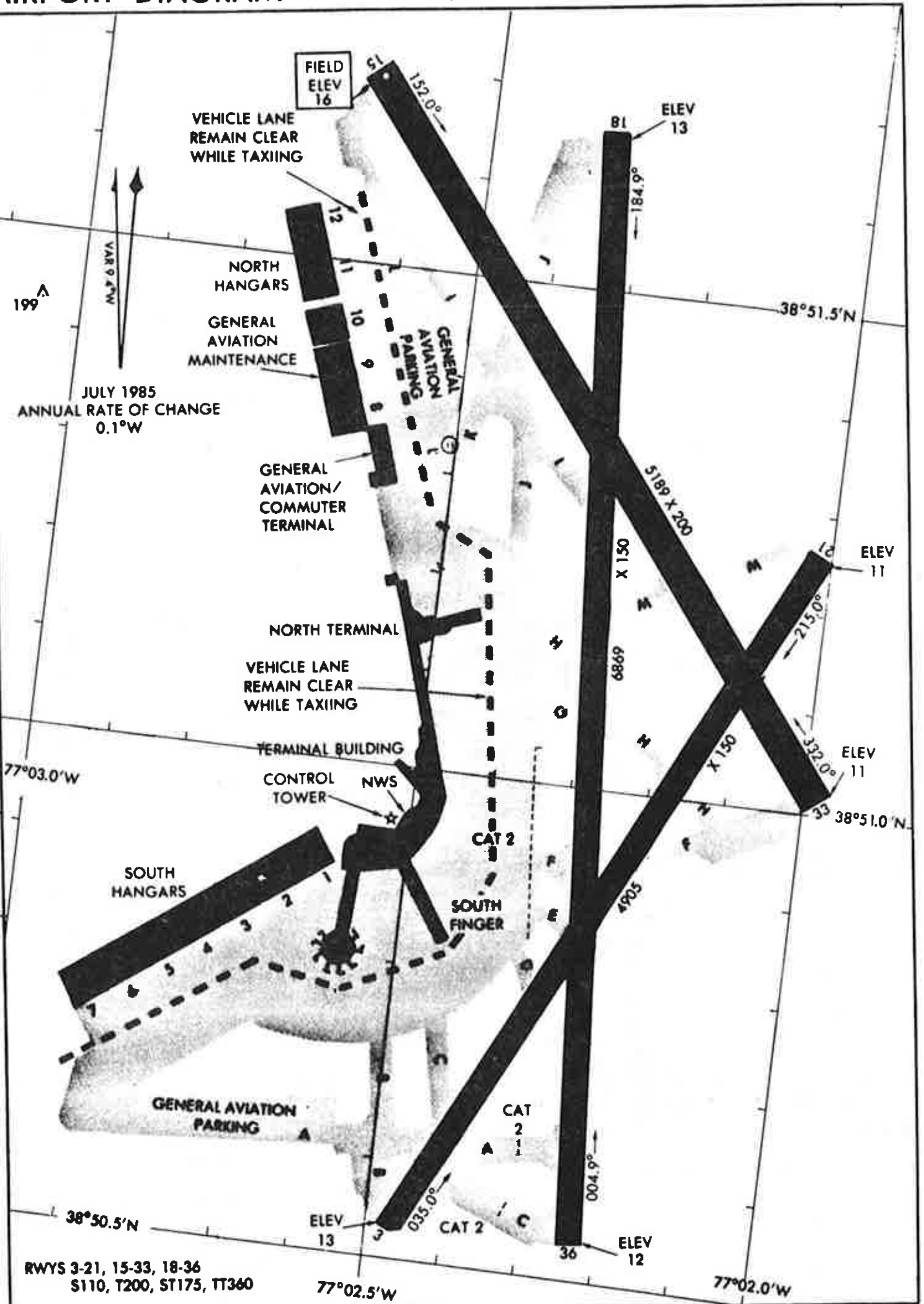
WASHINGTON D.C.
WASHINGTON /DULLES INTL (IAD)

87239

AIRPORT DIAGRAM

AL-443 (FAA)

WASHINGTON NATIONAL AIRPORT (DCA)
WASHINGTON, D.C.



AIRPORT DIAGRAM

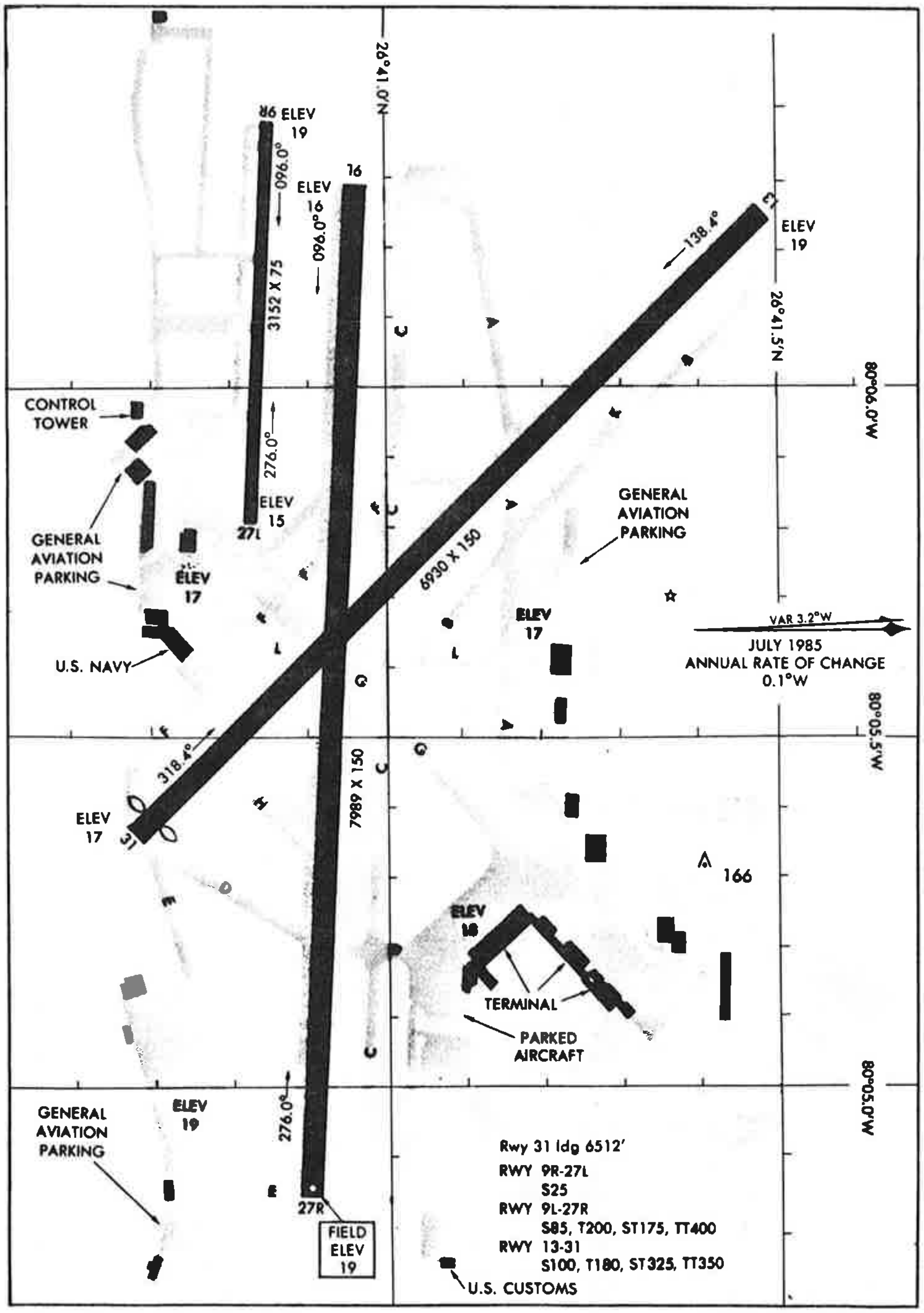
WASHINGTON, D.C.
WASHINGTON NATIONAL AIRPORT (DCA)

87295

AIRPORT DIAGRAM

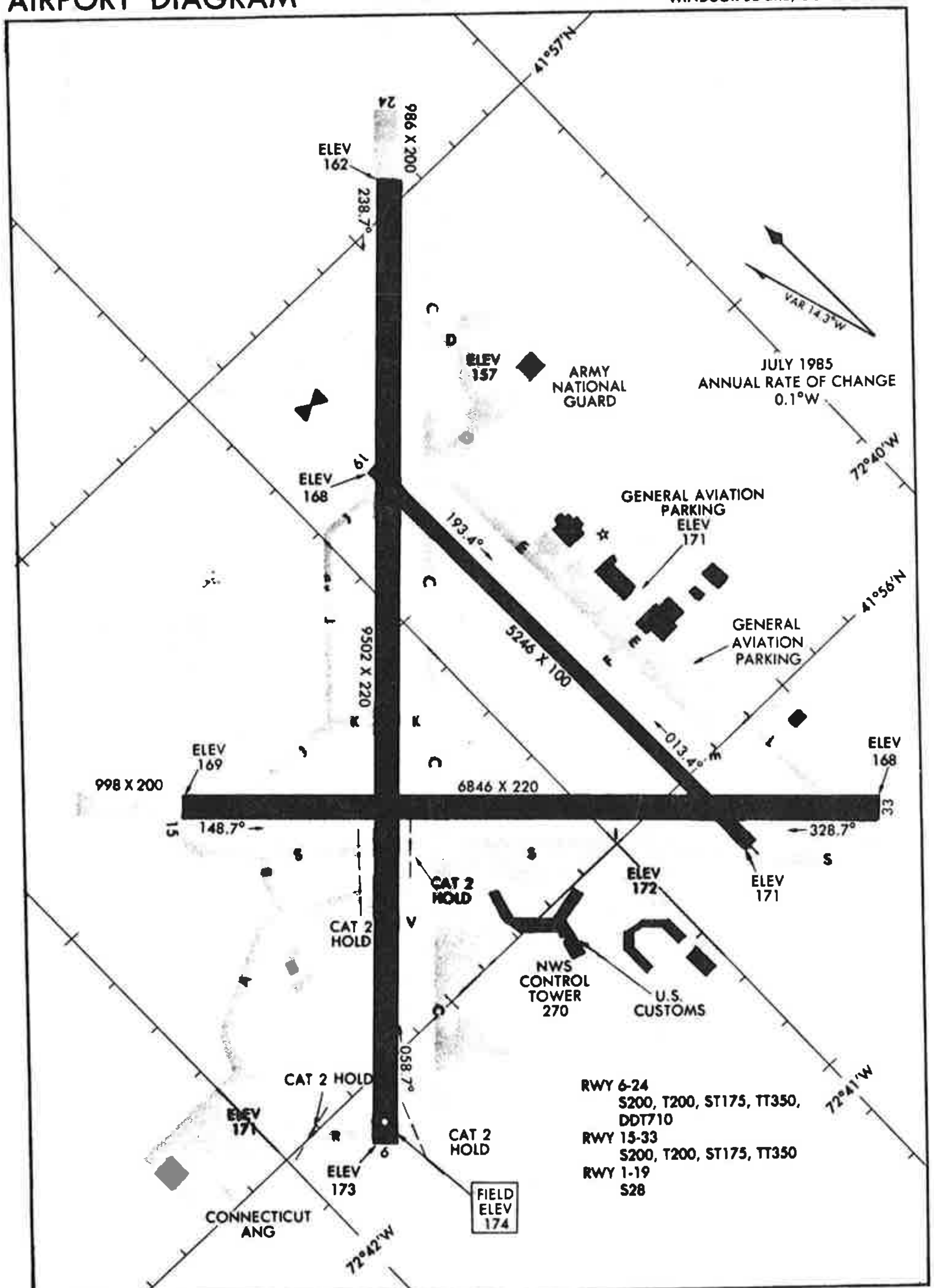
AL-449 (FAA)

WEST PALM BEACH/PALM BEACH INTL (PBI)
WEST PALM BEACH, FLORIDA



AIRPORT DIAGRAM

WEST PALM BEACH, FLORIDA
WEST PALM BEACH/PALM BEACH INTL (PBI)


41°57'N
24
986 X 200
ELEV 162
238.7°
ELEV 157
ARMY NATIONAL GUARD
VAR 14.3°W
JULY 1985
ANNUAL RATE OF CHANGE
0.1°W
72°40'W
19
ELEV 168
GENERAL AVIATION PARKING
ELEV 171
193.4°
9502 X 220
5246 X 100
GENERAL AVIATION PARKING
41°56'N
013.4°
ELEV 168
ELEV 169
998 X 200
6846 X 220
15
148.7°
33
328.7°
CAT 2 HOLD
ELEV 172
ELEV 171
CAT 2 HOLD
NWS CONTROL TOWER 270
U.S. CUSTOMS
058.7°
CAT 2 HOLD
ELEV 171
ELEV 173
6
CAT 2 HOLD
FIELD ELEV 174
CONNECTICUT ANG
72°42'W
72°41'W
RWY 6-24
S200, T200, ST175, TT350, DDT710
RWY 15-33
S200, T200, ST175, TT350
RWY 1-19
S28

APPENDIX J.

LOCATIONS OF 65 HELIPORTS IN THE 1986-1995 NPIAS

TABLE J-1. LOCATIONS OF 65 HELIPORTS IN THE 1986-1995 NPIAS

Location	Status
Mesa AZ	New
Tempe AZ	New
Little Rock AR	New
Huntington Beach CA	New
Anaheim CA	New
Canoga Park CA	New
Irvine CA	New
Los Angeles CA	New
Pasadena CA	New
San Francisco CA	New
Denver CO	New
Washington DC	New
Chicago IL	New
Schaumburg IL	New
Indianapolis Downtown	Existing
Lake Charles LA	New
New Orleans CBD Heliport	Existing
Baltimore MD	New
Boston MA	New
Ann Arbor MI	New
Detroit MI	New
Detroit/Romulus MI	New
Flint/Saginaw MI	New
Grand Rapids MI	New
Jackson MI	New
Kalamazoo/Battlecreek MI	New
Lansing MI	New
Livonia/Plymouth MI	New
Southfield/Pontiac MI	New
Warren MI	New
St. Louis MO	New
Camden NJ	New
Trenton NJ	New
Albuquerque NM	New
NewYork:	
E. 34th St. Heliport	Existing
Pan Am Metro Port	Existing
Downtown Manhattan/Wall St.	Existing
W. 30th St. Midtown	Existing
W.T.C - Battery Park Heliport	Existing
Columbus OH	New
Oklahoma City	New
Tulsa OK	New

TABLE J-1. LOCATIONS OF 65 HELIPORTS IN THE 1986-1995 NPIAS (Continued)

Location	Status
Portland Or	New
Harrisburg PA	New
Philadelphia PA	New
Pittsburgh PA	New
Abilene TX	New
Austin TX	New
Dallas TX	New
Dallas TX	New
Ft. Worth TX	New
Freeport TX	New
Garland TX	New
Houston TX	New
Hurst TX	New
Irving TX	New
Midland TX	New
San Antonio TX	New
Wichita Falls TX	New
Salt Lake City UT	New
Alexandria VA	New
Richmond VA	New
Seattle WA	New

*U.S.GOVERNMENT PRINTING OFFICE:1988-501-116:80010