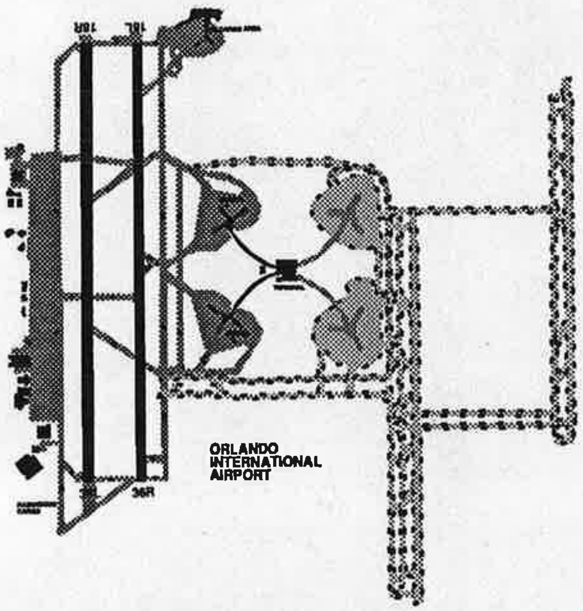
U.S. Department of Transportation
Federal Aviation Administration

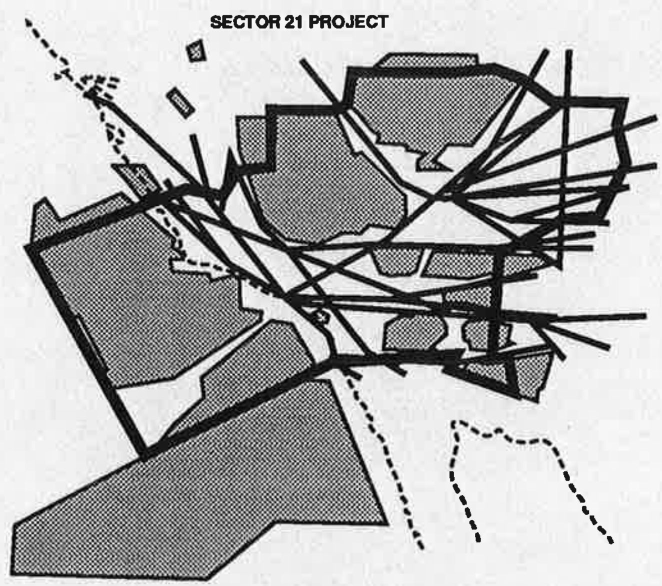
Airport Capacity Enhancement Plan

DOT/FAA/CP-89-4
DOT-TSC-FAA-89-1

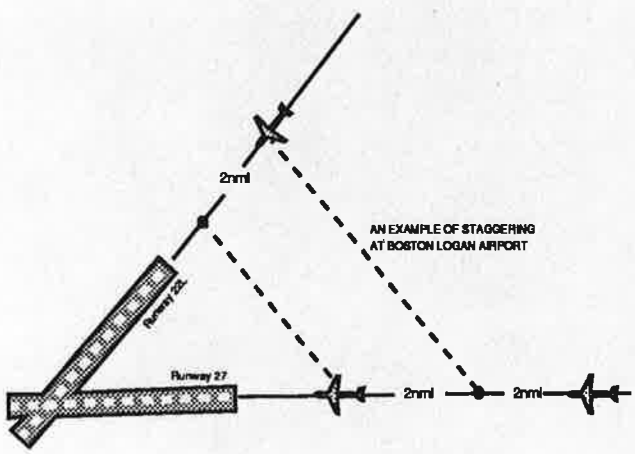
1989



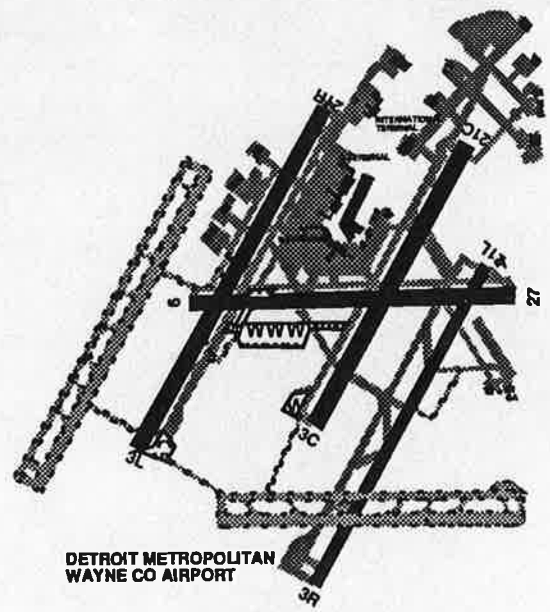
AIRPORT DEVELOPMENT



AIRSPACE DEVELOPMENT



AIRSPACE PROCEDURES



PLANNING PROGRAMS

Prepared for
Airport Capacity Program Office
Washington DC 20591

Prepared by
Transportation Systems Center
Cambridge MA 02142

Technical Report Documentation Page

1. Report No. DOT/FAA/CP/89-4	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle AIRPORT CAPACITY ENHANCEMENT PLAN 1989		5. Report Date May 1989
		6. Performing Organization Code DTS-42
7. Author(s)		8. Performing Organization Report No. DOT-TSC-FAA-89-1
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) FA914/A5120
		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 1988 - April 1989
		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 AIRPORT CAPACITY CAPACITY ENHANCEMENT DELAY REDUCTION	18. Distribution Statement 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	353	

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

Table of Contents

List of Tables

List of Figures

CHAPTER 1

INTRODUCTION

In 1987, 21 airports each exceeded 20,000 hours of airline flight delays. By 1997, the number of airports which could exceed 20,000 hours of annual aircraft delay is projected to grow from 21 to 39, unless capacity improvements are made. The purpose of this plan is to identify and facilitate actions that can be taken by both the public and private sector to reduce present flight delays and prevent the projected growth in delays. These actions include:

In 1987, 21 airports each exceeded 20,000 hours of airline flight delays. By 1997, the number of airports which could exceed 20,000 hours of annual aircraft delay is projected to grow from 21 to 39 unless capacity improvements are made.

- Airport Development
- Airspace Development and New Airspace Procedures
- New Technology, and
- Marketplace Solutions

1.1 Level Of Aviation Activity

This plan concentrates on the top 100 airports in the United States as measured by 1987 passenger enplanements on certificated route air carriers shown in Appendix A. These top 100 airports account for more than 93 percent of the 467 million airline passengers who enplaned nationally in 1987. In addition, solutions to lack of capacity at these top 100 airports are applicable to many of the remaining public-use airports which make up the national system of airports.

The top 100 airports account for more than 93 percent of the 467 million airline passengers who enplaned nationally in 1987.In 1997, 674 million passengers are forecast to enplane at the top airports.

In 1987, 434 million commercial airline passengers were boarded at the top 100 airports. In 1997, 674 million passengers are forecast to enplane at these airports. This represents a projected growth in enplanements of 55% over the next 10 years. Enplanements and relative rankings by airport are shown in Table 1-1.

In 1987, approximately 25.4 million aircraft operations occurred at the top 100 airports. By 1997, operations are forecast to grow to 33.3 million at the same 100 airports; a projected growth in operations of 31%.

In 1987, approximately 25.4 million aircraft operations occurred at these top 100 airports. By 1997, operations are forecast to grow to 33.3 million at the same 100 airports; a projected growth in operations of 31%, at those 100 airports. The top 100 airports handled 41% of total aircraft operations in 1987 and are forecast to handle 44% of total operations by 1997. Table 1-2 shows 1987 aircraft operations, 1997 forecasts, and percent change by airport.

TABLE 1-1. THE TOP 100 AIRPORTS RANKED BY FY 1987 ACTUAL ENPLANEMENTS COMPARED TO FY 1997 FORECAST ENPLANEMENTS

CITY-AIRPORT	AIRPORT IDENTIFIER	1987 ENPLNMTS* (000s)	1987 RANK	1997 ENPLNMTS (000s)	1997 RANK
Chicago (O'Hare International)	ORD	27,532	1	39,288	1
Atlanta (Hartsfield International)	ATL	23,871	2	29,238	4
Los Angeles (International)	LAX	21,229	3	24,882	5
Dallas-Fort Worth (International)	DFW	20,751	4	31,630	2
Denver Stapleton (International)	DEN	16,133	5	29,731	3
New York (Kennedy International)	JFK	14,390	6	20,772	6
San Francisco (International)	SFO	13,996	7	17,840	7
Newark (International)	EWR	12,194	8	16,220	10
New York (LaGuardia)	LGA	11,605	9	14,661	14
Miami (International)	MIA	11,601	10	16,859	9
Boston (Logan International)	BOS	11,543	11	15,048	12
St. Louis (Lambert International)	STL	10,130	12	14,300	16
Detroit (Metro Wayne County)	DTW	9,883	13	15,603	11
Honolulu (International)	HNL	9,412	14	12,536	19
Minneapolis-St. Paul	MSP	9,016	15	14,723	13
Phoenix (Sky Harbor International)	PHX	8,912	16	16,938	8
Pittsburgh (International)	PIT	8,502	17	14,559	15
Washington (National)	DCA	7,417	18	8,918	25
Philadelphia (International)	PHL	7,395	19	12,168	21
Houston (Intercontinental)	IAH	7,366	20	12,406	20
Las Vegas (McCarran)	LAS	7,330	21	14,300	17
Orlando (International)	MCO	7,272	22	13,661	18
Seattle Tacoma	SEA	7,156	23	10,659	22
Charlotte Douglas (International)	CLT	6,230	24	10,225	23
Memphis (International)	MEM	5,393	25	8,397	28
Washington Dulles (International)	IAD	5,065	26	8,520	27
San Diego (Lindbergh)	SAN	4,989	28	7,935	30
Salt Lake City (International)	SLC	4,867	27	8,763	26
Tampa (International)	TPA	4,725	29	7,598	31
Kansas City (International)	MCI	4,610	30	6,905	33
Baltimore-Washington (International)	BWI	4,553	31	8,136	29
Fort Lauderdale (International)	FLL	4,113	32	7,118	32
Houston (Hobby)	HOU	3,990	33	6,331	35
San Juan (Marin International)	SJU	3,472	34	4,850	42
New Orleans (International)	MSY	3,455	35	5,757	37
Cincinnati (International)	CVG	3,333	36	6,681	34
Cleveland Hopkins (International)	CLE	3,257	37	4,500	43

TABLE 1-1. THE TOP 100 AIRPORTS RANKED BY FY 1987 ACTUAL ENPLANEMENTS COMPARED TO FY 1997 FORECAST ENPLANEMENTS (Continued)

CITY-AIRPORT	AIRPORT IDENTIFIER	1987 ENPLNMTS* (000s)	1987 RANK	1997 ENPLNMTS (000s)	1997 RANK
Nashville (Metro)	BNA	3,119	38	5,480	39
San Jose (International)	SJC	2,836	39	5,186	40
Portland (OR) (International)	POX	2,811	40	4,300	45
San Antonio (International)	SAT	2,513	41	3,640	49
Dallas (Love)	DAL	2,491	42	4,414	44
Chicago (Midway)	MDW	2,435	43	5,038	41
Indianapolis (International)	IND	2,387	44	3,430	55
Dayton (International)	DAY	2,336	45	3,470	53
Kahului	OGG	2,331	46	3,207	56
Windsor Locks Bradley (International)	BDL	2,328	47	3,607	50
Albuquerque (International)	ABQ	2,256	48	3,648	48
West Palm Beach (International)	PBI	2,243	49	3,846	47
Ontario (International)	ONT	2,238	50	5,612	38
Santa Ana (John Wayne)	SNA	2,190	51	3,580	51
Oakland Metro (International)	OAK	1,979	52	3,447	54
Austin (Robert Mueller)	AUS	1,947	53	3,543	52
Raleigh-Durham (International)	RDU	1,932	54	9,139	24
Sacramento (Metro)	SMF	1,896	55	2,969	58
Columbus (International)	CMH	1,784	56	5,991	36
Buffalo (International)	BUF	1,780	57	2,581	59
Milwaukee (Mitchell International)	MKE	1,772	58	4,124	46
Norfolk (International)	ORF	1,665	59	2,470	61
Reno (Cannon International)	RNO	1,621	60	2,349	63
Burbank	BUL	1,574	61	2,100	67
Syracuse (Hancock International)	SYR	1,565	62	2,300	64
Tucson (International)	TUS	1,557	63	2,535	60
Oklahoma City (Will Rogers World)	OKC	1,517	64	2,461	62
Jacksonville (International)	JAX	1,468	65	2,189	65
Tulsa (International)	TUL	1,411	66	2,063	68
Anchorage (Anchorage)	ANC	1,356	67	2,156	66
El Paso (International)	ELP	1,323	68	1,970	70
Rochester (Monroe County)	ROC	1,316	69	2,000	69
Lihue	LIH	1,251	70	1,845	71
Fort Myers (SW Florida Regional)	RSW	1,209	71	3,111	57
Omaha (Eppley)	OMA	1,129	72	1,834	72
Louisville (Standiford)	SDF	1,079	73	1,656	74
Greensboro (Regional)	GSO	1,040	74	1,555	77

TABLE 1-1. THE TOP 100 AIRPORTS RANKED BY FY 1987 ACTUAL ENPLANEMENTS COMPARED TO FY 1997 FORECAST ENPLANEMENTS (Continued)

CITY-AIRPORT	AIRPORT IDENTIFIER	1987 ENPLNMTS* (000s)	1987 RANK	1997 ENPLNMTS (000s)	1997 RANK
Albany	ALB	1,018	75	1,666	73
Providence (Green State)	PVD	985	76	1,571	76
Richmond (International)	RIC	938	77	1,413	78
Little Rock (Adams)	LIT	899	78	1,316	82
Birmingham (Municipal)	BHM	893	79	1,334	81
Spokane (International)	GEG	849	80	1,353	80
Kailua-Kona (Keahole)	KOA	845	81	1,641	75
Des Moines	DSM	784	82	1,186	84
Sarasota-Bradenton	SRQ	781	83	1,160	85
Colorado Springs (Municipal)	COS	717	84	1,026	87
Charleston (SC) (AFB International)	CHS	705	85	1,052	86
Wichita (Mid-Continent)	ICT	690	86	999	89
Grand Rapids (Kent County Int'l)	GRR	674	87	978	90
Portland (ME) (International Jetport)	PWM	617	88	1,310	83
Columbia (SC) (Metro)	CAE	611	89	888	93
Long Beach	LGB	609	90	1,393	79
Knoxville (McGhee-Tyson)	TYS	584	91	877	94
Islip (Long Island MacArthur)	ISP	582	92	1,019	88
Midland (International)	MAF	570	93	847	95
Boise	BOI	568	94	896	92
Hilo (General Lyman)	ITO	559	95	646	100
Savannah (International)	SAV	548	96	798	96
Greer (Greenville-Spartanburg)	GSP	536	97	778	98
Lubbock (International)	LBB	535	98	797	97
Harlingen (Rio Grande International)	HRL	471	99	953	91
Amarillo (International)	AMA	462	100	747	99
TOTAL		434,401		674,161	

Source: FAA Office of Policy and Plans

* Includes U.S. certificated route air carriers, foreign flag, carriers, supplementals, air commuters, and air taxis.

TABLE 1-2. 1987 ACTUAL AND 1997 FORECAST OPERATIONS AT THE TOP 100 AIRPORTS

CITY-AIRPORT	AIRPORT IDENTIFIER	TOTAL OPERATIONS (000s)		% CHANGE 1987-1997
		1987	1997	
Atlanta (Hartsfield International)	ATL	802	903	13%
Chicago (O'Hare International)	ORD	797	819	3%
Los Angeles (International)	LAX	655	661	1%
Dallas-Fort Worth (International)	DFW	609	967	59%
Santa Ana (John Wayne)	SNA	527	644	22%
Denver (Stapleton International)	DEN	522	776	49%
San Francisco (International)	SFO	451	489	8%
Long Beach	LGB	438	503	15%
Phoenix (Sky Harbor International)	PHX	436	569	31%
Boston (Logan International)	BOS	436	511	17%
St. Louis (Lambert International)	STL	427	489	15%
Detroit (Metro Wayne County)	DTW	412	497	21%
Philadelphia (International)	PHL	412	492	19%
Oakland (Metro International)	OAK	398	497	25%
Las Vegas (McCarran)	LAS	389	512	32%
Honolulu (International)	HNL	389	464	19%
Memphis (International)	MEM	384	476	24%
Minneapolis-St. Paul	MSP	383	490	28%
Newark (International)	EWR	383	436	14%
Pittsburgh (International)	PIT	371	465	25%
New York (LaGuardia)	LGA	366	382	4%
Miami (International)	MIA	364	441	21%
Charlotte (Douglas International)	CLT	363	514	42%
San Jose (International)	SJC	358	496	39%
Washington (National)	DCA	324	374	15%
New York (Kennedy International)	JFK	312	364	17%
Houston (Intercontinental)	IAH	303	381	26%
Washington (Dulles International)	IAD	296	365	23%
Salt Lake City (International)	SLC	292	438	50%
Baltimore-Washington (International)	BWI	291	390	34%
Seattle (Tacoma)	SEA	281	360	28%
Houston (Hobby)	HOU	279	326	17%
Nashville (Metro)	BNA	268	336	25%
Chicago (Midway)	MDW	257	381	48%
Orlando (International)	MCO	252	468	86%
Tampa (International)	TPA	247	316	28%
Tucson (International)	TUS	244	394	61%

TABLE 1-2. 1987 ACTUAL AND 1997 FORECAST OPERATIONS AT THE TOP 100 AIRPORTS (Continued)

CITY-AIRPORT	AIRPORT IDENTIFIER	TOTAL OPERATIONS (000s)		% CHANGE 1987-1997
		1987	1997	
Burbank	BUR	243	283	16%
Portland (OR) (International)	PDX	241	311	29%
Columbus (International)	CMH	233	287	23%
Cincinnati (International)	CVG	231	387	68%
Albuquerque (International)	ABQ	231	370	60%
Rochester (Monroe County)	ROC	231	291	26%
West Palm Beach (International)	PBI	230	248	8%
Islip (Long Island MacArthur)	ISP	229	308	34%
Dallas (Love)	DAL	227	338	49%
Cleveland (Hopkins International)	CLE	226	272	20%
Fort Lauderdale (International)	FLL	224	309	38%
Raleigh-Durham (International)	RDU	217	504	132%
Anchorage	ANC	216	260	20%
Indianapolis (International)	IND	214	301	41%
Providence (Green State)	PVD	212	220	4%
Kansas City (International)	MCI	203	309	52%
San Juan (Marin International)	SJU	201	215	7%
Dayton (International)	DAY	201	245	22%
San Antonio (International)	SAT	197	293	49%
El Paso (International)	ELP	197	286	45%
Austin (Robert Mueller)	AUS	197	280	42%
Norfolk (International)	ORF	194	254	31%
San Diego (Lindbergh)	SAN	193	251	30%
Tulsa (International)	TUL	191	296	55%
Birmingham (Municipal)	BHM	190	246	29%
Milwaukee (Mitchell International)	MKE	190	223	17%
Sarasota-Bradenton	SRQ	183	206	13%
Albany	ALB	183	236	29%
Windsor (Locks Bradley International)	BDL	181	335	85%
Syracuse (Hancock International)	SYR	175	230	31%
New Orleans (International)	MSY	173	214	24%
Richmond (International)	RIC	171	248	45%
Reno (Cannon International)	RNO	169	287	70%
Des Moines	DSM	169	238	41%
Kahului	OGG	169	231	37%
Colorado Springs (Municipal)	COS	163	253	55%
Sacramento (Metro)	SMF	163	223	37%

TABLE 1-2. 1987 ACTUAL AND 1997 FORECAST OPERATIONS AT THE TOP 100 AIRPORTS (Continued)

CITY-AIRPORT	AIRPORT IDENTIFIER	TOTAL OPERATIONS (000s)		% CHANGE 1987-1997
		1987	1997	
Wichita (Mid-Continent)	ICT	162	283	75%
Omaha (Eppley)	OMA	159	229	44%
Little Rock (Adams)	LIT	158	246	56%
Oklahoma City (Will Rogers World)	OKC	158	214	35%
Louisville (Standiford)	SDF	155	194	25%
Knoxville (McGhee-Tyson)	TYS	154	191	24%
Greensboro (Regional)	GSO	150	200	33%
Boise	BOI	146	325	123%
Grand Rapids (Kent County Int'l)	GRR	146	180	23%
Jacksonville (International)	JAX	145	185	28%
Charleston (SC) (AFB International)	CHS	140	168	20%
Lihue	LIH	140	173	24%
Ontario (International)	ONT	137	209	53%
Buffalo (International)	BUF	132	161	22%
Columbia (SC) (Metro)	CAE	129	182	41%
Lubbock (International)	LBB	120	170	42%
Portland (ME) (International Jetport)	PWM	120	165	38%
Spokane (International)	GEG	112	131	17%
Savannah (International)	SAV	105	153	46%
Midland (International)	MAF	105	167	59%
Amarillo (International)	AMA	93	125	34%
Hilo (General Lyman)	ITO	79	86	9%
Kailua-Kona (Keahole)	KOA	70	128	83%
Greenville-Spartenburg	GSP	66	91	38%
Fort Myers (SW Florida Regional)	RSW	62	123	98%
Harlingen (Rio Grande International)	HRL	58	79	36%
TOTAL		25,378	33,320	

Source: FAA Office of Policy and Plans

1.2 Causes of Delay

Delay

The delay described here is actual delay - the difference between actual and optimal flight time (achievable in the absence of adverse weather, congestion, or National Airspace System (NAS) equipment outages, runway closures, etc.). It does not include delay caused by problems in the perview of the airlines such as aircraft maintenance, crew availability, etc. It is characterized both by phase of flight in which it is incurred and by cause. Airline schedules can absorb some actual delay as flight time used in their schedules anticipates some delay.[1]

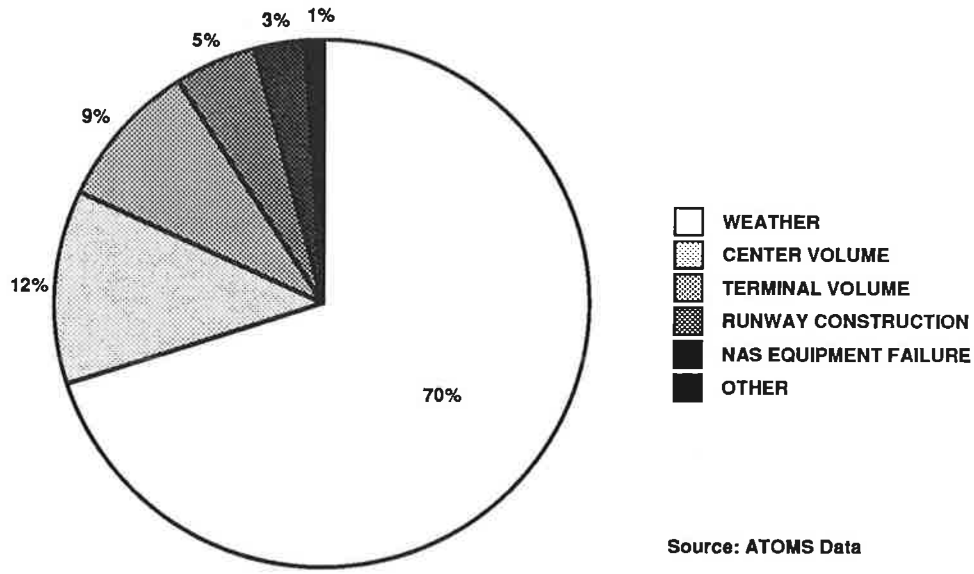
[1] The Federal Aviation Administration (FAA) maintains two major delay reporting systems, ATOMS (Air Traffic Operations Management System) and SDRS (Standardized Delay Reporting System). ATOMS and SDRS define delay as system delay (the difference between actual and optimal flight time), as opposed to passenger delay (the difference between actual and scheduled flight time). Some delay may be included in airline scheduling; however, FAA measures delay in terms of the difference between actual flight time experienced versus an optimal, unconstrained flight time.

Each system collects and reports delay in a different way. ATOMS delay data, which includes data that used to be reported under NAPRS (National Airspace Performance Reporting System), is reported by controllers and supervisors at Air Traffic Control (ATC) facilities. The number of operations delayed by 15 minutes or more is recorded, as well as the cause of delay. SDRS delay data is provided by three major air carriers comprising approximately 25% of all air carrier operations. This system chronicles delay during four phases of flight and is subdivided into length of delay.

Delay by Cause

Weather accounted for 70% of operations delayed by 15 minutes or more in 1988.

As shown in Figure 1-1, weather accounted for 70% of operations delayed by 15 minutes or more in 1988. Air traffic center volume accounted for 12% of delays, terminal air traffic delays for 9%, runway construction for 5%, NAS equipment failure for 3%, and 1% was attributed to other causes. The total number of operations delayed in FY 1988 was approximately the same as those delayed in 1987. Throughout the past five years, the basic distribution of delay by cause has remained fairly consistent as shown in Table 1-3.



Source: ATOMS Data

FIGURE 1-1. PRIMARY CAUSES OF DELAY OF 15 MINUTES OR MORE IN FY 1988

TABLE 1-3. DISTRIBUTION OF DELAY GREATER THAN 15 MINUTES BY CAUSE, 1984-1988

CAUSE	1984	1985	1986	1987	1988
WEATHER	60%	68%	67%	67%	70%
CENTER VOLUME	16%	11%	10%	13%	12%
TERMINAL VOLUME	18%	12%	16%	11%	9%
RUNWAYCONSTRUCTION	3%	6%	3%	4%	5%
NAS EQUIPMENT	2%	2%	3%	4%	3%
OTHER	1%	1%	1%	1%	1%
TOTAL DELAYS (000s)	404	334	418	325	322
PERCENT OF CHANGE FROM PREVIOUS YEAR		-17%	+25%	-22%	-1%

Source: ATOMS Data

Delay by Phase of Flight[2]

Eighty percent of all flights are delayed 1-14 minutes in taxi-in or taxi-out phases of flight. Conversely, only five percent of flights have any gatehold delay. More delay occurs during the taxi-out phase than any other phase. Table 1-4 presents the distribution of delay by length of delay and the phase of flight.

Eighty percent of all flights are delayed 1-14 minutes in taxi-in or taxi-out phases of flight.

TABLE 1-4. DELAYS BY FLIGHT PHASE

LENGTH OF DELAY (IN MINUTES)	GATEHOLD	TAXI-OUT	AIRBORNE	TAXI-IN
0	94.9%	6.0%	36.6%	16.0%
1-14	3.0%	80.4%	59.0%	81.8%
15-29	1.2%	11.5%	3.5%	1.8%
30-59	0.7%	1.8%	0.7%	0.4%
60 +	0.3%	0.3%	0.1%	0.0%
TOTAL	100.0%	100.0%	100.0%	100.0%

Source: SDRS Data -- January - December 1987

---

2 This delay reporting system accounts for any delay as opposed to major (greater than 15 minutes) delay as marked by the ATOMS system. SDRS defines delay in the four phases of flight as follows:

Taxi-in Delay: The difference between touchdown time and gate arrival time minus a standard taxi-in time for that type of aircraft and that airline at that airport.

Taxi-out Delay: The difference between the time of lift-off and the time that the aircraft departed the gate minus a standard taxi-out time established for that type of aircraft and that airline at that airport.

Airborne Delay: The difference between the time of lift-off from the origin airport and touchdown minus the computer-generated optimum profile flight time for that particular flight based on atmospheric conditions, aircraft loading, etc.

Gate-hold Delay: The difference between the time that departure of an aircraft is authorized by ATC and the time that the aircraft would have left the gate area in the absence of an ATC gatehold.

On average, each flight delay in 1987 was 15.5 minutes.

Since 1984, airborne delay has been declining while delay on the ground has been increasing.

Table 1-5 shows the overall rise in average total delay throughout the four phases of flight as reported by SDRS. This rise is gradual yet steady. On average, each flight in 1987 was delayed 15.5 minutes; an average of 8.9 minutes of delay was experienced per departure operation and 6.6 minutes of delay was experienced by each arrival. Since 1984, airborne delay has been declining while delay on the ground has been increasing.

TABLE 1-5. DELAY BY PHASE OF FLIGHT, 1984-1987

PHASE OF FLIGHT	AVERAGE DELAY (IN MINUTES)			
	1984	1985	1986	1987
ATC GATEHOLD	0.7	1.0	1.1	1.0
TAXI-OUT	6.5	6.4	7.3	7.9
AIRBORNE	4.0	4.0	3.7	3.6
TAXI-IN	2.4	2.5	3.0	3.0
TOTAL	13.6	13.9	15.1	15.5

Source: SDRS Data

CHAPTER 2

IDENTIFICATION OF FORECAST DELAY-PROBLEM AIRPORTS

In FY 1988, the number of airline flight delays in excess of 15 minutes decreased compared to 1987 at 15 of 22 major airports as shown in Figure 2-1. Table 2-1 presents the percentages of operations delayed 15 minutes or more at these airports over the last four years. These percentages ranged from 0.1% of flights at Las Vegas to 6.7% at Newark.

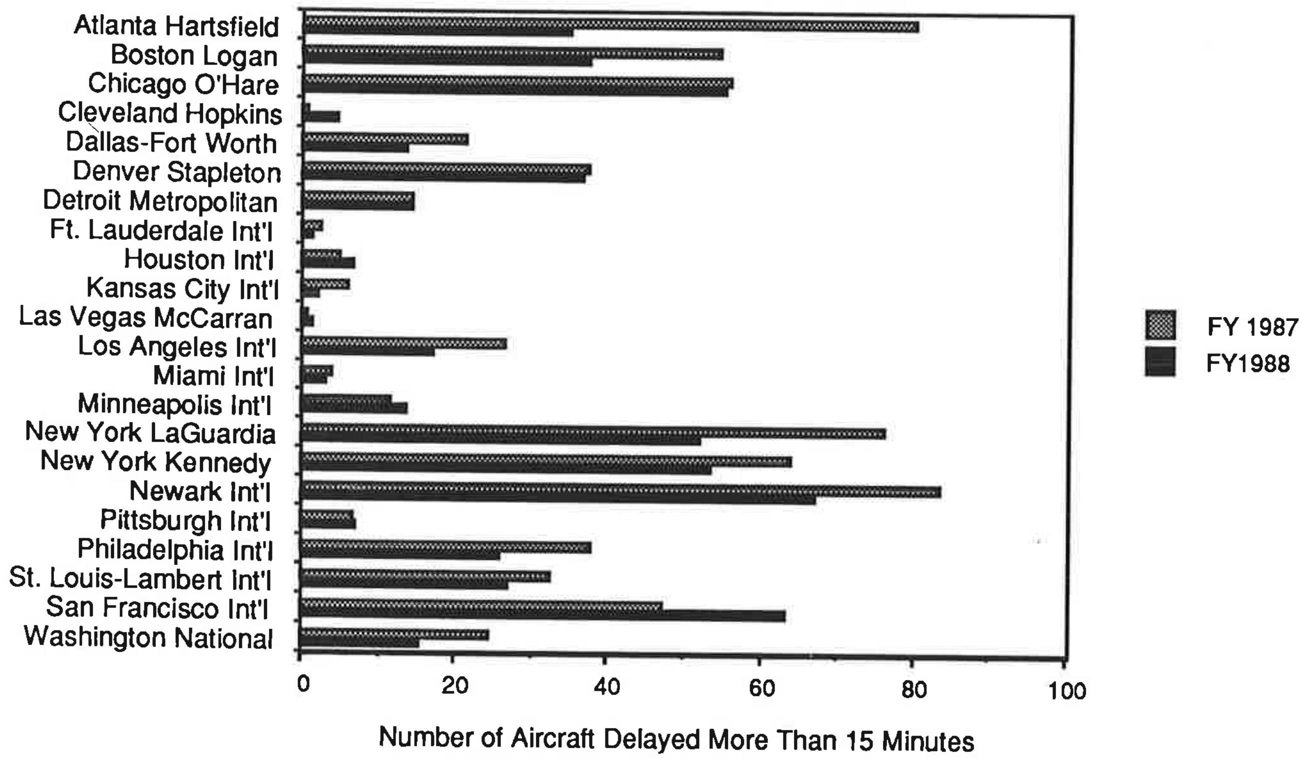
In FY 1988, the number of airline flight delays in excess of 15 minutes decreased compared to 1987 at 15 of 22 major airports.

Forecasts, however, suggest delay in the system will continue to grow. In 1987, 21 airports each exceeded 20,000 hours of airline flight delays. Assuming no improvements in airport capacity are made, 39 airports are forecast to each exceed 20,000 hours of airline flight delays by 1997 as shown in Table 2-2.

In 1987, 21 airports each exceeded 20,000 hours of airline flight delays.

With no improvements in airport and airspace capacity, three airports are forecast to each exceed 100,000 hours of airline aircraft delays by 1997 as opposed to 1 in 1987 as shown in Table 2-2.

Likewise, with no capacity improvements, 14 airports are forecast to have 50,000 to 100,000 hours of airline aircraft delays by 1997 as opposed to just four today.



Source: Atoms Data

FIGURE 2-1. DELAYS PER 1,000 OPERATIONS

TABLE 2-1. PERCENTAGE OF OPERATIONS DELAYED 15 MINUTES OR MORE

AIRPORT	PERCENTAGE			
	1985	1986	1987	1988
NEWARK INTERNATIONAL	9.2	13.8	6.5	6.7
SAN FRANCISCO INTERNATIONAL	3.4	5.3	6.2	6.3
CHICAGO O'HARE INTERNATIONAL	4.1	5.6	4.6	5.5
NEW YORK KENNEDY	6.1	7.0	6.5	5.3
NEW YORK LAGUARDIA	9.2	8.9	6.5	5.2
BOSTON LOGAN INTERNATIONAL	6.1	7.3	4.8	3.7
DENVER STAPLETON INTERNATIONAL	4.6	3.2	3.7	3.7
ATLANTA HARTSFIELD INTERNATIONAL	6.2	6.5	6.2	3.5
ST. LOUIS-LAMBERT INTERNATIONAL	4.6	4.4	1.6	2.7
PHILADELPHIA INTERNATIONAL	0.9	2.0	3.7	2.6
LOS ANGELES INTERNATIONAL	0.8	1.1	3.3	1.7
WASHINGTON NATIONAL	2.0	3.2	2.3	1.5
DETROIT METROPOLITAN	2.1	1.3	1.5	1.5
MINNEAPOLIS INTERNATIONAL	2.2	3.9	0.7	1.4
DALLAS-FORT WORTH INTERNATIONAL	1.7	2.6	2.0	1.4
PITTSBURGH INTERNATIONAL	1.7	0.6	0.7	0.7
HOUSTON INTERNATIONAL	0.3	0.2	0.5	0.7
CLEVELAND HOPKINS INTERNATIONAL	0.1	0.3	0.1	0.5
MIAMI INTERNATIONAL	0.3	0.7	0.4	0.3
KANSAS CITY INTERNATIONAL	0.3	1.0	0.5	0.2
FORT LAUDERDALE INTERNATIONAL	0.1	0.3	0.2	0.2
LAS VEGAS MCCARRAN INTERNATIONAL	0.0	0.0	0.1	0.1
AVERAGE	3.4	4.0	3.2	2.8

Source: ATOMS -- 22 Major Airports

Source: ATOMS Data

The number of airports with 20,000 to 50,000 hours of forecast airline aircraft delays could increase from 16 to 22 by 1997.

Of the top 100 airports, the number with forecast delays from 10,000 to 20,000 hours decreases by 1997 as airports move to higher categories of delay with no improvements in capacity.

TABLE 2-2. 1987 ACTUAL AND 1997 FORECAST AIR CARRIER DELAY HOURS[1]

ANNUAL HOURS OF AIRCRAFT DELAY	1987	1997
Greater than 100,000	Chicago O'Hare	Chicago O'Hare Atlanta Hartsfield Denver Stapleton
75,000 to 99,999	Atlanta Hartsfield Dallas-Fort Worth	Dallas-Fort Worth Newark International Miami International Los Angeles International
50,000 to 74,999	Los Angeles Denver Stapleton	St. Louis Lambert Orlando International Washington Dulles San Francisco International Philadelphia International Phoenix Sky Harbor New York LaGuardia Cincinnati International Boston Logan New York J. F. Kennedy
20,000 to 49,999	Newark International San Francisco New York LaGuardia New York J. F. Kennedy Boston Logan St. Louis Lambert Miami International Phoenix Sky Harbor Washington Dulles Detroit Metro Wayne County Philadelphia Washington National Minneapolis-St. Paul Honolulu International Pittsburgh International Houston Intercontinental	Detroit Metro Wayne Raleigh-Durham Las Vagas McCarran Minneapolis-St. Paul Pittsburgh International Nashville Metro Houston Intercontinental Salt Lake City International Washington National Honolulu International Charlotte Douglas Columbus International Memphis International Kansas City International Baltimore-Washington International Houston Hobby Ontario International San Jose International Indianapolis Seattle Tacoma Cleveland Hopkins Fort Lauderdale

TABLE 2-2. 1987 ACTUAL AND 1997 FORECAST AIR CARRIER DELAY HOURS (Continued)

ANNUAL HOURS OF AIRCRAFT DELAY	1987	1997
10,000 to 19,999	Orlando International	San Diego Lindbergh
	Cincinnati International	Tampa International
	Las Vegas McCarran	Dayton International
	Houston Hobby	Santa Ana John Wayne
	Memphis International	Windsor Locks Bradley
	Nashville Metro	Oakland Metro
	Charlotte Douglas	Milwaukee Mitchell
	Seattle Tacoma	Albuquerque
	Salt Lake City	New Orleans
	Kansas City International	Portland (OR)
	Baltimore-Washington	Louisville Standiford
	San Diego Lindbergh	West Palm Beach
	Tampa International	Anchorage
	Raleigh-Durham	
	Dayton International	
	Cleveland Hopkins	
	San Jose International	
Less Than 10,000	Fort Lauderdale	Syracuse Hancock
	Portland (OR) International	Kahului
	Windsor Locks Bradley	San Antonio
	Santa Ana John Wayne	Burbank
	Ontario International	Norfolk International
	Albuquerque	Buffalo International
	Syracuse Hancock	Reno Cannon
	Burbank	El Paso International
	Indianapolis	Austin Robert Mueller
	New Orleans	Rochester Monroe County
	Louisville Standiford	Jacksonville
	Oakland Metro	Tucson International
	San Antonio	Greensboro Regional
	Buffalo International	Tulsa International
	Columbus International	Oklahoma City Will Rogers
	Norfolk International	Fort Myers SW Florida Regional
	Reno Cannon	Sacramento Metro
	Rochester Monroe County	Charleston (SC) AFB Int'l
	West Palm Beach	Omaha Eppley
	Kahului	Little Rock Adams
	Milwaukee Mitchell	Kailua-Kona Keahole

TABLE 2-2. 1987 ACTUAL AND 1997 FORECAST AIR CARRIER DELAY HOURS (Continued)

ANNUAL HOURS OF AIRCRAFT DELAY	1987	1997
Less Than 10,000 (Continued)	Anchorage	Wichita Mid-Continent
	Tulsa International	Birmingham Municipal
	Oklahoma City Will Rogers	Richmond International
	Austin Robert Mueller	Providence Green State
	Sacramento Metro	Des Moines
	El Paso International	Islip Long Island
	Jacksonville International	Grand Rapids Kent County
	Greensboro Regional	Albany
	Richmond International	Savannah
	Tucson International	Spokane
	Omaha Eppley	Sarasota-Bradenton
	Providence Green State	Long Beach
	Charleston (SC) AFB	Columbia (SC) Metro
	Des Moines	Colorado Springs Municipal
	Wichita Mid-Continent	Lubbock International
	Birmingham Municipal	Portland (ME) International
	Albany	Knoxville McGhee-Tyson
	Fort Myers SW Florida Regional	Midland International
	Little Rock Adams	Greenville-Spartanburg
	Sarasota-Bradenton	Amarillo International
	Columbia (SC) Metro	Boise
	Islip Long Island MacArthur	Harlingen Rio Grande
	Kailua-Kona Keahole	
	Spokane	
	Long Beach	
	Grand Rapids Kent County	
	Savannah International	
	Colorado Springs Municipal	
	Greenville-Spartenburg	
	Knoxville McGhee-Tyson	
	Lubbock International	
	Midland International	
	Amarillo International	
	Boise	
	Portland (ME) International	
	Harlingen Rio Grande	

Derived from data resulting from a Delay Analysis performed by FAA Office of Policy and Plans

[1] This table gives a breakdown of 95 of the top 100 airports by categories of delay for 1987 and 1997. The 1997 estimated delay is based on the assumption that no capacity improvements are made beyond 1987. Delay estimates are based on SDRS data projected to all air carriers and are based on where delay occurs, not necessarily where it is caused. Dallas Love, Midway, Lihue, Hilo, and San Juan International are not ranked. The nationwide distribution of delay-problem airports (those exceeding 20,000 hours of annual aircraft delay) for 1987 are pictured in Figure 2-2, and for 1997 in Figure 2-3.

Source: FAA Office of Policy and Plans

FIGURE 2-2. AIRPORTS EXCEEDING 20,000 HOURS OF ANNUAL AIRCRAFT DELAY IN 1987

FIGURE 2-3. AIRPORTS EXCEEDING 20,000 HOURS OF ANNUAL AIRCRAFT DELAY IN 1997, ASSUMING NO CAPACITY IMPROVEMENTS

CHAPTER 3

AIRPORT DEVELOPMENT

3.1 New And Extended Runways

Over 50 of the top 100 airports are planning or constructing new runways or extensions of existing runways.

Building new runways and extending existing runways constitute two of the most direct and significant actions that can be taken to improve airport capacity.

Over 50 of the top 100 airports are planning or constructing new runways or extensions of existing runways as shown in Figure C-1.

Among 21 airports exceeding 20,000 hours of flight delay in 1987, 12 of them are constructing or planning new runways or extensions of existing runways to increase capacity.

Without airport improvements, 39 airports are forecast to exceed 20,000 hours of annual aircraft delay in 1997. Of those 39 airports 26 are planning to increase capacity by building new runways or runway extensions as shown in Figure 3-1.

Table 3-1 lists 70 runway construction projects planned, along with projected capacity benefit,[1] estimated project cost (rounded to the nearest million), and anticipated completion date. Appendix C describes these projects in greater detail. New capacity-enhancing flight procedures are possible with the construction of these new runways which are described in Chapter seven.

---

[1] The estimated current best Instrument Flight Rule (IFR) capacity at each of the airports is presented for comparison with the estimated future capacities expected after construction. The projected benefit shown is capacity increase in IFR arrivals. For several airports, the IFR arrival capacity remains unchanged even after the addition or extension of a runway. Capacity increases afforded by these improvements could be limited to Visual Flight Rules (VFR) capacity increases which are not reflected Table 3-1. Runway extensions improve capacity by allowing larger aircraft takeoff weights, or by allowing air carrier use of a currently limited use runway.

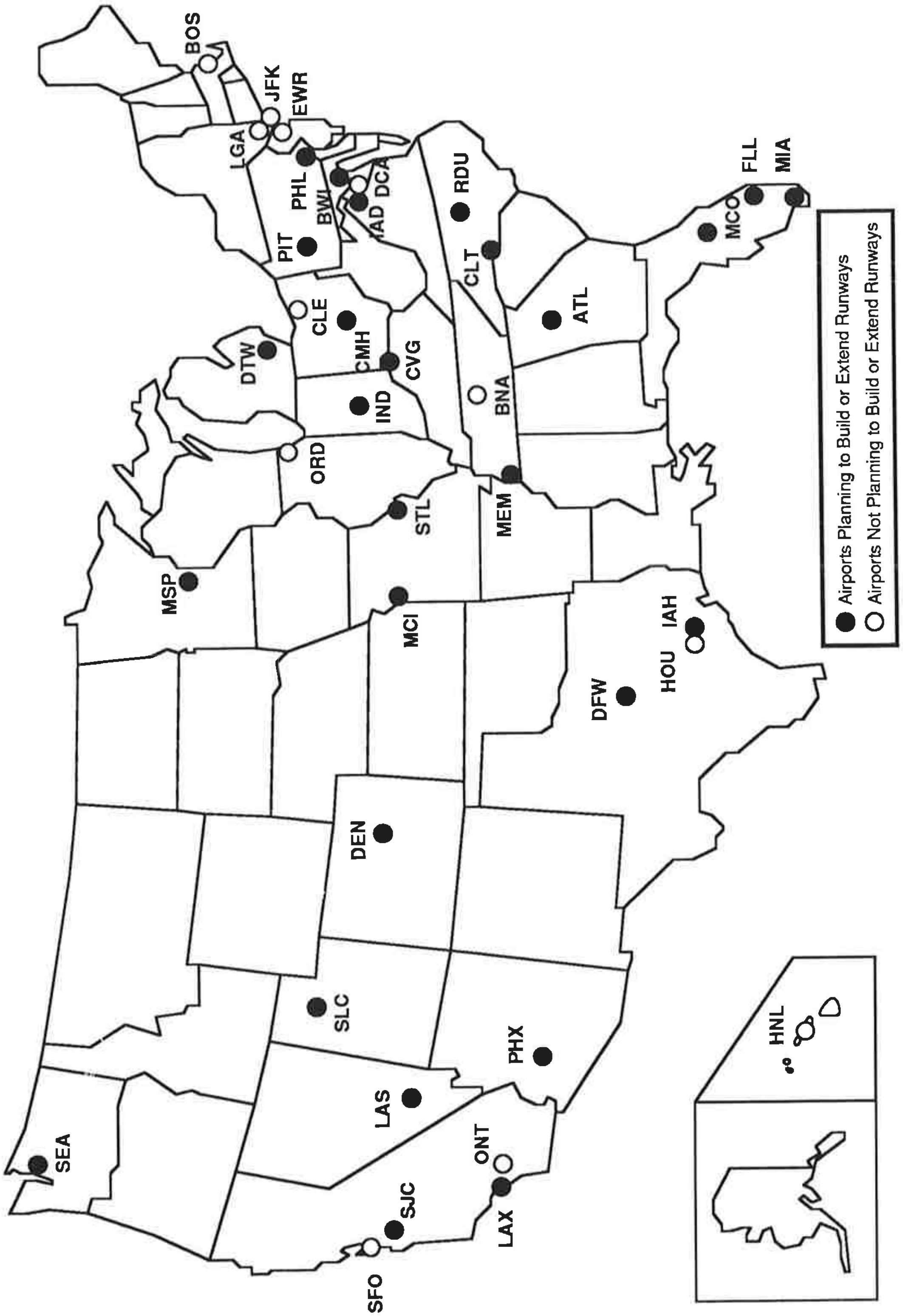


FIGURE 3-1. NEW OR EXTENDED RUNWAYS PLANNED OR RECOMMENDED AMONG AIRPORTS FORECAST TO EXCEED 20,000 HOURS OF ANNUAL AIRCRAFT DELAY IN 1997, ASSUMING NO CAPACITY IMPROVEMENTS

TABLE 3-1. NEW AND EXTENDED RUNWAYS PLANNED OR RECOMMENDED

AIRPORT	RUNWAY	IFR CAPACITY (ARR/HR) NEW CONFIG.	IFR CAPACITY (ARR/HR) CURRENT BEST	EST. COST ($M)	EST. DATE OPER.
Albuquerque (ABQ)	3/21 extension	26[2]	26[2]	$ 12	1991
Atlanta (ATL)	6/24 and 12/30	52[5]	52[1]	$100	1995
	or				
	E/W parallel	63[6]	52[1]		
Austin New Airport (AUS)	Parallels	52[1]	26[2]		
Baltimore (BWI)	10R/28L	36[4]	26[2]		1992
Baltimore (BWI)	15L/33R extension	26[2]	26[2]		1989
Birmingham (BHM)	18/36 extension	26[2]	26[2]	$ 40	1995
Buffalo (BUF)	5L/23R	26[2,8]	26[2,8]		1999
Charlotte (CLT)	18L/36R extension	52[7,8]	26[2,8]	$ 12	1990
Charlotte (CLT)	18/36 parallel	52[1,8]	26[2,8]	$ 50	1995
Cincinnati (CVG)	18L/36R	52[1]	26[2]	$ 65	1990
Colorado Springs (COS)	17L/35R	52[1]	26[2]	$142	1992
Columbia (CAE)	5/23 extension	26[2]	26[2]	$ 14	1990
Columbus (CMH)	10L/28R extension	36[4]	36[4]	$ 8	1992
Dallas-Fort Worth (DFW)	17R/35L extension	52[1]	52[1]	$ 26	1991
Dallas-Fort Worth (DFW)	18L/36R extension	52[1]	52[1]	$ 26	1992
Dallas-Fort Worth (DFW)	16L/34R	78[3]	52[1]	$110	1993
Dallas-Fort Worth (DFW)	16R/34L	78[3]	52[1]	$ 70	2000
Dayton (DAY)	6L24R extension	52[1]	52[1]	$ 11	1989
Denver New (DVX)	New Airport	104[10]	52[1]		1993
Detroit (DTW)	9R/27L	52[1]	52[1]	$ 69	
Detroit (DTW)	N/S parallel	78[3]	52[1]	$ 58	
Fort Lauderdale (FLL)	9R/27L extension	36[4]	26[2]	$ 26	1995
Fort Lauderdale (FLL)	9L/27R extension	36[4]	26[2]	$ 8	1990
Fort Myers (RSW)	6R/24L extension	52[1]	26[2]	$ 6	1991
Fort Myers (RSW)	6/24 parallel	52[1]	26[2]	$ 40	1996

1. Independent parallel approaches [52 IFR arrivals per hour].
2. Single runway approaches [26 IFR arrivals per hour].
3. Triple approaches (currently not authorized) [78 IFR arrivals per hour].
4. Dependent parallel approaches [36 IFR arrivals per hour].
5. Triple approaches with parallel and converging pairs may permit more than 52 IFR arrivals if procedures developed.
6. Triple approaches with dependent and independent pairs (currently not authorized) [63 IFR arrivals per hour].
7. Converging IFR approaches to minima higher than CAT I ILS [52 IFR operations per hour].
8. Added capacity during noise abatement operations.
9. Dependent parallel approaches with one short runway.
10. If and when independent quadruple approaches are approved [104 IFR arrivals per hour].

TABLE 3-1. NEW AND EXTENDED RUNWAYS PLANNED OR RECOMMENDED (Continued)

AIRPORT	RUNWAY	IFR CAPACITY (ARR/HR)		EST. COST ($M)	EST. DATE OPER.
		NEW CONFIG.	CURRENT BEST		
Grand Rapids (GRR)	8L/26R parallel	52[1]	26[2]	$ 31	1995
Grand Rapids (GRR)	18/36 extension	26[2]	26[2]	$ 30	1995
Greensboro (GSO)	5/23 parallel	52[1]	26[2]	$ 30	1997
Greer (GSP)	3/21 parallel	52[1]	26[2]	$ 25	1995
Houston (IAH)	8L/26R	78[3]	52[1]		1999
Houston (IAH)	9R/27L	52[1]	52[1]		
Indianapolis (IND)	4R/22L	26[4]	26[2]	$ 44	1993
Kansas City (MCI)	1R/19L	25[1]	26[2]	$ 50	1992
Kansas City (MCI)	9R/27L	52[1]	26[2]	$ 60	1999
Kansas City (MCI)	18L/36R	52[1]	26[2]	$ 65	1999
Kansas City (MCI)	18R/36L	52[1]	26[2]	$ 90	1999
Knoxville (TYS)	5R/23L extension	26[2]	26[2]	$ 17	1991
Las Vegas (LAS)	7R/25L	26[2]	26[2]	$ 32	1989
Little Rock (LIT)	4R/22L	52[1]	26[2]		1991
Los Angeles (LAX)	6L/24R extension	52[1]	52[1]	$ 4	1991
Louisville (SDF)	New parallels	52[1]	26[2]	$300	1995
Memphis (MEM)	18/36 parallel	52[1]	36[4]	$ 70	1995
Miami (MIA)	9/27 short parallel	52[1]	52[1]	$ 5	2010
Milwaukee (MKE)	7L/25R	36[9]	26[2]		
Milwaukee (MKE)	1L/19R extension	26[2]	26[2]		
Minneapolis (MSP)	4/22 extension	36[4]	36[4]	$ 11	1990
New Orleans (MSY)	1/19 parallel	52[1]	26[2]		1995
New Orleans (MSY)	10/28 parallel	52[1]	26[2]		1992
Norfolk (ORF)	5R/23L	26[2]	26[2]		
Oklahoma City (OKC)	N/S extensions	52[1]	52[1]		

1. Independent parallel approaches [52 IFR arrivals per hour].
2. Single runway approaches [26 IFR arrivals per hour].
3. Triple approaches (currently not authorized) [78 IFR arrivals per hour].
4. Dependent parallel approaches [36 IFR arrivals per hour].
5. Triple approaches with parallel and converging pairs may permit more than 52 IFR arrivals if procedures developed.
6. Triple approaches with dependent and independent pairs (currently not authorized) [63 IFR arrivals per hour].
7. Converging IFR approaches to minima higher than CAT I ILS [52 IFR operations per hour].
8. Added capacity during noise abatement operations.
9. Dependent parallel approaches with one short runway.
10. If and when independent quadruple approaches are approved [104 IFR arrivals per hour].

TABLE 3-1. NEW AND EXTENDED RUNWAYS PLANNED OR RECOMMENDED (Continued)

AIRPORT	RUNWAY	IFR CAPACITY (ARR/HR)		EST. COST ($M)	EST. DATE OPER.
		NEW CONFIG.	CURRENT BEST		
Orlando (MCO)	17L/35R 3rd parallel	52[1]	26[2]	$ 65	1989
Orlando (MCO)	17R/35L 4th parallel	78[3]	26[2]	$ 68	1993
Philadelphia (PHL)	E/W parallel	52[1]	52[7]		1993
Phoenix (PHX)	8/26 parallel	52[1]	52[1]	$ 50	1994
Pittsburgh (PIT)	14R/32L parallel	52[1]	52[1]		
Raleigh-Durham (RDU)	5/23 parallel	52[1]	26[2]	$ 5	1992
Salt Lake City (SLC)	16/34 parallel	63[6]	36[4]		1995
San Jose (SJC)	30L/12R	26[2]	26[2]		1989
San Jose (SJC)	30R/12L extension	26[2]	26[2]		1991
Sarasota-Bradenton (SRQ)	14/32 parallel	26[2]	26[2]		
Seattle (SEA)	16/34 parallel	26[2]	26[2]		
Spokane (GEG)	3L/21R	52[1]	26[2]	$12	
St. Louis (STL)	13/31	26[2]	26[2]	$ 1	
Syracuse (SYR)	10L/28R	52[1]	26[2]		1993
Tampa (TPA)	17/35 parallel	52[1]	52[1]		
Tucson (TUS)	11R/29L parallel	26[2]	26[2]	$38	1992
Tulsa (TUL)	17/35 parallel	78[3]	52[1]		
Washington (IAD)	N/S parallel	78[3]	52[1]		1994
Washington (IAD)	12/30 parallel	52[1]	52[1]		1994
West Palm Beach (PBI)	9L/27R extension	26[2]	26[2]	$ 5	1994

---

1. Independent parallel approaches [52 IFR arrivals per hour].
2. Single runway approaches [26 IFR arrivals per hour].
3. Triple approaches (currently not authorized) [78 IFR arrivals per hour].
4. Dependent parallel approaches [36 IFR arrivals per hour].
5. Triple approaches with parallel and converging pairs may permit more than 52 IFR arrivals if procedures developed.
6. Triple approaches with dependent and independent pairs (currently not authorized) [63 IFR arrivals per hour].
7. Converging IFR approaches to minima higher than CAT I ILS [52 IFR operations per hour].
8. Added capacity during noise abatement operations.
9. Dependent parallel approaches with one short runway.
10. If and when independent quadruple approaches are approved [104 IFR arrivals per hour].

3.2 Task Force Activities At Major Airports

In 1985, the FAA initiated a renewed program of sponsoring local capacity enhancement task forces at major airports. Each task force is to develop a coordinated airport action plan for reducing airport delay.

Airport capacity task forces support capacity enhancement by employing analytical tools to quantify the benefits of various capacity enhancement actions. Each task force performs an in-depth study of an airport's current and anticipated demand levels. 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 airport capacity task force product is an action plan that serves as a guide for improvements at the particular airport. These task forces include representatives of the airport sponsor and sponsor's master planning consultant, system users, industry groups, local and regional FAA, FAA Technical Center, and the Airport Capacity Program Office.

Seven airport capacity task forces have completed their activities and published their recommendations. 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.

3.3 Task Force Recommendations

Airport Capacity task forces have been completed at:

William B. Hartsfield Atlanta International Airport
Detroit Metropolitan Wayne County Airport
Memphis International Airport
Metropolitan Oakland International Airport
San Francisco International Airport
San Jose International Airport
Lambert-St. Louis International Airport

This section contains a table and airport layout for each completed airport capacity task force and lists recommended improvements.

It is important to understand that the charter of these airport capacity task forces is to consider technically feasible alternatives to reduce delay and improve capacity.

Environmental and local issues are addressed through master planning and the environmental process. Many recommendations test the sensitivity of user changes (i.e., reducing or increasing general aviation activity, modifying noise procedures, or examining multiple options for runway spacing).

TABLE 3-2. THE WILLIAM B. HARTSFIELD ATLANTA INTERNATIONAL AIRPORT TASK FORCE PROJECT SUMMARY

RECOMMENDED IMPROVEMENT

Airfield Improvements

(1) International concourse
(2) Fifth concourse
(3) Commuter/General Aviation (GA) terminal and runway south of R/W 9R/27L (three possible alternatives)
(4) Three hold pads at end of departure runways
(5) Taxiway C parallel to the west of taxiway D (not pictured)
(6) Angled exits for commuter aircraft; widen fillets at exits to facilitate their use in either direction (not pictured)

Facilities and Equipment

(7) Expedite development and installation of wake vortex forecasting and avoidance systems
(8) Upgrade Navigational Aids (NAVAIDS) and approach lights on R/W 26R and 27L to Category II
(9) Update terminal approach radar
(10) Upgrade Runway Visual Range (RVR) system to Category (CAT) IIIB and International Civil Aviation Organization (ICAO) standards

IMPROVEMENTS

(11) Install Airport Surface Detection Equipment (ASDE) III with tracking
(12) Install touchdown zone lights on R/W 27L
(13) Reduce arrival separations to 2.5 nmi
(14) Enhance traffic management procedures

User Improvements

(15) Depeak airline schedules within the hour

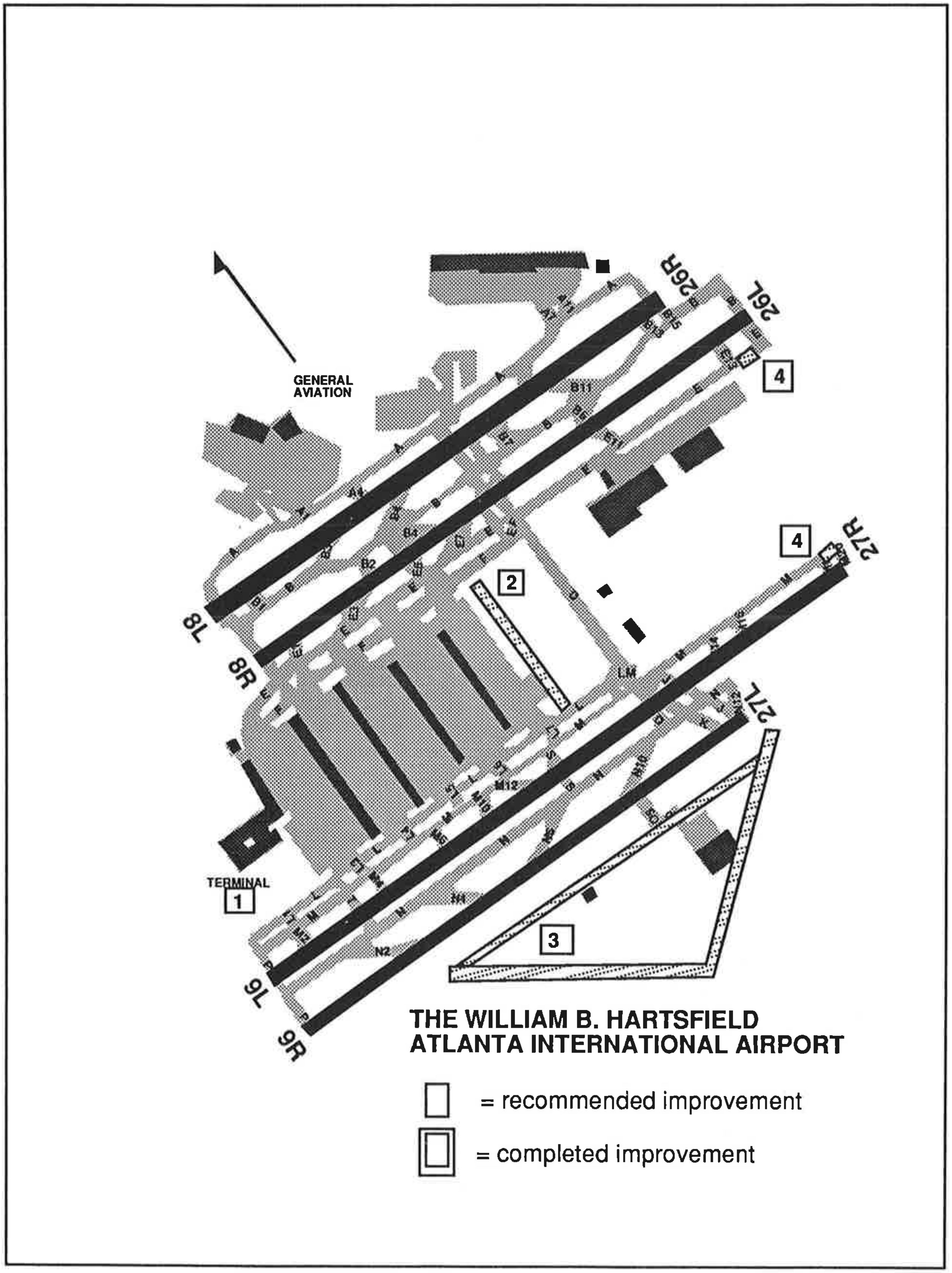


FIGURE 3-2. THE WILLIAM B. HARTSFIELD ATLANTA INTERNATIONAL AIRPORT

TABLE 3-3. THE DETROIT METROPOLITAN WAYNE COUNTY AIRPORT TASK FORCE PROJECT SUMMARY

RECOMMENDED IMPROVEMENT

Airfield Improvements

(1) Holding Apron and Taxiway South of Runway 9/27
(2) Runway and Taxiway Improvement Package
- (2a) Highspeed Exit Taxiway - Runway 21R to Taxiway G
- (2b) Extend Taxiway P to Taxiway H
- (2c) Construct and Expand Holding Aprons at Runways 3C, 3L, and 3R
- (2d) Extend Inner Taxiway Parallel to Taxiway H
- (2e) Construct Exit Taxiway - Runway 9/27 to Taxiway H
- (2f) Construct Taxiway S to East GA Area

(3) Terminal Expansion (Not Pictured)
(4) Construct Independent Crosswind Runway - 9R/27L or
Construct Dependent Crosswind Runway - 9R/27L
(5) Construct Independent 4th N/S Runway or
Construct Dependent 4th N/S Runway or
Construct Dependent 4th N/S Runway with Staggered Approaches
(6) Construct 3rd E/W Crosswind Runway (Not Pictured)

Facility and Equipment

(7) ILS Microwave Landing System (MLS), RVR and Approach Lights on Runway 3C
(8) ASDE
(9) Terminal Doppler Weather Radar
(10) Upgrade Runway 21R Instrument Landing System (ILS) to CAT III
(11) RVR and Centerline Lights on Runway 27
(12) Expedite Development and Installation of Wake Vortex Forecasting and Avoidance System
(13) Install an Airport Variable Omni Range (VOR)

Air Traffic Control Improvements

(14) Independent Converging VFR/IFR Approaches to Runways 27 and 21R, Hold Short of 21R
(15) Add Controller Positions Establish Standard Terminal Arrival (STAR) Routes, Relocate MOTER Intersection
(16) Use Departure Corridors
(17) Realign Cleveland Center Sector Airspace
(18) Expand Tower En Route Program
(19) Reduce Arrival Longitudinal Separation to 2.5NM
- (19a) Runway Occupancy Time Reduced 10%
- (19b) Runway Occupancy Time Reduced 20%
- (19c) Runway Occupancy Time Reduced 30%

User Improvements

(20) Relocate General Aviation Traffic
- (20a) 10%
- (20b) 20%
- (20c) 30%

(21) More Uniform Distribution of Scheduled Operations Within the Hour

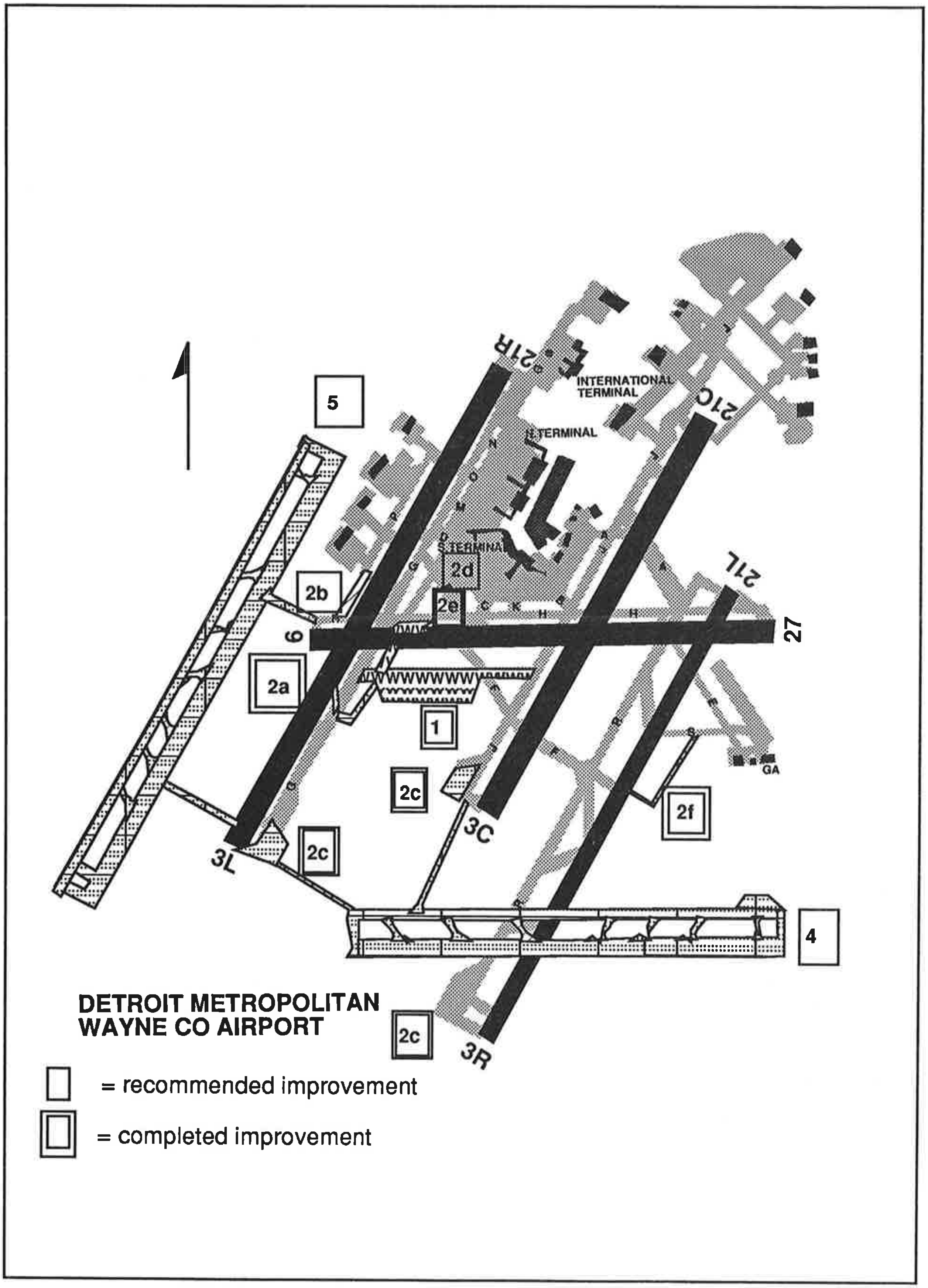


FIGURE 3-3. THE DETROIT METROPOLITAN COUNTY AIRPORT

TABLE 3-4. THE MEMPHIS INTERNATIONAL AIRPORT TASK FORCE PROJECT SUMMARY

RECOMMENDED IMPROVEMENT

Airfield Improvements

(1) Construct Rwy 18E/36E, Dual Departures
(2) Construct Rwy 18E/36E, Triple Departures in VFR
(3) Construct Rwy 18E/36E, Triple Departures in All Weather Conditions (Wavier Required)
(4) Extend Inner Parallel Twy North to Twy V (Not Pictured)
(5) Extend Outer Twy P North to Twy V (Not Pictured)
(6) Extend Rwy 18L/36R South (Not Pictured)
(7) Extend Twy A from B to BB
For Existing Runways
For Existing Runways & Future Runway
(8) Large Freight Ramp, East of 18E, South of 27
(9) Extend Twy BB to Approach End of 36L
(10) New Crossover Twy KK, South of Twy HH (Not Pictured)
(11) Terminal Expansion (Not Pictured)
(12) Angled Exits on 18R/36L [Reduce Runway Occupancy Times (ROT) by ten percent]
For Existing Runways
For Existing Runways & Future Runway

Facility and Equipment Improvements

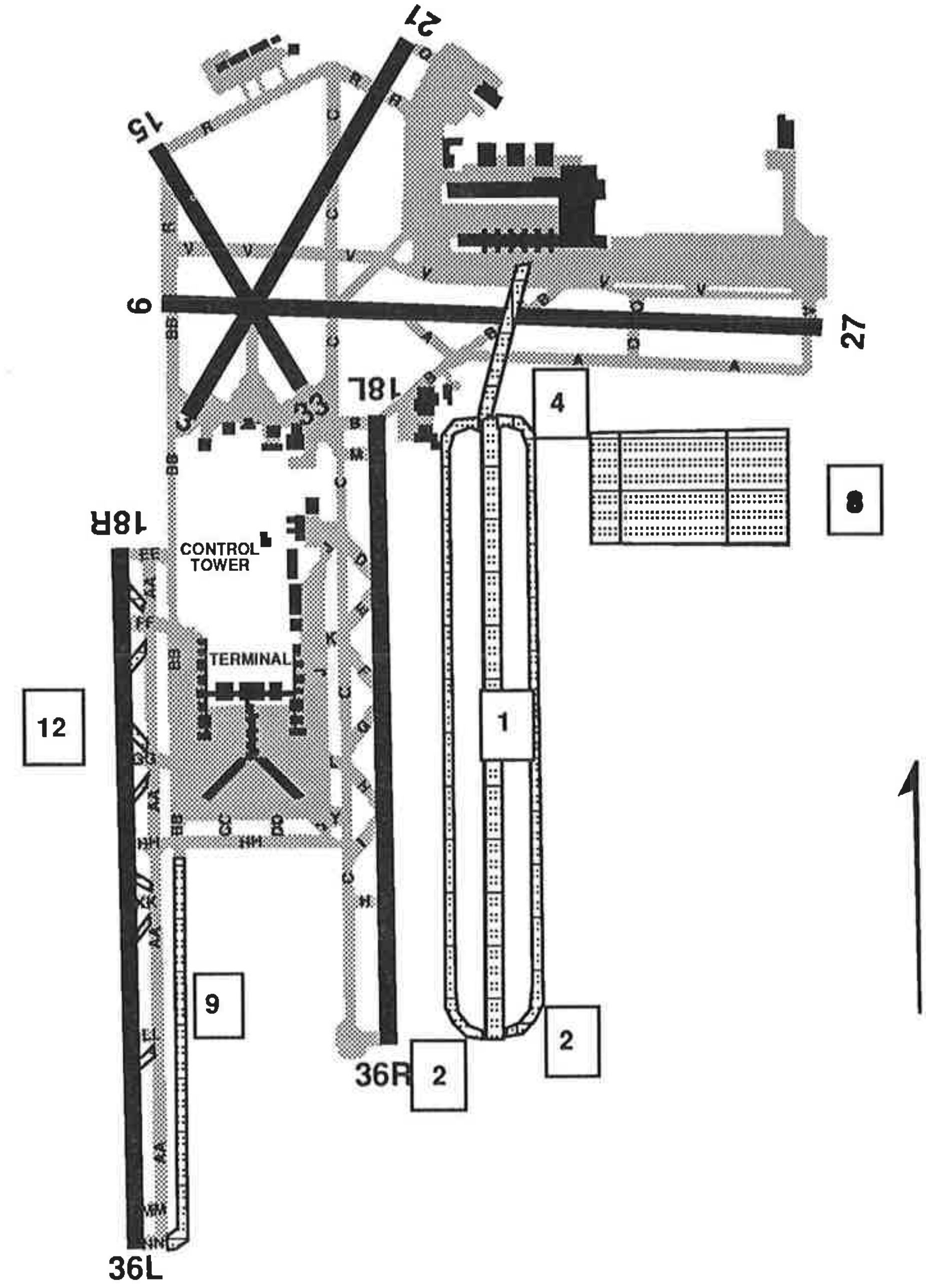
(13) CATEGORY II/III ILS on 36R
(14) CATEGORY II/III ILS on 36E
(15) CATEGORY II/III ILS on 18R, 18L, 18E
(16) Install ASDE (Airport Surface Detection equipment)
(17) Reroute High-Altitude Traffic Away from MEM Combined VOR and TACAN (VORTAC)

Operational Improvements

(18) Reduce Longitudinal Spacing to 2.5 NM
Between Similar Class, Non-Heavy Arrivals
For Existing Runways
For Existing Runways & Future Runway
(19) Reduce Lateral Spacing
(Simultaneous ILS Approaches to Existing Parallels)
(20) Small Aircraft Hold Short of Rwys 3/21 & 15/33
When Landing 27 (Regardless of Wind)
(21) 1.5 NM Staggered ILS Approach to Existing Parallels
(22) Relief from Airspace Criteria

User Improvements

(23) Reduce Small Slow Aircraft
By 10%
By 25%
(24) Uniformly Distribute Traffic Within the Hour
For Existing Runways
For Existing Runways & Future Runway
(25) Increase GA Forecast by 20% (User Option)
(26) Relocate Air Guard (Off MEM)



MEMPHIS INTERNATIONAL AIRPORT

□ = recommended improvement

▣ = completed improvement

FIGURE 3-4. THE MEMPHIS INTERNATIONAL AIRPORT

TABLE 3-5. THE METROPOLITAN OAKLAND INTERNATIONAL AIRPORT TASK FORCE PROJECT SUMMARY

RECOMMENDED IMPROVEMENT

Airfield Improvements

(1) Construct Taxiway From SE Corner of Terminal to Runway 29 Approach Threshold
(2) Build Taxiway Parallel to Runway 27L
(3) Add Taxiway Between North and South Complexes
(4) Convert Taxiway 1 to Air Carrier Runway 29 and Add Parallel Taxiway
(5) Enlarge Staging Pads at Entrances to Runway 11/29
(6) Construct Additional Angled Exit Off Runway 11
(7) Build Penalty Box on South Side of Approach End of Runway 29 (Not Pictured)

Facilities and Equipment

(8) Install MLS on Runways 29 and 27
(9) Install a Non-Directional Beacon Approach to Runway 29

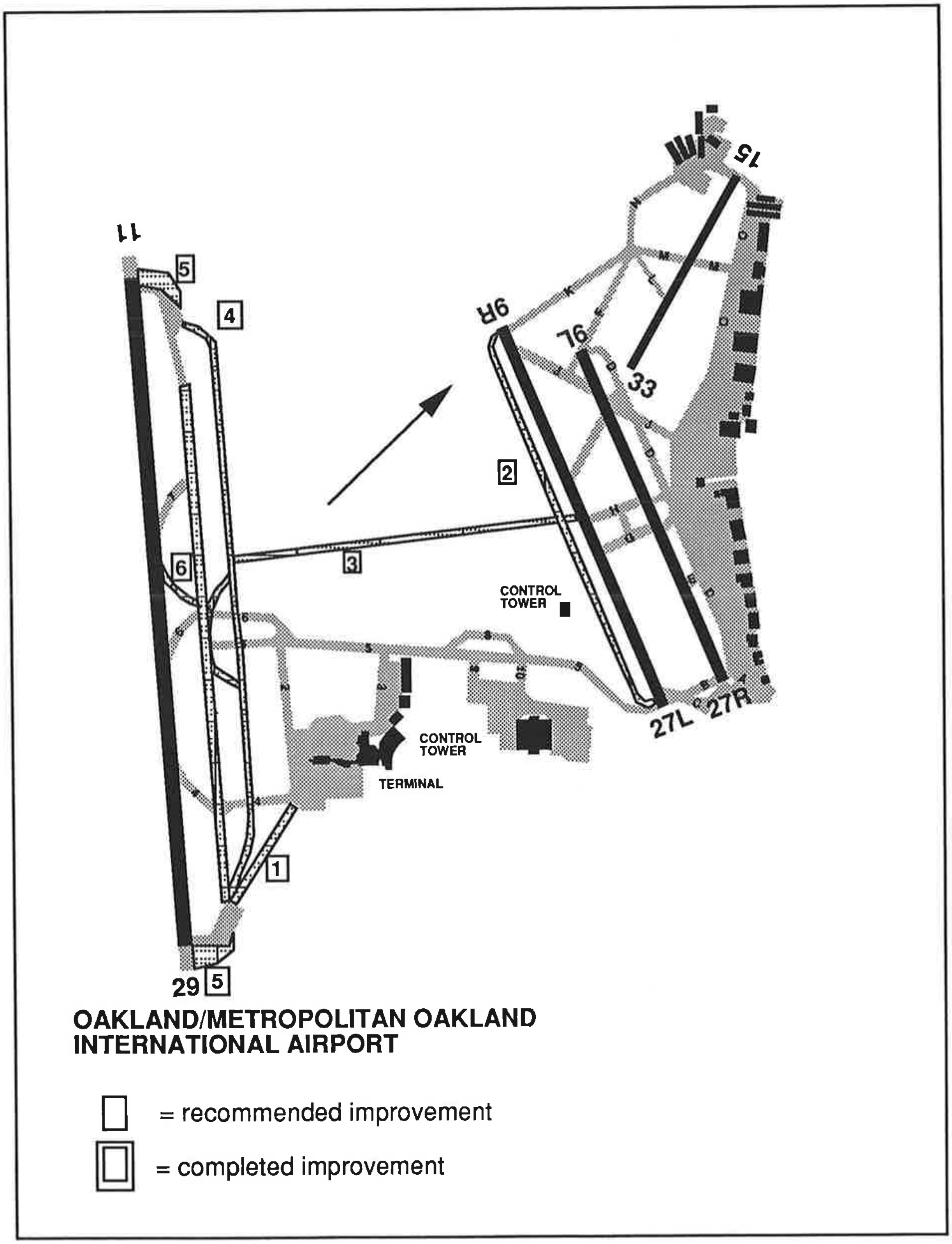


FIGURE 3-5. THE METROPOLITAN OAKLAND INTERNATIONAL AIRPORT

TABLE 3-6. THE SAN FRANCISCO INTERNATIONAL AIRPORT TASK FORCE PROJECT SUMMARY

RECOMMENDED IMPROVEMENT

Airfield Improvements

(1) Create Holding Areas Near Runway 10L/R, 1R and 28R
(2) Improve Noise Barrier for Runway 1R (Not Pictured)
(3) Extend Runway 19L/R
(4) Extend Runway 28L/R
(5) Construct Independent Parallel Runway 28
(6) Extend Taxiway C to Threshold Runway 10L
(7) Create High Speed Exit From Runway 10L Between Taxiways L and P
(8) Extend Taxiway T to Taxiway B or A

Air Traffic Control Improvements

(9) Expand Visual Approach Procedures
(10) Offset Instrument Approach to Runway 28R
(11) Use Staggered 1-Mile Divergent IFR Departures on Runway 10L/R

Facilities and Equipment

(12) Install MLS on Runway 28 and 19

RECOMMENDED IMPROVEMENT

User Improvements

(13) Taxi Aircraft Across Active Runways Instead of Towing
(14) Distribute Airline Traffic More Evenly Among Three Airports
(15) Distribute Traffic Uniformly Within the Hour
(16) Divert 50% General Aviation to Reliever Airports

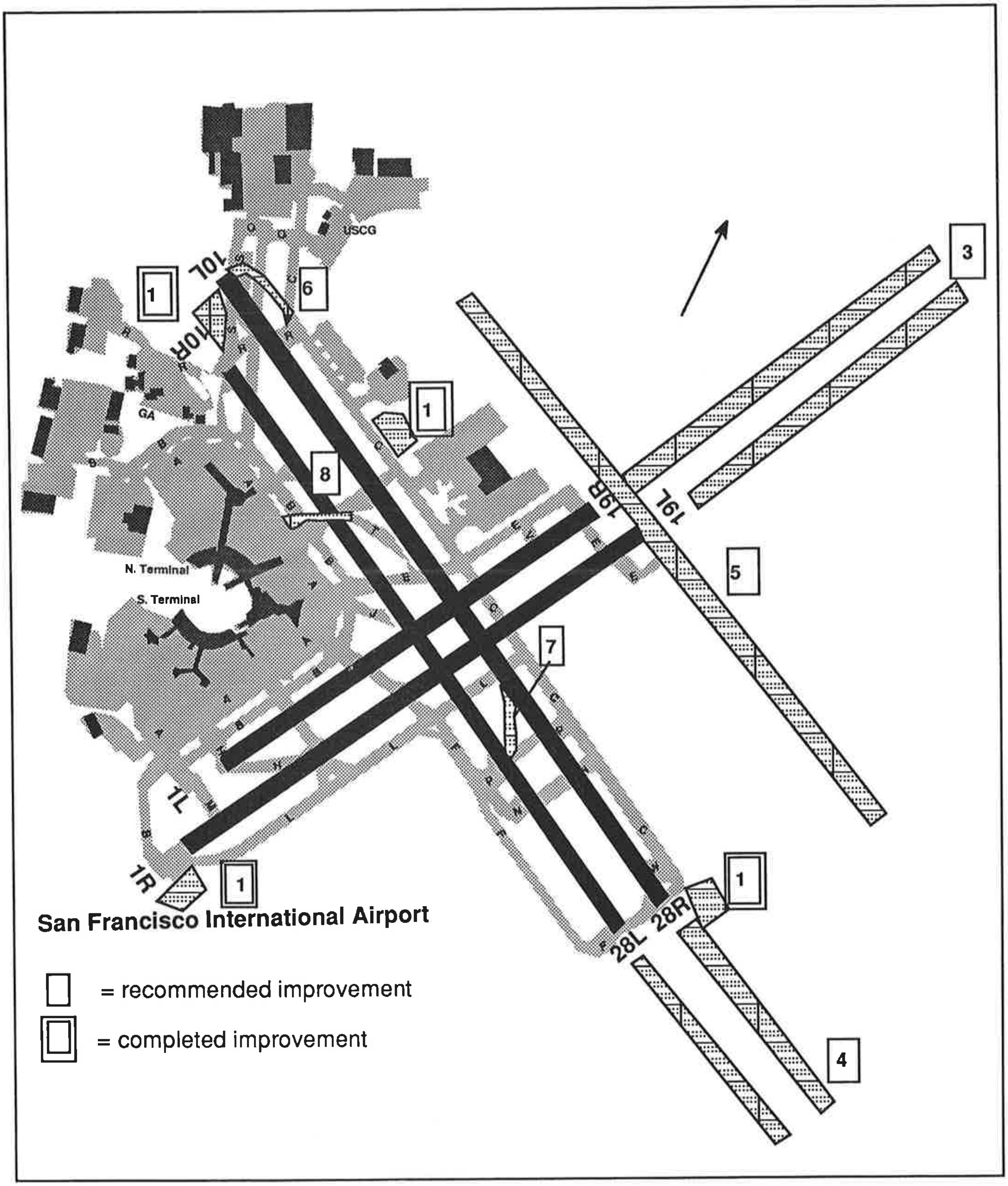


FIGURE 3-6. THE SAN FRANCISCO INTERNATIONAL AIRPORT

TABLE 3-7. THE SAN JOSE INTERNATIONAL AIRPORT TASK FORCE PROJECT SUMMARY

RECOMMENDED IMPROVEMENT

Airfield Improvements

(1) Create Staging Area at Runway 30L/R
(2) Extend and Upgrade Runway 30R/29
(3) Create Angled Exits for Runway 12R

Facilities and Equipment

(4) Promote Use of Reliever ILS Training Facility
(5) Install MLS on Runway 30L

Air Traffic Control Improvements

(6) Implement Simultaneous Departures With Moffett Field (U.S. Navy)

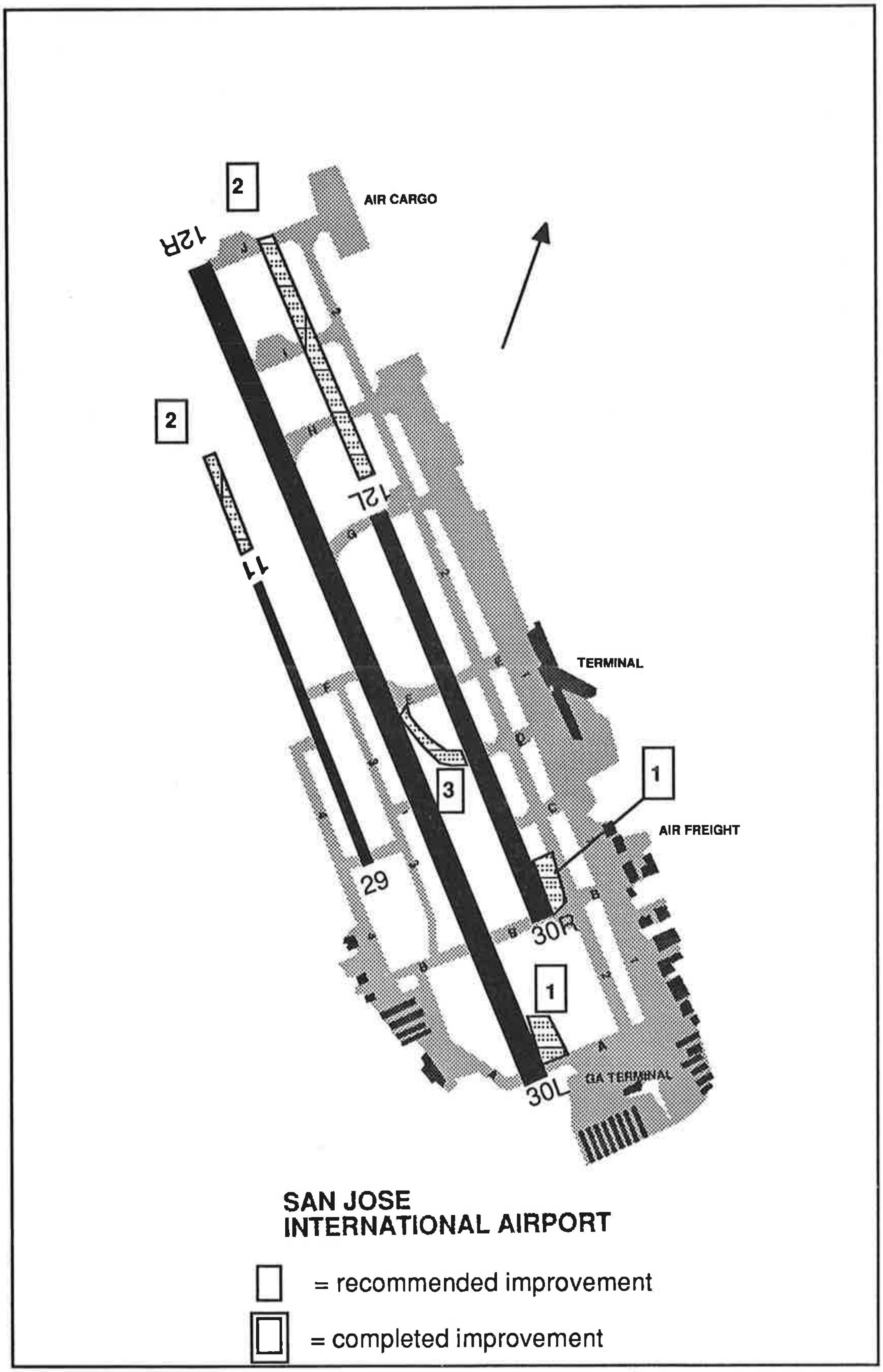


FIGURE 3-7. THE SAN JOSE INTERNATIONAL AIRPORT

TABLE 3-8. THE LAMBERT-ST. LOUIS INTERNATIONAL AIRPORT TASK FORCE PROJECT SUMMARY

RECOMMENDED IMPROVEMENT

Airfield Improvements

(1) New Runway Parallel to Runway 12L/30R
- (1a) Alternate 1: New Independent Comuter Runway 2500' from Runway 12L/30R
- (1b) Alternate 2: New Dependent Commuter Runway 1400' from Runway 12L/30R (Not Pictured)
- (1c) Alternate 3: New Independent Air Carrier Runway Parallel to Runway 12L/30R (Not Pictured)

(2) Convert Taxiway F to Permanent VFR Runway 13/31
(3) Angled Exits on Runway 12L/30R (Not Pictured)
(4) Taxiway Extensions
- (4a) Extend Taxiway A-South to end of Runway 30L
- (4b) Extend Taxiway P from Taxiway C to Taxiway M (Not Pictured)
- (4c) Extend Taxiway C from Taxiway F to Runway End 24

(5) Realign Taxiway B off A to Runway 12R/30L (Not Pictured)
(6) Establish Queuing Areas to Various Runway Ends (Not Pictured)
(7) Relocate Cargo Area (Not Pictured)
(8) Relocate Mid Coast Aviation to Northeast (Not Pictured)
(9) Install Marker Lights and Parking Lanes in Center Field Remote Holding Area (Not Pictured)

Facilities and Equipment

(10) Wake Vortex System
(11) Install CAT III ILS to Reduce Approach Minima on Runway's 12L/30R
(12) IFR Approaches with Additional Instrumentation on Runway 6
(13) IFR Approaches with Additional Instrumentation Runway Alignment Indicator Lights (RAIL) on Runway 24
(14) Localizer type Directional Aid (LDA) Approaches Support
- (14a) Equipment Installation on Runway 30L
- (14b) Equipment Installation on Runway 12L

(15) Install Light Systems at Taxiway and Runway Intersection
(16) Install ASDE

Operational Improvements

(17) Reduce IFR Parallel Approach Stagger to 2NM
(18) Reduce IFR Initial Separations to 2.5NM
(19) Converging IFR Approaches to
- (19a) Runway 6 and 30R
- (19b) Runway 6 and 30L

(20) Converging IFR Approaches to
- (20a) Runways 6 and 30R
- (20b) Runways 6 and 30L

(21) Simultaneous Approaches to ILS 30R, LDA 30L, and ILS 24*

User Improvements

(22) Change Fleet Mix
- (22a) Relocate GA 25%
- (22b) Relocate GA 50%
- (22C) Relocate GA 75%

(23) Distribute Scheduled Commercial Operations Within the Hour
(24) Relocate Air National Guard

*Procedure not possible by today's criteria as proper separation is not obtainable for missed approaches

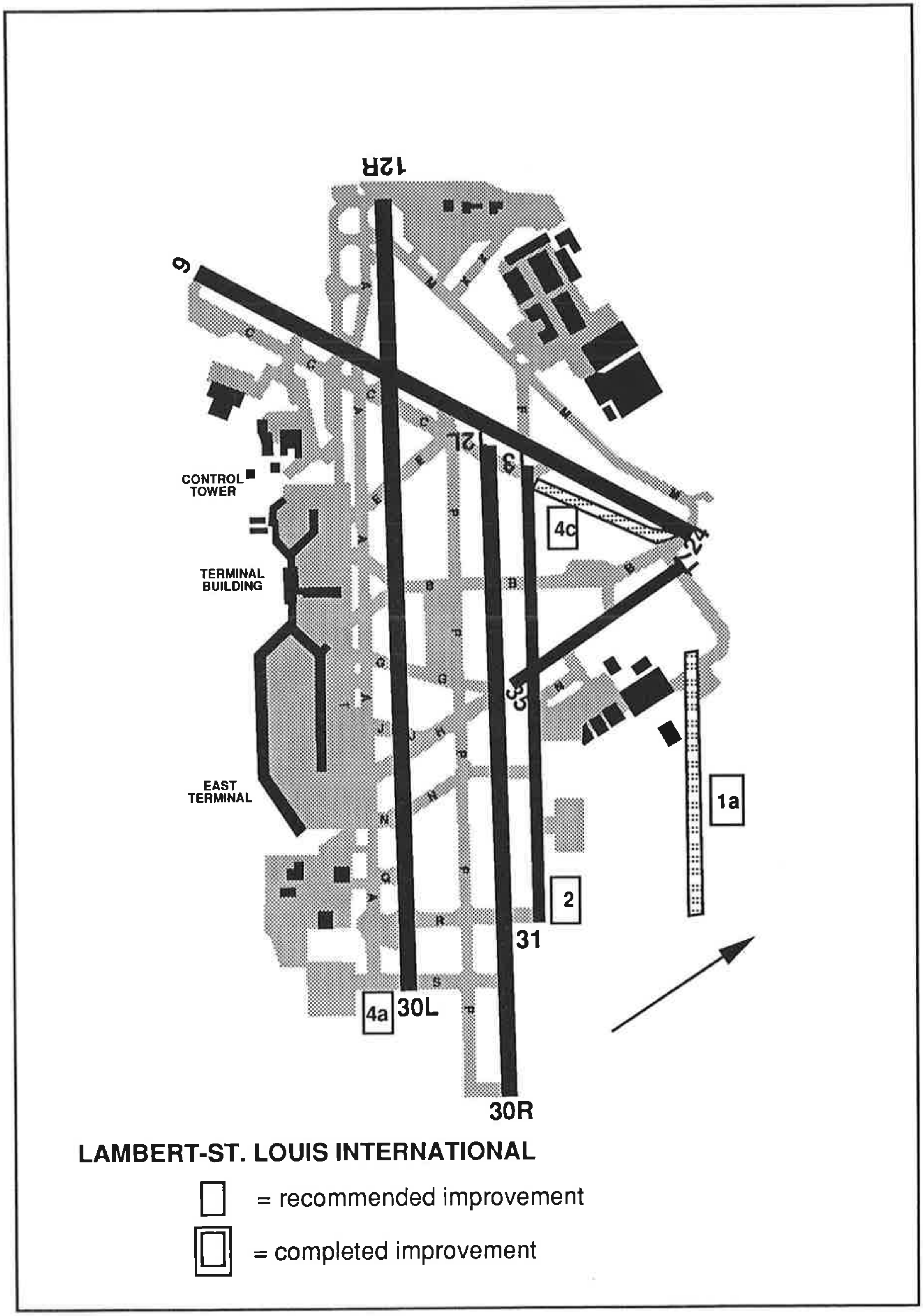


FIGURE 3-8. THE LAMBERT ST. LOUIS INTERNATIONAL AIRPORT

3.4 Potential Improvements At Ongoing Task Forces

This section describes the potential improvements being evaluated at Boston-Logan, Kansas City, Miami, Phoenix-Sky Harbor, Salt Lake City, Seattle, and Dulles International Airports.[2] Task forces have recently begun at Chicago O'Hare, Midway, Orlando, and Raleigh-Durham; however, work is in preliminary phases.

---

2 An airport layout and corresponding table is provided for each airport. The relationship between the figure and table are the same as in Section 3.3.

This page intentionally left blank

TABLE 3-9. THE GENERAL EDWARD LAWRENCE LOGAN INTERNATIONAL AIRPORT TASK FORCE PROJECT SUMMARY

POTENTIAL IMPROVEMENT BEING EVALUATED

Airfield Improvements

(1) New Runway 14/32 (4300') With a Fully Instrumented Parallel Approach Unidirectional Departure 14 and Arrival 32
(2) New Runway 14/32 (4300') With a Fully Instrumented Parallel Approach Bidirectional
(3) Extend Runway 15L/33R to Approximately 3,500' and Add New Parallel Taxiway
  (3a) Combine Improvements 1 and 3
  (3b) Combine Improvements 2 and 3
(4) New Parallel Taxiway Between Runway 4L/22R and 4R/22L (Not Pictured)
(5) New South Exit Parallel Taxiway for Runway 27 (Not Pictured)
(6) Add Fillets at Intersections of Taxiways D and C with Runway 15R/33L
(7) Extend and Recover Runway 9/27 to the West 400' (Not Pictured) (Required for Improvement 24)
(8) Add Staging Areas at End of Runway 15R/33L, 27, 4R, 22R and at Intersection of Taxiway G of Runway 33L
(9) Extend Taxiway D to Runway 4R/22L (Not Pictured)
(10) Extend Runway 27 125' East (to Allow Hold Short Ops.) (Required for Improvement 23)

Facility and Equipment Improvements

(11) CAT II/III ILS on 15R and/or 22L and/or 33L.
(12) Benefit of Microwave Landing System (Dual Glide Slopes)
(13) Simultaneous Approaches to the 4's and 22's in Less Than VFR-V Conditions

Operational Improvements

(14) Benefit of Wake Vortex Advisory System (WVAS) and Vortex Advisory System (VAS)
(15) Modify ATC Procedures to Allow Simultaneous Operations to Runway 27 and 22L or Runway 4L and 33L Under IFR Conditions
(16) Removal of Noise Restrictions on 4L Departure and 22R Arrival
  (16a) Remove Noise Restriction and Extend Runway 4L to New Taxiway B
(17) Impact of Fleet Mix Changes
(18) Reduce Minimums to 250 and 3/4 on 22L CAT I
(19) Side Step Approaches From Runway 4R to Runway 4L
(20) Fan Headings for Runway 22L and 22R Departure Operations
(21) Separate GA and Commuters From Commercial Jet Traffic
(22) Use of Runway 27 by Jet Aircraft to Hold Short of 22L
(23) Use of Runway 9 by Class 3 and 4 to Hold Short of 15R
(24) Use of Hold Short Procedures Under Wet Conditions of Landing Distances 6000' or greater for Turbojet Aircraft on Runway's 15R-Hold Short of 9, 22L-Hold Short of 27, 33L-Hold Short of 4L
(25) Improve Metering, Spacing and Segregate Heavy Jets

User Improvements

(26) Improve or Redistribute Airline Schedules Within Hour

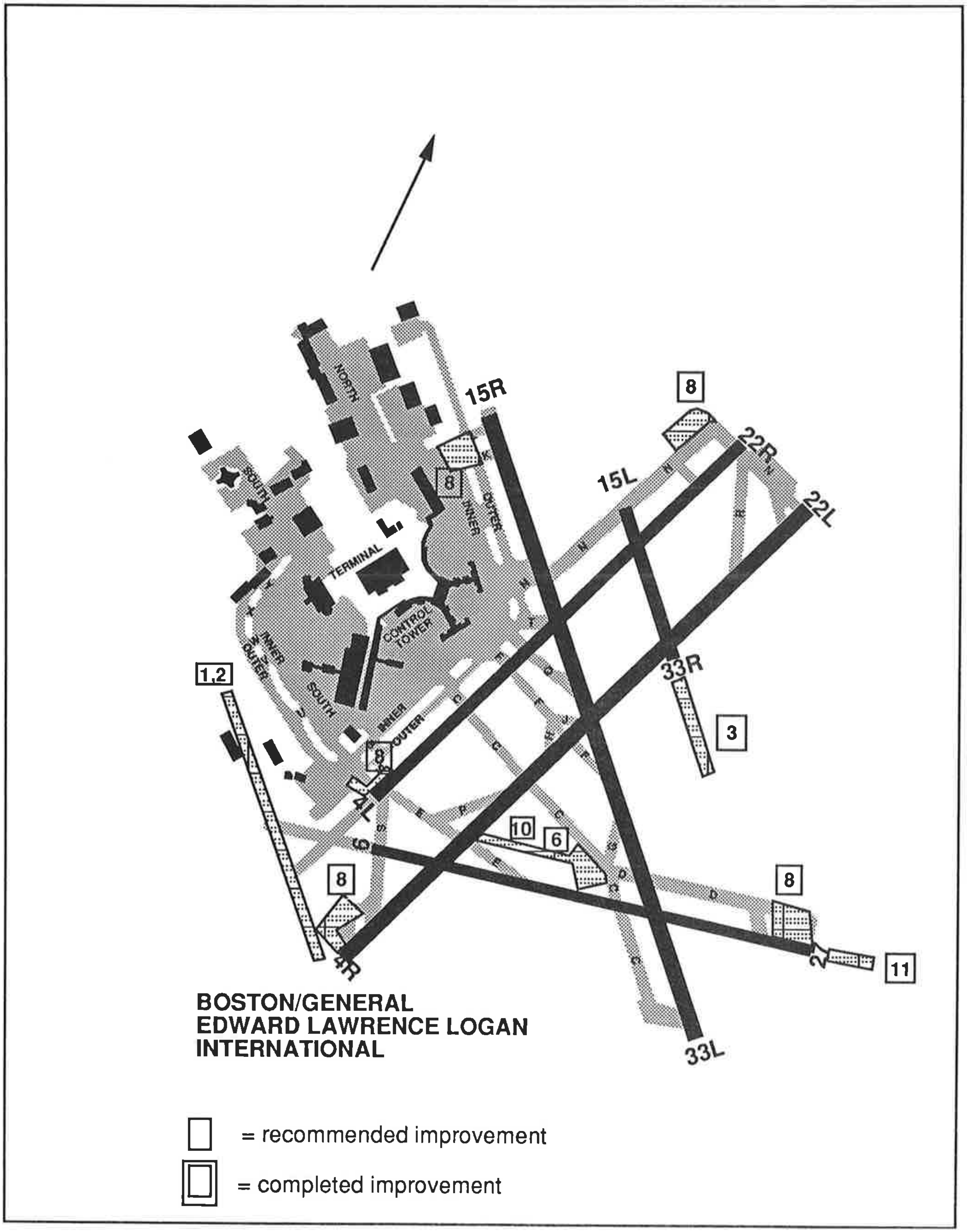


FIGURE 3-9. THE GENERAL EDWARD LAWRENCE LOGAN INTERNATIONAL AIRPORT

TABLE 3-10. THE KANSAS CITY INTERNATIONAL AIRPORT TASK FORCE PROJECT SUMMARY

POTENTIAL IMPROVEMENT BEING EVALUATED

Airfield Improvements

(1) New N/S 9500' independent runway (1R/19L).
(2) New dependent 10,000' parallel runway 9R/27L to south of 9L/27R.
(3) New independent 10,000' parallel runway 18R/36L to west of 1/19.
(4) New dependent 10,000' parallel runway 18L/36R to west 1/19.
(5) Single parallel taxiway (including holding aprons) full length 1R/19L.
(6) Dual parallel taxiway to Runway 1R/19L (full length).
(7) Extend Taxiway D east to D2.
    (a) Extend Taxiway D to D1.
(8) Add fourth terminal.
(9) Extension of Taxiway G to new runway 1R/19L.
(10) Extension of Taxiways B & D to Taxiway H. (Not Pictured)
(11) Build holding aprons west to Terminal B.
(12) High speed exit at A2.
(13) High speed exit at A3 for Runway 19.
    (a) Extend B5 to Runway to Runway 19 and change for A2 exit additional high speed between C5 and C7.

Facilities and Equipment

(14) CAT III ILS on 1R
(15) CAT I ILS on 19L.
(16) ILS/MLS on existing Runway 27.
(17) Distance Measuring Equipment (DME) for Runway 1L/19R and 1R/19L.
(18) RVR for new Runway 1R/19L.
(19) Upgrade Runway 1L ILS to CAT III.
(20) Benefit of ASDE.
(21) Relocate VOR to airport and KINSEY outer marker to 4 miles from downtown Runway 19 and increase glide angle to Runway 27.

Operational Improvements

(22) Reduce arrival longitudinal separations to 2.5 mi for like class aircraft.
(23) Simultaneous IFR converging approaches.
(24) Impact of terminal service road.
(25) Impact of perimeter service road.
(26) Effect of noise restrictions.
(27) Effect of Airport Radar Services Area (ARSA) type separations within the Terminal Control Areas (TCA).

User Improvements

(28) Uniformly distribute traffic within the hour.
(29) Make Airman's Information Manual (AIM) a regulatory document.
(30) Reduce ROT through pilot & controller education (stop use of reverse high speeds).

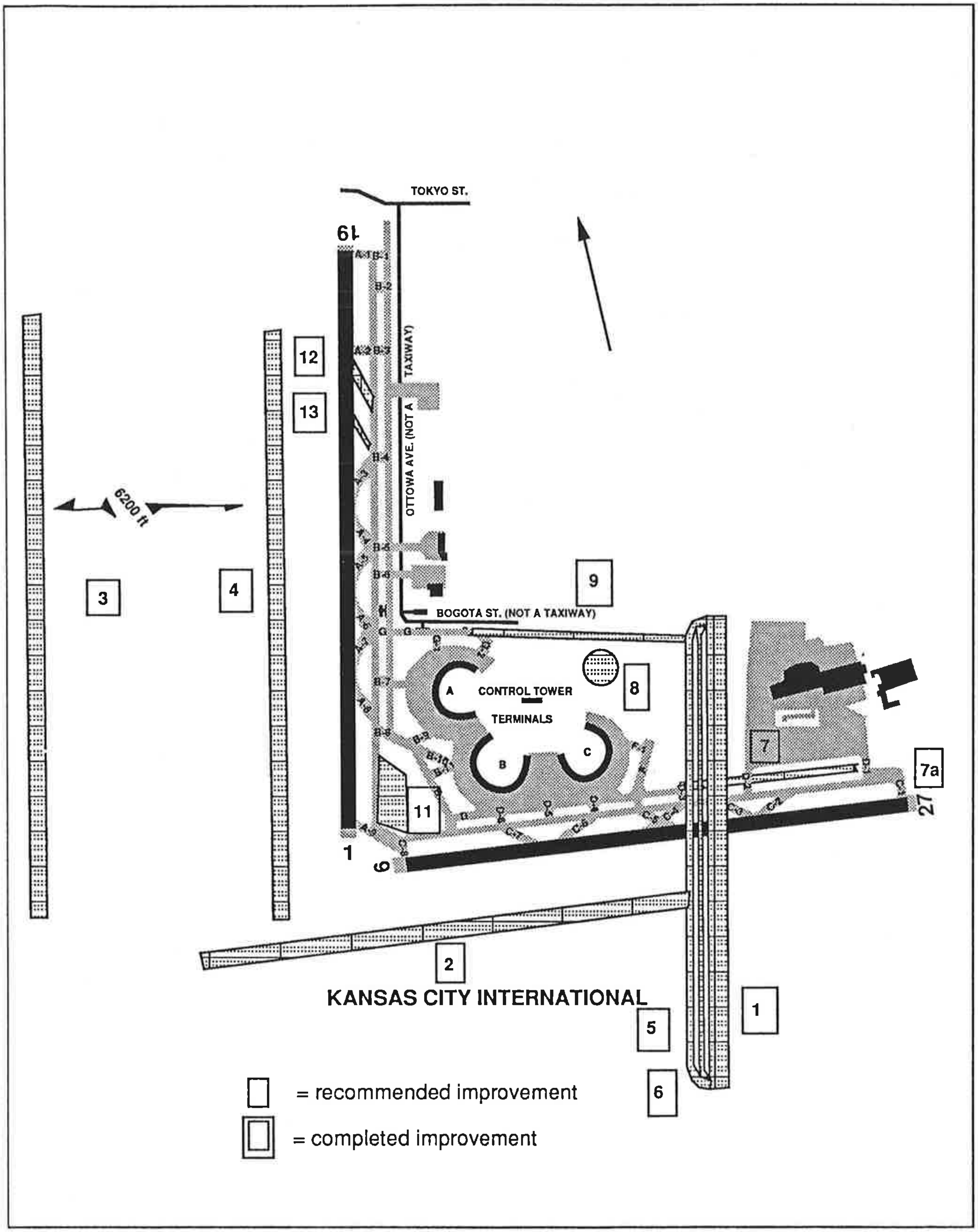


FIGURE 3-10. THE KANSAS CITY INTERNATIONAL AIRPORT

TABLE 3-11. THE MIAMI INTERNATIONAL AIRPORT TASK FORCE PROJECT SUMMARY

RECOMMENDED IMPROVEMENT

Airfield Improvements

(1) Dual Taxiway Around Concourse H (Remove 2 End Gates) (Not Pictured)
(2) Extend Taxiway L to End Runway 9L
(3) Construct New Concourse J With and Without Dual Taxiway for Concourse H (Not Pictured)
(4) Construct New Short (3600 ft) Parallel Runway 1000 Feet North of Runway 27R
(5) Develop Improved Exits for 9L/27R Northside (Not Pictured)
(6) Improve Exits M4 and M5 on 9L/27R

Facility and Equipment Improvements

(7) CAT II on Runway 9L
(8) CAT II on runway 9R
(9) Install Touchdown and Midpoint RVR on Runway 9R
(10) VOR/DME (on airport)
(11) Glideslope, Medium intensity approach lighting system with runway alignment indicator lights (MALSR) and Middle Marker on Runway 30
(12) ASDE
(13) Benefits of MLS
(14) Install Midpoint and Rollout RVR on 9L

Operational Improvements

(15) Intersection Takeoffs on Runway 27L
(16) Intersection Takeoffs on Runway 30
(17) Independent Converging IFR Approaches to Runways 12 and 9R
(18) Independent Converging IFR Approaches to Runways 27R and 30
(19) 2.5 Mile In-Trail Longitudinal Approach Separation (IFR)

User Improvements

(20) Uniformly Distribute Airline Schedule Within the Hour
(21) Change Fleet Mix
- (a) Relocate GA by 10%
- (b) Relocate GA by 25%
- (c) Relocate GA by 40%

(22) Change Fleet Mix Between Hours of 1100 to 1900
- (a) Relocte GA by 25%
- (b) Relocate GA by 50%
- (c) Relocate GA by 75%

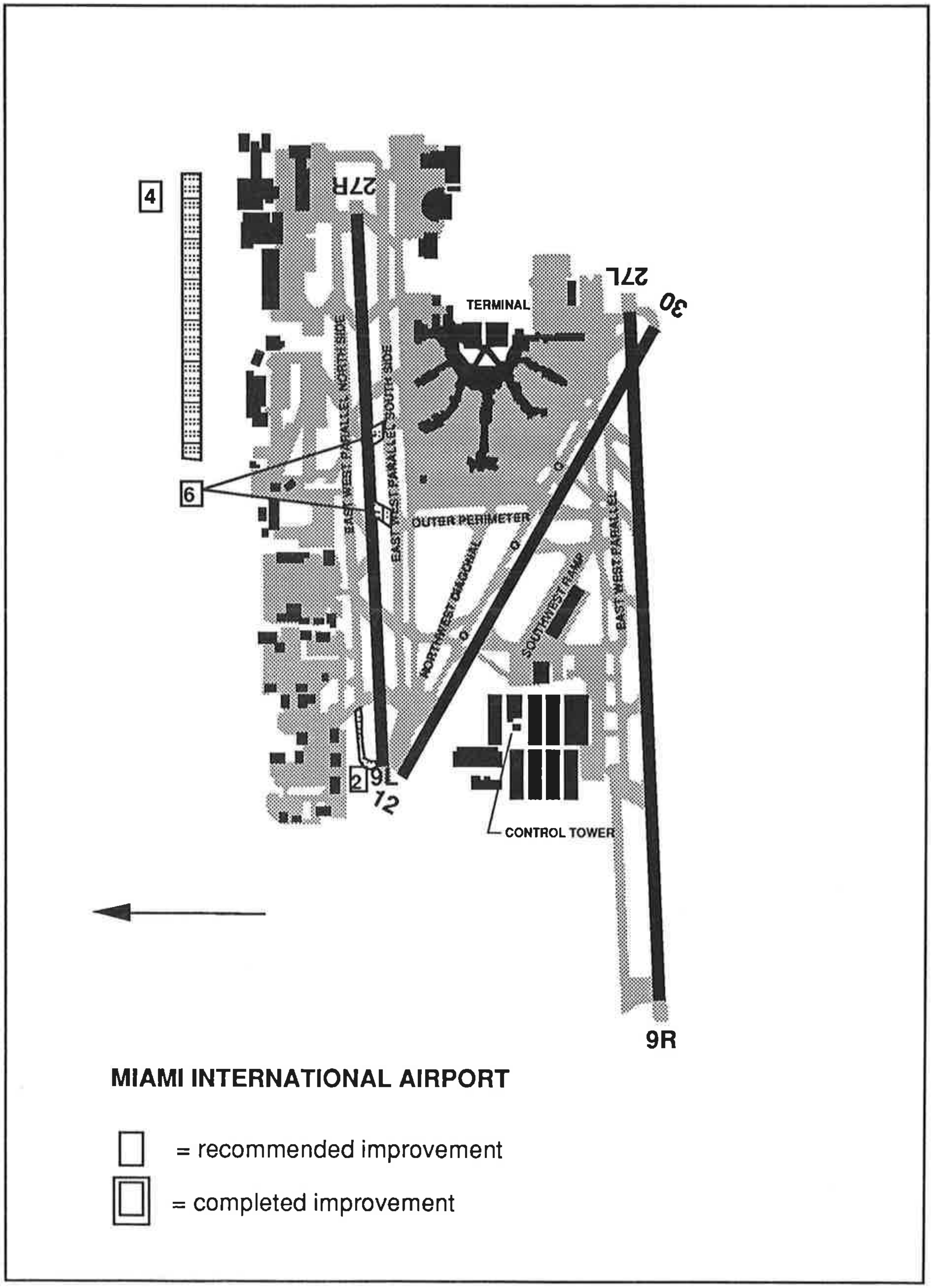


FIGURE 3-11. THE MIAMI INTERNATIONAL AIRPORT

TABLE 3-12. THE PHOENIX-SKY HARBOR INTERNATIONAL AIRPORT TASK FORCE PROJECT SUMMARY

POTENTIAL IMPROVEMENT BEING EVALUATED

Airfield Improvements

(1) Extend Taxiway Delta (D) to end of Runway 26L.
(2) Construct new Runway 800' South of RWY 8R/26L.
(3) Construct run up pads at four runway ends. (Not Pictured)
(4) Widen fillets at Taxiway C5 and C7 off Runway 8R/26L
(5) Construct holding area (Penalty Box) SE of Terminal 3. (Not Pictured)
(6) Construct angled exit off of Runway 8R/26L between Taxiways C3 and C4 TWY C. (Not Pictured)
(7) Construct angled exit off of Runway 8S/26S between Taxiways D3 and D5 to TWY D.
(8) Widen crossover Taxiway X for two way operation. (Not Pictured)
(9) Construct crossover Taxiway W at RWY ends 26R and 26L.
(10) Construct crossover taxiway west of Terminal 1 (from Exit B3 to Exit C3). (Not Pictured)
(11) Extend Taxiway A to RWY end 26R.
(12) Extend Taxiway BB to crossover Taxiway W. (Not Pictured)
(13) Construct Taxiway CC from Exit C8 (east of DYNAIR) to crossover Taxiway W. (Not Pictured)
(14) Complete Northside taxilane (parallel to TWY C) from RWY end 8R to cross over Taxiway X. (Not Pictured)
(15) Construct Terminal 4 (77 gates) and remove Terminal 1.
(16) Relocate ANG south of RWY 8R/26L. (Not Pictured)

Facilities and Equipment

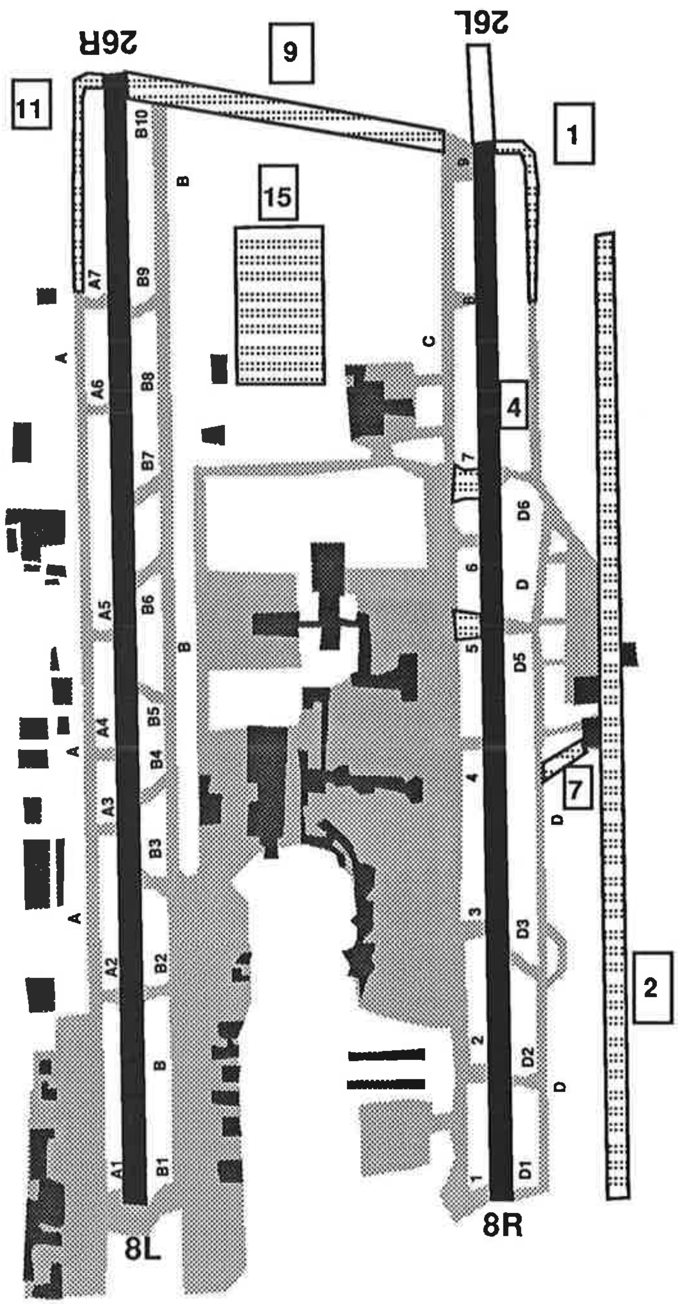
(19) Install TVOR/VORTAC in Northern Valley.
(20) Install ILS (CAT I) MLS for RWY 26R. (Ref. Items 27 & 28)
(21) Install ILS (CAT I) MLS for RWY 8L. (Ref. Items 27 & 28)
(22) Determine benefits of MLS.
(23) Install VORTAC on Airport.
(24) Install quick scan sensor. (Ref. Item 28).

Operational Improvements

(25) Reduce intrail longitudinal separations to 2.5 miles.
(26) Reduce ROT on RWYs 8R/26L and 8L/26R.
(27) IFR dependent close parallel approaches.
(28) IFR independent parallel approaches.
(29) Remove intrail departure restrictions to allow simultaneous departures.
(30) Segregate fast and slow aircraft for arrivals and departures.
(31) Reduce noise restrictions: Utilize special turboprop corridors.
(32) Reduce DEP/ARR Separations for intersection departures (arrivals hold short of take off point).

User Improvements

(33) Uniformly distribute traffic within the hour.
(34) Provide attractive alternate facilities for GA at other airports.
  (a) Retain 90%
  (b) Retain 74%
  (c) Retain 50%



PHOENIX-SKY HARBOR
INTERNATIONAL AIRPORT

□ = recommended improvement

▣ = completed improvement

FIGURE 3-12. THE PHOENIX-SKY HARBOR INTERNATIONAL AIRPORT

TABLE 3-13. THE SALT LAKE CITY INTERNATIONAL AIRPORT TASK FORCE PROJECT SUMMARY

POTENTIAL IMPROVEMENT BEING EVALUATED

Airfield Improvements

(1) New Independent Air Carrier Runway to West With CAT III on Both Ends
(2) Extend 34R to 12000 Length
(3) Construct Stopway on 34R (Not Pictured)
(4) Taxiway to Delta Hangar (Not Pictured)
(5) Crossover Taxiway Between 16L and 16R at North End
(6) Relocate Tower (Not Pictured)
(7) Relocate Freight Terminal (Not Pictured)
(8) High Speed Exits to West of 34R and 16L
(9) Runup Pad for 16R and 34L (Not Pictured)
(10) High Speed Exit to Proposed Taxiway F2 (Not Pictured)
(11) Effect of Terminal Expansions (Not Pictured)
(12) Penalty Box/Extend F1 and F2 to West Boundary of Terminal (Not Pictured)

Facilities and Equipment

(13) CAT III on 16R
(14) CAT I on 34R
(15) Install MLS on 34R
(16) Determine benefit of MLS
(17) Install RVR on 34R
(18) ASDE
(19) Centerline Lights on 34R
(20) Install Taxiway Centerline Lights

Operational Improvements

(21) Make Bonneville Routing One-Way
(22) Impact of Military Airspace
(23) Effect of Noise Restrictions
(24) Reduce Intrail Arrival Separations to 2.5 NM (must be combined with improvements 8 and 9)
(25) IFR Independent Converging Approaches
(26) LDA to 34R

User Improvements

(27) Reduce ROT Through Pilot Education
(28) GA Reservations System During Peak IFR
(29) Relocate GA by Providing an ILS to Satellite Airports at Ogden and Provo
(30) Uniformly Distribute Schedule Within the Hour
(31) Delta Ramp Control

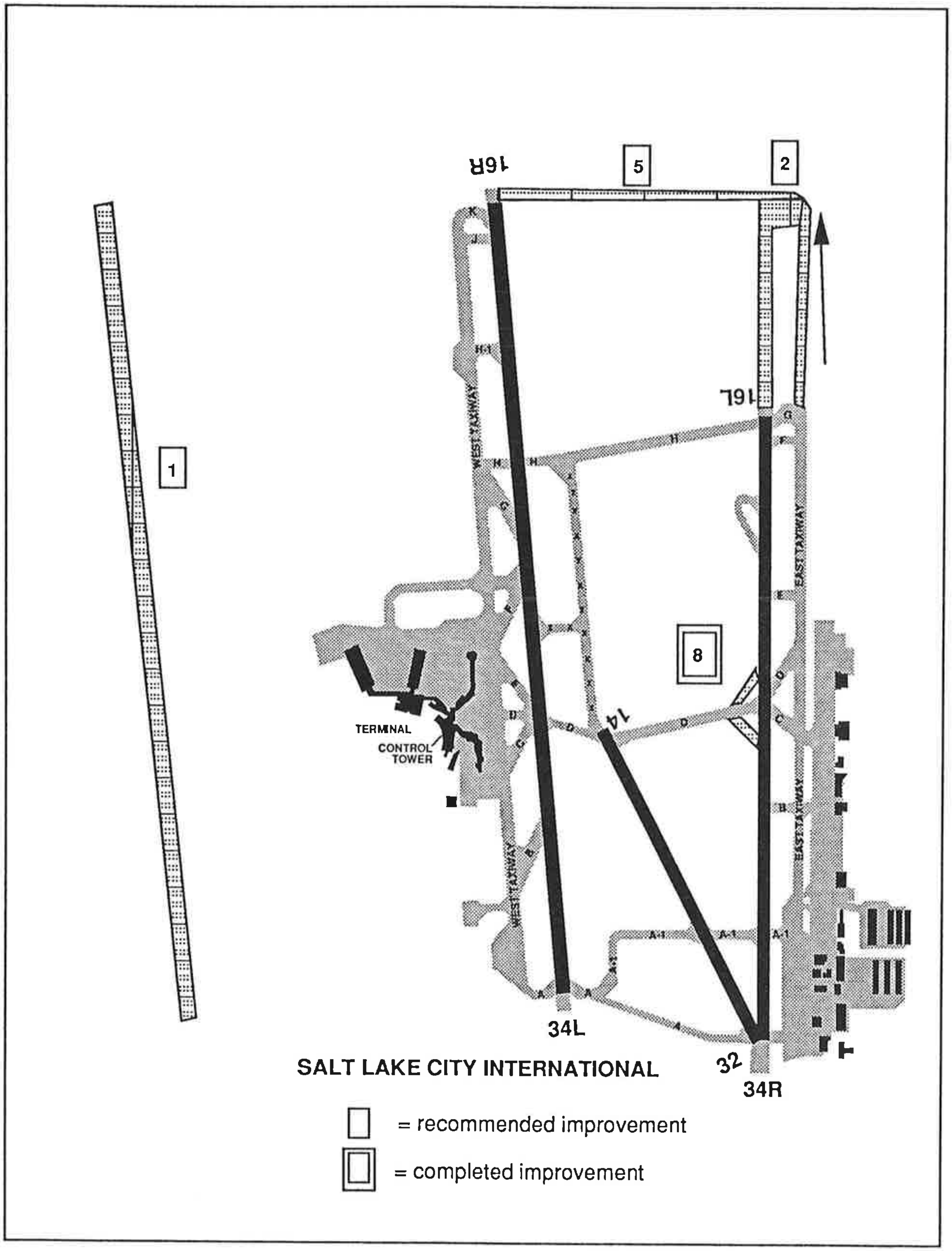


FIGURE 3-13. THE SALT LAKE CITY INTERNATIONAL AIRPORT

TABLE 3-14. THE SEATTLE-TACOMA INTERNATIONAL AIRPORT TASK FORCE PROJECT SUMMARY

POTENTIAL IMPROVEMENT BEING EVALUATED

Airfield Improvements

(1) Runway alternates:
- (a) Convert Taxiway C to 5000' commuter Runway 17/35 with associated taxiway system.
- (b) Dependent aircarrier 7000' Runway 16W/34W 2500' from 16L/34R.
- (c) Independent aircarrier 7000' Runway 2500' from 16L/34R.
- (d) Cross Runway 13/31 lined up with Boeing field.

(2) Taxiway construction:
- (a) Two (2) high speed exits at midpoint on Runway 16R/34L.
- (b) High speed (B6) and crossover taxiways to apron at Runway end 34L.
- (c) High speed exit (B-1) between Taxiway B and B-2 to Runway 16R/34L. (No more than 600 ft. south of threshold)
- (d) Crossover taxiway to apron at Runway end 16R.
- (e) New exits midway between TWYs A3 and A4 to Runway 16L/34R.
- (f) Fillets at Taxiways A1 and B2 (Not Pictured)

(3) New west commuter terminal.
(5) Penalty Box west of Runway 16R/34L.
(6) Provide wider runup pads for Runway ends 34R and 34L. (Not Pictured)
(7) Provide hard stands for overnight aircraft parking.

Facilities and Equipment Improvements

(8) High speed exit centerline lights for both North and South flows at exit A5 on Runway 16L/34R.
(9) ILS CAT I 16L.
(10) ILS CAT I 34L.
(11) LDA to Runway 16R. (See #17)
(12) LDA to TWY C (Runway 17).
(13) MLS to Runways 16R, 16L, 17 and for new Runway 16W.
(14) ILS CAT I Runway 16W.
(15) ILS CAT I Runway 34W.
(16) RVR for Runway 16W/34W.

Operational Improvements

(17) LDA approaches to 16R; Taxiway C (17); 16W.
(18) Operate 34L as primary arrival Taxiway.
(19) Noise abatement procedure effects on arrivals and departures. (Install markers for departures).
(20) Modify noise abatement with percent use change of Stage 3 aircraft operations on the airport (fleet mix change).
(21) Four (4) corner concept for approaches (3 routes to 4 routes). Airspace and Airport Simulation Model (SIMMOD) may be used instead of Airport Delay Simulation Model (ADSIM) if SIMMOD application at Salt Lake City is successful.
(22) Fanned departures both to the North and to the South.
(23) Stagger approaches to 16L/17 and 16L/16W.
(25) Reduce intrail spacing 2.5 NM.
(26) Wake vortex advisory system for close spacing.
(27) Uniformly distribute scheduled operations within the hour.
(28)
- (a) Retain 50% of commuter operations (Implied move to Boeing).
- (b) Retain 25% commuter operations (Implied move to Boeing).

(29) Operation agreement to limit Boeing activity during rush critical periods.
(30) Provide attractive alternate facilities for short haul aircarriers at other airports.

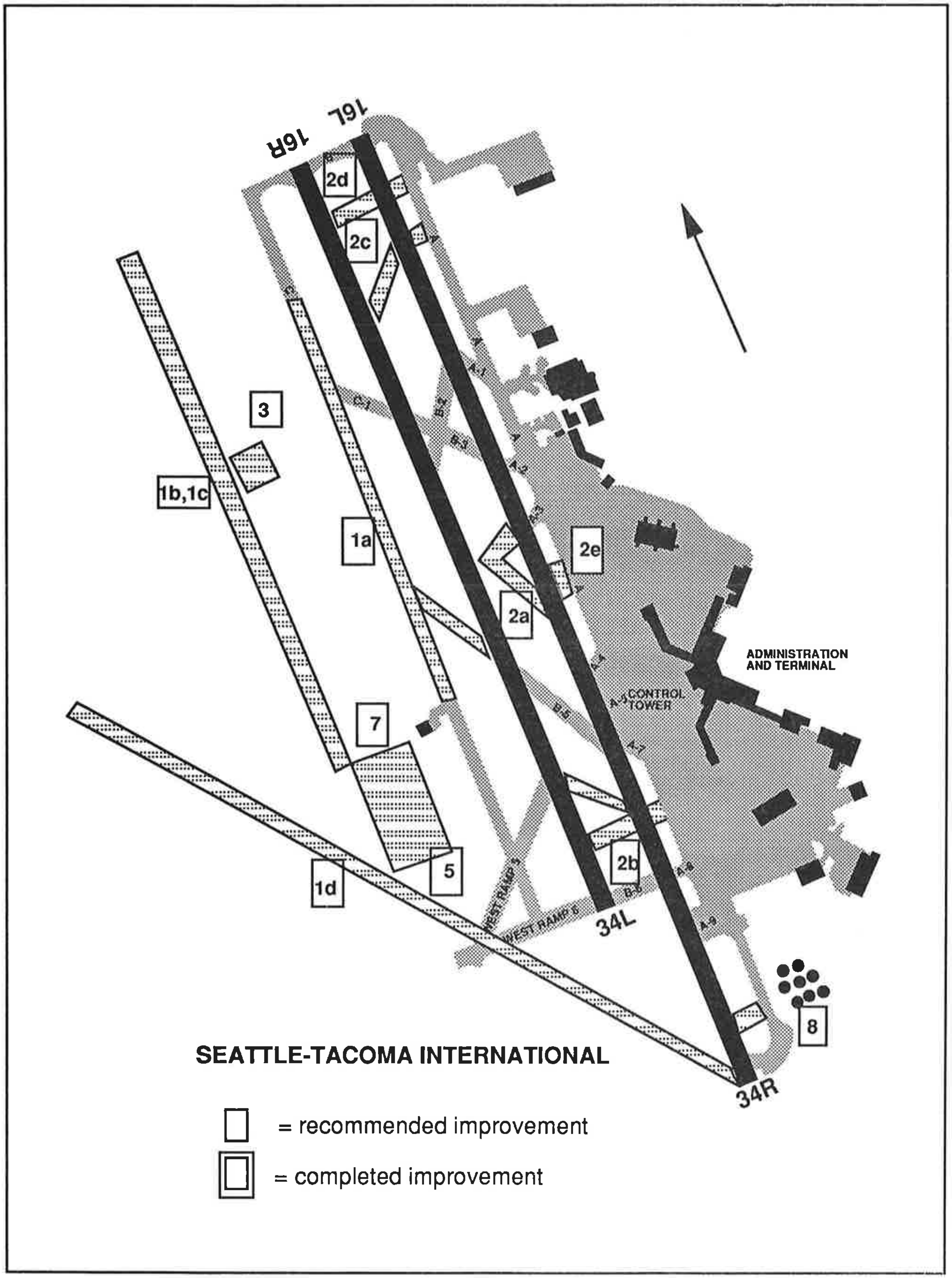


FIGURE 3-14. THE SEATTLE-TACOMA INTERNATIONAL AIRPORT

TABLE 3-15. THE DULLES INTERNATIONAL AIRPORT TASK FORCE PROJECT SUMMARY

POTENTIAL IMPROVEMENT BEING EVALUATED

Airfield Improvements

(1) Add Runway 1W/19W--11,500' Long, 2500' From Runway 1L, Full ILS
(2) Add Runway 12R/30L--10,000' Long, 4300' From Runway 12/30, Full ILS
(3) Add GA Runway(s) West of Runway 1L (With Increased GA Traffic) (Not Pictured)
(4) Widen Turnback Fillets to Runway 1L (at Exits W-3, W-5) (Not Pictured)
(5) Widen Turnback Fillets to Runway 19L (at Exits E-6, E-8) (Not Pictured)
  (5a) Complete Construction of R-2 (Not Pictured)
(6) Add GA Exit to Runway 1R (South of Exit E-8) (Not Pictured)
(7) Add GA Exit to Runway 1L (South of Exit W-8) (Not Pictured)
(8) Add GA Exit to Runway 19R (North of Exit W-3) (Not Pictured)
(9) Add GA Exit to Runway 19L (North of Exit E-3) (Not Pictured)
(10) Extend Runway 12/30 SE and Add Holding Pad
(11) Add Runway 1R Holding Pad and Extend Taxiway E-2 South (to Approach End of 1R)
  (12a) Add Runway 19R Holding Pad (or By-Pass) and Extend Taxiway W-2 North
  (12b) Add 19R Bypass (Not Pictured)
(13) Extend Taxiway W-2 North to Approach End of 19R
(14) Add Midfield Ramp
(15) Add Centerfield North/South Taxiway (May Reduce # of Gates) (Not Pictured)
  -- Escape Mechanism if Someone is in Pushback
  -- Base of Phase 1A and Phase 1B
(16) Phase 1A--1st Phase Midfield (24 Gates and N/S Taxiway) (Not Pictured)
  -- Base for Phase 1B
(17) Phase 1B--Add Midfield Terminal (48 Gates and N/S Taxiway) (Not Pictured)
  -- Includes 24 Gates in Phase 1A)
(18) Add East/West Taxiway R-3 (South of R-2)
(19) Additional Fixed-Base Operator (FBO) to East of Runway 19R Threshold (Not Pictured)

Facilities and Equipment Improvements

(20) RVR 1L
(21) RVR 12/30 (waiver required)
(22) Centerline Lights on 12/30

Operational Improvements

(23) Simultaneous Approach 1's and 19's
(24) Simultaneous Converging Instrument Approaches 12 & 19's (Dual Arrivals)

POTENTIAL IMPROVEMENT BEING EVALUATED

(25) Simultaneous Converging Instrument Approaches 12 & 19's (Triple Arrivals)
(26) 2.5 NM Longitudinal Spacing Inside Outer Marker (2.5 vs. 3 for non-heavy A/C) -- Base for all Runs

User Improvements

(27) Uniformly Distribute Traffic Within the Hour
(28) Reduce GA Traffic by Use of Reliever Airports (10%, 25%, 50%)
(29) ROTs

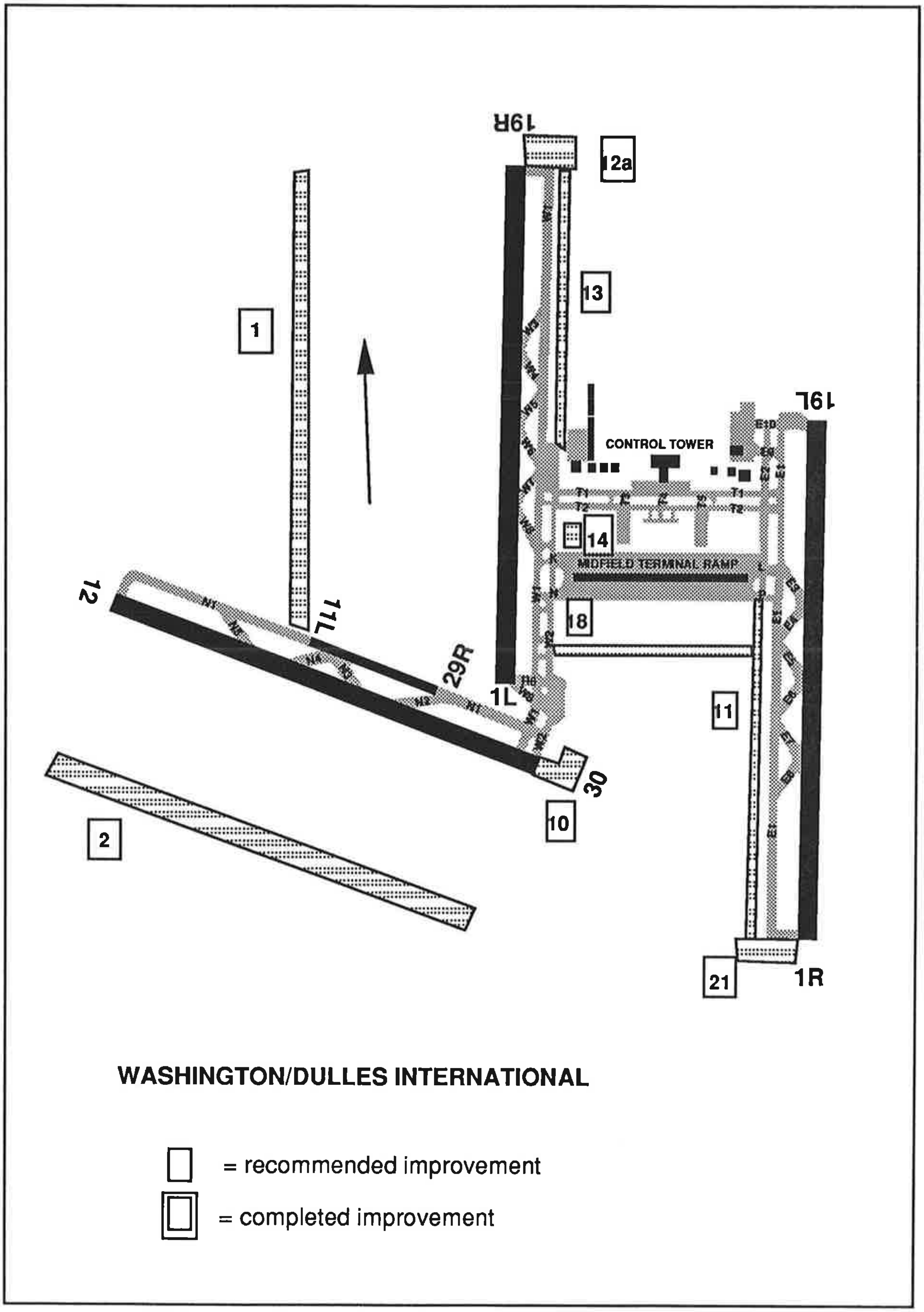


FIGURE 3-15. THE DULLES INTERNATIONAL AIRPORT

Conclusion

Airport capacity task forces have become one of the most successful forums for combining local and federal expertise for new aviation system capacity.

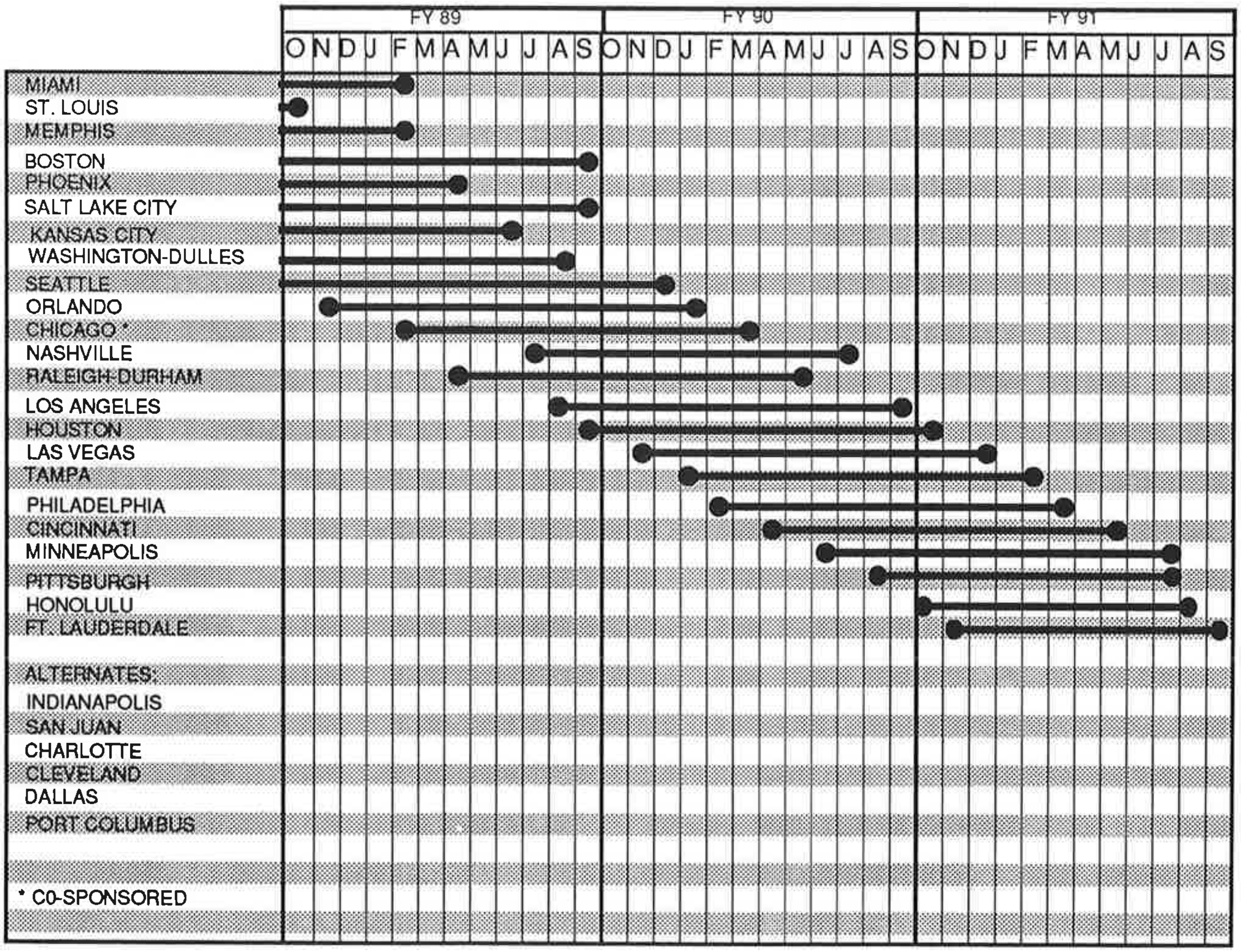
Computer technology is combined with knowledge of future anticipated airspace procedures, systems and equipment and then applied to airports on a site-specific basis.

Capacity projects are quantified in terms of future delay-savings, both in hours of flight delay and dollars.

The results are helpful in establishing the priority of capacity projects in terms of delay savings and providing a basis for cost-benefit analysis.

Table 3-16 depicts a tentative schedule for future airport capacity task forces.

TABLE 3-16. AIRPORT CAPACITY THREE - YEAR TASK FORCE PLAN



CHAPTER 4

FACILITIES AND EQUIPMENT NEEDED TO USE NEW RUNWAYS

Establishing new runway pavement and associated taxiway and apron systems will increase the operations capacity of airports under weather conditions that permit visual, uninstrumented airport arrivals and departures. To establish added capacity that can be relied upon in less than visual conditions, the new or extended runway must be equipped with properly sited electronic and electric instrumentation. The extent to which a runway is instrumented and its orientation and location with respect to existing runways, determine the weather minima to which IFR approaches may be conducted. The FAA ATC Controllers Handbook and related orders specify the numbers of IFR-operated aircraft that may conduct arrival and departure operations simultaneously.

This plan considers airspace procedures that may be used to increase airport capacity. These procedures may require added facilities or equipment. Table 4-1 lists the additional equipment required for each of seven capacity-enhancing airspace procedures.[1] For example, independent IFR converging approaches require precision landing systems on each participating runway and an airport surveillance radar.

---

[1] Table D-1 shows present and planned precision landing systems at each of the nation's 100 busiest airports required to implement five of these capacity-enhancing procedures.

An IFR arrival or departure is one that a properly equipped and certificated commercial-service aircraft is permitted to conduct, provided that the reported ceiling and prevailing visibility are above specified minima. A Category I ILS will permit precision approach arrivals to weather minima of 200 feet decision height (DH) and three-quarters statute mile meteorological visibility. Aircraft operated under FAR Parts 121, 123, 125, 129, or 135 with more than two engines must have at least one-half statute mile visibility to depart. To conduct, an IFR arrival or departure during weather conditions below these minima, additional airport equipment must be provided.[2] By improving IFR arrival and departure minima, capacity can be maintained at its enhanced value during most conditions of deteriorated weather.

---

2 Table D-2 shows the progressively lower minima that may be authorized when specific additional equipment is operational.

TABLE 4-1. FACILITIES AND EQUIPMENT NEEDED TO IMPLEMENT CAPACITY-ENHANCING AIRSPACE PROCEDURES

	INSTRUMENT LANDING SYSTEM (ILS) ON EACH PARTICIPATING RUNWAY	APPROACH RADAR (ASR)	MODIFIED ARTS DISPLAY	ADDITIONAL RADAR DISPLAY
Independent Converging Approaches	X	X		
Dependent Converging Approaches	X	X	X	
Independent Parallel Approaches	X	X		X
Dependent Parallel Approaches	X	X		
Improved Longitudinal Separation	X	X		
Triple IFR Approaches	X	X		X
Separate Short Runways	No Additional Equipment Required			

CHAPTER 5

AIRPORT IMPROVEMENT PROGRAM FUNDING ACTIVITIES

Section 507(c) of the Airport and Airway Improvement Act of 1982 (AAIA), as amended, authorizes the Secretary to make grants to primary airports and their relievers from discretionary funds for the purpose of preserving and enhancing airport capacity. Airports are encouraged to use their entitlement funds to expand capacity. Funding for airport capacity shares top priority with safety and security projects in meeting development needs of the national air transportation system.

In selecting projects for federal grants, consideration is given to the project's effect on overall national air transportation system capacity, project benefit and cost, and the financial commitment of the airport operator or other non-federal funding sources to preserve or enhance capacity. The demand for discretionary funds for capacity enhancement exceeds the amount available.

The FAA has developed project selection criteria to help make decisions on the relative priority of competing capacity projects proposed during the fiscal year. Under this system, projects are favored which best preserve and enhance capacity. The criteria allows FAA to rank-order these diverse airport development projects according to their value in reducing delays and increasing capacity, not only at the airport where the project is accomplished, but also according to their beneficial impact on airspace system delays and on delays and capacity at other airports in the national system.

In measuring the effect an airport has on the national system, FAA considered four parameters:

- Delay (current and forecast)
- Aircraft operations (current and forecast)
- Number of nonstop flights
- Proportion of connecting passengers

Project benefit and cost can be measured either by broad categories, or actual measurement of benefit through simulation studies such as those performed by airport capacity task forces. Where task force simulations are available, individual projects can be prioritized by benefit. In absence of modeling, a general project priority has been established as listed in Table 5-1:

TABLE 5-1. AIRPORT PROJECT PRIORITY WITH RELATIVE WEIGHTING

ITEM	ACTIVITY	WEIGHT
New Airport	Construct	20 points
	Acquire	20
Runway	New or Reconstruction	15
	Extension or Overlay	10
Taxiway	New or Reconstruction	10
	Extension or Overlay	8
Apron	New or Reconstruction	8
	Extension or Overlay	5
Other	Varies	1-10

The airport's ranking in its contribution to system capacity, combined with the benefit of the project, and the willingness of the airport to commit funding determines the priority assigned to funding with discretionary funds for capacity enhancement. On the following page, Table 5-2 summarizes FY 1988 funding for capacity development.

TABLE 5-2. FISCAL YEAR 1988 GRANT FUNDING AT THE TOP 100 AIRPORTS

ACTIVITY	FUNDS	PERCENT
New Airport (AUSTIN)	$ 10,000,000	2.6
Runways	$ 87,776,194	23.2
Taxiways	$ 114,897,597	30.3
Aprons	$ 90,398,727	23.9
Instrument Approach Aids	$ 4,372,483	1.2
Terminal expansions	$ 32,697,503	8.6
Lighting and Signage	$ 12,310,104	3.3
Land Acquisitions	$ 26,075,446	6.9
	$378,528,054	100.0%

For the top 100 airports, the Fiscal Year 1989 requests for capacity-project funding (pre-applications) are $991,000,000. Total available funding is $1.4 billion for all airport development. Funds available nationwide for fiscal year 1989 safety, security, capacity, and noise discretionary projects are limited to $93,400,000-ten percent of that requested by the 100 top airports.

Funds available nationwide for fiscal year 1989 safety, security, capacity, and noise discretionary projects are limited to $93,400,000-ten percent of that requested by the 100 top airports.

CHAPTER 6

AIRSPACE DEVELOPMENT

Second to weather, Table 1-3 shows that the next greatest cause of delay exceeding 15 minutes are center and terminal volume restrictions. One way to address these problems is to redesign airspace structure and traffic flow to accommodate more aircraft.

The FAA has focused on several critical capacity and delay problems using simulation models as tools in identifying and evaluating potential solutions. These applications included evaluating alternatives to realign airspace, redesign routings, and revise procedures to enhance the efficiency and safety of air traffic operations. Computer modeling was used to quantify delay, travel time, capacity, sector loading, and aircraft operating cost impacts of new proposed airspace structures, routings, and procedures. Studies were completed at Los Angeles and Boston, and are underway at Chicago, Dallas-Fort Worth, and Denver.

6.1 Los Angeles Airspace Capacity Project

This project involved the redesign of airspace in the Los Angeles Air Route Traffic Control Center (ARTCC) and its underlying terminal airspaces and airports to enable more aircraft to be controlled. Los Angeles Center operations were simulated to calculate the delays caused by airspace congestion resulting from Special Use Airspace. Operations in the Los Angeles Center and underlying Terminal Radar Approach Control (TRACON) airspaces were simulated to quantify the delay, capacity, and sector loading impacts associated with airspace realignment in the Los Angeles Basin. Figure 6-1 shows the Los Angeles Center-Special Use Airspace and Choke Point Corridors.

Major Results

Major results from the project include:

- Under nominal operating conditions with demand evenly split between arrivals and departures, Los Angeles International Airport can sustain 116 operations per hour under IFR conditions. Under VFR conditions, 140 operations per hour can occur without air traffic control reporting delays of 15 minutes or greater.

- Substantial delays are incurred by traffic passing through choke points in Los Angeles Center airspace due to Special Use Airspace. Figure 6-1 shows the location of the choke points caused by Special Use Airspace. Total aircraft delay through the four major airspace choke points is a least 30 hours per day for baseline traffic levels.

- Unless choke point constraints are relaxed to improve capacity, increases in traffic volumes within Los Angeles Center airspace will result in substantial increases in delay.

- Realignment of Los Angeles Basin Airspace will relieve the airspace saturation in Los Angeles Center Sector 21 and result in substantial improvements in efficiency. Figure 6-2 shows Los Angeles Center Sectors.

- Airspace capacity will be substantially increased in the new airspace realignment enabling increased volumes of traffic to be accommodated with less delay.

- The intensity and complexity of traffic operations in Los Angeles Center Section 21 will be substantially reduced under the new airspace realignment.

- The airspace realignment will increase traffic loading for both Los Angeles and Coast TRACONs.

- The new terminal airspace, with the addition of a second eastbound route, will provide the increased capacity needed to accommodate current and forecasted near-term increases in eastbound traffic demand in the Los Angeles Basin. An existing third route should be maintained to provide additional capacity and enhance controller flexibility in relieving traffic congestion.

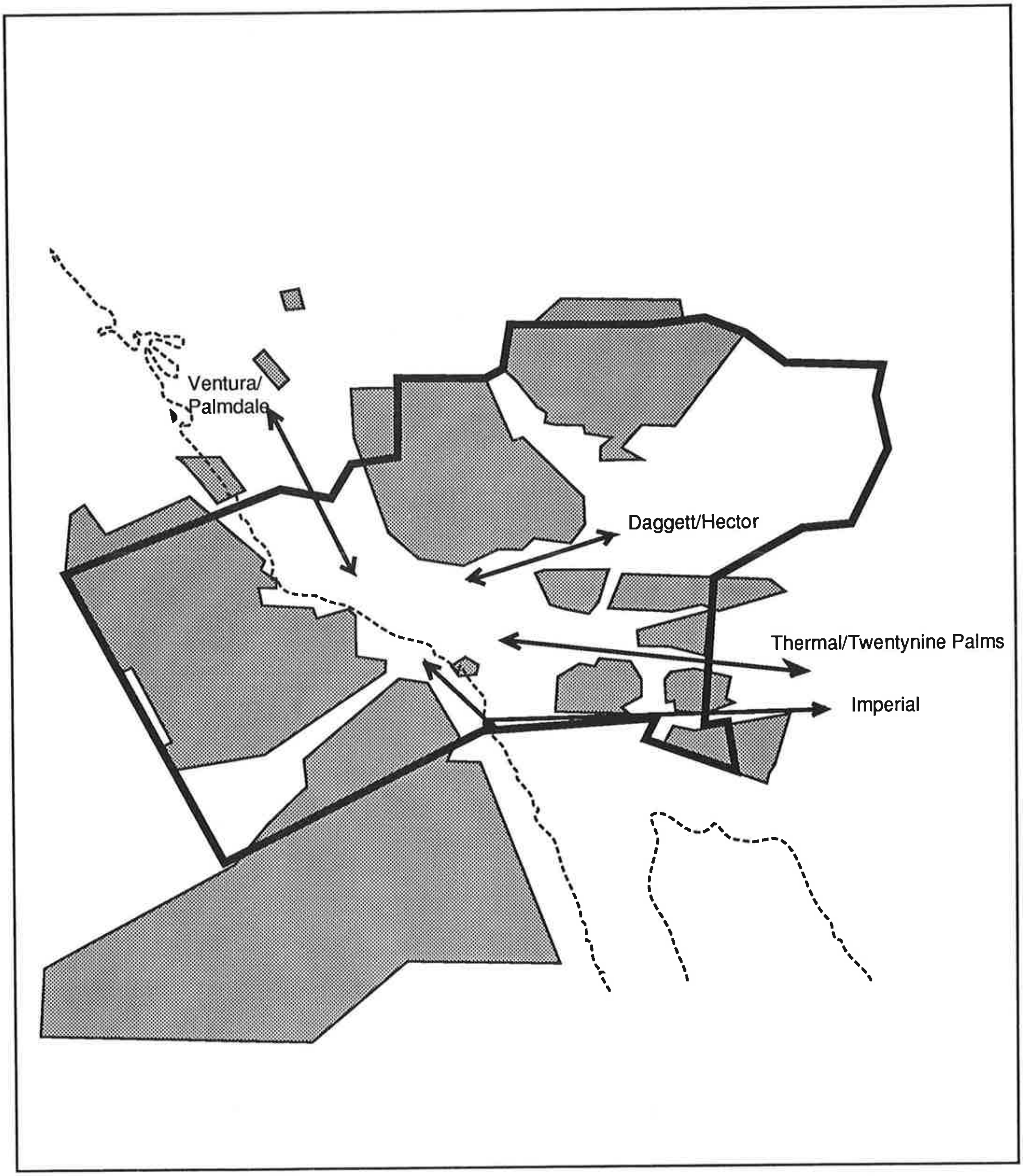


FIGURE 6-1. LOS ANGELES CENTER-SPECIAL USE AIRSPACE AND CHOKE POINT CORRIDORS

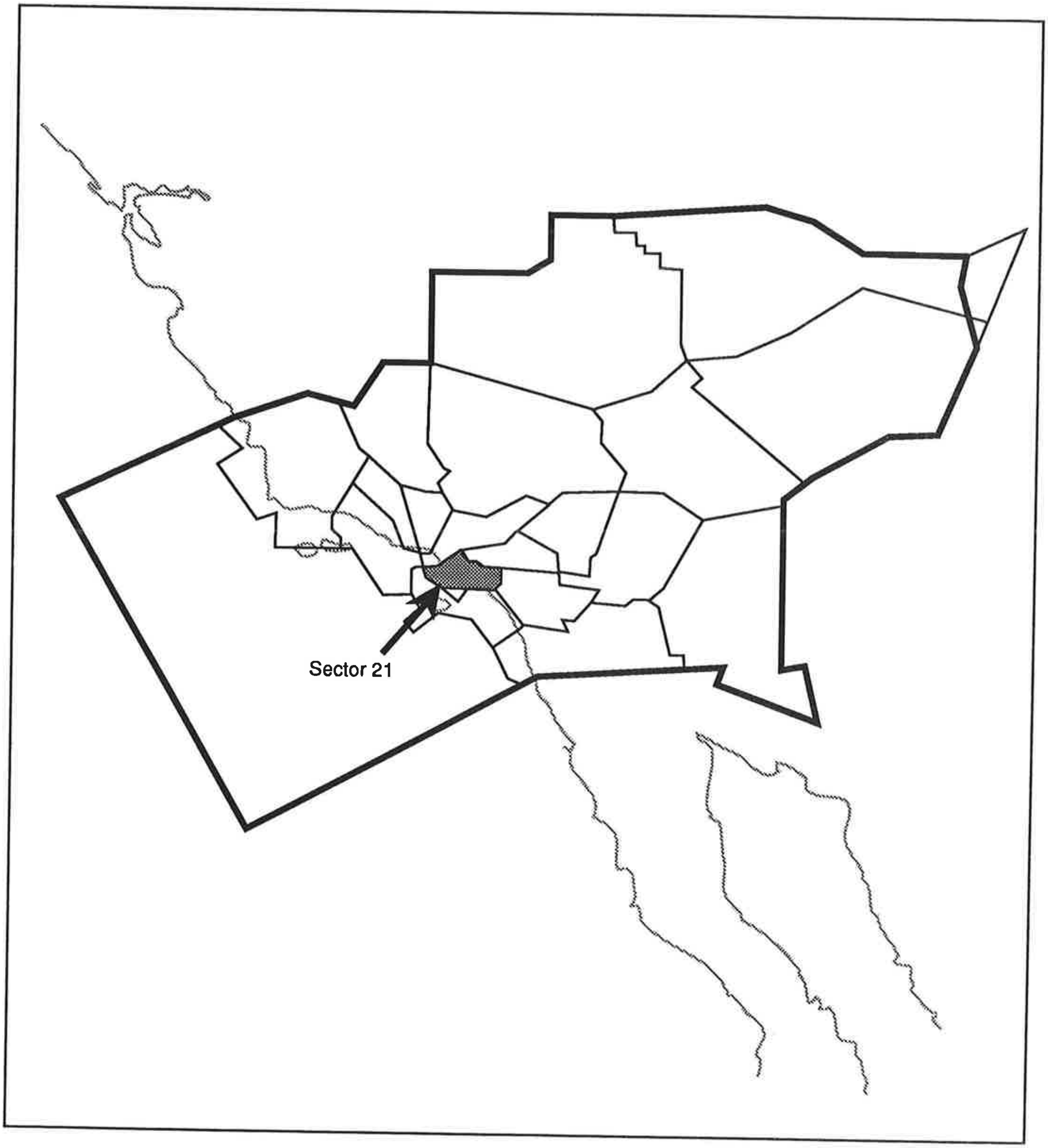


FIGURE 6-2. LOS ANGELES CENTER-SECTORS

Los Angeles Basin Airspace Project

Sector 21 is a relatively small sector encompassing, at its maximum, a distance of approximately 35 miles from north to south and 50 miles from east to west. The bottom of Sector 21 airspace commences at an altitude of 7,000 feet and reaches its highest altitude at FL 230. Considerable shelving exists at the lower altitudes, mainly in areas where Sector 21 interfaces with Los Angeles and Coast TRACONs.

The initial airspace realignment for the early phases of the project primarily involves airspace and routing changes for Sector 21, Sector 22, and Los Angeles and Coast TRACONs. Major modifications to the old system include:

- Expanding the lateral boundaries of Coast TRACON.
- Establishing a common ceiling of 13,000 feet for Coast and Los Angeles TRACONs.
- Assigning departures from Los Angeles International Airport previously using a northeastern routing to an eastbound routing.
- Assigning departures from Orange County and Long Beach airports currently on northern routings to an eastbound routing.
- Assigning departures from Orange county and Long Beach airports currently on northern routings (previously handled by Sector 21) to Coast TRACON for routing to the west.
- Assigning southbound arrivals to Coast TRACON earlier, with Coast TRACON keeping this traffic under Long Beach and Orange County departures being worked to the west.

Delay Reductions and Cost Savings Results Under the New System

The delay reductions and cost savings results from the simulation runs are summarized in Table 6-1. All values shown in this table are the new versus old system. This table shows that substantial reductions in delay are realized for all traffic levels. In the near-term cases, the average daily flight hour savings under the new system is between 12 to 13 hours corresponding to an annual cost saving of seven to

If the high-growth traffic increase occurs, then 70 hours in delay reductions and $41 million in annual cost savings will be gained under the new system.

eight million dollars. By the year 2000, if a nominal traffic increase is realized, the new system will save at least an additional 26 hours of delay per day, which equated to another $15 million in annual cost savings. If the high-growth traffic increase occurs, then 70 hours in delay reductions and $41 million in annual cost savings will be gained under the new system.

TABLE 6-1. DELAY REDUCTIONS AND COST SAVINGS FOR THE NEW SYSTEM

TRAFFIC DEMAND LEVEL	FORECAST DAILY ADDITIONAL COMMERCIAL FLIGHTS	AVERAGE DAILY FLIGHT TIME REDUCTION	COST PER AIRCRAFT FLIGHT HOUR	ANNUAL COST SAVINGS
Near-term Case [1]	93	12 Hours	$1,600	$7 Million
Near-term Case [2]	98	13 Hours	$1,600	$8 Million
Nominal Year 2000	156	39 Hours	$1,600	$23 Million
High-growth Year 2000	195	70 Hours	$1,600	$41 Million

1 Case 1&2 refer to different traffic build scenarios which were examined.

2 These figures represent the daily reduction in aircraft delays in hours that result from the redesigned airspace when compared to present irspace accommodations the forecast daily additional flights shown.

6.2 Boston Airspace Capacity Project

This project involved the study of airspace problems around the major terminal area at Boston. It was necessary to identify, evaluate, and analyze potential airspace redesign options for air traffic routings and procedures that would make maximum effective use of airspace capacity to improve operating efficiency and reduce delay.

The project focused on providing a simulation of en route airspace operations in the Boston Center. SIMMOD was used to quantitatively evaluate the delay, travel time, capacity, sector loading and aircraft operating cost impacts of proposed airspace structures, routings and procedures.

Major modifications were implemented as a result of this project:

- Boston Center airways were realigned to provide more direct routings.
- Departure routes were realigned with revised New York Center routings.
- More efficient routings for arrivals were implemented.
- Sectors were revised to allow for uniform distribution of the traffic load among the various sectors.
- Airspace sector complexity was reduced by providing for a reduced amount of "shelving."

Figure 6-3 shows the configuration of low altitude en route airways sectors that existed prior to this project and those that were implemented as a result of recommended changes.

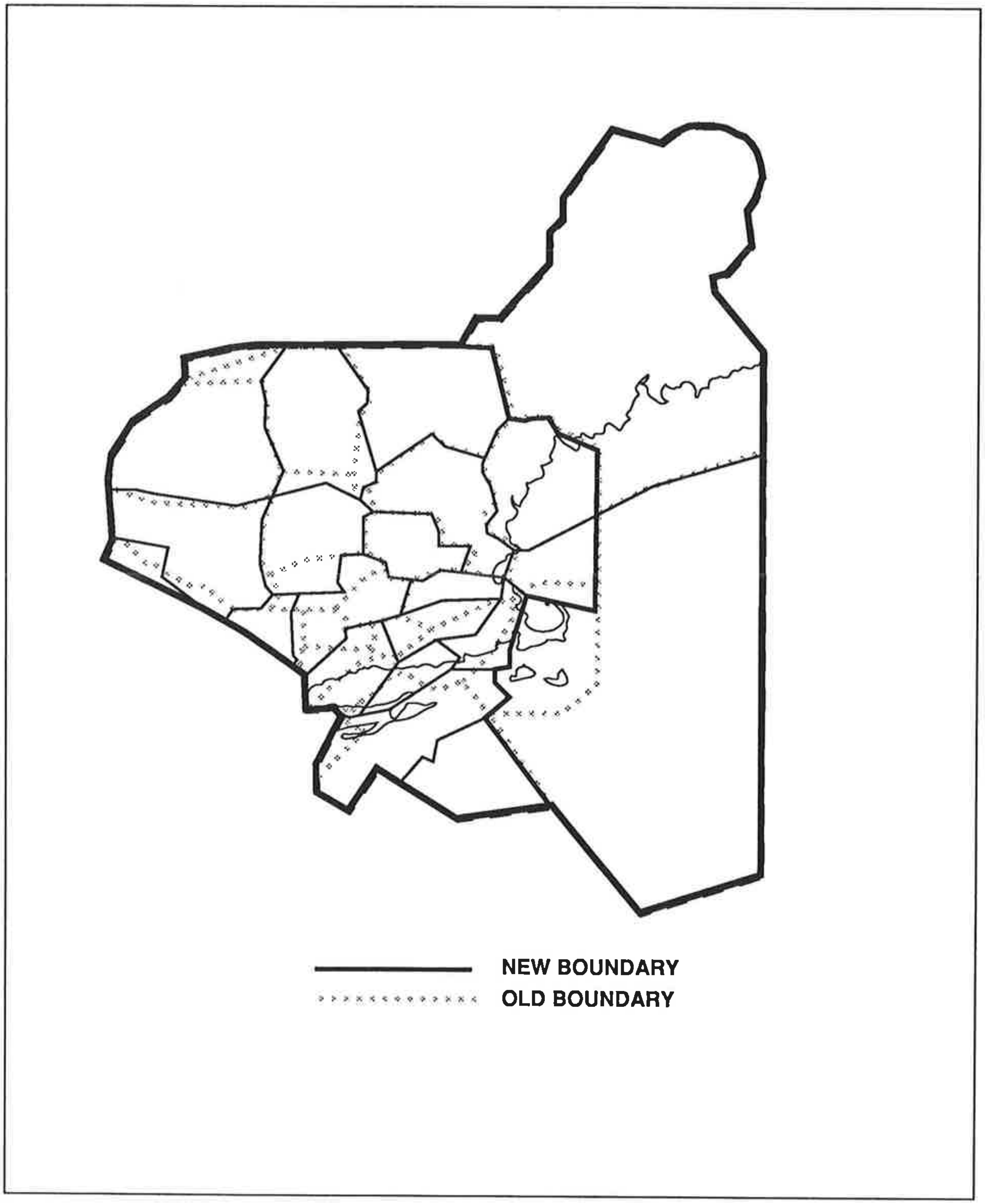


FIGURE 6-3. BOSTON CENTER-LOW ALTITUDE SECTORS

Table 6-2 shows the expected benefit of this realignment under different growth scenarios.

TABLE 6-2. COST SAVINGS FOR THE NEW PROPOSED SYSTEM FOR VARIOUS TRAFFIC LEVELS AT BOSTON

PERCENT INCREASE IN TRAFFIC	AVERAGE DAILY FLIGHT TIME REDUCTION	COST PER AIRCRAFT FLIGHT HOUR	ANNUAL COST SAVINGS
0%	41 Hours	$1,600	$23 Million
10%	52 Hours	$1,600	$30 Million
20%	81 Hours	$1,600	$47 Million
30%	109 Hours	$1,600	$63 Million
40%	141 Hours	$1,600	$82 Million
50%	212 Hours	$1,600	$123 Million

6.3 Chicago, Dallas - Fort Worth and Denver Airspace Capacity Projects

An airspace capacity design project was begun in the FAA Southwest Region for the development, evaluation, and analysis of the Dallas-Fort Worth Metroplex air traffic system plans. The Great Lakes Region also began a project for the purpose of identifying, analyzing, and quantitatively evaluating the impacts on capacity, delay, and operating costs of potential airport and airspace improvement options aimed at increasing capacity, reducing delays, and improving the overall efficiency of air traffic operations at Chicago.

Similarly, the Northwest-Mountain region began a project revising airspace and procedures to efficiently accommodate air traffic operations at a new Denver Airport.

Figures 6-4 through 6-6 show that airport/airspace project areas of consideration for Dallas-Fort Worth, Chicago, and the new Denver airport, respectively.

This page intentionally left blank

Dallas-Fort Worth Airspace Analysis

The problems and issues being addressed in the Dallas-Fort Worth (DFW) Metroplex Air Traffic Analysis Project include:

- Evaluation and refinement of routings and procedures for the new airspace design under South Flow and North Flow operations in both VFR and IFR weather.

- Analysis of capacity of the new DFW airspace design, including the capability to accommodate future traffic volumes and expanded airport capacity.

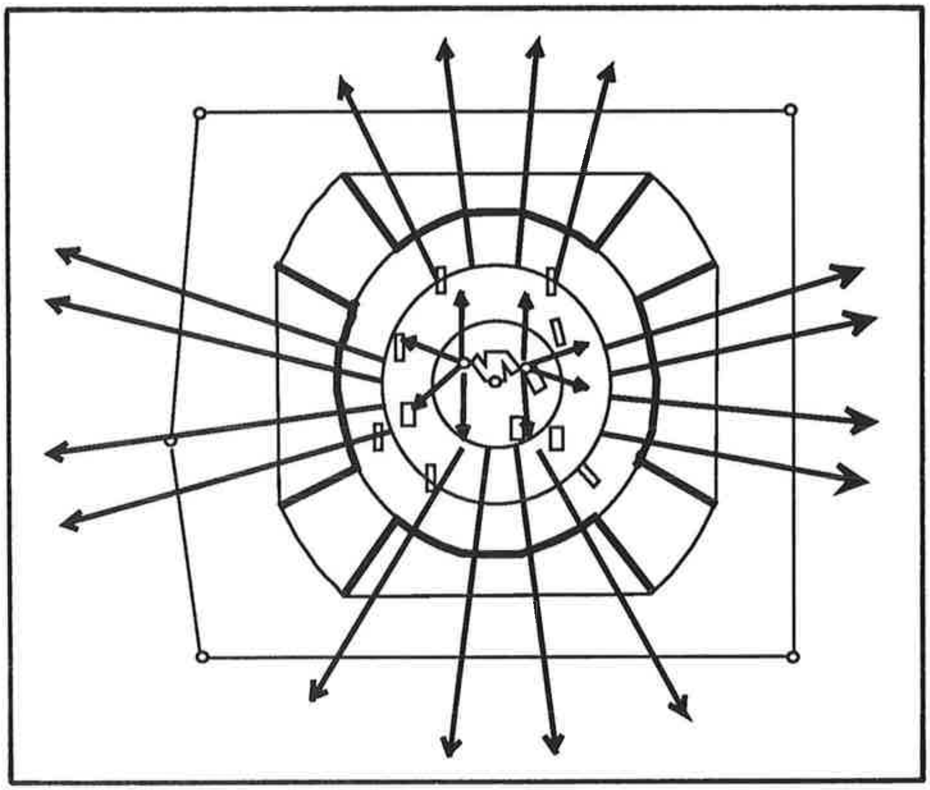
- Procedures for four simultaneous ILS approaches to DFW airport.

- Operating alternatives associated with new runway options at DFW airport (Runways 16L/34R and 16R/34L).

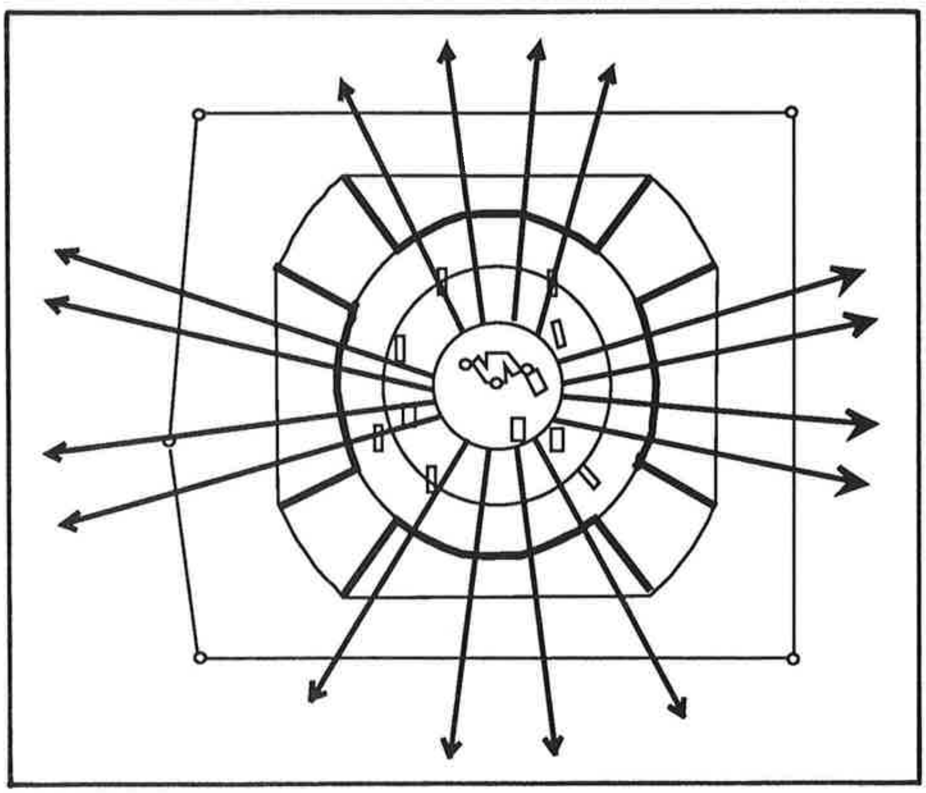
- Impacts of running noise abatement procedures on a 24-hour basis for Dallas Love Field departures.

- Airspace interactions between DFW airport and Navy Dallas Airfield traffic in North Flow operations.

- Airspace interactions among operations associated with the new Alliance airport and other Metroplex airports.



PROP AND TURBOPROP DEPARTURES



TURBOJET DEPARTURES

FIGURE 6-4. DEPARTURE ROUTES AT DALLAS-FORT WORTH

New Denver Airport Airspace Analysis

The problems and issues being addressed in the New Denver Airport Analysis Project include:

- Evaluation of alternative arrival/departure gate configurations for the new terminal airspace to provide information relevant to FAA decisions regarding siting of NAVAIDS.

- Analysis of the capacity of two alternative runway utilization plans for a 6-runway configuration under VFR and IFR weather conditions, under demand levels expected when the New Denver Airport opens as well as the capability to accommodate future traffic.

- Assess the impact on departure delays when the East/West runways are used as arrival overflow runways.

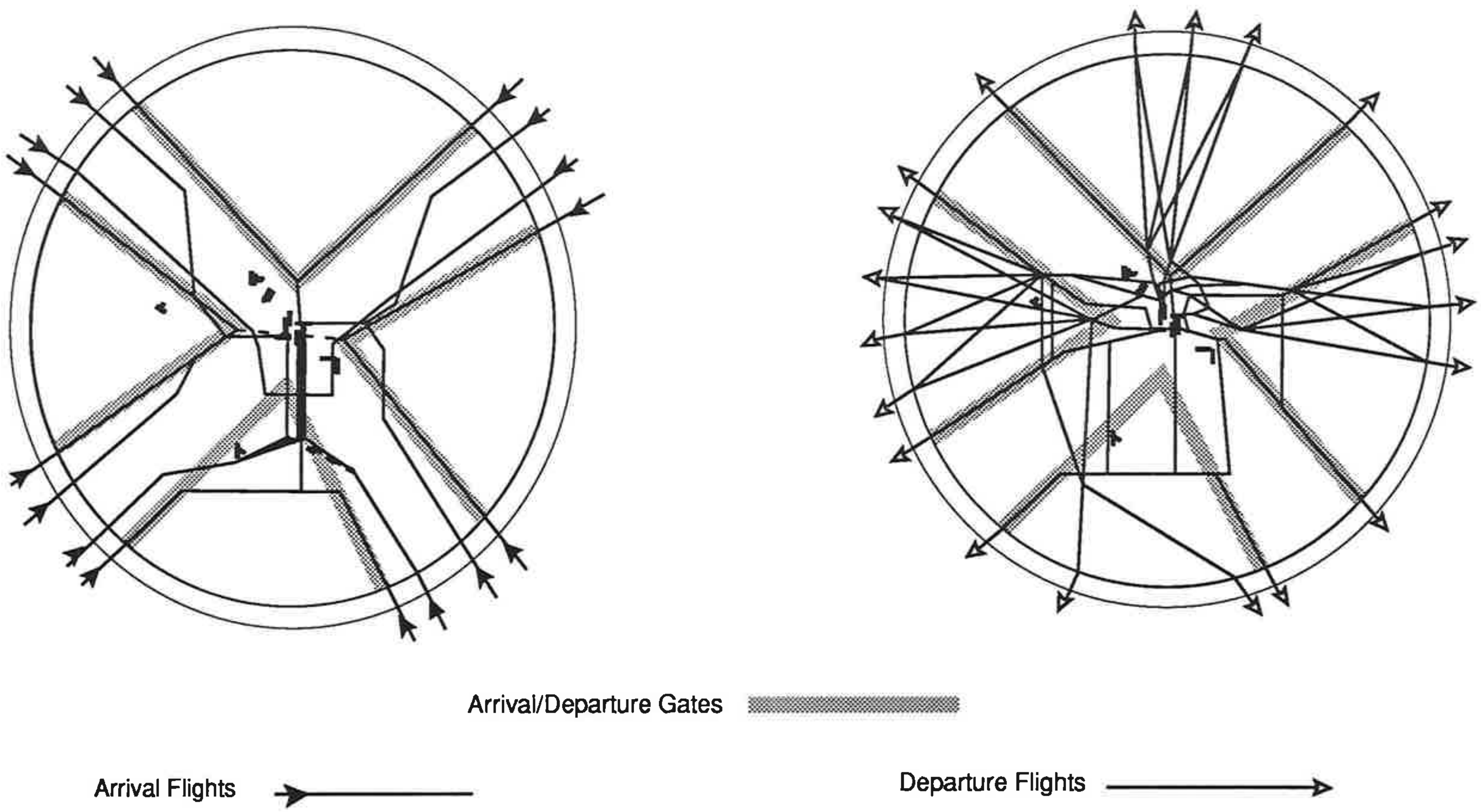


FIGURE 6-5. NEW DENVER

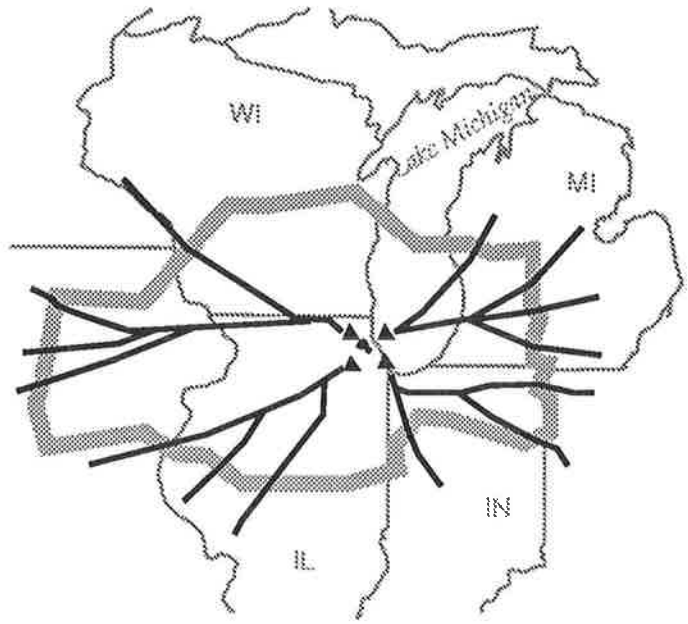
Chicago Airport Airspace Analysis

The potential problems and issues to be addressed initially in the Chicago Area Airport Airspace Air Traffic Analysis Project include:

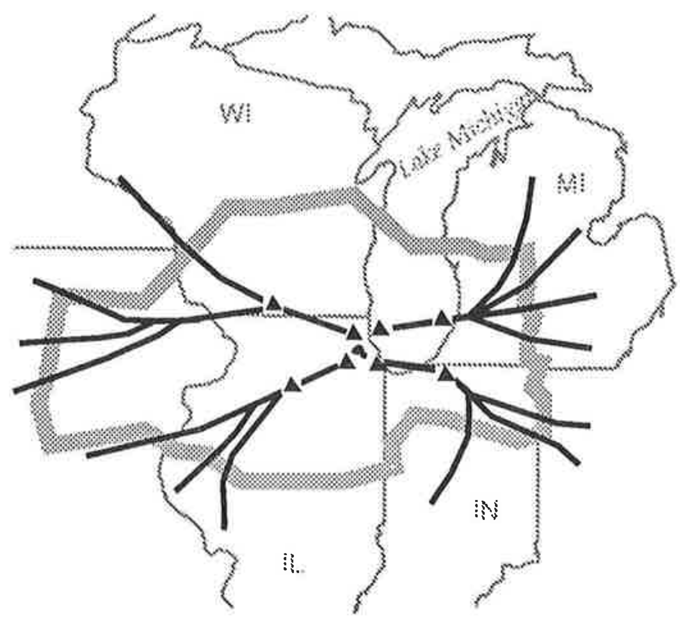
- Analysis of Chicago area airport/airspace operations for O'Hare and Midway airports for current and future demand levels.

- Analysis of performance and efficiency of air traffic operations for five runway use configurations under various weather conditions for O'Hare and Midway Airports.

- Identification of airspace structures or procedures which might limit system capacity and operational alternatives for increasing capacity, reducing delays, and improving the overall efficiency of air traffic operations.



CURRENT ARRIVAL TRAFFIC FLOWS



RESTRUCTURED ARRIVAL TRAFFIC FLOWS

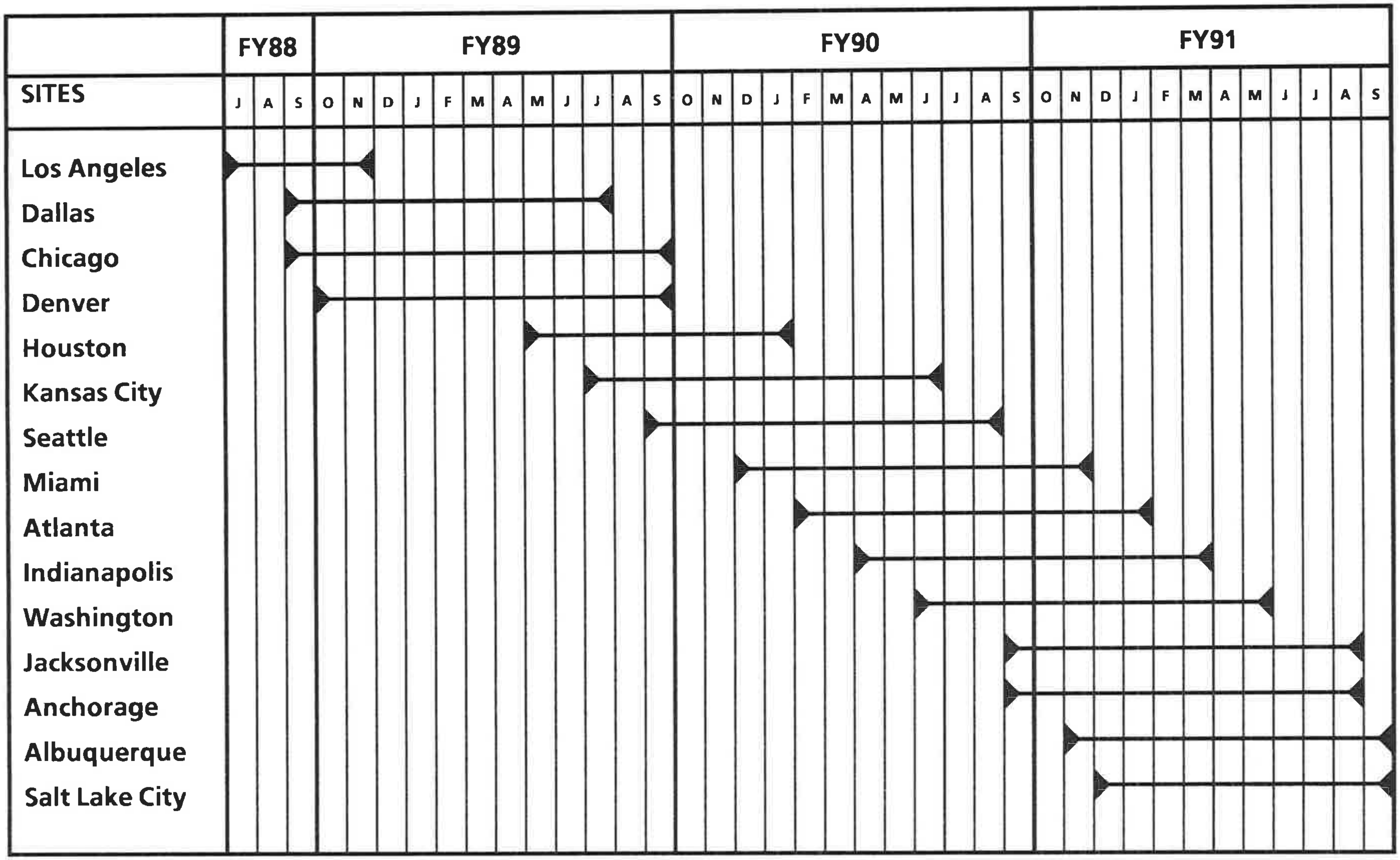
FIGURE 6-6. CHICAGO CENTER-ARRIVAL FLIGHTS

Conclusion

Airspace capacity design projects are relatively short-term methods to increase aviation system capacity by combining computer planning technology with the expertise and ingenuity of air traffic planners.

The technology and expertise is available to allow airspace design projects virtually throughout the U.S. A tentative schedule for conducting future airspace capacity design projects is shown in Table 6-13.

TABLE 6-3. AIRSPACE CAPACITY PROJECT THREE YEAR PLAN



CHAPTER 7

APPROACH PROCEDURES TO ENHANCE AIRPORT CAPACITY

Seventy percent of delays occur during adverse weather conditions. The delays are partly the result of approach procedures that are much more restrictive than those in effect during better weather. Much of the delay could be eliminated if the approach procedures used during IFR operations permitted aircraft separation requirements closer to those observed during VFR operations.

During the past few years the FAA has been working on the development of new, capacity-enhancing approach procedures for use during IFR. In most cases, these are multiple approach procedures, aimed at allowing the simultaneous or near-simultaneous use of more than one arrival runway.

In general, depending on the airport aircraft mix, single-runway IFR approach procedures allow about 26 arrivals per hour. Hence, two simultaneous approach streams, when operating independent of each other double arrival capacity to 52 per hour. Three streams would allow 78 hourly arrivals, and so on. Such procedures are called "independent," because the aircraft in one stream do not interfere with arrivals in the other. Conversely, "dependent" procedures place restrictions between the aircraft streams, and as a result, hourly capacity for dual dependent approaches is somewhere between 26 and 52 arrivals. In the case of triple streams, the arrivals are somewhere between 52 and 78, depending on airport runway configurations.

Single-runway IFR approach procedures allow about 26 arrivals per hour. Two simultaneous approach streams, when operating independent of each other double arrival capacity to 52 per hour. Three streams would allow 78 hourly arrivals.

"Dependent" procedures place restrictions between the aircraft streams. Hourly capacity for dual dependent approaches is somewhere between 26 and 52 arrivals. In the case of triple streams, the arrivals are somewhere between 52 and 78, depending on airport runway configurations.

The following sections present a brief description of the most promising approach concepts being developed, as well as sample lists of airports that might benefit through use of the new procedures. The sample lists are based on the 100 busiest U.S. airports in terms of 1987 enplanement figures. Section 7.8 is the result of an analysis encompassing these top 100 airports, showing where the new procedures might be used and what the benefit would be in relation to the airports' best current capacity. Some of these same procedures could apply at other airports in the National Air Transportation System.

7.1 Dependent Parallel IFR Approaches

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. Recent studies show that this diagonal separation could be safely changed to 1.5-nmi.

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 requirement prevents a faster aircraft on one approach from overtaking a slower aircraft on the other approach, limiting the capacity increase associated with using the two arrival streams. Ongoing projects involve changes in the runway separation requirements 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. Improvements below 2,500 feet (down to 1,000 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 (see Figure 7-1) and selecting sites for demonstrating these procedures. Two sites already selected are New York (JFK) and Washington (IAD), where flight demonstrations will take place in 1989.

Of the top 100 airports 27 have, or plan to have, parallel runways with spacing between runway pairs in the 1,000 - 2,499-foot range.

Of the top 100 airports 27 have, or plan to have, parallel runways with spacing between runway pairs in the 1,000 - 2,499-foot range. Capacity increases for dependent parallel operations and are approximately ten arrivals per hour greater than single runway hours for a two nmi diagonal seperation. Approximately 14 total additional arrivals per hour are possible if improvements in seperation are made to 1.5 nmi.

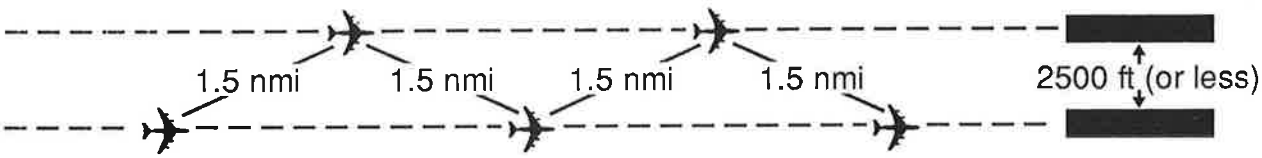


FIGURE 7-1. DEPENDENT PARALLEL IFR APPROACHES

TABLE 7-1. CANDIDATES FOR DEPENDENT IFR PARALLEL APPROACHES (WITH IMPROVED DIAGONAL SEPARATION) AMONG THE TOP 100 AIRPORTS

Atlanta ATL	Milwaukee MKE
Boston BOS	Minneapolis MSP
*Charlotte CLT	Nashville BNA
Cincinnati CVG	Oakland OAK
Columbus CMH	Omaha OMA
Dallas DAL	Orlando MCO
Denver DEN	Oakland OAK
Detroit DTW	Philadelphia PHL
El Paso ELP	Pittsburgh PIT
*Indianappolis IND	Portland PDX
Knoxville TYS	Providence PVD
Long Beach LGB	Raleigh-Durham RDU
Memphis MEM	Salt Lake City SLC
Midland MAF	St. Louis STL

* These airports will be able to use the new approach procedure if and when planned runway construction/extensions take place.

7.2 Independent Parallel IFR Approaches

Separation between parallel runways must be at least 4,300 feet for simultaneous independent IFR operations. The FAA is actively pursuing ways to change this separation standard to a goal of between 2,500 and 3,000 feet. This may permit an increase of 12-17 operations per hour under IFR

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 change this separation standard to a goal of between 2,500 and 3,000 feet. Since dependent IFR parallel operations are currently permitted with runway spacings between 3,000 and 4,299 feet, the goal is to permit a shift to independent operations in this spacing range. This may permit an increase of 12-17 operations per hour under IFR. The flexibility inherent in having two independent arrival streams is a significant advantage relative to the dependent case in which diagonal separations must be maintained. Demonstrations using new sensors and spacing reductions between parallel runways are being conducted in Memphis (MEM) and Raleigh-Durham (RDU) during 1989.

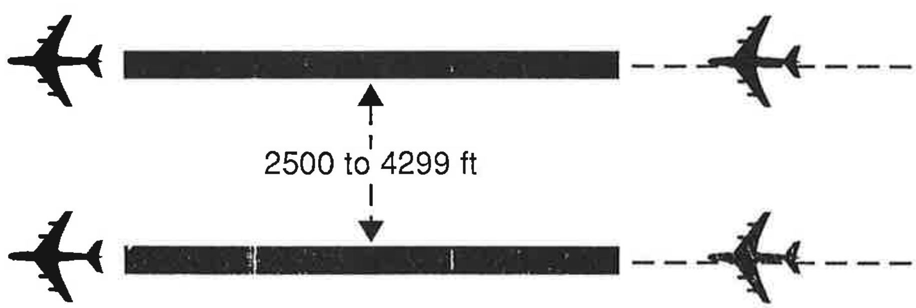


FIGURE 7-2. INDEPENDENT PARALLEL IFR APPROACHES

Among the top 100 airports, 28 have or plan to have parallel runways with spacings between 3,000 and 4,299 feet. Arrived capacity is approximately double that of single runway capacity. The airports that would benefit are shown in Table 7-2, below.

TABLE 7-2. CANDIDATES FOR INDEPENDENT PARALLEL IFR APPROACHES AMONG THE TOP 100 AIRPORTS

*Atlanta ATL	*Louisville SDF
*Baltimore BWI	Memphis MEM
*Charlotte CLT	Minneapolis - St. Paul MSP
*Cininnati CVG	*Nashville BNA
*Colorado Springs COS	*New Orleans MSY
Dallas DAL	New York JFK
Fort Lauderdale FLL	*Orlando MCO
*Fort Myers FMY	*Philadelphia PHL
*Grand Rapids GRR	Phoenix PHX
*Greensboro GSO	Portland PDX
Harlingen HRL	Raliegh-Durham RDU
*Kansas City MCI	Salt Lake City SLC
*Little Rock LIT	Savannah SAV
Long Beach LGB	*Syracuse SYR

* These airports will be able to use the new approach procedure if and when planned runway construction/extensions take place.

7.3 Dependent Converging IFR Approaches

The objective of this project is to increase capacity by lowering the minima required by existing dependent converging IFR approach procedures. Preliminary studies indicate that dependent approaches to converging runways can permit ceilings down to Category I minima Decision Heights (200 feet).

As in the independent approach case (Section 7.4), the possibility of simultaneous missed approaches is the primary concern. An automation concept is under development by the FAA to assist the controller in maintaining a minimum separation between aircraft landing on two converging run-ways, ensuring safe separation in case both aircraft execute missed approaches. The aircraft alternate arrivals on the two runways so that, in the event of a simultaneous missed approach, separation is ensured. Since the streams are dependent, aircraft flow in one stream affects aircraft flow in the other stream, especially when there are large speed or size differences between aircraft.

Among the top 100 airports, 58 are candidates for dependent converging approaches.

Among the top 100 airports, 58 are candidates for dependent converging approaches. A program is underway in St. Louis to demonstrate this concept within the next year. Figure 7-3 shows an example of the concept as applied to Boston. Notice the aircraft stagger maintained by the air traffic controller, assuring separation during missed approaches. Table 7-3 shows the airports that might use dependent converging IFR approaches. Estimated benefits are shown in Table 7-8 at the end of this chapter. Capacity increases of approximately eight arrivals per hour over single runway arrived capacity.

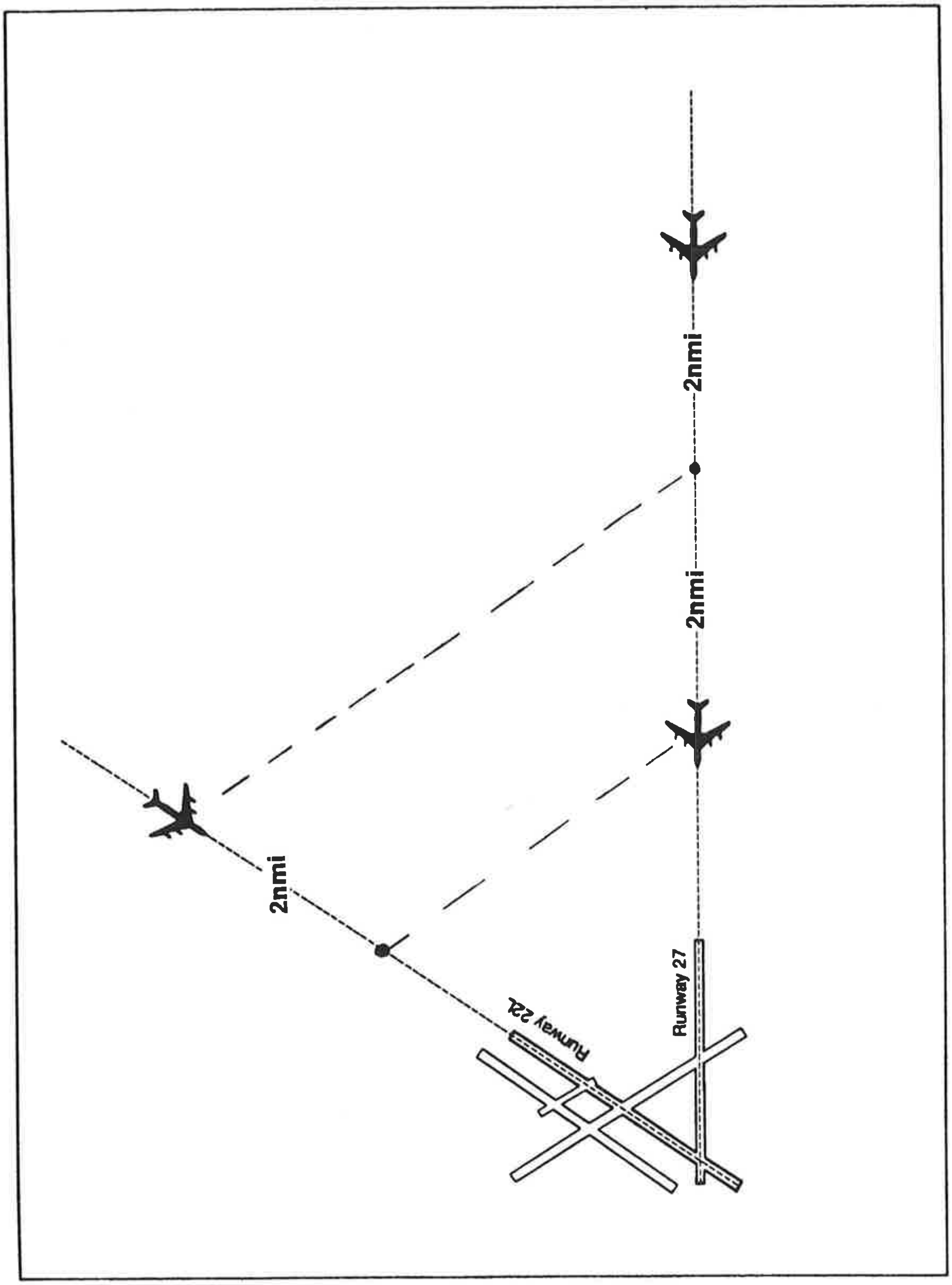


FIGURE 7-3. DEPENDENT CONVERGING IFR APPROACHES AT BOSTON LOGAN AIRPORT

TABLE 7-3. CANDIDATES FOR DEPENDENT CONVERGING IFR APPROACHES AMONG THE TOP 100 AIRPORTS

Albany ALB	Miami MIA
Austin AUS	Midland MAF
Baltimore BWI	Milwaukee MKE
Boston BOS	Minneapolis-St. Paul MSP
Buffalo BUF	Nashville BNA
Burbank BUR	New York JFK
Charleston CHS	New York LGA
Charlotte CLT	Newark EWR
Cincinnati CVG	Norfolk ORF
Cleveland CLE	Omaha OMA
Colorado Springs COS	Ontario ONT
Columbia CAE	Philadelphia PHL
Dayton DAY	Pittsburgh PIT
Des Moines DSM	Portland PDX
Fort Lauderdale FLL	Portland PWM
Fort Myers FMY	Providence PVD
Greensboro GSO	Raleigh-Durham RDU
Harlingen HRL	Reno RNO
Hilo ITO	Rochester ROC
Honolulu HNL	San Antonio SAT
Houston HOU	San Francisco SFO
Indianapolis IND	Savannah SAV
Islip ISP	Spokane GEG
Kahului OGG	St. Louis STL
Las Vegas LAS	Syracuse SYR
Lihue LIH	Tampa TPA
Long Beach LGB	Tulsa TUL
Louisville SDF	Washington DCA
Memphis MEM	West Palm Beach PBI

7.4 Independent Converging IFR Approaches

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 (decision heights generally 700 feet or more due to geometric constraints shown in Figure 7-4).

Of the top 100 airports, 33 are candidates for independent converging IFR approaches.

Of the top 100 airports, 33 are candidates (or can become candidates given their construction plans) for independent converging IFR approaches. Estimated capacity benefits at these airports are shown in Table 7-8, at the end of this chapter.[1] IFR arrival capacity from independent converging approaches approximately double the capacity of single IFR runway arrivals.

TABLE 7-4. CANDIDATES FOR INDEPENDENT CONVERGING IFR APPROACHES AMONG TOP 100 AIRPORTS

Anchorage ANC	Midland MAF
Charlotte CLT	Milwaukee MKE
Chicago ORD	New Orleans MSY
Colorado Springs COS	New York JFK
Columbus CMH	Newark EWR
Dallas-Fort Worth DFW	Oakland OAK
Dayton DAY	Oklahoma City OKC
Detroit DTW	Richmond RIC
El Paso ELP	Rochester ROC
Harlingen HRL	Salt Lake City SLC
Houston IAH	*San Antonio SAT
Jacksonville JAX	San Juan SJU
Kansas City MCI	St. Louis STL
Lihue LIH	Tampa TPA
Little Rock LIT	Washington IAD
Memphis MEM	Wichita ICT
Miami MIA	

* This airport will become a candidate once planned runway extensions take place.

1 Any airports conducting independent converging approaches can also operate dependent converging approaches. However, for the purposes of this report, Table 7-4 is not a subset of Table 7-3 due to the selection criterion used to prepare the tables, which focuses on the airports that would benefit the most with each procedure.

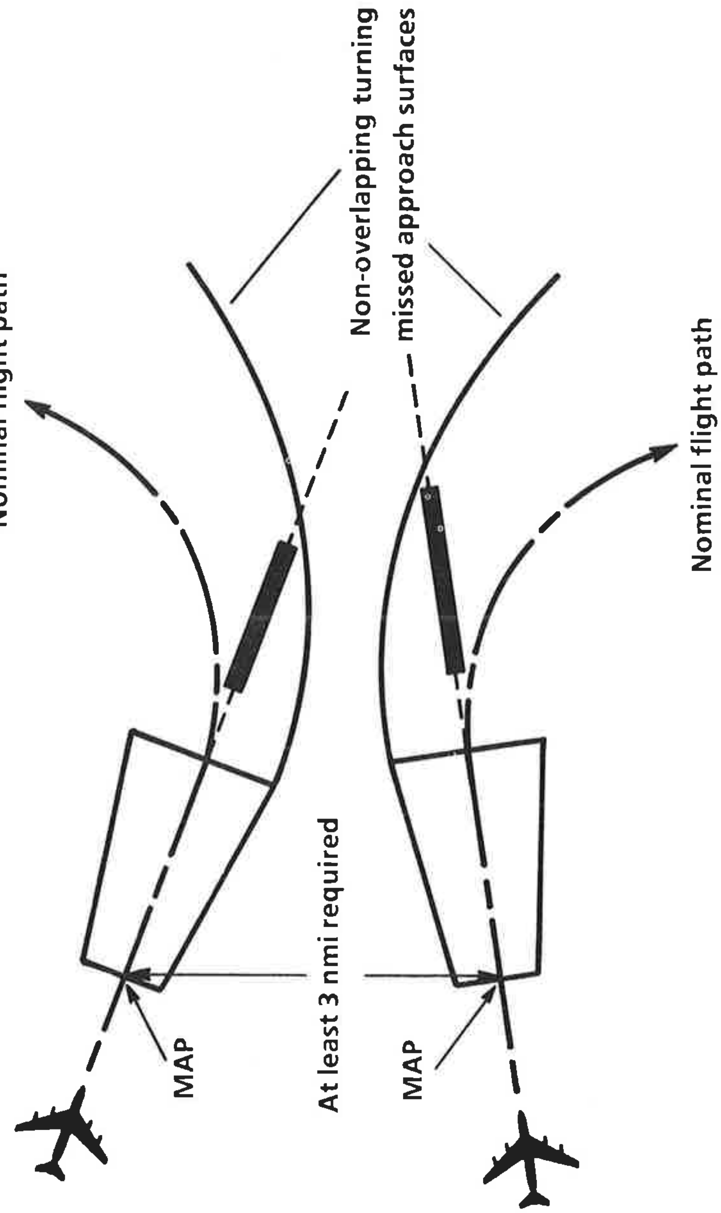


FIGURE 7-4. INDEPENDENT CONVERGING IFR APPROACHES

7.5 Triple IFR Approaches

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.

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

Of the top 100 airports, 10 are candidates (or based on their construction plans, will become candidates) for triple IFR approaches. The estimated capacities are given in Table 7-8 at the end of this chapter.

Of the top 100 airports, 10 are candidates for triple IFR approaches.

TABLE 7-5. CANDIDATES FOR TRIPLE IFR APPROACHES AMONG THE TOP 100 AIRPORTS

*Atlanta ATL
Chicago ORD
*Dallas-Fort Worth DFW
*Detroit DTW
*Houston IAH
*Orlando MCO
*Raleigh-Durham RDU
*Salt Lake City SLC
*Tulsa TUL
Washington IAD

* Triples will be applicable upon completion of runway construction/extension plans.

7.6 Improved IFR Longitudinal Separation

Minimum longitudinal separation standards for aircraft in IFR approach streams vary from 2.5 to 6 nmi, depending on the relative sizes of the leading and trailing aircraft.

An improvement in the separation standard from 3.0 to 2.5 nmi has been recently approved.

Procedures can provide potential capacity gains of three to five arrivals per runway per hour.

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 the runway. An improvement in the separation standard from 3.0 to 2.5 nmi between certain classes of aircraft has been recently approved for dry runway conditions. Research work is going on to investigate properties of wake vortices that may permit reductions below 2.5 nmi.

All airports will benefit from improvement of required longitudinal separations. These procedures can provide potential capacity gains of three to five arrivals per runway per hour.

TABLE 7-6. AIRPORTS APPROVED TO USE NEW IFR LONGITUDINAL SEPARATION, ON FINAL APPROACH

Atlanta ATL	New York JFK
Baltimore BWI	New York LGA
Boston BOS	Newark EWR
Charlotte CLT	Norfolk ORF
Chicago ORD	Orlando MCO
Cincinnati CVG	Philadelphia PHL
Dallas-Fort Worth DFW	Pittsburgh PIT
Denver DEN	St. Louis STL
Houston IAH	Tampa TPA
Los Angeles LAX	Washington DCA
Nashville BNA	Washington IAD

7.7 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 above can be applied to short runways, adding to an airport's IFR capacity for slower airplanes and rotorcraft. A significant benefit can be realized through segregation of slower/smaller aircraft to their own IFR runway, reducing the need for increased longitudinal spacing in the arrival stream used by larger aircraft.

The use of a short IFR runway for slower aircraft along with a long runway in a multiple approach scheme can benefit large airports. In some cases, this can more than double the capacity. Among the top 30 U.S. airports (based on 1987 enplanement figures), 13 are potential candidates to use separate short runways. Of the top 100 airports, about 60 can benefit from the use of separate short IFR runways.

Of the top 100 airports, about 60 can benefit from the use of separate short IFR runways.

TABLE 7-7. CANDIDATES FOR SEPARATE SHORT IFR RUNWAYS AMONG THE TOP 30 AIRPORTS

Boston BOS	Philadelphia PHL
Charlotte CLT	Pittsburgh PIT
Honolulu HNL	Salt Lake City SLC
Las Vegas LAS	San Francisco SFO
Memphis MEM	St. Louis STL
Minneapolis-St. Paul MSP	Tampa TPA
New York LGA	

7.8 Capacity Improvements Applicable at the Top 100 Airports

This section presents the results of an analysis of the applicability of the five multiple approach procedures described in Sections 7.1 through 7.5 at the top 100 U.S. airports.

Table 7-8 shows the applicability of current and proposed procedures for each airport. The first column to the left shows the current best hourly arrival capacity and the approach procedure utilized to achieve that capacity. The following five columns show which of the five proposed procedures are applicable. It is important to bear in mind that the analysis was performed by inspecting runway approach diagrams only; considerations such as noise, obstructions, and community concerns were not used in the analysis. Some airports may not actually be using their "current best" approach procedures. Likewise, the actual aircraft fleet mix at each airport was not used: the capacity figures used are the standard figures mentioned at the beginning of this chapter, which are good approximations of real capacity. The objective of the table is to provide initial information on the applicability of approach procedures being developed by the FAA. The estimated capacity numbers should be used as standards of comparison only.

An asterisk (*) indicates that the proposed approach procedure in the column in question is applicable at a given airport. A superscript "P" indicates that the approach procedure may be applicable if and when proposed construction/extension plans actually take place. Some of this construction is in progress while other is only at the proposal stage. A blank space indicates that the runways do not support the proposed procedure, it is a borderline application, or that there is not enough information to determine applicability. Finally, in order to highlight new approach procedures that would provide better capacity at a given airport than any other procedures (current or proposed), an asterisk was replaced by a capacity number wherever the new procedure can provide higher capacity than any other method. The number indicates the hourly arrival capacity of the procedure in question. It is easy to identify the most beneficial improvement by looking for a number in the "new approach procedure" part in each row.

TABLE 7-8. POTENTIAL IFR ARRIVAL CAPACITY AT THE TOP 100[1] AIRPORTS

AIRPORT LOCATION AND CODE	CURRENT BEST IFR ARRIVAL CAPACITY (PROCEDURE)[2]	NEW APPROACH PROCEDURES[3]				
		DEPENDENT PARALLEL	INDEPENDENT PARALLEL	DEPENDENT CONVERGING	INDEPENDENT CONVERGING	TRIPLE
Albany ALB	26 (S)			34		
Albuquerque ABQ	26 (S)					
Amarillo AMA	26 (S)					
Anchorage ANC	26 (S)				52	
Atlanta ATL	52 (IP)	*	*^{P}			63^{P}
Austin AUS	26 (S)			34		
Baltimore BWI	26 (S)		52^{P}		*	
Birmingham BHM	26 (S)					
Boise BOI	26 (S)					
Boston BOS	26 (S)	36		*		

1 Top one hundred U. S. airports based on 1987 enplanement figures.

2 Current Best (based on airport diagrams only, see Section 7.8) Approach Procedure Abbreviations:

- S - Single Runway Approach
- DP - Dependent Parallel
- IP - Independent Parallel
- DC - Dependent Converging
- IC - Independent Converging

3 - An Asterisk (*) indicates proposed new approach procedures applicable at the airport in question; however, it also means that either the current best approach procedure or another proposed procedure (under new rules) provides equal or better arrival capacity.

- A Number indicates the hourly arrival capacity provided by a new approach procedure when such capacity is larger than the one provided by other procedures (current or new) applicable at the airport in question.

- A Superscript "P" indicates that the approach procedure will be applicable if and when Planned runway construction/extensions take place at the airport in question.

TABLE 7-8. POTENTIAL IFR ARRIVAL CAPACITY AT THE TOP 100[1] AIRPORTS (Continued)

AIRPORT LOCATION AND CODE	CURRENT BEST IFR ARRIVAL CAPACITY (PROCEDURE)[2]	NEW APPROACH PROCEDURES[3]				
		DEPENDENT PARALLEL	INDEPENDENT PARALLEL	DEPENDENT CONVERGING	INDEPENDENT CONVERGING	TRIPLE
Buffalo BUF	26 (S)			34		
Burbank BUR	26 (S)			34		
Charleston CHS	26 (S)			34		
Charlotte CLT	52 (IP)	*P		*P		**
Chicago MDW	26 (S)					
Chicago ORD	52 (IP)				*	78
Cincinnati CVG	26 (S)	*	52P	*		
Cleveland CLE	26 (S)			34		
Colorado Springs COS	26 (S)		*P	*	52	
Columbia CAE	26 (S)			34		
Columbus CMH	36 (DP)				52	
Dallas DAL	36 (DP)		52			
Dallas-Fort Worth DFW	52 (IP)				*	78P
Dayton DAY	52 (IP)			*	*	
Denver DEN	52 (IC)	*				
Des Moines DSM	26 (S)			34		
Detroit DTW	52 (IP)	*			*	63P
El Paso ELP	26 (S)	*			52	

TABLE 7-8. POTENTIAL IFR ARRIVAL CAPACITY AT THE TOP 100[1] AIRPORTS (Continued)

AIRPORT LOCATION AND CODE	CURRENT BEST IFR ARRIVAL CAPACITY (PROCEDURE)[2]	NEW APPROACH PROCEDURES[3]				
		DEPENDENT PARALLEL	INDEPENDENT PARALLEL	DEPENDENT CONVERGING	INDEPENDENT CONVERGING	TRIPLE
Fort Lauderdale FLL	26 (S)		52	*		
Fort Myers FMY	26 (S)		52^P	*		
Grand Rapids GRR	26 (S)		52^P			
Greensboro GSO	26 (S)		52^P	*		
Greer GSP	26 (S)					
Harlingen HRL	26 (S)		*	*	52	
Hilo ITO	26 (S)			34		
Honolulu HNL	52 (IP)			*		
Houston HOU	26 (S)					
Houston IAH	52 (IP)				*	78^P
Indianapolis IND	26 (S)	36^P		*		
Islip ISP	26 (S)			34		
Jacksonville JAX	26 (S)				52	
Kahului OGG	26 (S)			34		
Kailua-Kona KOA	26 (S)					
Kansas City MCI	26 (S)		$*^P$		52	
Knoxville TYS	26 (S)	36				
Las Vegas LAS	26 (S)			34		

TABLE 7-8. POTENTIAL IFR ARRIVAL CAPACITY AT THE TOP 100[1] AIRPORTS (Continued)

AIRPORT LOCATION AND CODE	CURRENT BEST IFR ARRIVAL CAPACITY (PROCEDURE)[2]	NEW APPROACH PROCEDURES[3]				
		DEPENDENT PARALLEL	INDEPENDENT PARALLEL	DEPENDENT CONVERGING	INDEPENDENT CONVERGING	TRIPLE
Lihue LIH	26 (S)			*	52	
Little Rock LIT	26 (S)		*P		52	
Long Beach LGB	26 (S)	*	52		*	
Los Angeles LAX	52 (IP)					
Louisville SDF	26 (S)		52P		*	
Lubbock LBB	26 (S)					
Memphis MEM	36 (DP)		*	*	52	
Miami MIA	52 (IP)			*	*	
Midland MAF	26 (S)		*			* 52
Milwaukee MKE	26 (S)		*			* 52
Minneapolis-St. Paul MSP	36 (DP)			52		*
Nashville BNA	26 (S)		*		52P	*
New Orleans MSY	26 (S)					
New York JFK	36 (DP)			*		* 52
New York LGA	26 (S)				34	
Newark EWR	26 (S)				*	52
Norfolk ORF	26 (S)				34	
Oakland OAK	26 (S)		*			52

TABLE 7-8. POTENTIAL IFR ARRIVAL CAPACITY AT THE TOP 100[1] AIRPORTS (Continued)

AIRPORT LOCATION AND CODE	CURRENT BEST IFR ARRIVAL CAPACITY (PROCEDURE)[2]	NEW APPROACH PROCEDURES[3]				
		DEPENDENT PARALLEL	INDEPENDENT PARALLEL	DEPENDENT CONVERGING	INDEPENDENT CONVERGING	TRIPLE
Oklahoma City OKC	52 (IP)					*
Omaha OMA	26 (S)	36			*	
Ontario ONT	26 (S)					
Orlando MCO	26 (S)		*		$*^{P}$	78^{P}
Philadelphia PHL	52 (IC)		*		$*^{P}$	*
Phoenix PHX	26 (S)			52		
Pittsburgh PIT	52 (IP)		*			*
Portland PDX	36 (DP)			52		*
Portland PWM	26 (S)			34		
Providence PVD	26 (S)	36		*		
Raleigh-Durham RDU	36 (DP)		*	*		63^{P}
Reno RNO	26 (S)			34		
Richmond RIC	26 (S)				52	
Rochester ROC	26 (S)			*	52	
Sacramento SMF	52 (IP)					
Salt Lake City SLC	36 (DP)		*		*	63^{P}
San Antonio SAT	26 (S)			*	52^{P}	
San Diego SAN	26 (S)					

TABLE 7-8. POTENTIAL IFR ARRIVAL CAPACITY AT THE TOP 100[1] AIRPORTS (Continued)

AIRPORT LOCATION AND CODE	CURRENT BEST IFR ARRIVAL CAPACITY (PROCEDURE)[2]	NEW APPROACH PROCEDURES[3]				
		DEPENDENT PARALLEL	INDEPENDENT PARALLEL	DEPENDENT CONVERGING	INDEPENDENT CONVERGING	TRIPLE
San Francisco SFO	26 (S)			34		
San Jose SJC	26 (S)					
San Juan SJU	26 (S)				52	
Santa Ana SNA	26 (S)					
Sarasota-Bradenton SRQ	26 (S)					
Savannah SAV	26 (S)		52^P		*	
Seattle SEA	26 (S)					
Spokane GEG	26 (S)			34		
St. Louis STL	26 (S)	*		*	52	
Syracuse SYR	26 (S)		52^P	*		
Tampa TPA	52 (IP)			*	*	
Tucson TUS	26 (S)					
Tulsa TUL	52 (IP)			*		78^P
Washington DCA	26 (S)			34		
Washington IAD	52 (IP)				*	78
West Palm Beach PBI	26 (S)				34	
Wichita ICT	52 (IP)					*
Windsor Locks BDL	26 (S)					

CHAPTER 8

NEW TECHNOLOGY

The FAA has identified specific improvements in ATC system performance that must be made in order to achieve a desired increase in the number of aircraft operations. The planning process[1] has identified the obstacles to improving ATC system performance which provide the focus for developing a Research, Engineering and Development (R,E&D) program that must be put in place if the capacity increases are to be achieved. By specifying the goals in terms of the number of aircraft operations per hour that would be expected from a successful research and development program, the program plan provides specific guidance to the engineering community about what improvements in system performance parameters are needed to achieve these goals.

The scope of current R,E&D activities is limited to methods for increasing the capacity of existing runways when the aircraft using them are operating under IFR during instrument meteorological conditions (IMC). New technology provides opportunities to increase the capacity of existing runways and airports. For example, by using technological improvements to safely remove unnecessary gaps in the arrival and departure streams of aircraft, the IMC capacity of existing airports can be increased by as much as 20%.

By using technological improvements to safely remove unnecessary gaps in the arrival and departure streams of aircraft, the IMC capacity of existing airports can be increased by as much as 20%.

---

1 This process is based on a paper by John Barrer and James Diehl of the MITRE corporation, "Toward a Goal-Oriented Plan for Identifying Technology to increase Airfield Capacity," MP-88W52, September 1988.

In visual conditions, the capacity of a single runway is higher than that of the same runway in instrument conditions. Certain parameters such as in-trail separation and ROT, determine the capacity of a runway and these parameters vary with time. Assuming that near-term technological improvements might achieve a realistic reduction of the present difference between visual and instrument values of the parameters that determine runway capacity, the FAA Airfield Capacity Model shows that a 20% improvement in IMC capacity is possible.

Improved surveillance capability and other improvements could permit independent parallel approaches to be conducted at parallel runways separated by as little as 2,500 feet.

Improvements could permit dependent parallel approaches to be conducted with diagonal separation reduced from two to one mile.

In general, the following kinds of improvements are expected. Better management of arrival traffic flows and landing aircraft and better planned runway exits may be able to reduce interarrival time and runway occupancy time variability. Shorter runway occupancy time may permit an improvement in departure separation minima. Improved surveillance capability and other improvements could permit independent parallel approaches to be conducted at parallel runways separated by as little as 2,500 feet. These same improvements could permit dependent parallel approaches to be conducted with diagonal separation reduced from two to one mile. Finally, simultaneous operations on converging runways could be conducted if separation assurance could be provided in the rare event that two aircraft must execute simultaneous missed approaches. The limits of the expected improvements in those parameters that determine airport capacity during instrument conditions are determined by those values routinely achieved today under visual conditions, and these values are further limited by what appears to be within the technological state of the art.

In-trail separation could be reduced to a minimum of two miles.

Interarrival time variability could be reduced from 18 to 9 seconds. Runway occupancy time could be reduced by about 15%.

Departure separations could be reduced by about 15%.

These improvements could permit single runway capacity to increase from 52 to 64 operations per hour in instrument conditions.

Table 8-1 presents a comparison between the current values of all of these parameters and the values that are potentially achievable through technological improvements. In the case of single runway capacity, in-trail separation could be reduced to a minimum of two miles (observed VMC separations are less than two nmi). Interarrival time variability could be reduced from 18 to 9 seconds. Runway occupancy time could be reduced by about 15%. Arrival runway occupancy time variability may be reduced from ten to five seconds. Finally, departure separations could be reduced by about 15%. Accomplishing these improvements could permit single runway capacity to increase from 52 to 64 operations per hour in instrument conditions as compared to the present 26 arrivals per hour in IMC conditions. The following section discusses the specific goals for improvement that are suggested as a consequence of achieving the improvements shown in Table 8-1.

TABLE 8-1. POTENTIAL SYSTEM PERFORMANCE IMPROVEMENTS

ARRIVAL IN-TRAIL SEPARATION

Trailing Aircraft Separation in Nautical Miles						
	Present Value			Goal		
Lead	Small	Large	Heavy	Small	Large	Heavy
Small	2.5	2.5	2.5	2	2	2
Large	4	2.5	2.5	3	2	2
Heavy	6	5	4	5	4	3

DEPARTURE SEPARATION

	Small/Large behind Heavy	Heavy behind Heavy	All Others
Present	120 seconds	4 mi--90 sec	6000 ft--60 sec
Goal	100 seconds	3 mi--75 sec	4500 ft--50 sec

MULTIPLE APPROACH SEPARATION CRITERIA

	Diagonal separation Parallel Runways less than 2500 ft apart-nm	Lateral separation Non-parallel precision approaches-nm
Present	2	3
Goal	1	1

TIME VARIABILITY

	Interarrival Time (IAT) (seconds)	Arrival Runway Occupancy time (ROT-sec)
Present	18	10
Goal	9	5

ARRIVAL RUNWAY OCCUPANCY TIME

Aircraft Size	Mean Value (seconds)	
	Present	Goal
Small	43	35
Large Prop	45	37
Large Jet	46	40
Heavy	50	45

ADDITIONAL IMPROVEMENTS NEEDED

SURVEILLANCE CAPABILITY--Provide technological and parallel approach monitoring aids to permit independent parallel approaches to runways separated by as little as 2500 feet

- -1 milliradian accuracy or better
- -1 second sensor update rate or better
- -Automated blunder detection
- -Flight deck displays

MISSED APPROACH PROCEDURE--Ensure separation during simultaneous missed approaches to converging runways with at least 7000 feet from thresholds to intersection

APPROACH PATHS--Provide electronic guidance at all public use airports where needed to provide Category I ILS approach minimums

- -Curved Path
- -Variable Glide Path Angle

RUNWAY REPAIR AND MAINTENANCE--Decrease downtime due to maintenance and repair

8.1 Proposed Capacity Goals

If the improvements discussed in the previous section were to be accomplished, it would be possible to increase single runway capacity from 52 to 64 operations per hour in IMC. Because of this expected capacity increase in single runways, the capacity of dual independent parallel or converging runways could increase from 104 to 128 operations per hour during instrument conditions.

The number of operations per hour during instrument conditions on converging runways could be increased from 52 to 128.

The number of operations per hour during instrument conditions on parallel runways separated by more than 2,500 feet but less than 4,300 feet may be increased from 74 to 128 by providing surveillance capability and other improvements to monitor closely spaced parallel approaches and achieving single runway capacity goals. The number of operations per hour during instrument conditions on converging runways with at least 7000 feet from threshold to intersection could be increased from 52 to 128 by reducing radar monitored lateral separation on final approach from three to one mile and achieving single runway capacity goals. The large increase possible for converging runways is due to the fact that under current procedures, only one of the runways can be used during IMC operations.

Operations per hour during instrument conditions on triple runways could be increased from 104 to 192.

Capacity of dependent parallel runways during instrument conditions could be increased from 74 to 93 operations per hour.

The number of operations per hour during instrument conditions on triple runways with at least 4,300 feet between thresholds could be increased from 104 to 192 by providing procedures for safe separation during simultaneous missed approaches, providing surveillance capability and other improvements to monitor closely spaced parallel approaches, and achieving the single runway capacity improvement goals. The capacity of dependent parallel runways during instrument conditions could be increased from 74 to 93 operations per hour by achieving a diagonal separation reduction of one mile from the current two mile requirement.

The capacity of dependent converging runways could be increased from 26 to 35 arrivals per hour during.

Runway downtime could be decreased by ten percent by decreasing runway maintenance and repair times.

The capacity of dependent converging runways could be increased from 26 to 35 arrivals per hour during instrument conditions by ensuring safe separation during simultaneous missed approaches. Precision approaches to CAT I minimums may be provided at all airports by providing curved and variable glide paths as needed using electronic guidance. Finally, runway downtime could be decreased by ten percent by decreasing runway maintenance and repair times.

8.2 Obstacles To Achieving Improvements

There are significant obstacles to achieving these technological improvements that must be recognized, described, and overcome to reach these goals for capacity. These obstacles are well-known and limit the performance capability of the current ATC system. It will take significant improvements in procedures and equipment to overcome the limitations they impose on current IMC capacity. One of the tasks of the R,E&D program will be to determine if there are cost-effective ways to overcome them.

The following problems are recognized to pertain to each of the performance parameters:

- In-trail separation during instrument conditions may be safely reduced only by providing reliable separation from wake turbulence, ensuring that simultaneous runway occupancy is prevented, and ensuring aircraft separation on final approach.

- ROTs may be safely reduced by better braking and improved availability of suitably located exits.

- Needless gaps in the arrival stream (caused by interarrival time variability) may be eliminated by providing pilots and controllers with the techniques and equipment to reduce the uncertainty in navigation and control.

- Departure separations may be reduced by mitigating the wake vortex hazards, reducing the variability in departure runway occupancy times, and also by providing multiple diverging departure routes.

Lateral and diagonal separation during instrument conditions may be reduced by addressing the wake vortex issue and blunder recovery techniques. New controller procedures may be developed if more data is provided on the actual and expected performance of aircraft while on approach. MLS and ILS may provide precision approach paths to any desired runway. Finally, improved construction and repair techniques may reduce runway downtime and improve availability.

8.3 Developing A Goal-Oriented R,E&D Program

Table 8-1 stated expected improvements in the determinants of runway capacity that, if attained, would support the overall goal of increasing single runway capacity during instrument operations by 20%. Figure 8-1 depicts obstacles to attaining these improvements. The goal of an effective R,E&D program should be to explore alternative approaches for overcoming these obstacles within a specified period of time.

Because of the FAA Airfield Capacity Model and other modeling techniques, it is possible to quantify the relationship between potential improvements in ATC system performance parameters and the resulting increase in runway capacity. This enables the development of a top-down approach to R,E&D planning. Goals can be established (e.g., improve single-runway capacity by 20% by a specific year), required system performance improvements can be identified (e.g., interarrival time variability must be reduced from 18 to 9 seconds), technological and procedural obstacles to improvements can be described,

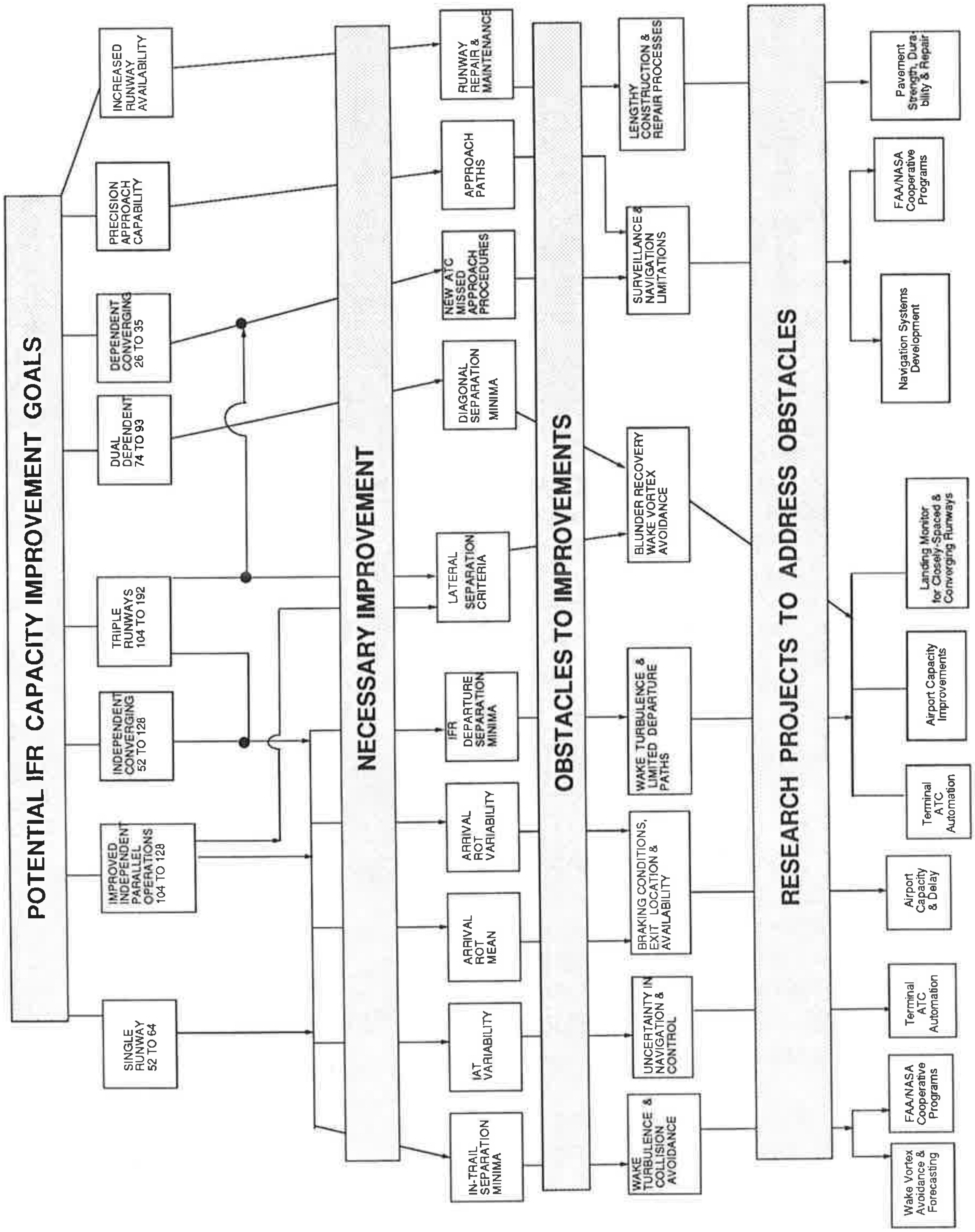


FIGURE 8-1. GOAL-ORIENTED R,E&D PLANNING

and finally, a goal-oriented R,E&D program can be established to overcome these obstacles.* It illustrates the value of having an accepted analytical tool that can estimate the behavior of the ATC system under assumptions about expected improvements in system performance parameters.

---

* These obstacles are identified in Section 8.1.

8.4 Project Descriptions

The Airport and Airway Safety and Capacity Expansion Act established "a minimum authorization of $25 million for airport capacity research and development programs. A report from the FAA on compliance with this provision is required after the end of each fiscal year."

The Fiscal year 1989 report to Congress is presented in Appendix B. A brief description of each of the 24 R,E&D projects is provided. These projects each address one or more of the obstacles to improvement in IFR capacity.* The following is a list of the projects described in Appendix B:

B-1 AIRPORT DESIGN AND CONFIGURATION

B-2 AIRPORT PAVEMENT

B-3 RUNWAY EXIT ADVISORY SYSTEM

B-4 AIRPORT SAFETY PLANNING

B-5 AIRPORT SURFACE VISUAL CONTROL (LIGHTING)

B-6 AIRPORT SAFETY SUPPORT SYSTEM

B-7 PRECISION RUNWAY MONITOR-HIGH DATA RATE

B-8 PRECISION RUNWAY MONITOR-BACK-TO-BACK

B-9 TERMINAL/LANDSIDE TRAFFIC MODELING

B-10 AIRPORT CAPACITY ENHANCEMENT PLANNING

B-11 SIMULATION MODEL DEVELOPMENT AND EVALUATION

B-12 AIRPORT CAPACITY TASK FORCE STUDIES

B-13 CAPACITY DEVELOPMENT

B-14 WAKE VORTEX

B-15 SEPARATION STANDARDS

B-16 TERMINAL AIRSPACE ASSESSMENT

B-17 LONG-TERM AIRPORT SYSTEM PLAN

---

* These obstacles are identified in Section 8.1.

B-18 COCKPIT TRAFFIC INFORMATION

B-19 REGIONAL AIRPORT CAPACITY TASK FORCE SUPPORT

B-20 NATIONAL AIRSPACE SYSTEM PERFORMANCE ANALYSIS CAPABILITY (NASPAC)

B-21 AIRSPACE SYSTEM MODELS

B-22 TERMINAL AIR TRAFFIC CONTROL AUTOMATION

B-23 REDUCED RUNWAY OCCUPANCY TIME

B-24 AIRPORT SURFACE TRAFFIC AUTOMATION

CHAPTER 9

MARKETPLACE SOLUTIONS

Marketplace solutions to airport capacity are those that rely primarily on competitive, free market influences. They consist of reliever airports, alternative origination and destination airports, potential new connecting hub airports, and use of new aircraft types.

9.1 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 reduced between planes of similar size.

The FAA provides assistance for construction and improvements at reliever airports under the Airport Improvement Program. The objective of this assistance is to increase utilization of reliever airports by building new relievers. For existing relievers, the facilities and navigational aids will be improved and environmental impacts on neighboring communities will be reduced.

Reliever airports can be expected to play significant roles in reducing congestion and delay at delay-problem airports especially those where general aviation constitutes a significant portion of operations.

Table 9-1 identifies reliever airports for those airports forecast to exceed 20,000 hours annual aircraft delay by 1997.

TABLE 9-1. RELIEVER AIRPORTS

FORECAST DELAY-PROBLEM AIRPORTS*	NUMBER OF RELIEVERS	PERCENT OF GENERAL AVIATION OPERATIONS (FY 1987)
Atlanta Hartsfield	10	4
Baltimore-Washington	2	22
Boston Logan	6	11
Charlotte Douglas	1	25
Chicago O'Hare	8	4
Cleveland-Hopkins	5	25
Columbus	3	54
Dallas-Fort Worth	13	3
Denver Stapleton	4	8
Detroit Metro Wayne County	10	16
Fort Lauderdale	2	40
Greater Cincinnati	4	11
Honolulu	1	22
Houston Hobby	2	48
Houston Intercontinental	9	17
Indianapolis	5	33
Kansas City	10	7
Los Angeles	6	10
Las Vegas McCarran	1	29
Memphis	5	23
Miami	2	18
Minneapolis-St. Paul	7	19
Nashville	2	36
New York J. F. Kennedy	1	8
New York La Guardia	1	8
Newark	7	7
Ontario	4	27
Orlando	2	14
Philadelphia	11	16
Phoenix-Sky Harbor	6	27
Pittsburgh	6	8
Raleigh-Durham	2	44
Salt Lake City	2	30
San Francisco	4	8
San Jose	5	71
Seattle-Tacoma	8	6
St. Louis-Lambert	12	11
Washington Dulles	2	24
Washington National	5	23

* Assuming no increases in capacity.

Table 9-2 and Figure 9-1 identify airports forecast to exceed 20,000 hours of aircraft delay in 1997 that also had at least 25% general aviation operations in 1987. Existing and planned reliever airports are also listed for each of these airports.

TABLE 9-2. AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997, 25% OR MORE GENERAL AVIATION TRAFFIC

DELAY-PROBLEM AIRPORT	PERCENT GA OPERATIONS (FY 1987)	RELIEVER AIRPORT
Phoenix-Sky Harbor International	27	Chandler Municipal Falcon Field Glendale Municipal Phoenix-Deer Valley Municipal Phoenix-Litchfield Municipal Scottsdale Municipal
Raleigh-Durham International	44	New Airport New Airport
Charlotte-Douglas International	25	Bryant Field
Cleveland-Hopkins International	25	Cuyahioga County Freedom Field Lorain County Regional Lost Nation Strongsville Airpark
Columbus-Port Columbus International	54	Bolton Field Ohio State University Rickenbacker Airport
Fort Lauderdale International	40	Fort Lauderdale Executive North Perry
Houston Hobby	48	Brazoria County Ellington Field
Indianapolis International	33	Indianapolis Downtown Indianapolis Metropolitan Indianapolis Terry Mount Comfort Greenwood Municipal
Las Vegas McCarran International	29	North Las Vegas Air Terminal

TABLE 9-2. AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997, 25% OR MORE GENERAL AVIATION TRAFFIC (Continued)

DELAY-PROBLEM AIRPORT	PERCENT GA OPERATIONS (FY 1987)	RELIEVER AIRPORT
Nashville	36	New Airport Smyrna
Ontario	27	Bracket Field Cable Rialto Municipal Riverside Municipal
Salt Lake City International	30	New Airport Salt Lake City Municipal 2
San Jose	71	New Airport New Airport Palo Alto Airport of Santa Clara Reid-Hillview of Santa Clara South County Airport of Santa Clara

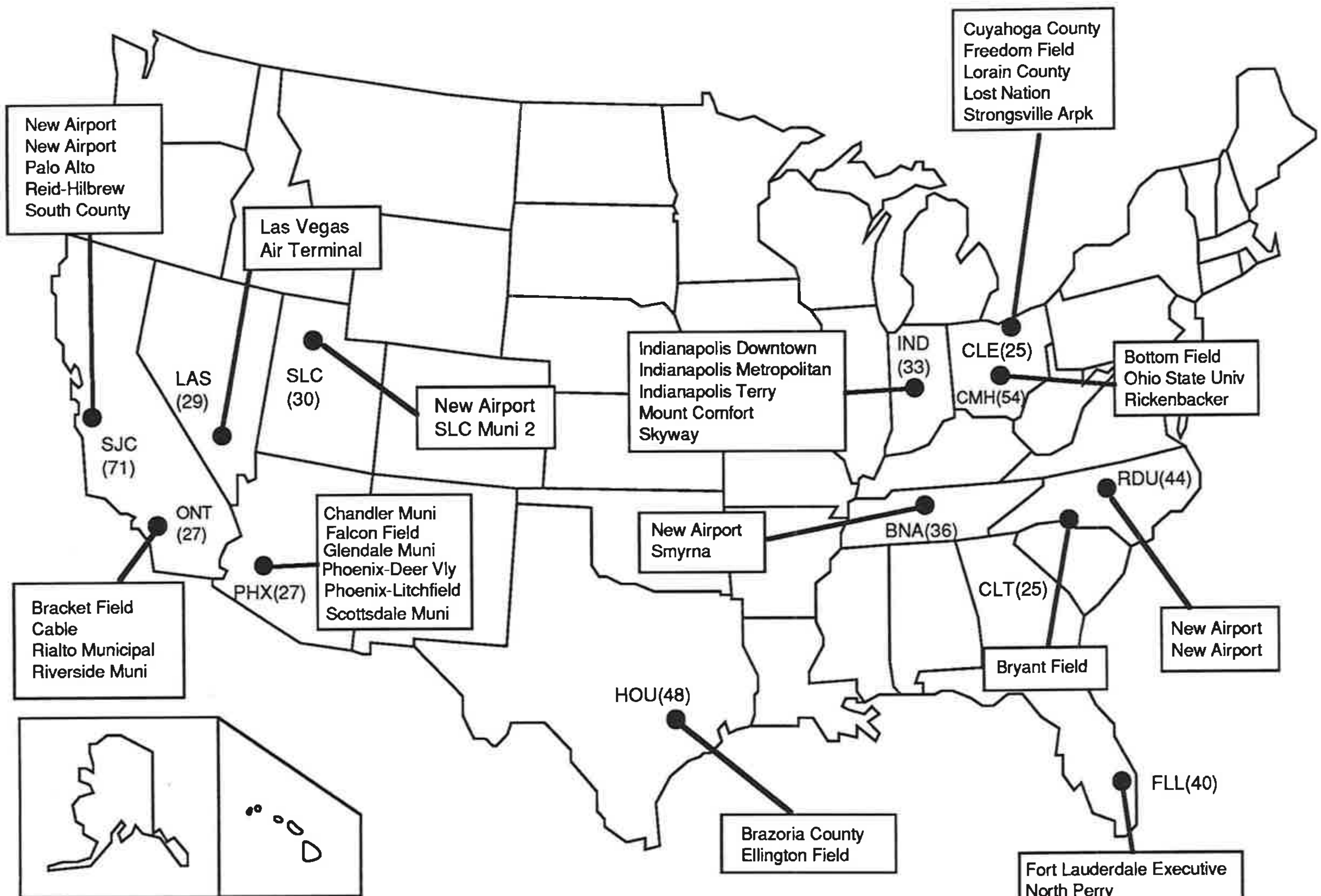


FIGURE 9-1. AIRPORTS FORECAST TO EXCEED 20,000 HOURS OF ANNUAL AIRCRAFT DELAY IN 1997 WITH 25% OR MORE GENERAL AVIATION OPERATIONS IN 1987 AND THEIR RELIEVERS

9.2 Alternate Origination and Destination Airports

The development and use of nearby airports, particularly those that provide multiple IFR arrival capability as alternatives 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 of the 39 airports forecast to exceed 20,000 hours of annual aircraft delay in 1997 have other commercial service airports in the general area (within 50 nmi 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.[1] 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.

---

1 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.

Capacity Potential Near Delay-Problem Airports

A set of potential alternate airports within 50 miles of the 39 forecast delay-problem airports was identified.[2] A conservative estimate of unused capacity was made of potential operations per year only for those airports with present or potential multiple IFR approach capabilities.

Table 9-3 shows the potential unused capacity at airports near each of the delay-problem airports. The number shown reflects the aggregate unused capacity in thousands of annual operations. The table summarizes selected information from Appendix E. It lists airports that are located within 50 miles of delay problem airports and have an "unused capacity." "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.

---

2 Appendix E details the selection criteria and presents detailed information for scheduled service airports that were considered as potential alternatives for the 39 airports forecast to exceed 20,000 hours annual aircraft delay by 1997.

TABLE 9-3. SCHEDULED SERVICE AIRPORTS WITH PRESENTLY UNDERUTILIZED CAPACITIES

UNDERUTILIZED AIRPORT	POTENTIAL TO RELIEVE	UNUSED CAPACITY (OPERATIONS/ YEAR)
Macon, GA	Atlanta (ATL)	150,000
Manchester, NH	Boston (BOS)	33,000
Milwaukee, WI	Chicago (ORD)	110,000
Louisville, KY	Cincinnati (CVG)	45,000
Dayton, OH	Cincinnati (CVG)	99,000
Dallas (DAL), TX	Dallas-Fort Worth (DFW)	73,000
Colorado Springs, CO	Denver (DEN)	47,000
Flint, MI	Detroit (DTW)	76,000
Toledo, OH	Detroit (DTW)	86,000
Houston (HOU), TX	Houston (IAH)	21,000
Topeka, KS	Kansas City (MCI)	134,000
Palmdale, CA	Los Angeles (LAX) Ontario (ONT)	229,000
Fort Lauderdale, FL	Miami (MIA)	76,000
Rochester, MN	Minneapolis-St. Paul (MSP)	139,000
Huntsville, AL	Nashville (BNA)	219,000
Islip, NY	Newark (EWR) New York-Kennedy (JFK) New York-LaGuardia (LGA)	71,000
Newburgh, NY	Newark (EWR) New York-Kennedy (JFK) New York-LaGuardia (LGA)	94,000
Tampa, FL	Orlando (MCO)	53,000
Allentown, PA	Philadelphia (PHL)	77,000
Reading, PA	Philadelphia (PHL)	85,000
Atlantic City, NJ	Philadelphia (PHL)	108,000
Youngstown, OH	Pittsburgh (PIT)	81,000
Akron, OH	Pittsburgh (PIT)	62,000
Greensboro, NC	Raleigh-Durham (RDU)	150,000
Kinston, NC	Raleigh-Durham (RDU)	152,000
Logan, UT	Salt Lake City (SLC)	268,000
Sacramento, CA	San Jose (SJC) San Francisco (SFO)	137,000
Springfield, MO	St. Louis (STL)	75,000
Decatur, IL	St. Louis (STL)	215,000
Wilmington, DE	Baltimore-Washington (BWI)	6,000
Dover AFB, DE	Baltimore-Washington (BWI)	200,000
Mansfield, OH	Columbus (CMH)	143,000
Dayton, OH	Columbus (CMH)	99,000
Akron-Canton, OH	Cleveland-Hopkins (CLE)	62,000
Terre-Haute, IN	Indianapolis (IND)	123,000

9.3 Potential New Connecting Hub Airports

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
- Multiple IFR arrival capability
- Strong economy and availability of balanced work force
- Ability to accommodate existing/planned scheduled service fleet

Potential new hub airports more than 50 miles from forecast delay-problem airports, each with sufficient potential runway capacity to accommodate significant increased airport operations are shown in Figure 9-2.

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 and Nashville.

More than two dozen airports have been identified as potential new connecting hub airports.

More than two dozen airports have been identified as potential new connecting hub airports.

The potential new connecting hub airports in Figure 9-2 were selected from the top 100 airports ranked by total aircraft operations. Each airport selected has the capacity to permit multiple approach streams during instrument meteorological conditions. The actual development of new connecting hub will be a function of airline, state, and local community decisions.

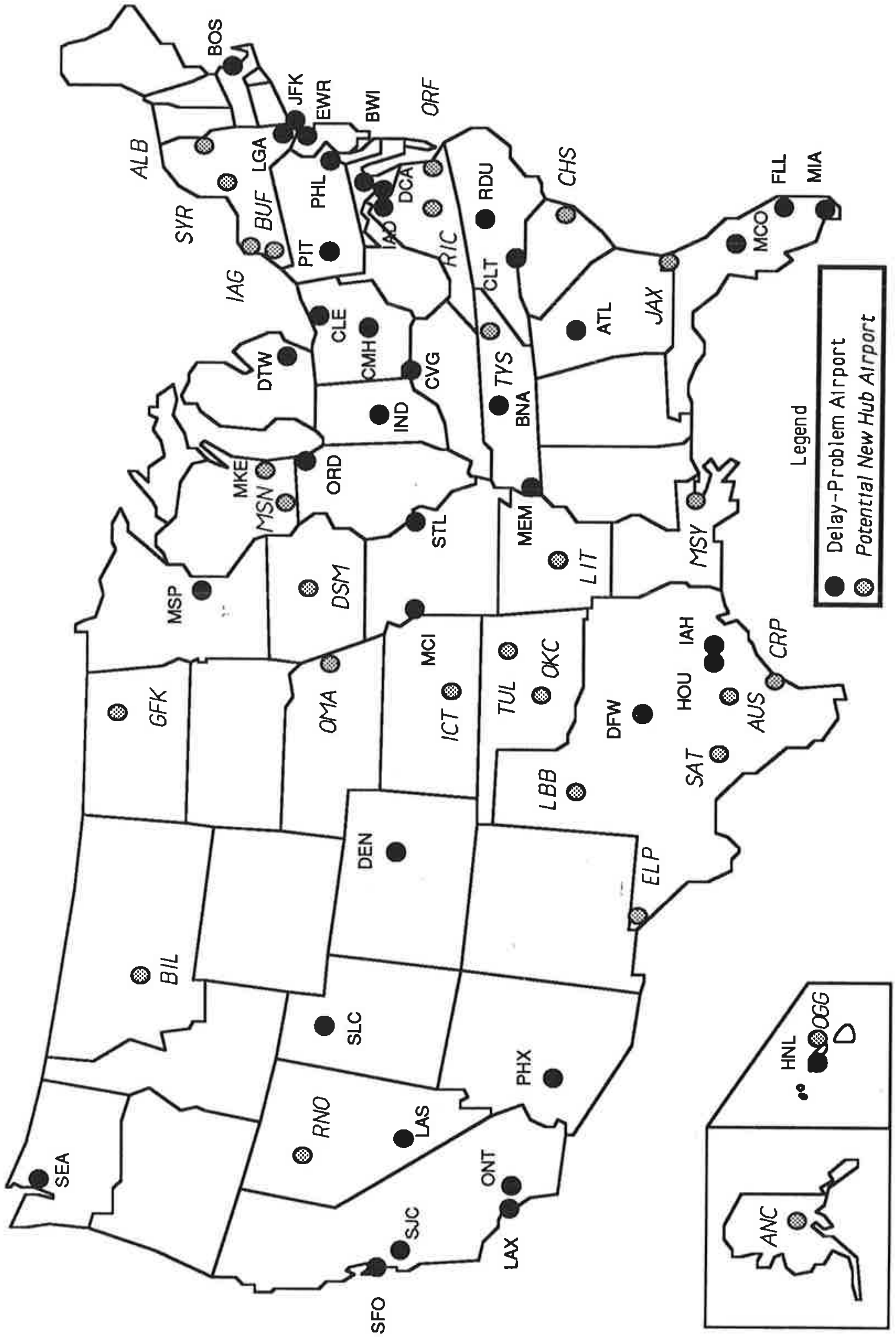


FIGURE 9-2. POTENTIAL NEW CONNECTING HUB AIRPORTS MORE THAN 50 MILES FROM 1997 DELAY-PROBLEM AIRPORTS AND HAVING DUAL IFR APPROACHES

9.4 New Aircraft Types

The Civil Tiltrotor Implementation Plan has targeted late 1995 for the introduction of commercial operations. This timing, if achieved, could make an essential contribution to additional capacity.

As an example, the New York--Boston market was studied as being representative of high-density passenger commuting. Here civil tiltrotors can off-load demand for fixed-wing capacity and free conventional airport capacity to large fixed-wing aircraft for an overall enhancement of system capacity. Titlrotor aircraft could operate either between airports (segregated from other traffic) or city center to city center using vertiports.

Tiltrotors can operate in the present ATC environment, but with limits imposed on their operational capabilities. Changes in operating environment and infrastructure that will make the commercial tiltrotor fully effective include: (1) development of procedures to take advantage of the latest navigation aids, (2) development of new Terminal Instrument Procedures (TERPS) needed to support IFR operations at vertiports and VTOL IFR operations at current conventional airports and heliports, and (3) improvement in approach and landing minimums, cockpit displays, airways, and airports.

Other aircraft types under consideration include the Hypersonic Transport (HST). This aircraft could be capable of transporting several hundred passengers at speeds far exceeding today's commercial aircraft, traveling further point-to-point distances in less time.

CHAPTER 10

SUMMARY

Airport and airspace capacity are variable, depending on many factors and do not have constant values. Maximum throughput capacity, or hourly safe and efficient capacities, can be calculated for each configuration in which airports operate. If those numbers are annualized, they provide some semblance of absolute maximum capacity. However, these capacity numbers are artificially high since they assume perfect twenty-four hour, year-long aircraft demand. Flight schedules and demand vary widely causing peaking problems during prime demand hours of the day at many airports. Those flights are eventually accommodated in the system, albeit with delays.

Likewise, there are literally hundreds of airports which today experience no appreciable aircraft delays. Even though average total flight delay is approaching 15 minutes, the vast majority of scheduled flights do not have delays in excess of 15 minutes today. That condition cannot be expected to continue without improvements in airport and airspace capacity.

In a worst-case scenario, the number of airports that each exceed 20,000 hours of aircraft delay will virtually double in the next ten years. Compounding that delay problem is the ripple effect throughout the aviation system. Since the top 100 airports account for more than 90% of all airline passengers, nearly 40 of those airports having significant delay problems would multiply the delays in the total system. Average flight delays increase rapidly as demand approaches capacity.

That worst-case delay scenario is unlikely to happen if the capacity programs outlined in this plan are implemented. The biggest capacity gains, of course, come with new runway construction on existing or new airports. More than 50 of the top 100 airports have potential runways in some stage of planning or construction. The next biggest gains occur by utilizing existing runways during IFR so that the difference between IFR and VFR operations is reduced.

There are many technical programs underway to increase system capacity. One program involves new airport surveillance systems which will facilitate new airspace procedures allowing multiple flight arrivals and other improvements. This program could permit capacity increases up to 100% in IFR weather. Other programs such as terminal automation and wake vortex projects primarily relate to improvements in in-trail spacing and other efficiencies. Prospective capacity gains from these technological improvements range from five to 20%.

Marketplace solutions are still available to affect airport and airspace capacity. This plan identifies dozens of alternate origin and destination airports available as options as well as potential new connecting hub airports.

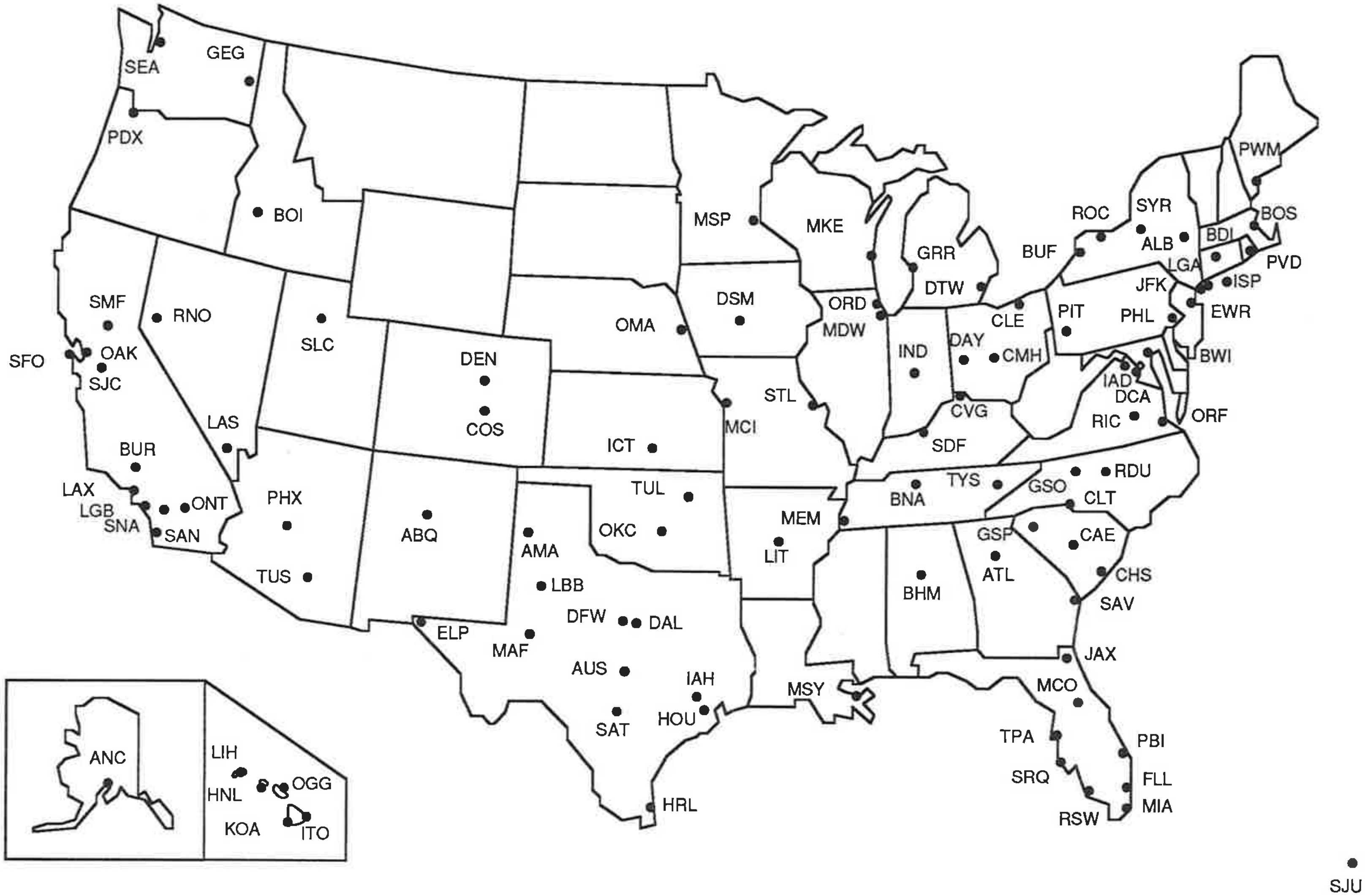
There is a trade-off between air fares and flight delays. Flight delays are an indirect consequence of peaking. Peaking is largely a consequence of scheduling and hubbing. Hubbing is a consequence of consolidating traffic and economies of scale in order to provide lower costs and, subsequently, lower air fares. As long as the public demand for lower air fares is perceived by the airline industry to outweigh that for more nonstop flights, hubbing and peaking will continue.

This plan does not address flight delays beyond a ten year period. Most of the capacity benefits from new technology allowing optimization of existing runways could occur in that time period. Capacity benefits from longer term programs tend to be more marginal since limiting factors will tend to be human performance and laws of physics as more technology is implemented.

Beyond the technological improvements possible in the next ten years, the most significant airport capacity gainers on the horizon appear to be the biggest gainers today--new runways.

APPENDIX A:

TOTAL AIRPORT OPERATIONS AND ENPLANEMENTS AT THE TOP 100 AIRPORTS



Source: FAA Airport Activity Statistics of Certificated Route Carriers-1987

FIGURE A-1. THE TOP 100 AIRPORTS BY ENPLANEMENTS 1987

TABLE A-1. TOTAL AIRPORT OPERATIONS AND ENPLANEMENTS AT THE TOP 100 AIRPORTS RANKED BY 1987 ENPLANEMENTS

CITY-AIRPORT	AIRPORT IDENTIFIER	TOTAL OPERATIONS (000s)		TOTAL ENPLANEMENTS (000s)	
		FY 1988	FY 1987	CY 1987	CY 1986
Chicago O'Hare International	ORD	796	797	26,122	24,794
Atlanta Hartsfield International	ATL	783	802	22,649	21,377
Dallas-Fort Worth International	DFW	664	609	19,905	19,094
Los Angeles International	LAX	632	655	18,970	17,696
Denver Stapleton International	DEN	511	522	15,594	16,087
San Francisco International	SFO	461	451	13,117	12,354
New York LaGuardia	LGA	364	366	11,326	10,429
Newark International	EWR	377	383	11,289	14,405
Boston Logan International	BOS	445	436	10,255	9,696
New York Kennedy International	JFK	329	312	10,140	9,125
St. Louis Lambert International	STL	429	427	9,727	9,825
Miami International	MIA	358	364	9,342	8,589
Detroit Metro Wayne County	DTW	380	412	9,254	8,206
Phoenix Sky Harbor International	PHX	455	436	8,785	7,720
Minneapolis-St. Paul	MSP	380	383	8,310	7,982
Pittsburgh International	PIT	387	371	8,156	7,470
Honolulu International	HNL	367	389	7,773	7,352
Washington National	DCA	328	324	7,113	6,622
Orlando International	MCO	290	252	7,075	5,947
Houston Intercontinental	IAH	297	303	6,929	6,560
Las Vegas McCarran	LAS	373	389	6,836	5,329
Seattle Tacoma	SEA	311	281	6,826	6,652
Philadelphia International	PHL	416	412	6,603	5,424
Charlotte Douglas International	CLT	405	363	6,021	5,687
Memphis International	MEM	359	384	5,023	4,177
Washington Dulles International	IAD	241	296	4,917	4,269
San Diego Lindbergh	SAN	206	193	4,901	4,558
Salt Lake City International	SLC	289	292	4,729	4,651
Tampa International	TPA	245	247	4,682	4,494
Kansas City International	MCI	226	203	4,481	3,911
Baltimore-Washington International	BWI	304	291	4,010	3,848
Houston Hobby	HOU	261	279	3,930	3,722
Fort Lauderdale International	FLL	223	224	3,929	3,577
New Orleans International	MSY	147	173	3,311	3,040
Cincinnati International	CVG	271	231	3,265	2,136

TABLE A-1. TOTAL AIRPORT OPERATIONS AND ENPLANEMENTS AT TOP 100 AIRPORTS RANKED BY 1987 ENPLANEMENTS (Continued)

CITY-AIRPORT	AIRPORT IDENTIFIER	TOTAL OPERATIONS (000s)		TOTAL ENPLANEMENTS (000s)	
		FY 1988	FY 1987	CY 1987	CY 1986
Cleveland Hopkins International	CLE	248	226	3,103	3,093
San Juan Marin International	SJU	196	201	2,995	2,156
Nashville Metro	BNA	263	268	2,987	2,166
Portland (OR) International	PDX	270	241	2,834	2,415
San Jose International	SJC	356	358	2,807	2,764
Chicago Midway	MDW	296	257	2,541	1,699
Dallas Love	DAL	217	227	2,436	2,729
San Antonio International	SAT	196	197	2,425	2,243
Raleigh-Durham International	RDU	274	217	2,316	1,442
Indianapolis International	IND	219	214	2,273	2,030
Windsor Locks Bradley International	BDL	183	181	2,268	1,998
Ontario International	ONT	141	137	2,232	2,030
West Palm Beach International	PBI	230	230	2,230	1,985
Dayton International	DAY	217	201	2,167	2,140
Santa Ana John Wayne	SNA	528	527	2,120	1,951
Albuquerque International	ABQ	229	231	2,101	2,052
Kahului	OGG	167	169	2,032	2,160
Austin Robert Mueller	AUS	190	197	1,929	1,831
Oakland Metro International	OAK	402	398	1,918	1,833
Sacramento Metro	SMF	182	163	1,750	1,606
Buffalo International	BUF	130	132	1,729	1,731
Columbus International	CMH	233	233	1,695	1,573
Milwaukee Mitchell International	MKE	186	190	1,619	1,514
Reno Cannon International	RNO	164	169	1,584	1,413
Norfolk International	ORF	192	194	1,550	1,541
Tucson International	TUS	239	244	1,526	1,379
Burbank	BUR	221	243	1,524	1,444
Oklahoma City Will Rogers World	OKC	134	158	1,506	1,478
Syracuse Hancock International	SYR	178	175	1,500	1,381
Jacksonville International	JAX	155	145	1,407	1,373
Tulsa International	TUL	200	191	1,388	1,383
El Paso International	ELP	193	197	1,329	1,235
Rochester Monroe County	ROC	213	231	1,254	1,242
Fort Myers Southwest Regional	RSW	64	62	1,242	967
Lihue	LIH	132	140	1,211	1,184

TABLE A-1. TOTAL AIRPORT OPERATIONS AND ENPLANEMENTS AT TOP 100 AIRPORTS RANKED BY 1987 ENPLANEMENTS (Continued)

CITY-AIRPORT	AIRPORT IDENTIFIER	TOTAL OPERATIONS (000s) FY 1988	FY 1987	TOTAL ENPLANEMENTS (000s) CY 1987	CY 1986
Omaha Eppley	OMA	156	159	1,073	1,078
Louisville Standiford	SDF	159	155	1,034	946
Greensboro Regional	GSO	141	150	1,026	1,040
Anchorage	ANC	206	216	1,006	1,078
Birmingham Municipal	BHM	187	190	912	754
Little Rock Adams	LIT	147	158	880	823
Richmond International	RIC	166	171	874	808
Providence Green State	PVD	203	212	864	716
Kailua-Kona Keahole	KOA	57	70	815	791
Spokane International	GEG	115	112	810	725
Albany	ALB	181	183	768	734
Sarasota-Bradenton	SRQ	169	183	761	637
Des Moines	DSM	163	169	739	688
Colorado Springs Municipal	COS	166	163	682	711
Charleston (SC) AFB International	CHS	137	140	680	586
Wichita Mid-Continent	ICT	171	162	655	634
Grand Rapids Kent County Int'l	GRR	143	146	609	578
Long Beach	LGB	435	438	605	557
Portland (ME) International Jetport	PWM	126	120	574	532
Midland International	MAF	109	105	570	563
Columbia (SC) Metro	CAE	122	129	571	627
Savannah International	SAV	107	105	553	503
Boise	BOI	144	146	541	545
Hilo General Lyman	ITO	80	79	537	521
Lubbock International	LBB	120	120	526	530
Knoxville McGhee-Tyson	TYS	164	154	520	477
Greer Greenville-Spartenburg	GSP	68	66	498	423
Islip Long Island MacArthur	SP	222	229	495	376
Harlingen Rio Grande International	HRL	69	58	478	412
Amarillo International	AMA	87	93	455	432
TOTALS		25,468	25,377	405,934	379,791

Sources:

Enplanement data: *Airport Activity Statistics of Certificated Route Air Carriers*, 1987 and 1986.

Operations data: *FAA Air Traffic Activity*, FY 1988 and FY 1987 includes air carrier, air taxi, general aviation, and military operations.

APPENDIX B

NEW TECHNOLOGY PROJECT LISTINGS

Research, Engineering And Development Program 08-System Capacity And Airports Funding Summary

	($ THOUSANDS) FY 1989	FY 1990
1. Airport Design and Configuration	770	0
2. Airport Pavement	813	2,080
3. Runway Exit Advisory System	534	0
4. Airport Safety Planning	602	663
5. Airport Surface Visual Control (Lighting)	677	1,149
6. Airport Safety Support System	356	666
7. Precision Runway Monitor-High Data Rate	5,400	2,966
F&E Implementation	5,000	
8. Precision Runway Monitor Back-to-Back (R,E&D)	3,097	0
F&E Implementation		13,500
9. Terminal/Landside Traffic Modeling	350	350
10. Airport Capacity Enhancement Planning	635	1,447
11. Simulation Model Development and Evaluation	1,568	1,465
12. Airport Capacity Task Force Studies	913	565
13. Capacity Development	1,808	2,984
14. Wake Vortex	1,699	570
15. Separation Standards	3,557	0
16. Terminal Airspace Assessment	1,600	0
17. Long-Term Airport System Plan	400	0
18. Cockpit Traffic Information	200	0
19. Regional Airport Capacity Task Force Support	800	0
20. National Airspace System Performance Capability (NASPAC)	0	2,500
21. Airspace System Models	0	733
22. Terminal Air Traffic Control Automation	0	3,593
23. Reduced RunwayOccupancy Time	0	1,006
24. Airport Surface Traffic Automation	0	2,343
TOTAL	$25,779	$25,120

TABLE B-1. AIRPORT DESIGN AND CONFIGURATION

EXPECTED COMPLETION DATE:	Ongoing	
FUNDS	FY 1989	*FY 1990
	$770,000	-0-

Statement Of Research Issue

As our major airports become congested, airport design and operating techniques must increasingly consider efficiency as well as safety. Improved designs of runway exists and taxiway routes are needed to expedite ground traffic flow, thereby increasing airport capacity.

Research Approach

Design efficient runway exit design algorithms that take into account aircraft performance, aircraft mix, various ROT values, and ride comfort limitations. Incorporate multi-lane exit design in exit algorithm. Develop improved taxiway routings from runways to gates. Validate design concepts and pilot acceptance through simulations of selected airport configurations. Field test and demonstration of new designs at selected airports, where appropriate.

FY 1989 Activities

- Airport design and configuration studies are being conducted to reduce runway occupancy time and increase efficiency of aircraft operations on the ground.
- Evaluation of efficient runway exit designs being conducted in simulator, which will result in selection of specific airport for demonstration in 1990.

---

* This project is related to B-3, Runway Exit Advisory System and is combined into a new project, B-23, Runway Occupancy Time in FY 1990.

TABLE B-2. AIRPORT PAVEMENT

EXPECTED COMPLETION DATE:	Ongoing	
FUNDS	FY 1989 $813,000	FY 1990 $2,080,000

Statement Of Research Issue

Shutdown of runways for maintenance and repair result in a three to five percent decrease in the airport capacity that has ripple effects throughout the airport system. Criteria are needed to attain longer pavement life, more crack-free surfaces and more rapid and effective repair operations to reduce runway downtime.

Research Approach

Continuation of efforts with contractor support in 15 projects related to improved pavement design and maintenance. This project will result in standards for future materials, design, construction, and maintenance of runways and taxiways.

FY 1989 Activities

Study on characterization and application to airport pavements of polymers to reduce cracking, promote rapid repair, and decrease maintenance cost was completed.

FY 1990 Activities

- Quality control acceptance criteria for pavement materials will be completed and made available to appropriate airport operators.

- Studies on non-destructive testing methodology and layered elastic design will be completed. The results of this study will help airport operators evaluate the strength of existing pavements for heavy air traffic.

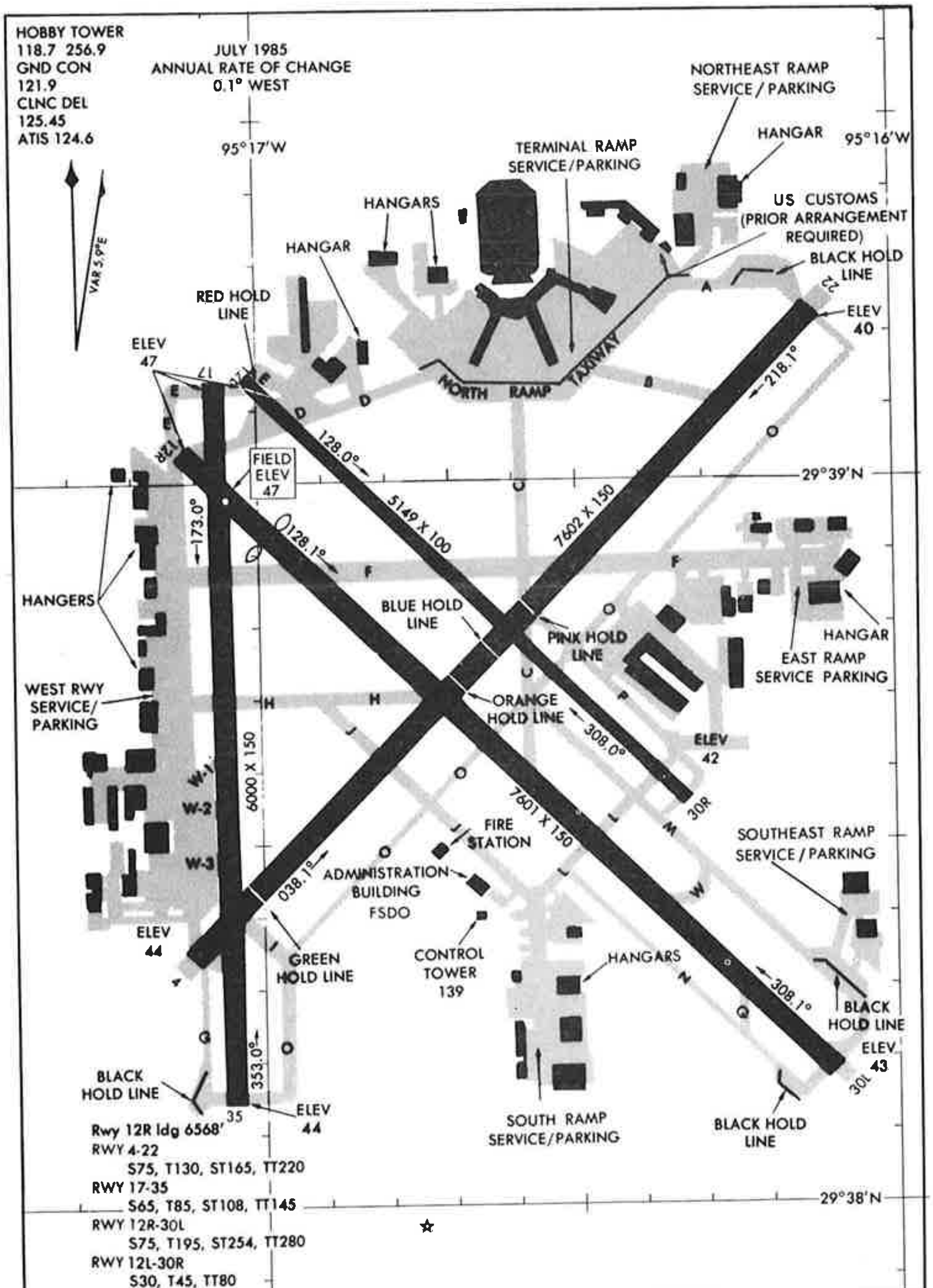
WVP	Wake Vortex Project
LLWAS	Low Level Windshear Advisory System
MNPS	Minimum Navigation Performance Standards
RNAV	Air Navigation
TCAS	Terminal Collision Avoidance System
NASPAC	National Airspace System Performance Analysis Capability
AAS	Advanced Automation System
ARTS	Automated Radar Terminal Systems
FONSI	Finding of No Significant Impact
ALP	Airport Layout Plan
EIS	Environmental Impact Statement
PRS	Preferential Runway System
NPIAS	National Plan for Integrated Airport Systems
HST	Hypersonic Transport
TERPS	Terminal Instrument Procedures
VTOL	Vertical Take-off and Landing
PLS	Precision Landing System

LDA	Localizer type Directional Aid
WVAS	Wake Vortex Advisory System
VAS	Vortex Advisory System
ARSA	Airport Radar Services Area
TCA	Terminal Control Areas
AIM	Airman's Information Manual
ROT	Runway Occupancy Time
RWY,R/W,R	Runway
TWY,T/W,T	Taxiway
ANG	Air National Guard
VORTAC	Combined VOR and TACAN
DEP	Departure
ARR	Arrival
SIMMOD	Airspace and Airport Simulation Model
ADSIM	Airport Delay Simulation Model
FBO	Fixed-Base Operator
AAIA	Airport and Airway Improvement Act
ARTCC	Air Route Traffic Control Center
TRACON	Terminal Radar Approach Control
EECP	Expanded East Coast Plan
nmi	Nautical Miles
VMC	Visual Meteorological Conditions
R,E&D	Research, Engineering & Development
IMC	Instrument Meterological Conditions
AIP	Airport Improvement Program
O&D	Origin/Destination
TSC	Transportation Systems Center
ATA	Air Transport Association
ALPA	Airline Pilots Association

FAA	Federal Aviation Administration
ATOMS	Air Traffic Operations Management System
SDRS	Standardized Delay Reporting System
NAPRS	National Airspace Performance Reporting System
ATC	Air Traffic Control
NAS	National Airspace System
IFR	Instrument Flight Rules
CAT	Category
ICAO	International Civil Aviation Organization
SCIA	Simultaneous Converging Instrument Approaches
ACEP	Airport Capacity Enhancement Plan
ILS	Instrument Landing System
DH	Decision Height
FAR	Federal Aviation Regulation
GA	General Aviation
NAVAIDS	Navigational Aids
RVR	Runway Visual Range
ASDE	Airport Surface Detection Equipment
MLS	Microwave Landing System
VOR	Variable Omni Range
VFR	Visual Flight Rules
STAR	Standard Terminal Arrival
A/C	Advisory Circular or Aircraft
WX	Weather
TVOR	Terminal VOR
DME	Distance Measuring Equipment
MALSR	Medium intensity approach lighting system with runway allignment indicator lights
RAIL	Runway Alignment Indicator Lights

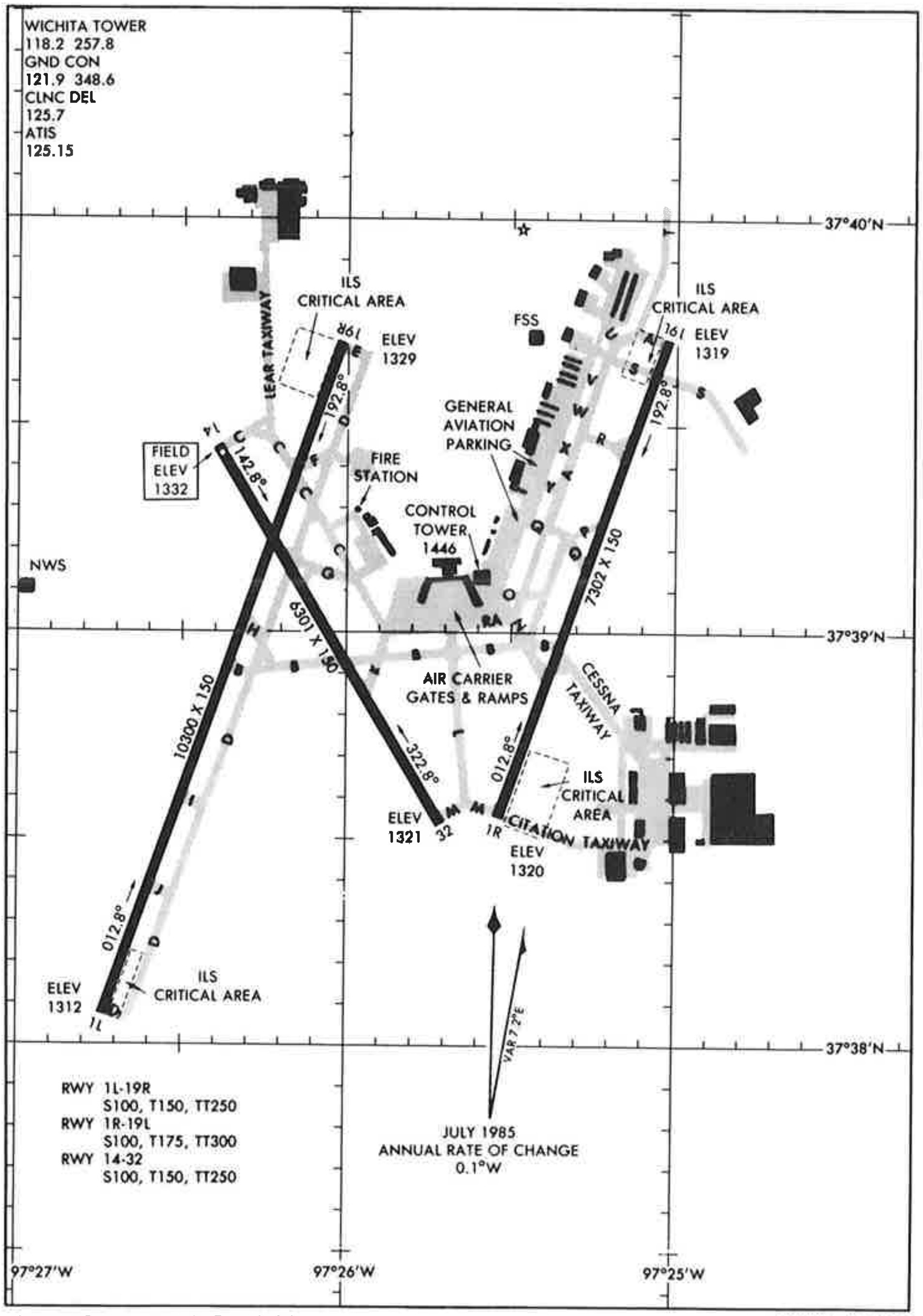
APPENDIX H

ACRONYM LIST



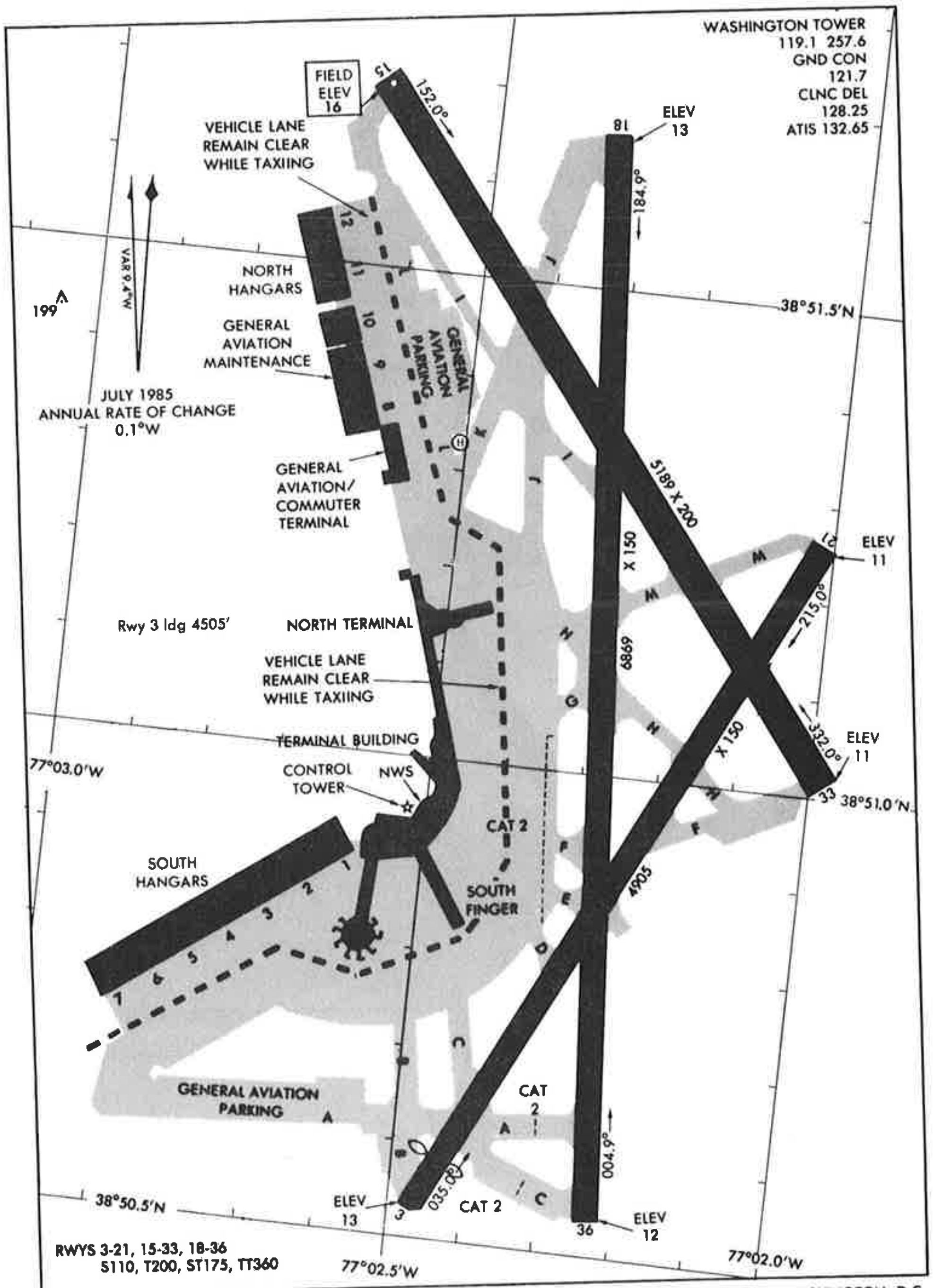
AIRPORT DIAGRAM

HOUSTON, TEXAS
HOUSTON/WILLIAM P. HOBBY (HOU)



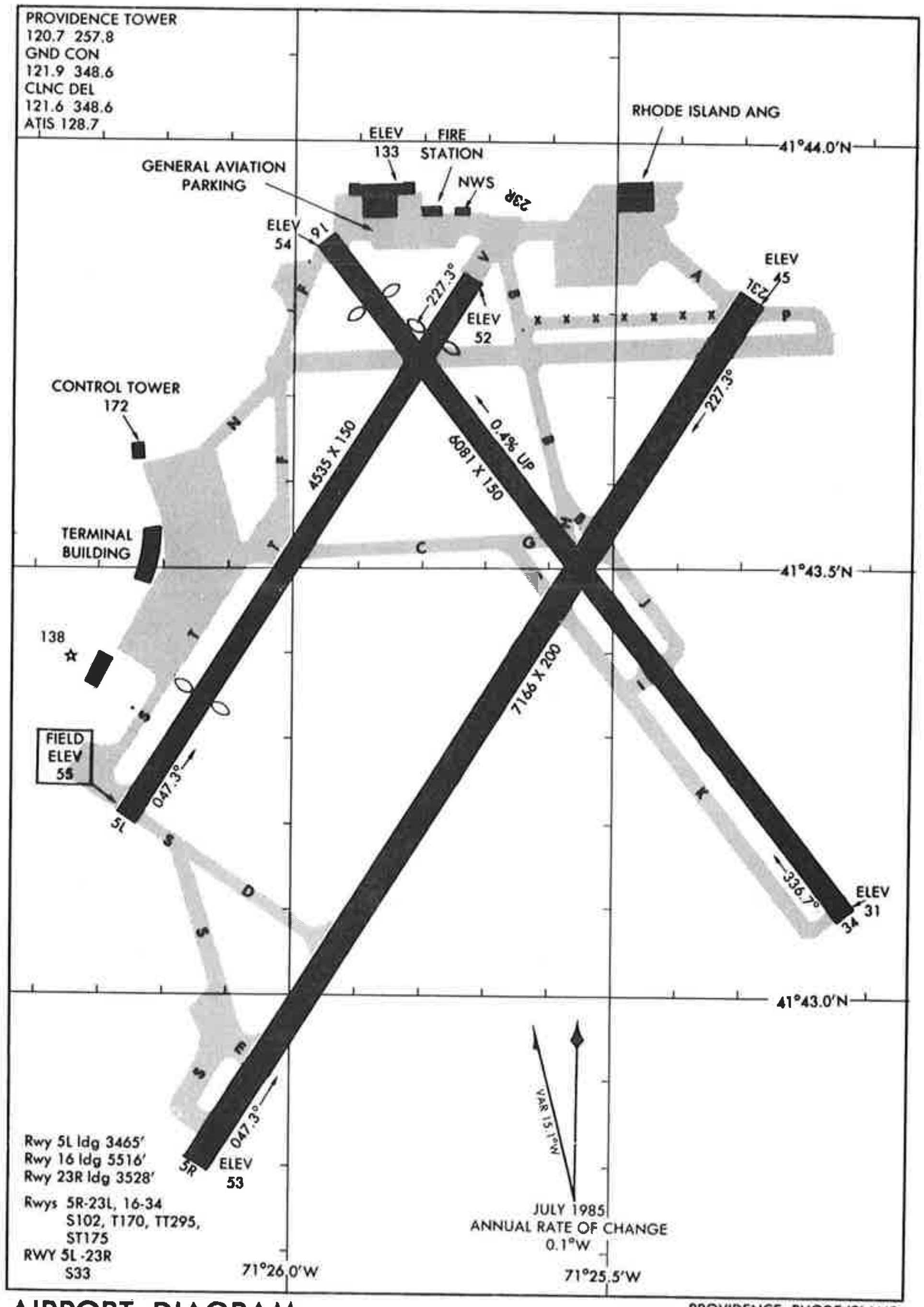
AIRPORT DIAGRAM

WICHITA, KANSAS
WICHITA MID-CONTINENT (ICT)



AIRPORT DIAGRAM

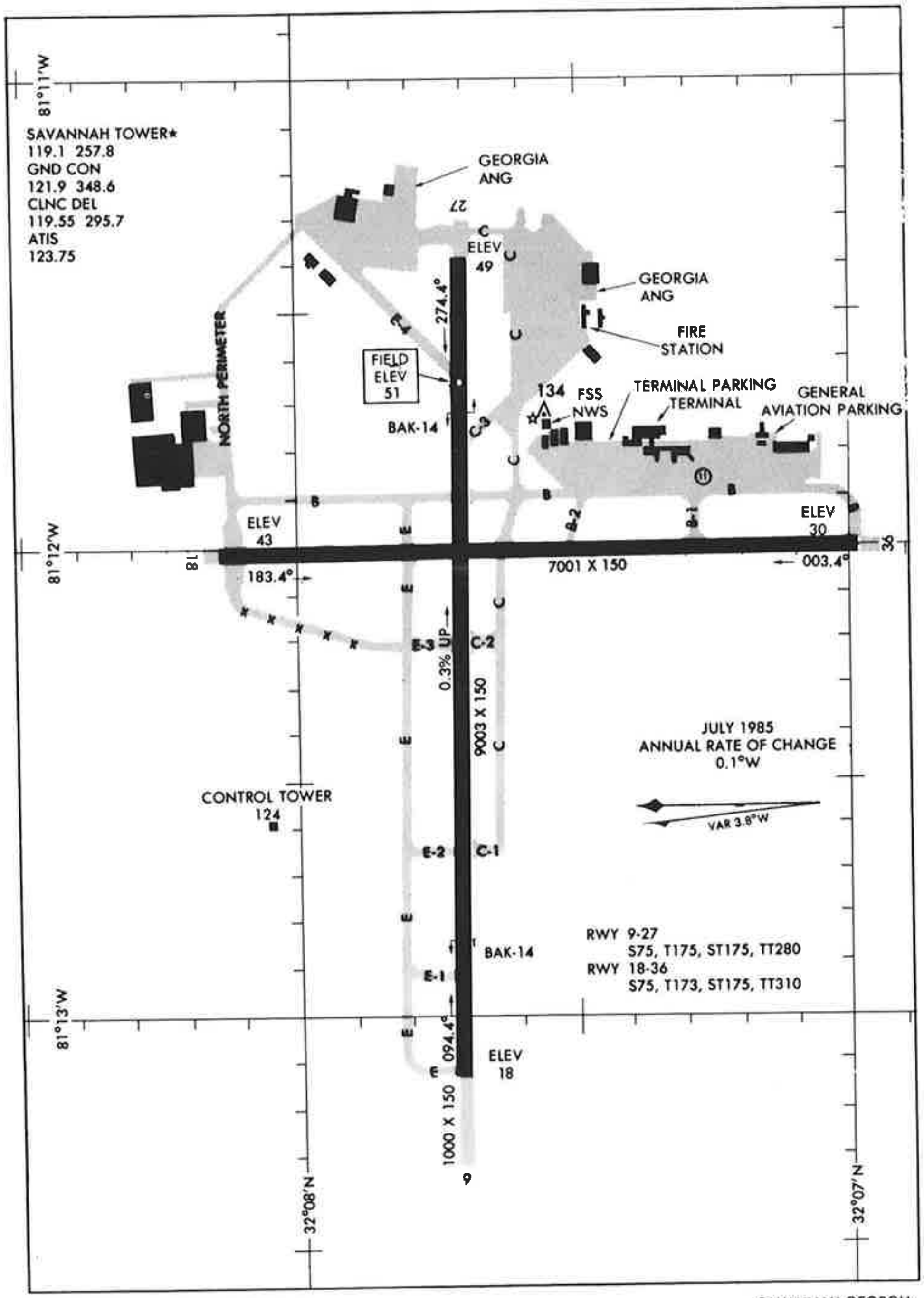
WASHINGTON, D.C.
WASHINGTON NATIONAL AIRPORT (DCA)



AIRPORT DIAGRAM

PROVIDENCE, RHODE ISLAND

PROVIDENCE/THEODORE FRANCIS GREEN STATE (PVD)



AIRPORT DIAGRAM

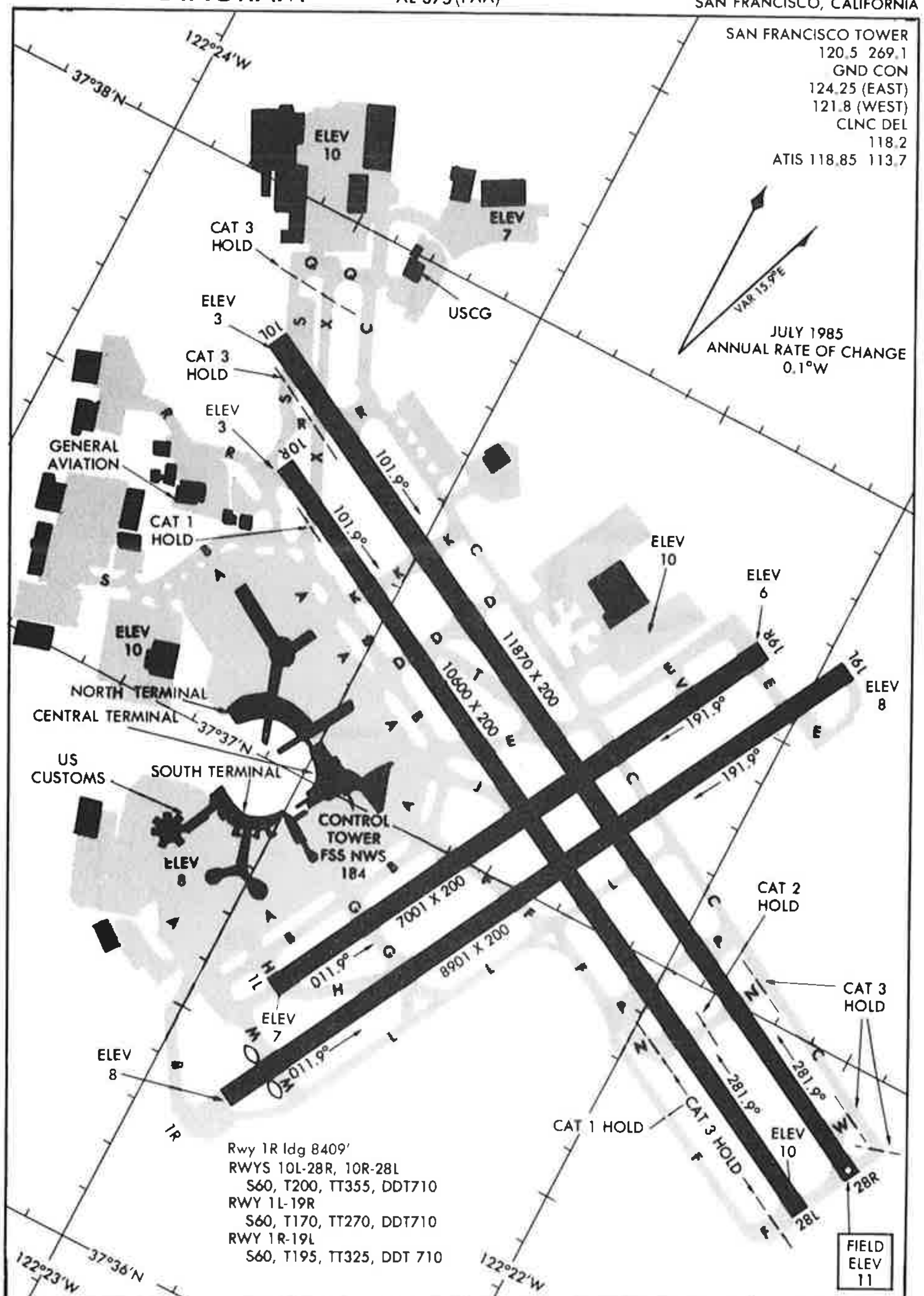
SAVANNAH, GEORGIA
SAVANNAH INTL AIRPORT (SAV)

88210

AIRPORT DIAGRAM

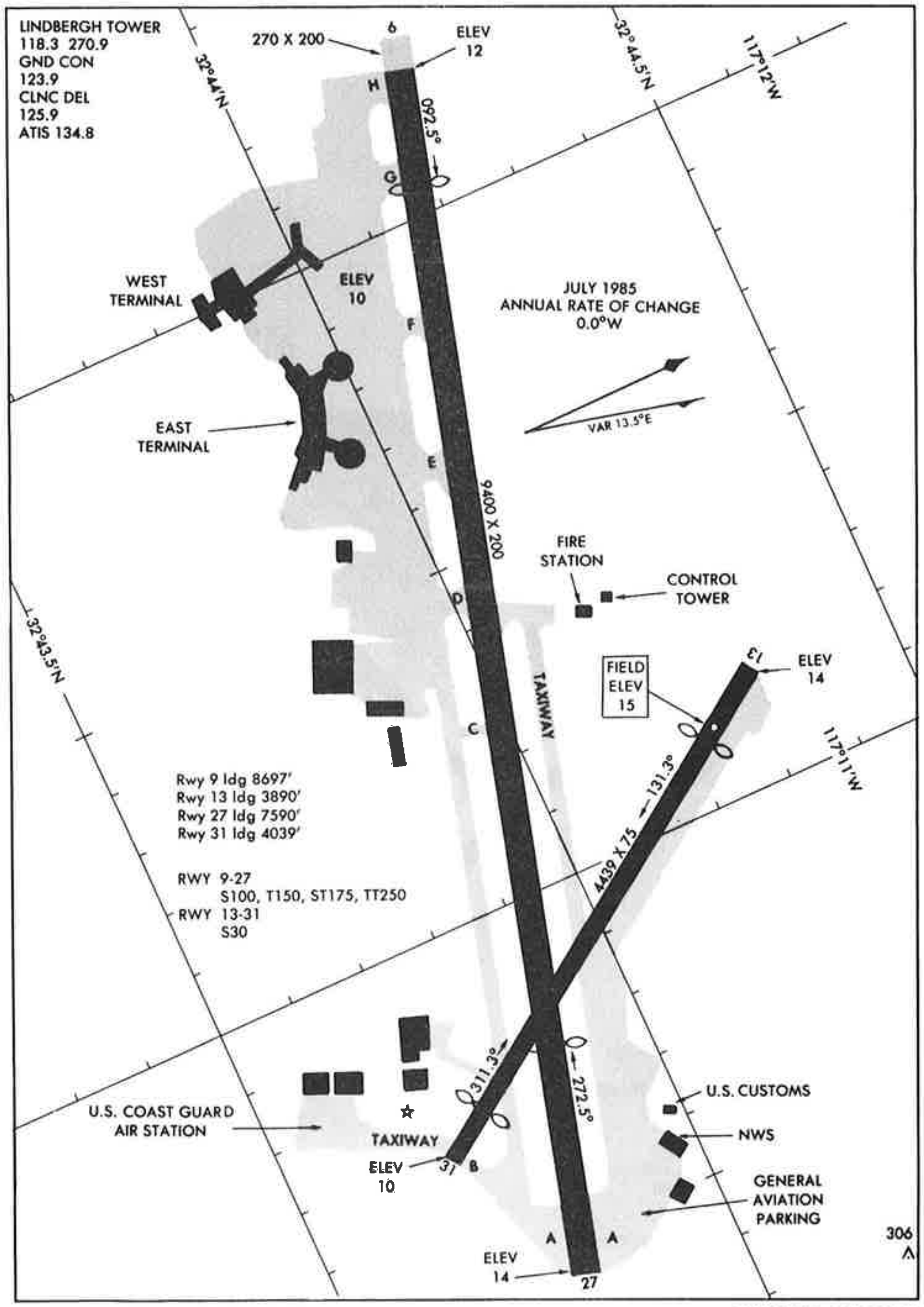
AL-375(FAA)

SAN FRANCISCO INTL(SFO)
SAN FRANCISCO, CALIFORNIA



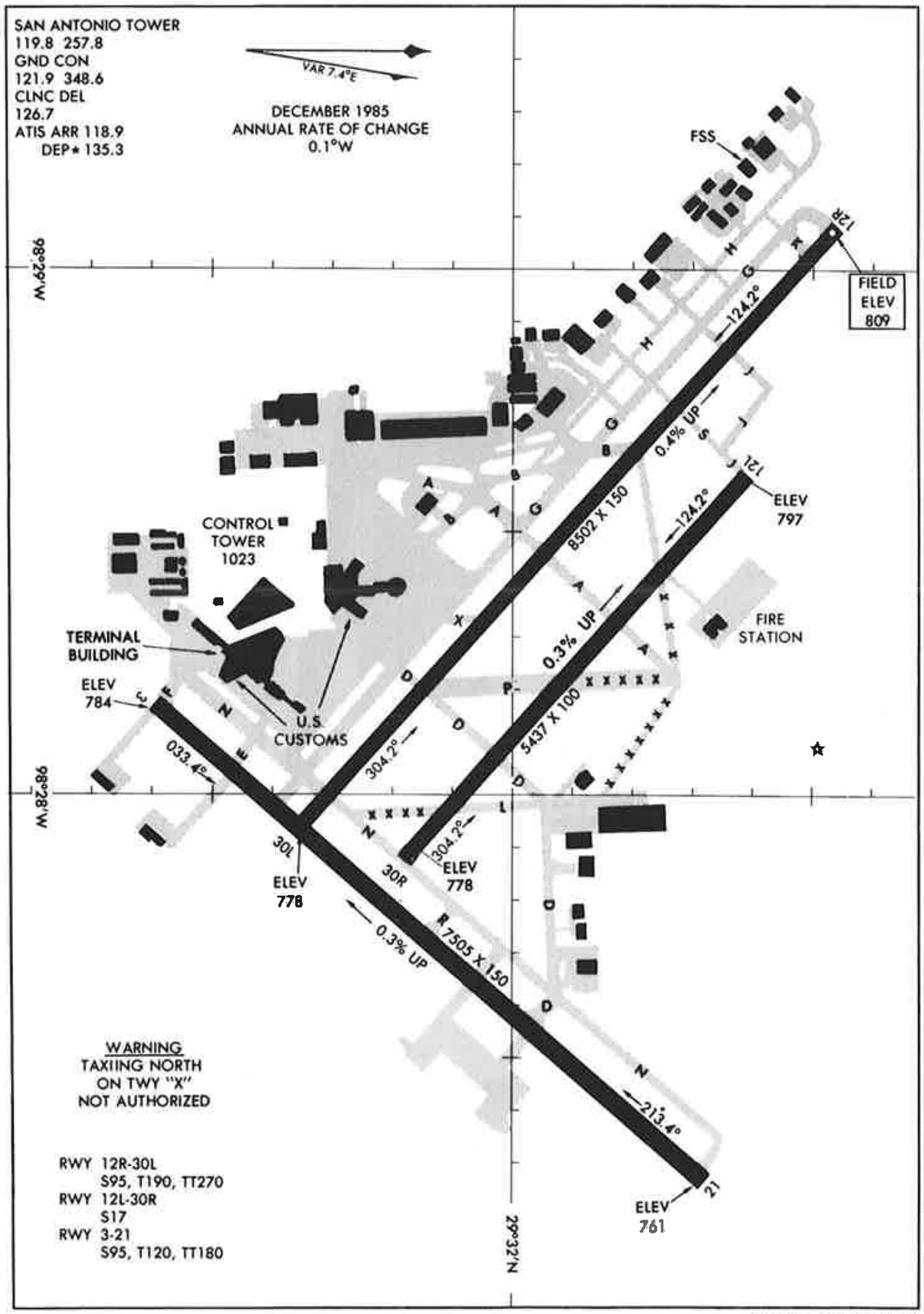
AIRPORT DIAGRAM

SAN FRANCISCO, CALIFORNIA
SAN FRANCISCO INTL (SFO)



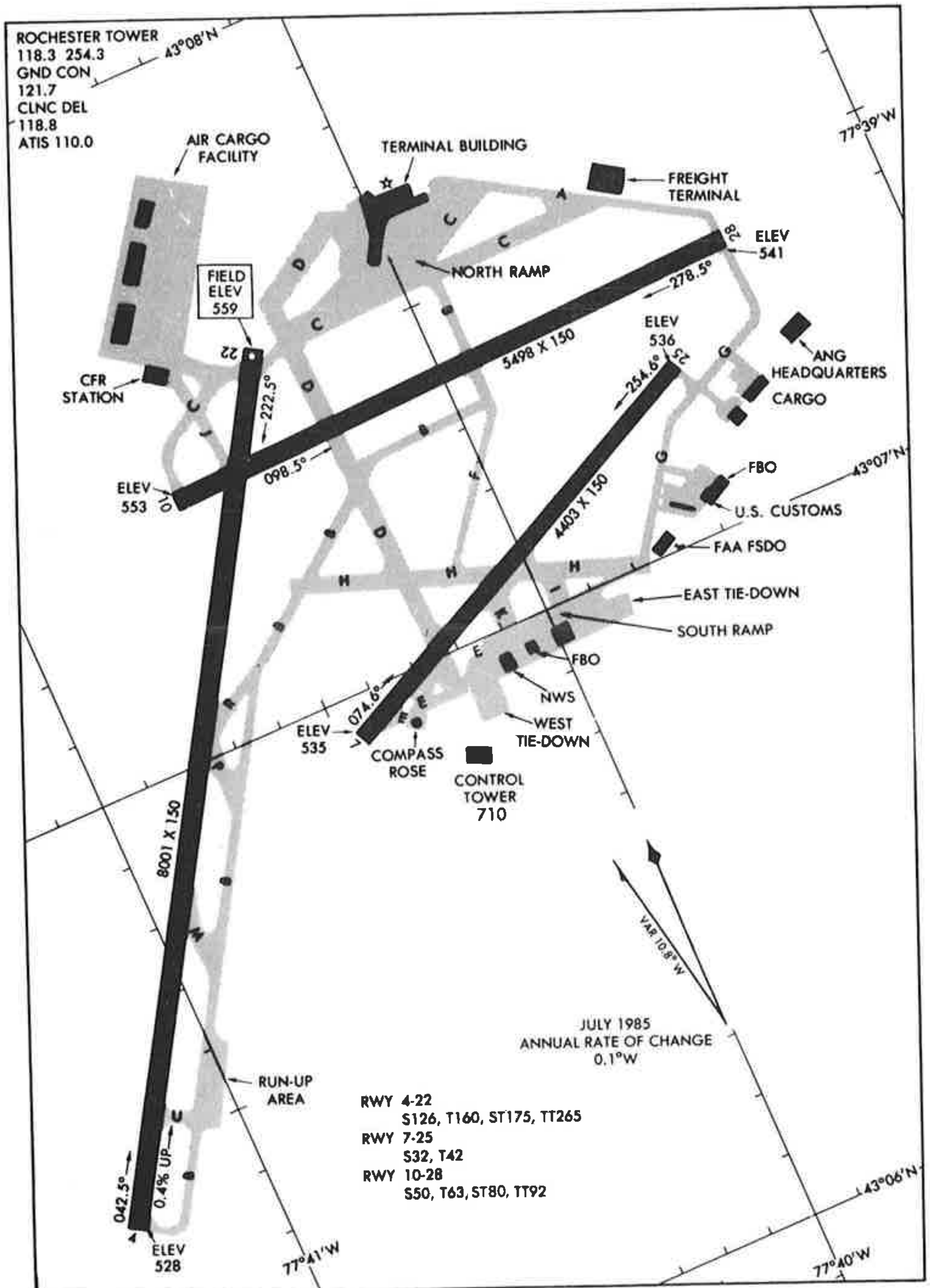
AIRPORT DIAGRAM

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



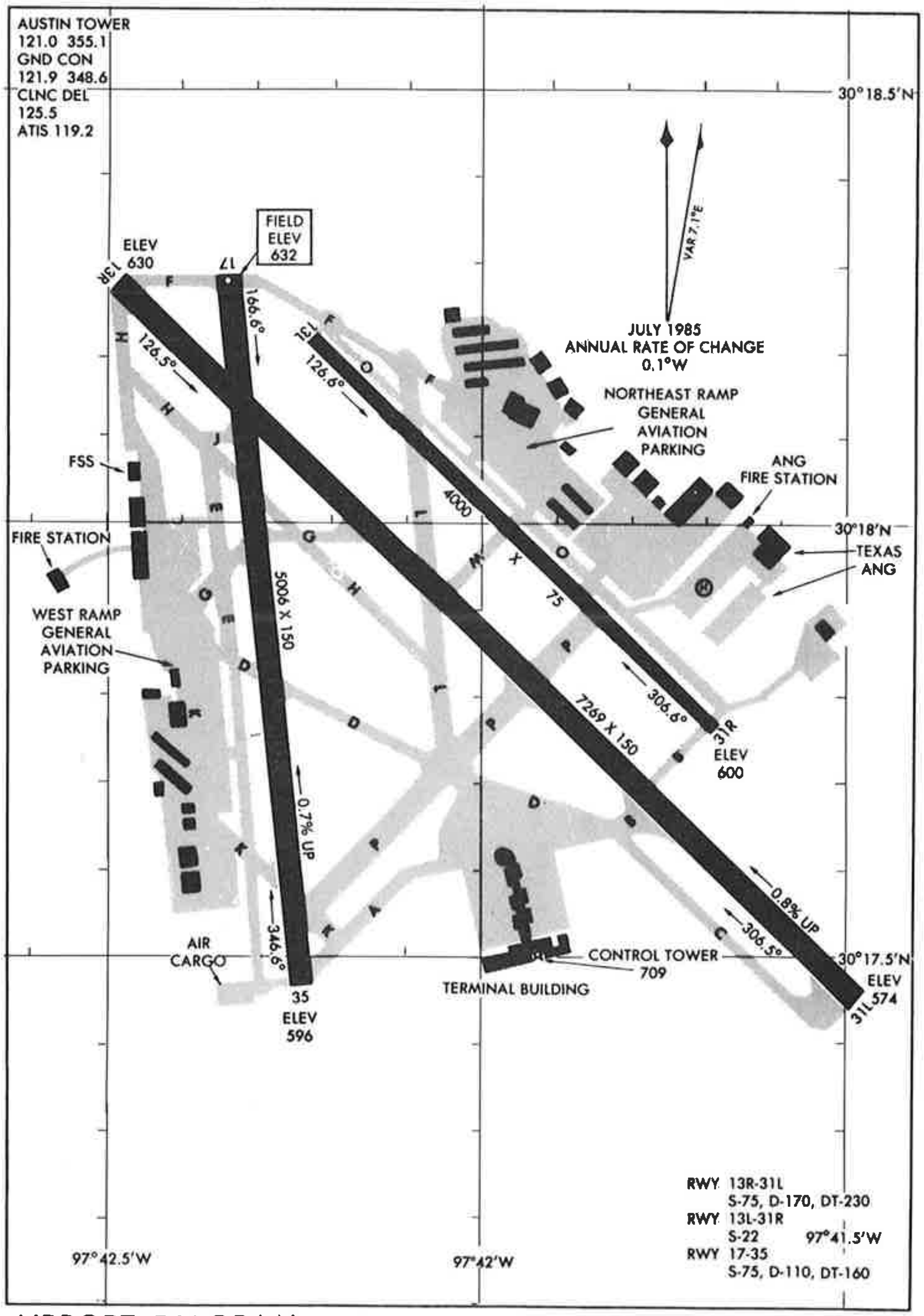
AIRPORT DIAGRAM

SAN ANTONIO, TEXAS
SAN ANTONIO INTERNATIONAL (SAT)



AIRPORT DIAGRAM

ROCHESTER, NEW YORK
ROCHESTER-MONROE COUNTY (ROC)



AIRPORT DIAGRAM

AUSTIN, TEXAS

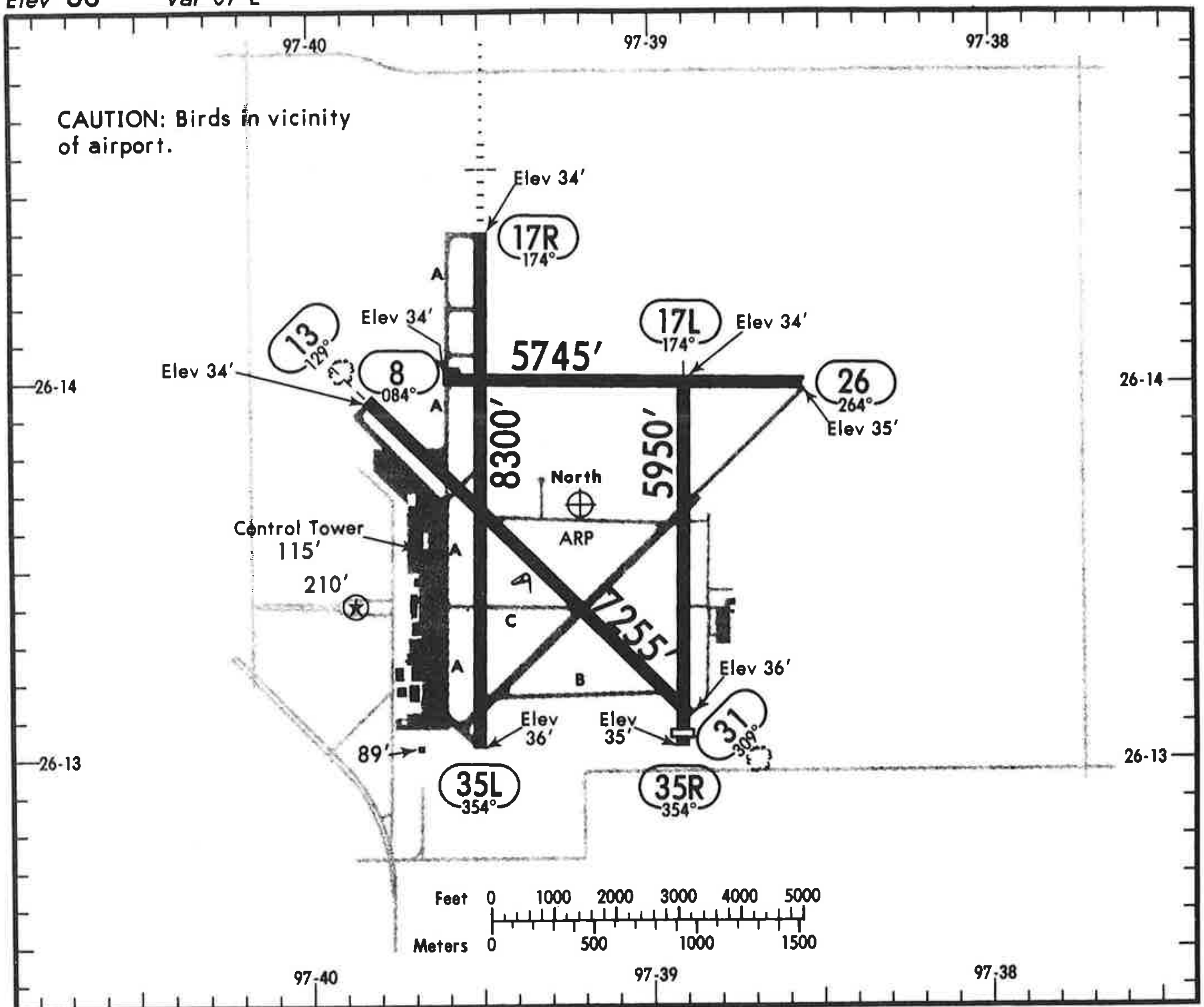
AUSTIN/ROBERT MUELLER MUNICIPAL (AUS)

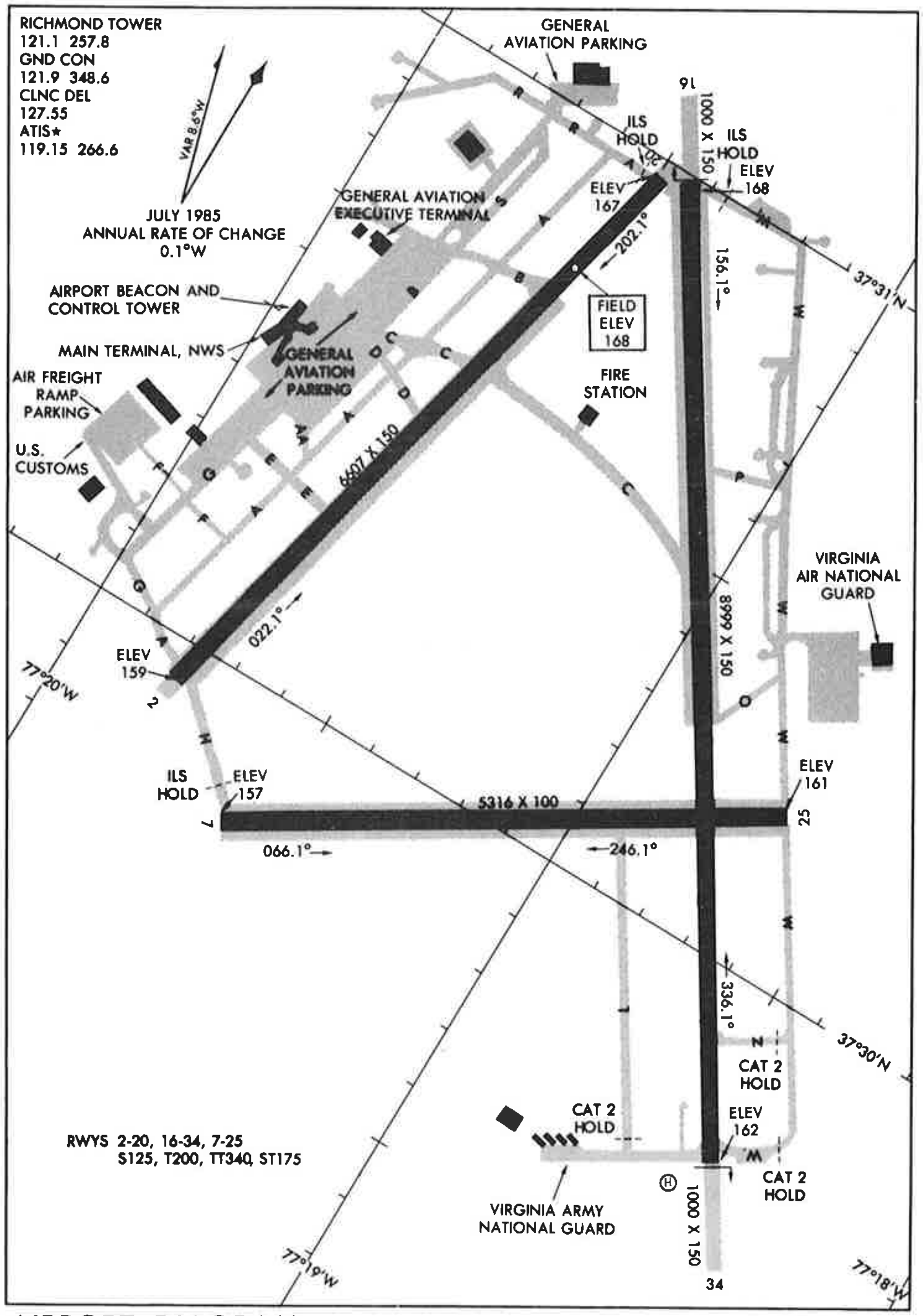
HARLINGEN, TEXAS

RIO GRANDE VALLEY INTL

N26 13.7 W097 39.2 107.6°/8.4 From HRL 108.8

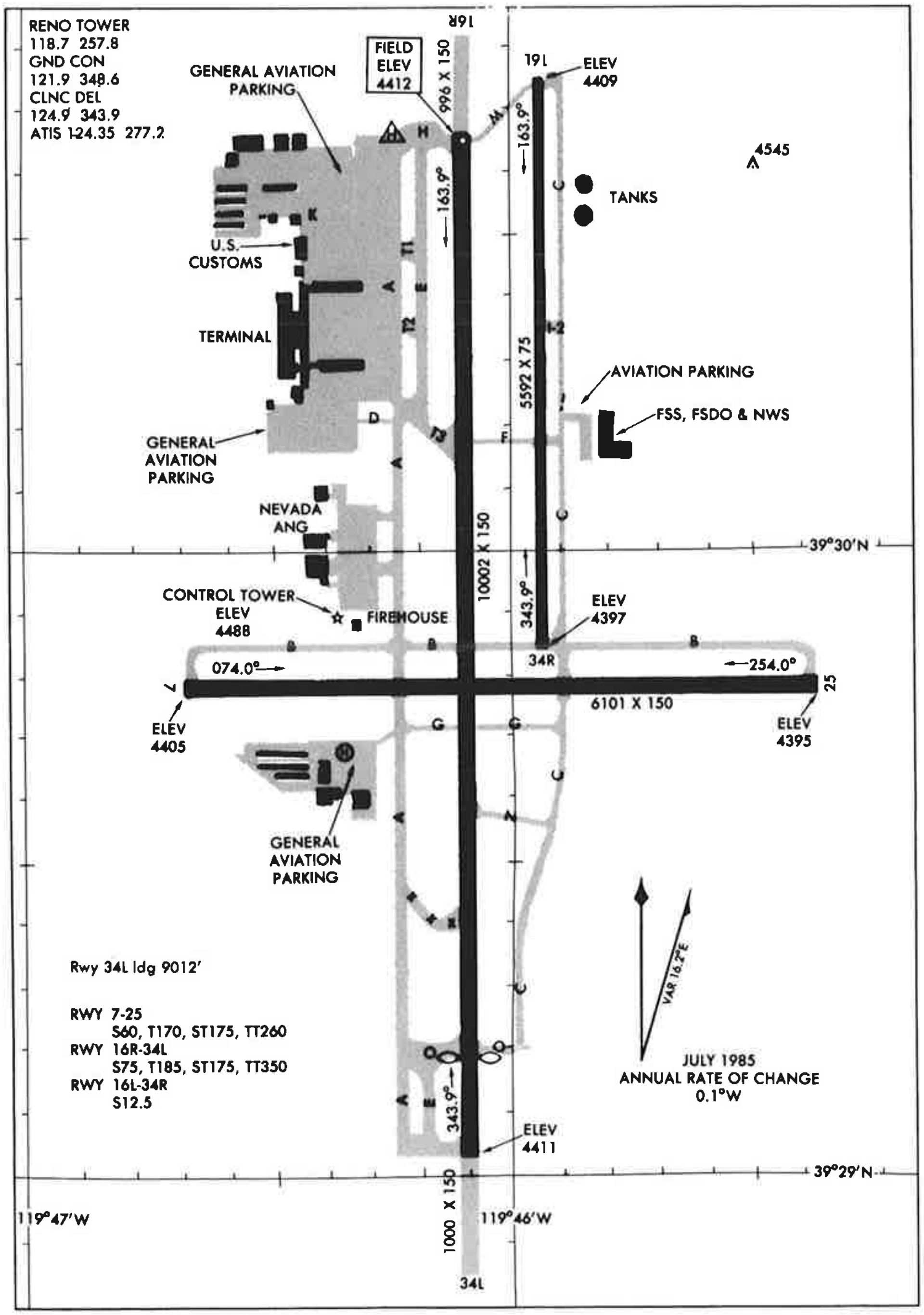
Elev 36′ *Var* 07°E





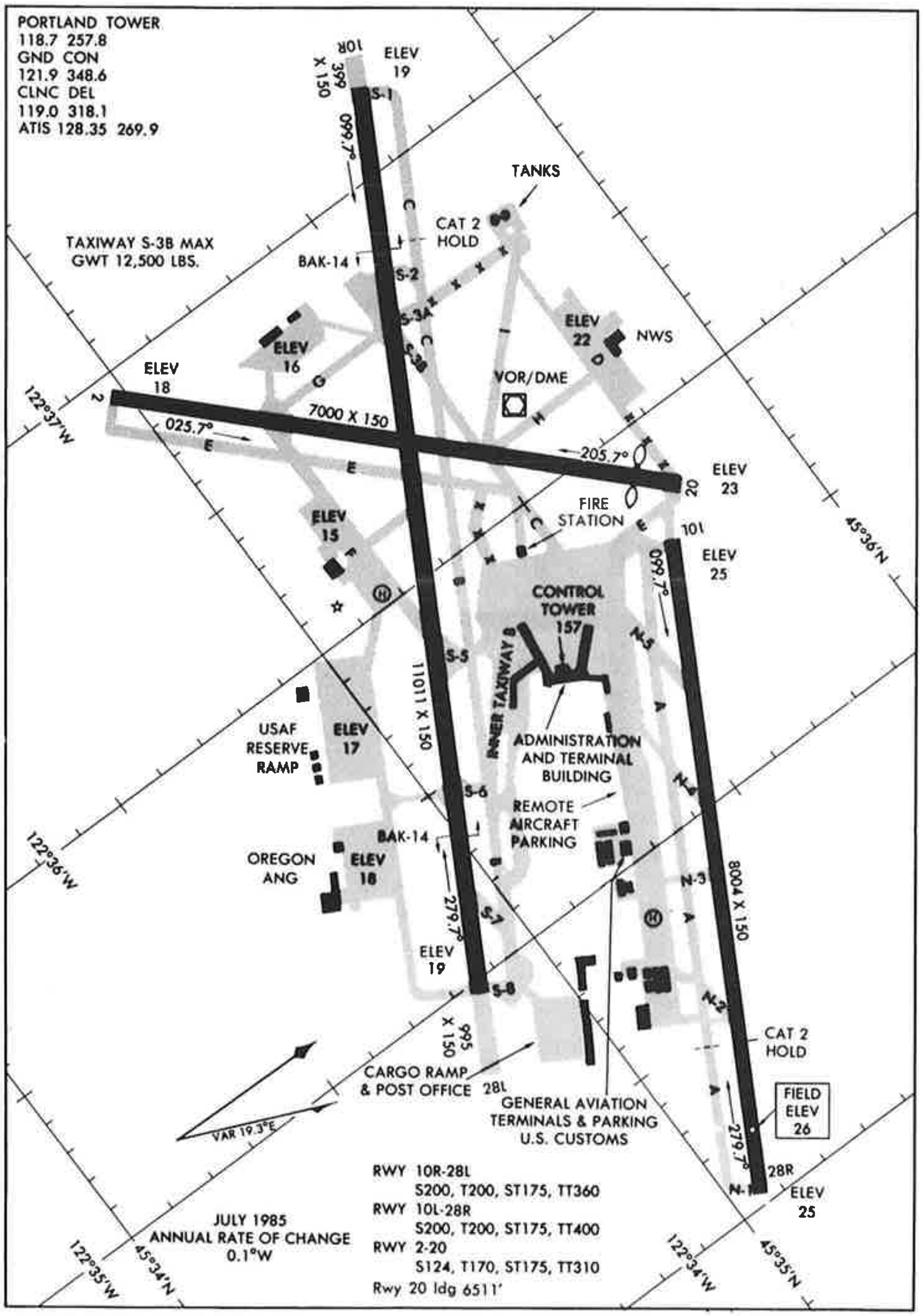
AIRPORT DIAGRAM

RICHMOND, VIRGINIA
RICHMOND INTL (BYRD FIELD) (RIC)



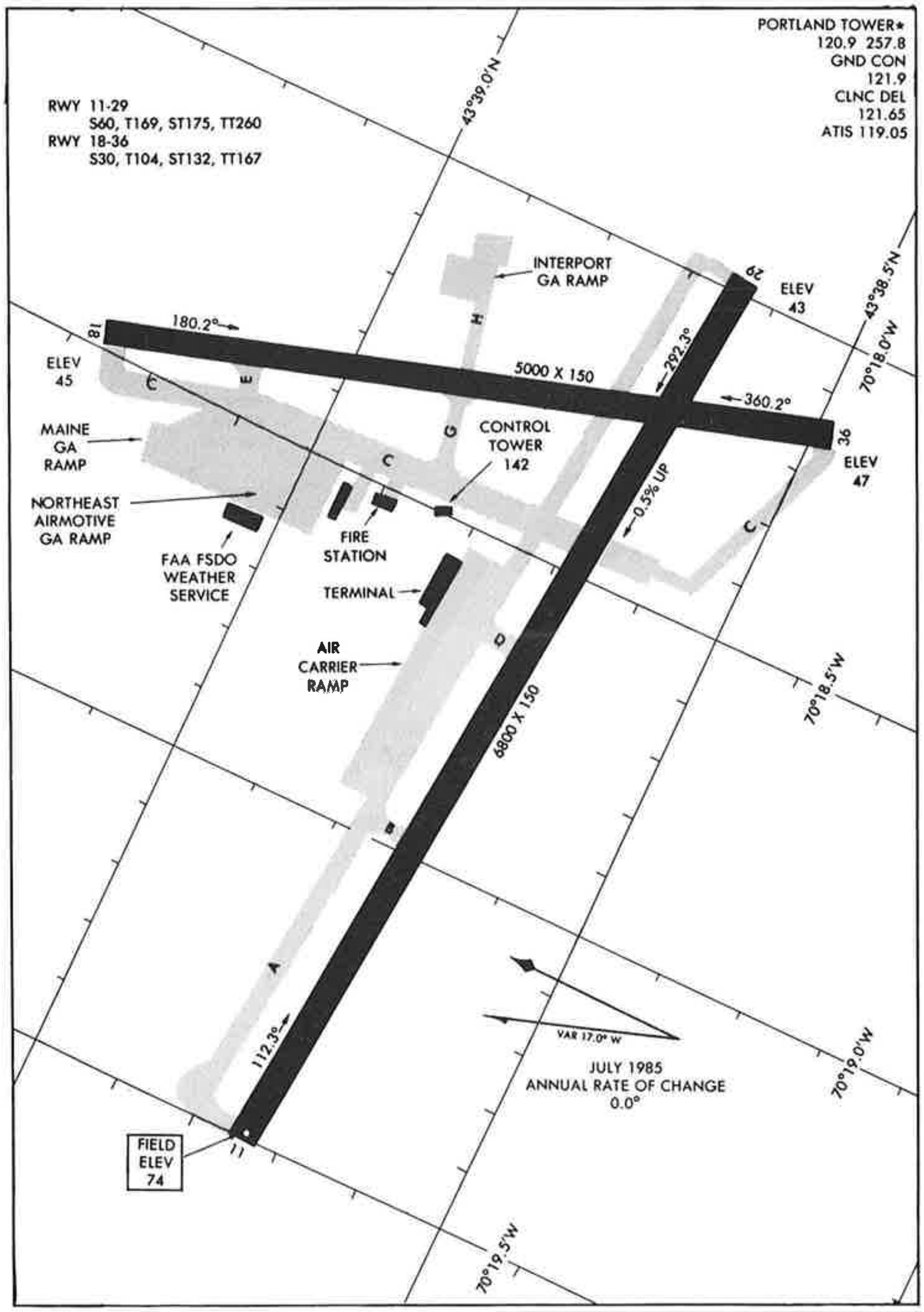
AIRPORT DIAGRAM

RENO, NEVADA
RENO CANNON INTL AIRPORT (RNO)



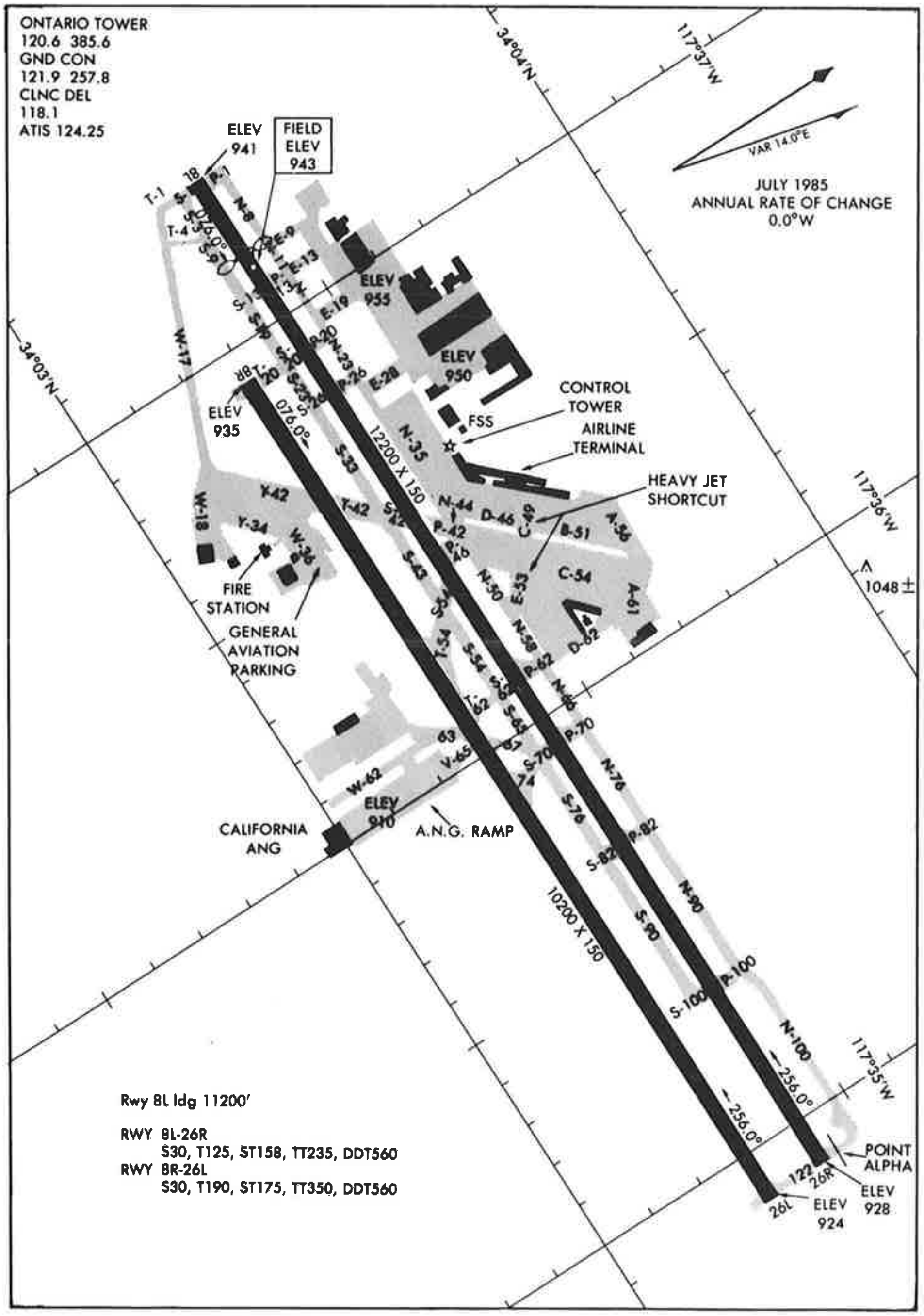
AIRPORT DIAGRAM

PORTLAND, OREGON
PORTLAND INTL (PDX)



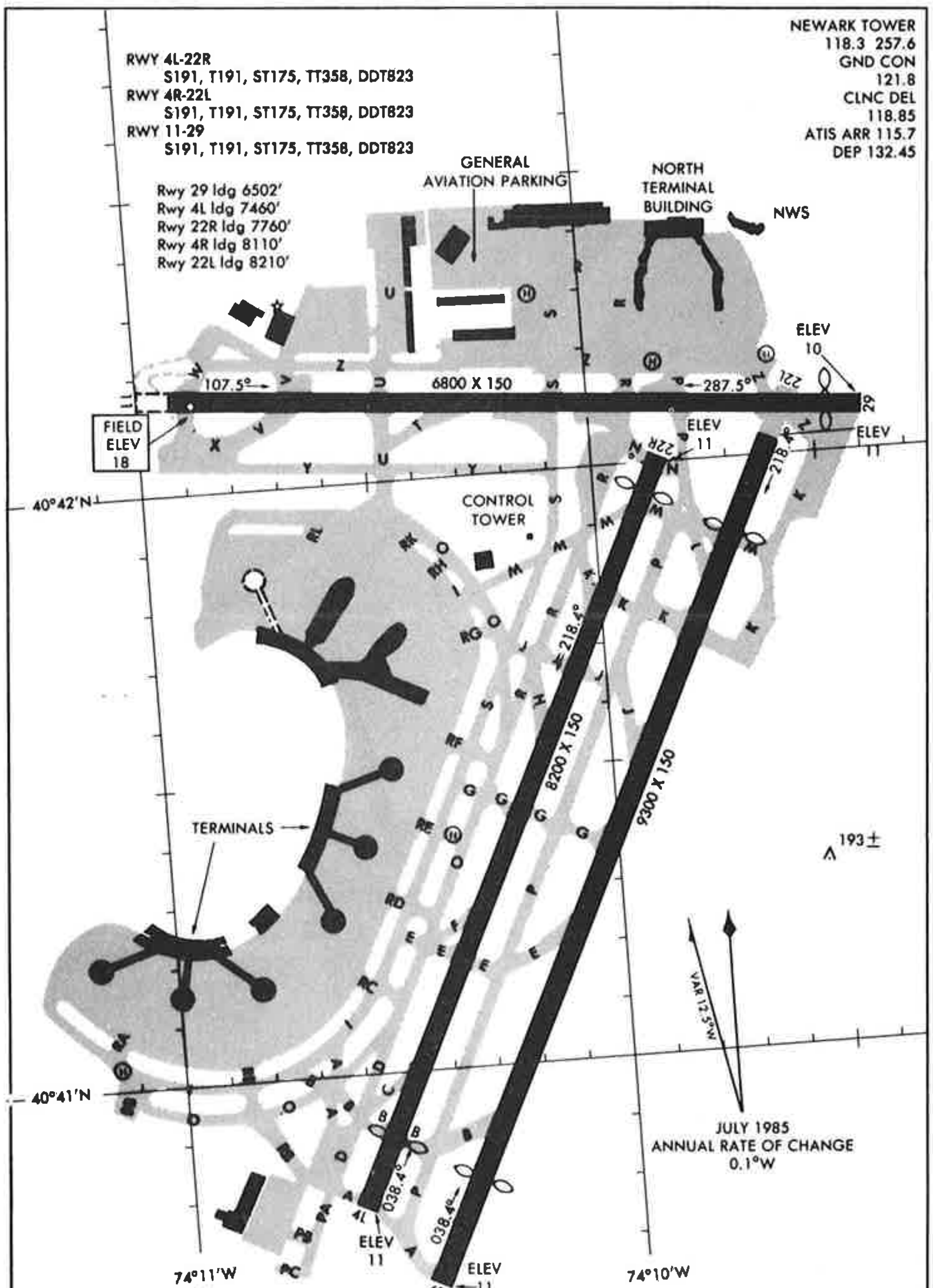
AIRPORT DIAGRAM

PORTLAND, MAINE
PORTLAND INTL JETPORT (PWM)



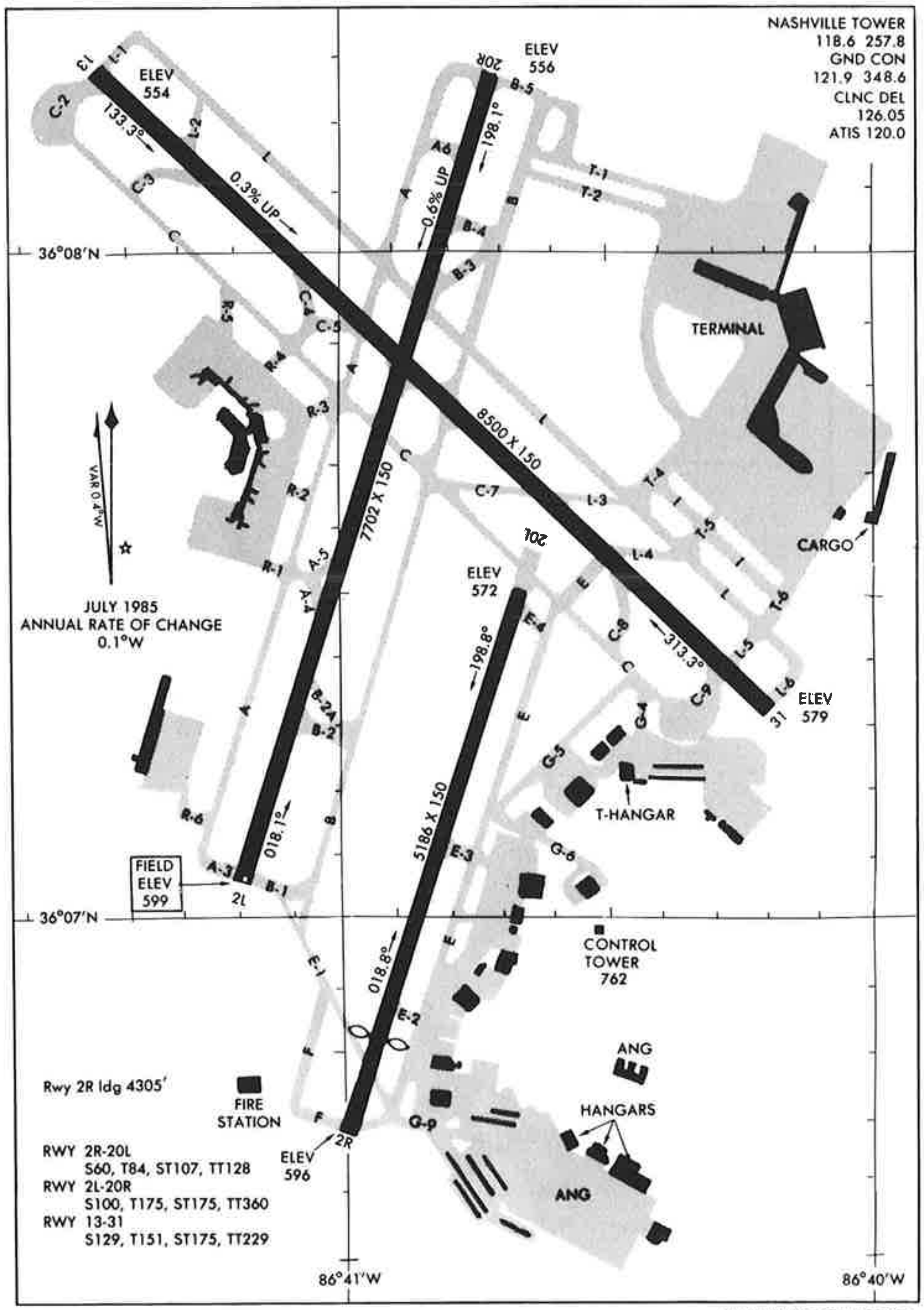
AIRPORT DIAGRAM

ONTARIO, CALIFORNIA
ONTARIO INTL AIRPORT (ONT)



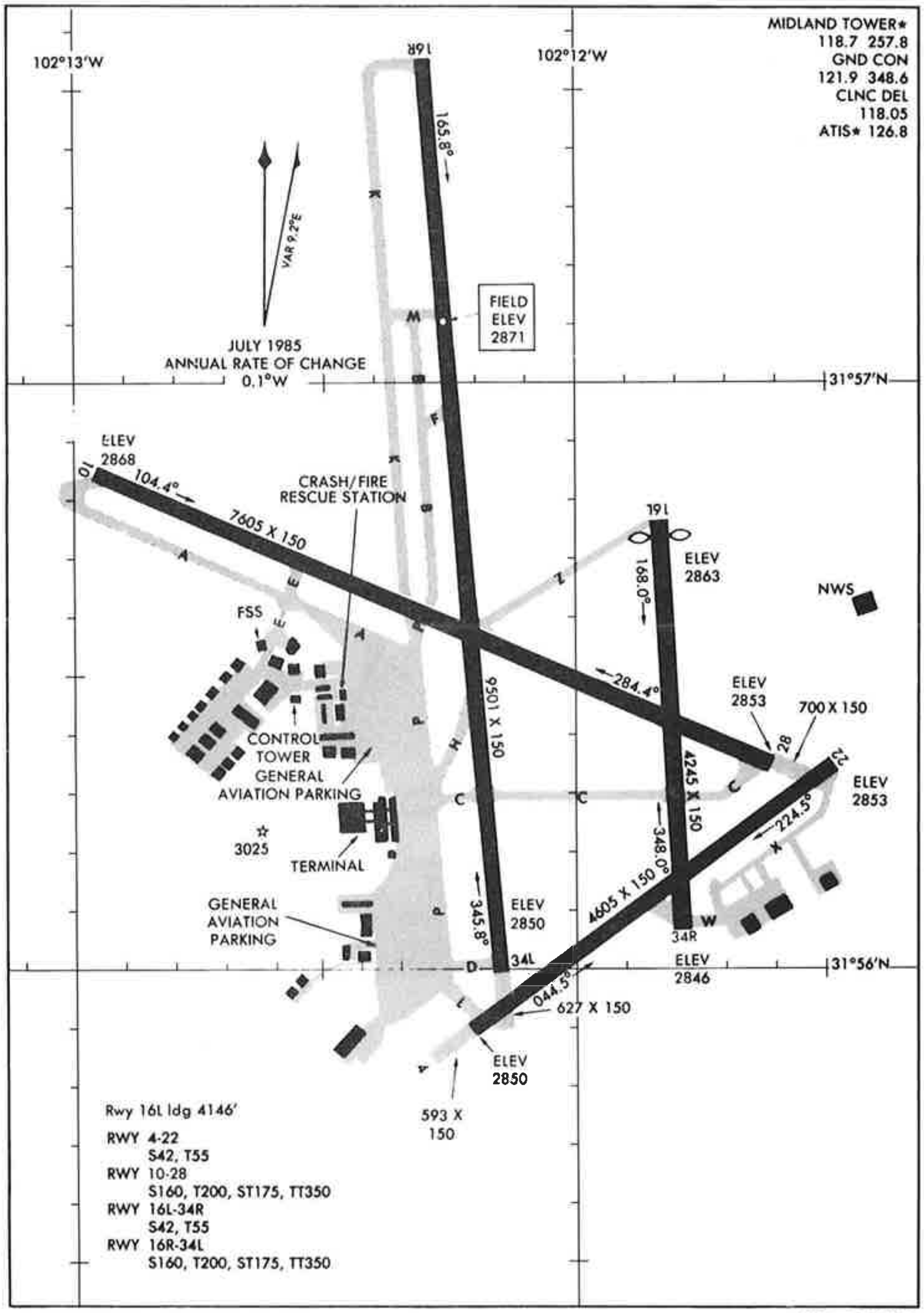
AIRPORT DIAGRAM

NEWARK, NEW JERSEY
NEWARK INTL (EWR)



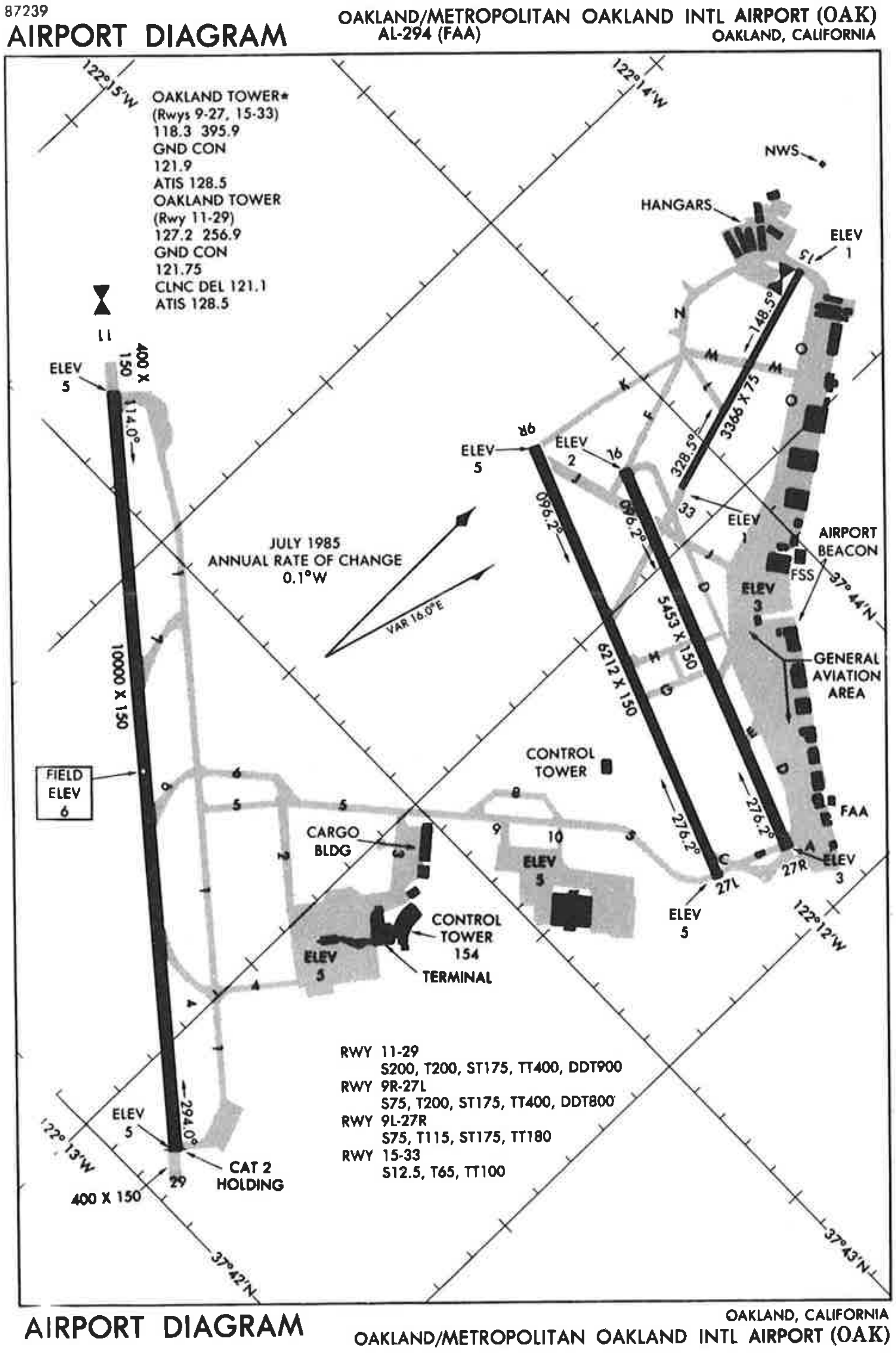
AIRPORT DIAGRAM

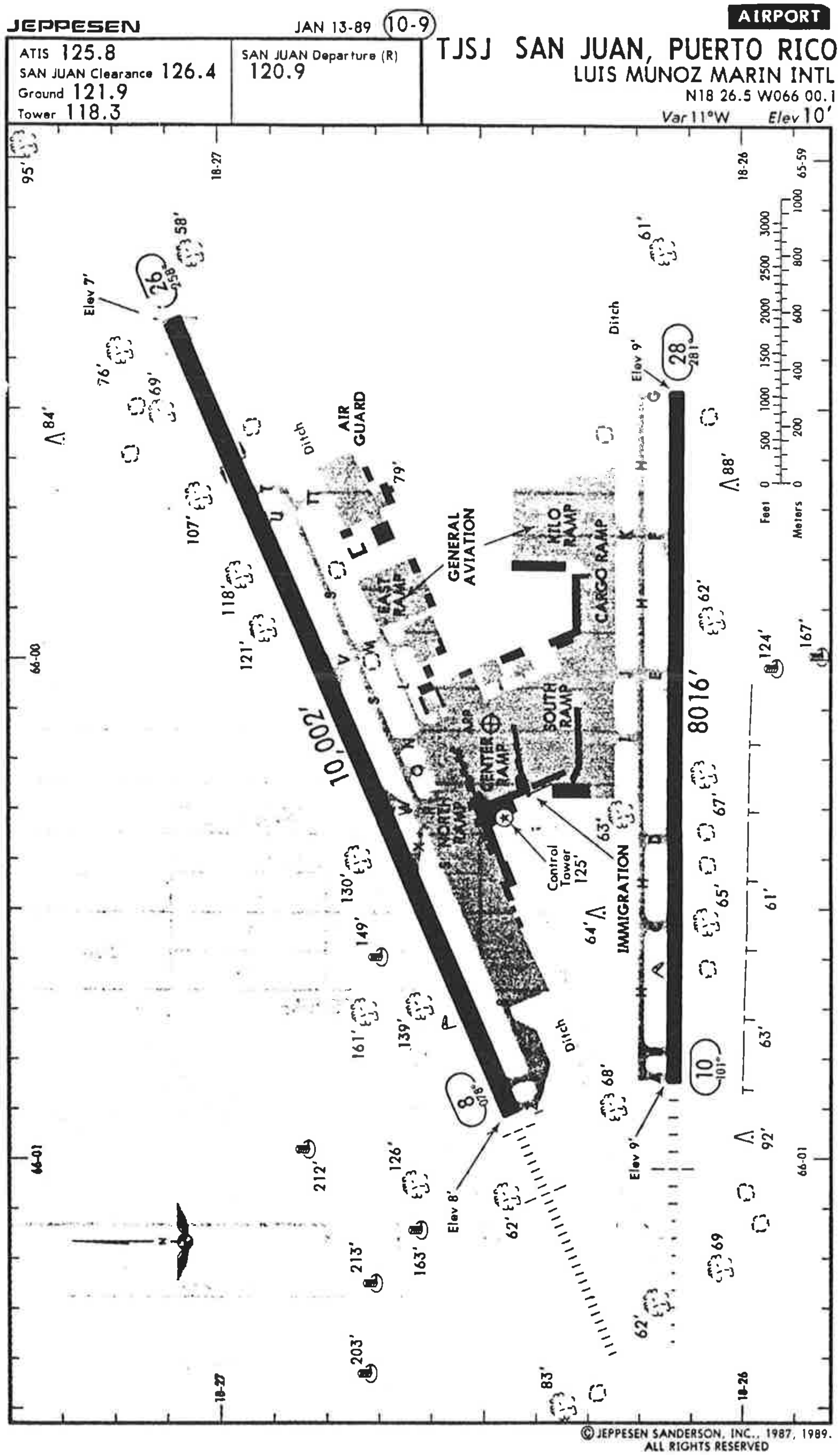
NASHVILLE, TENNESSEE
NASHVILLE INTL(BNA)

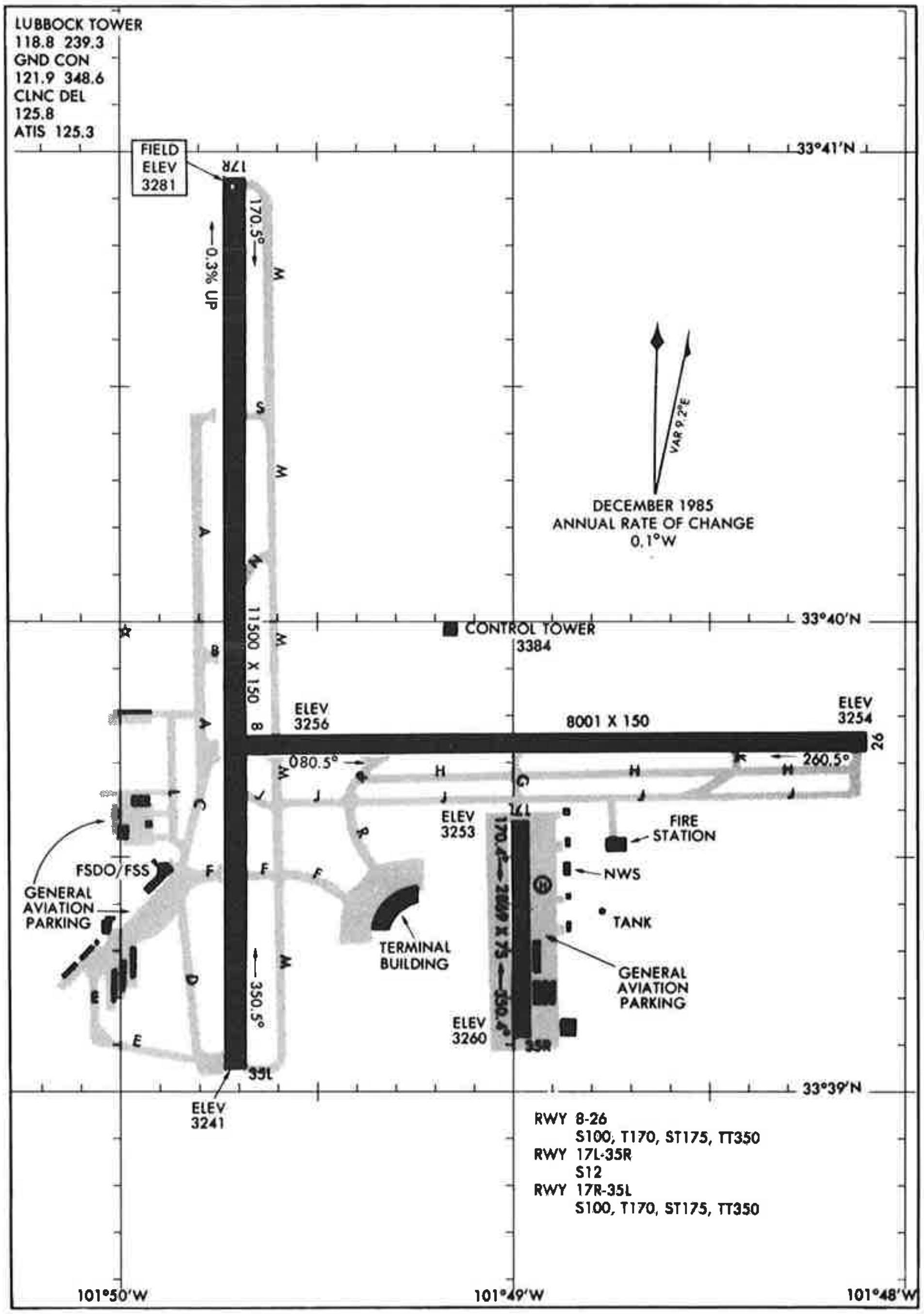


AIRPORT DIAGRAM

MIDLAND, TEXAS
MIDLAND INTERNATIONAL (MAF)

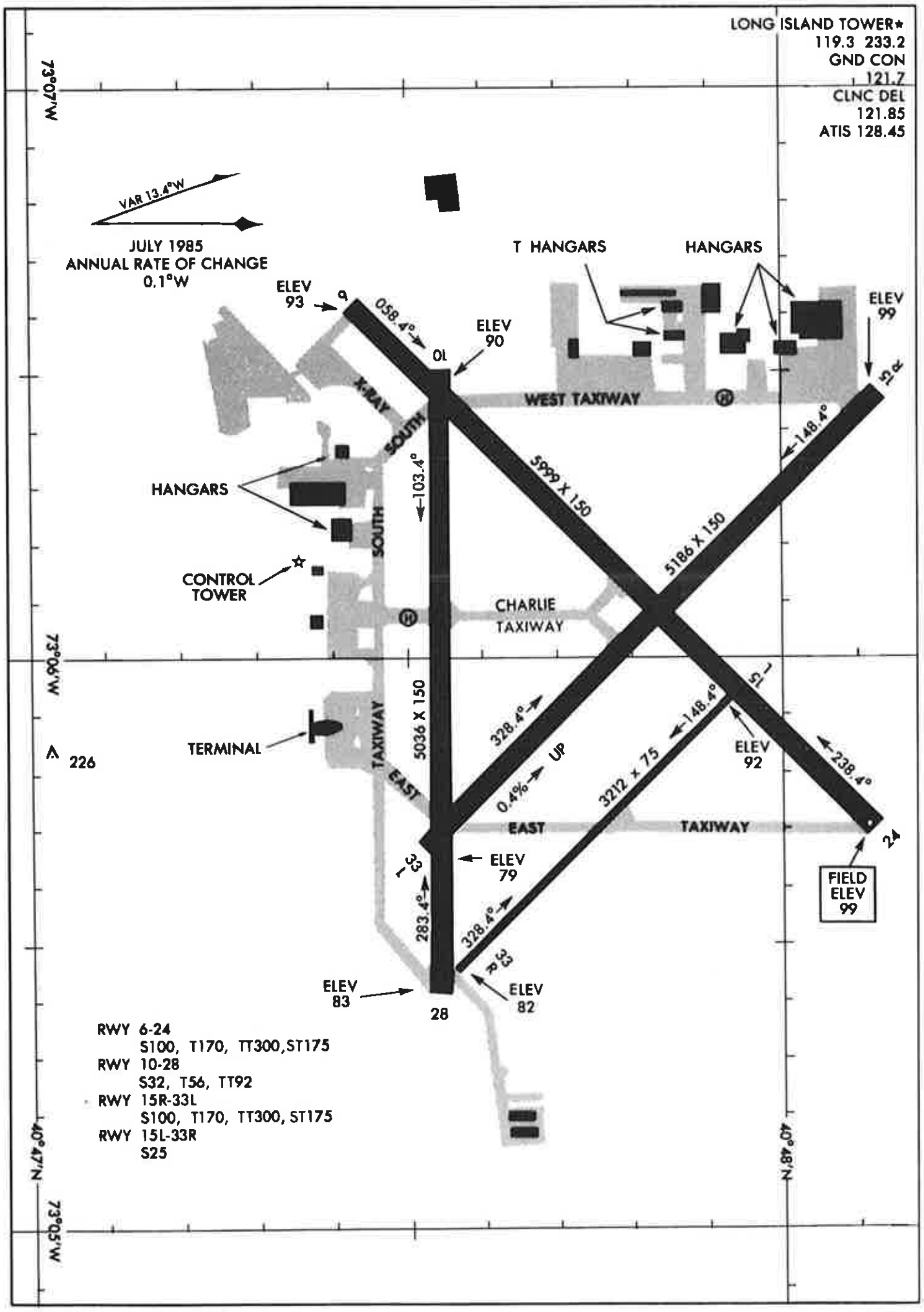

87239
AIRPORT DIAGRAM
OAKLAND/METROPOLITAN OAKLAND INTL AIRPORT (OAK)
AL-294 (FAA)
OAKLAND, CALIFORNIA
OAKLAND TOWER*
(Rwys 9-27, 15-33)
118.3 395.9
GND CON
121.9
ATIS 128.5
OAKLAND TOWER
(Rwy 11-29)
127.2 256.9
GND CON
121.75
CLNC DEL 121.1
ATIS 128.5
122°15'W
122°14'W
122°13'W
122°12'W
37°42'N
37°43'N
37°44'N
NWS
HANGARS
ELEV 1
ELEV 5
ELEV 2
ELEV 3
ELEV 6
FIELD ELEV 6
400 X 150
10000 X 150
6212 X 150
5453 X 150
3366 X 75
114.0°
294.0°
096.2°
276.2°
148.5°
328.5°
11
29
9R
9L
27L
27R
15
33
JULY 1985
ANNUAL RATE OF CHANGE
0.1°W
VAR 16.0°E
AIRPORT BEACON
FSS
GENERAL AVIATION AREA
CONTROL TOWER
FAA
CARGO BLDG
CONTROL TOWER 154
TERMINAL
CAT 2 HOLDING
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)


JEPPESEN
JAN 13-89 10-9
AIRPORT
ATIS 125.8
SAN JUAN Clearance 126.4
Ground 121.9
Tower 118.3
SAN JUAN Departure (R) 120.9
TJSJ SAN JUAN, PUERTO RICO
LUIS MUNOZ MARIN INTL
N18 26.5 W066 00.1
Var 11°W Elev 10'
10,002'
8016'
AIR GUARD
GENERAL AVIATION
EAST RAMP
KILO RAMP
CARGO RAMP
SOUTH RAMP
CENTER RAMP
NORTH RAMP
Control Tower 125'
IMMIGRATION
Ditch
Elev 7'
Elev 8'
Elev 9'
©JEPPESEN SANDERSON, INC., 1987, 1989.
ALL RIGHTS RESERVED



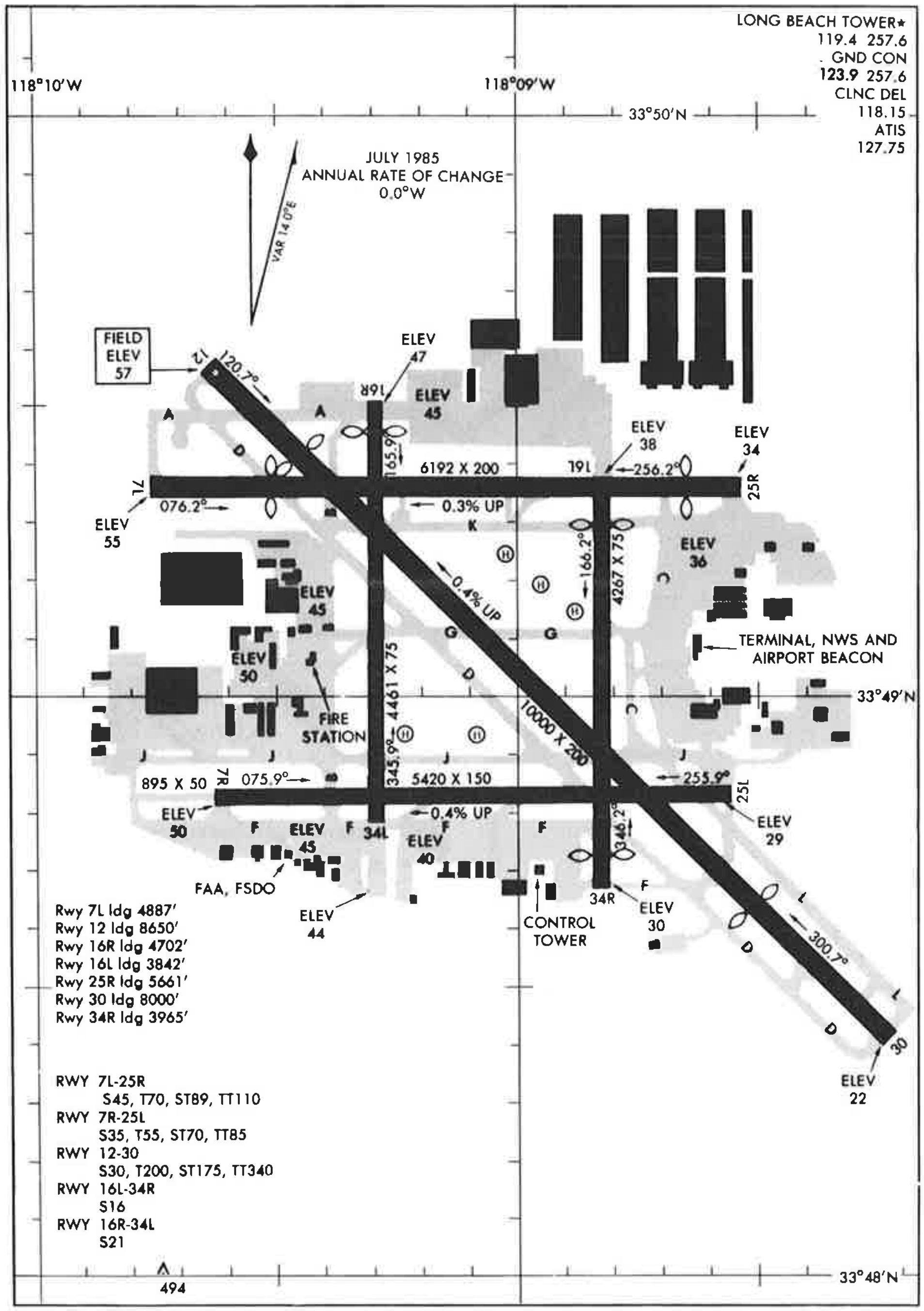
AIRPORT DIAGRAM

LUBBOCK, TEXAS
LUBBOCK INTERNATIONAL(LBB)



AIRPORT DIAGRAM

ISLIP, NEW YORK
ISLIP/LONG ISLAND MACARTHUR (ISP)



AIRPORT DIAGRAM

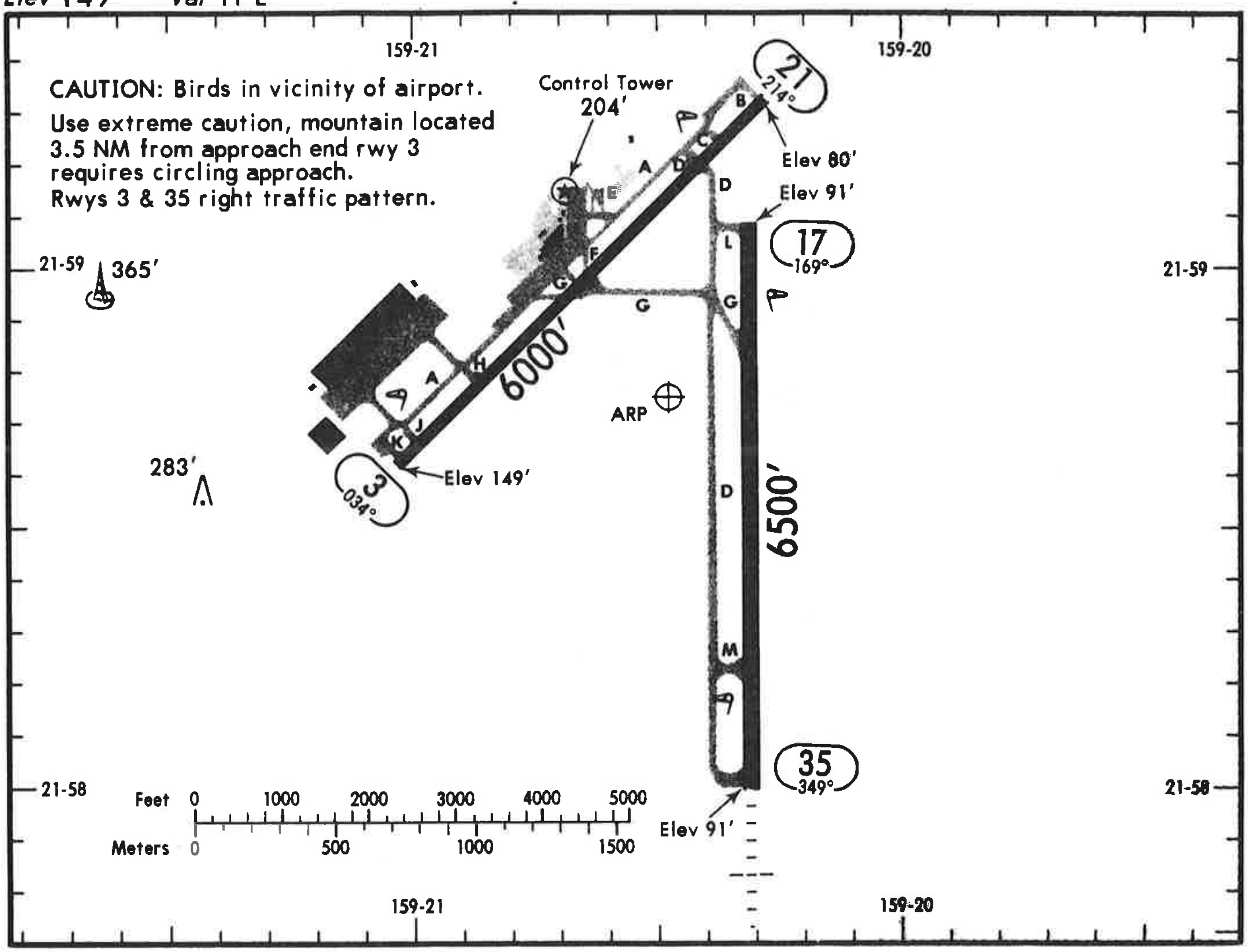
LONG BEACH, CALIFORNIA
LONG BEACH AIRPORT (DAUGHERTY FIELD) (LGB)

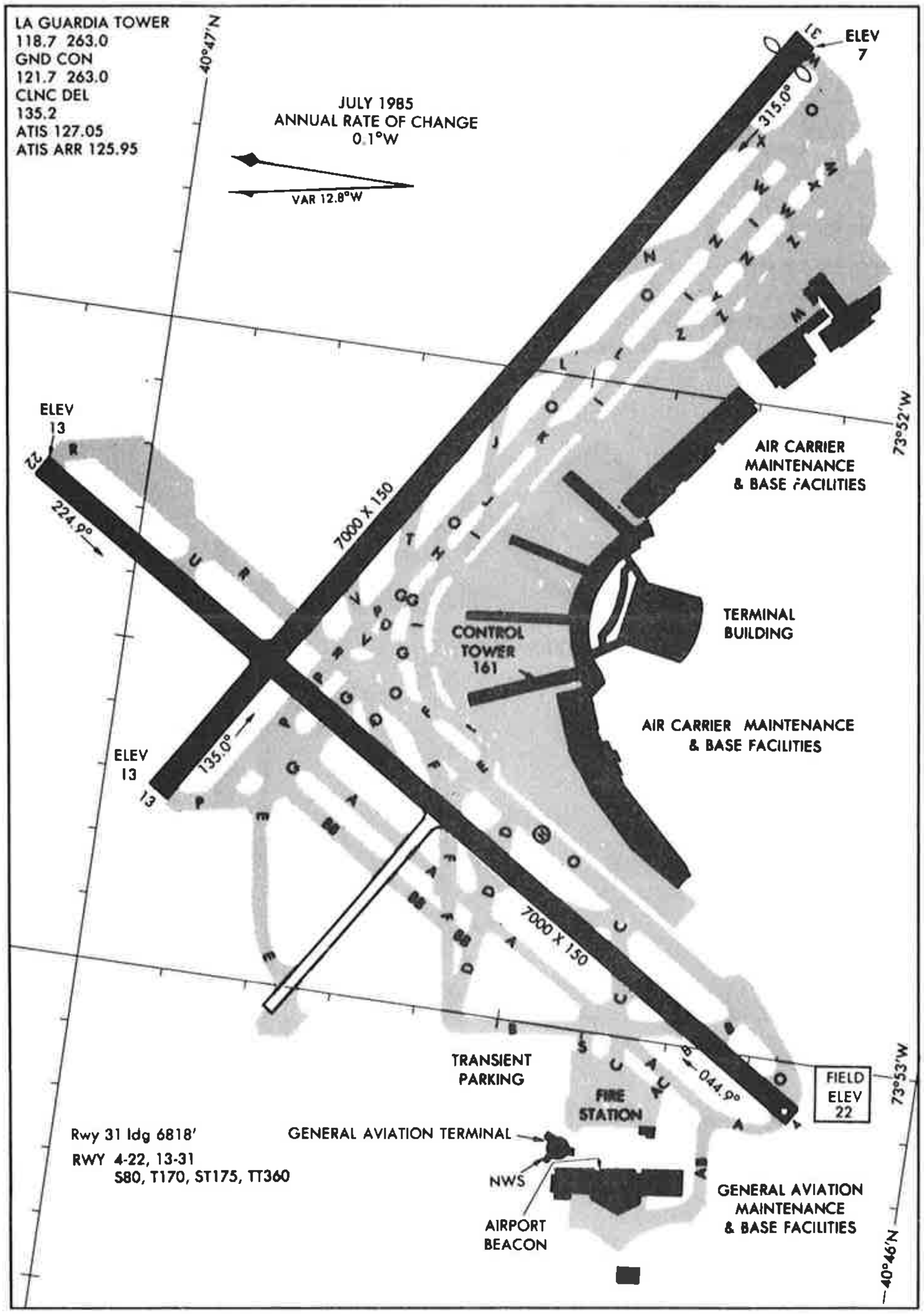
LIHUE, HAWAII

LIHUE

N21 58.8 W159 20.5

Elev 149′ *Var* 11°E





AIRPORT DIAGRAM
NE-2
27 AUG 87

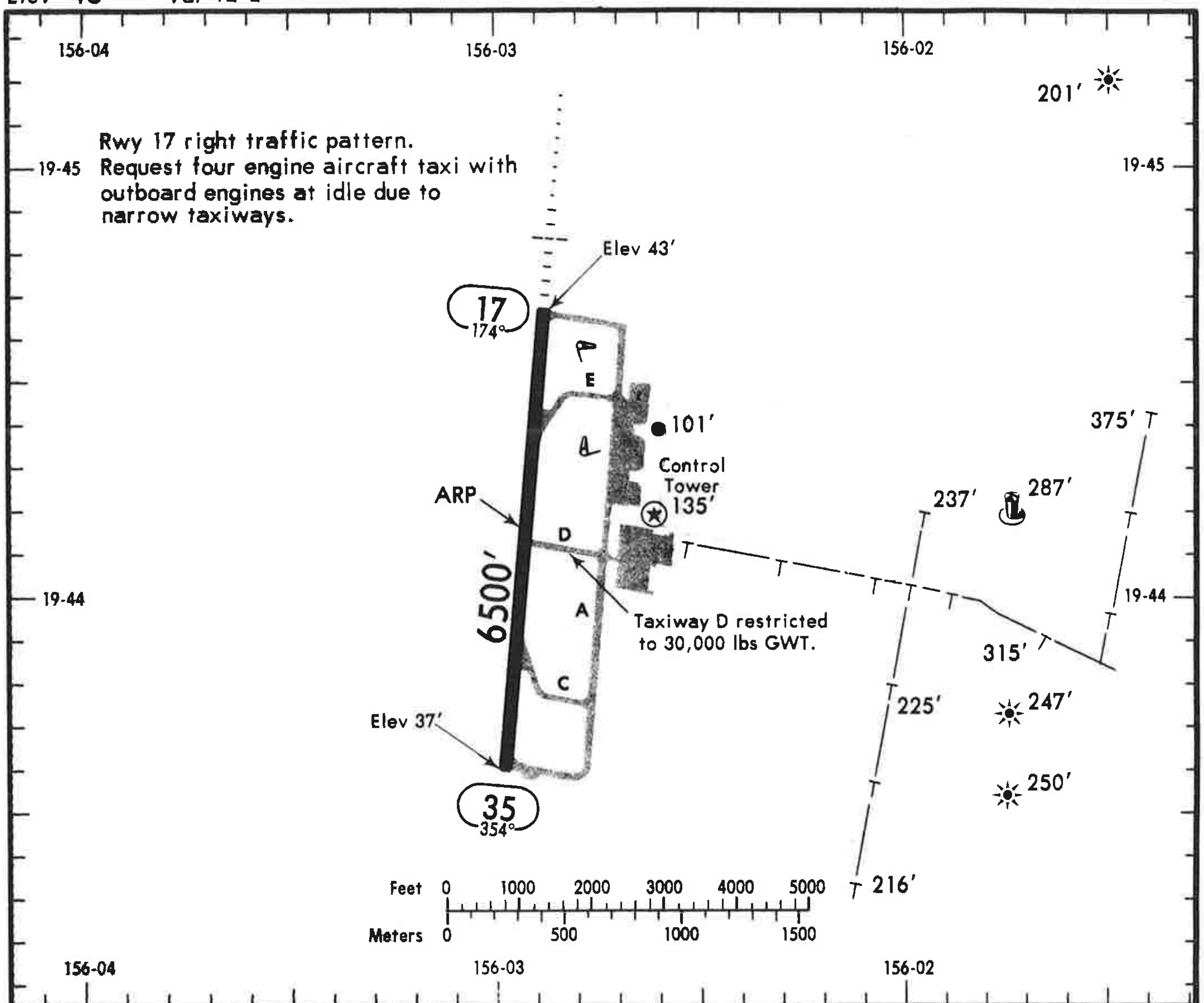
NEW YORK, NEW YORK
NEW YORK/LA GUARDIA (LGA)

KAILUA-KONA, HAWAII

KEAHOLE

N19 44.1 W156 02.9

Elev 43′ *Var* 12°E

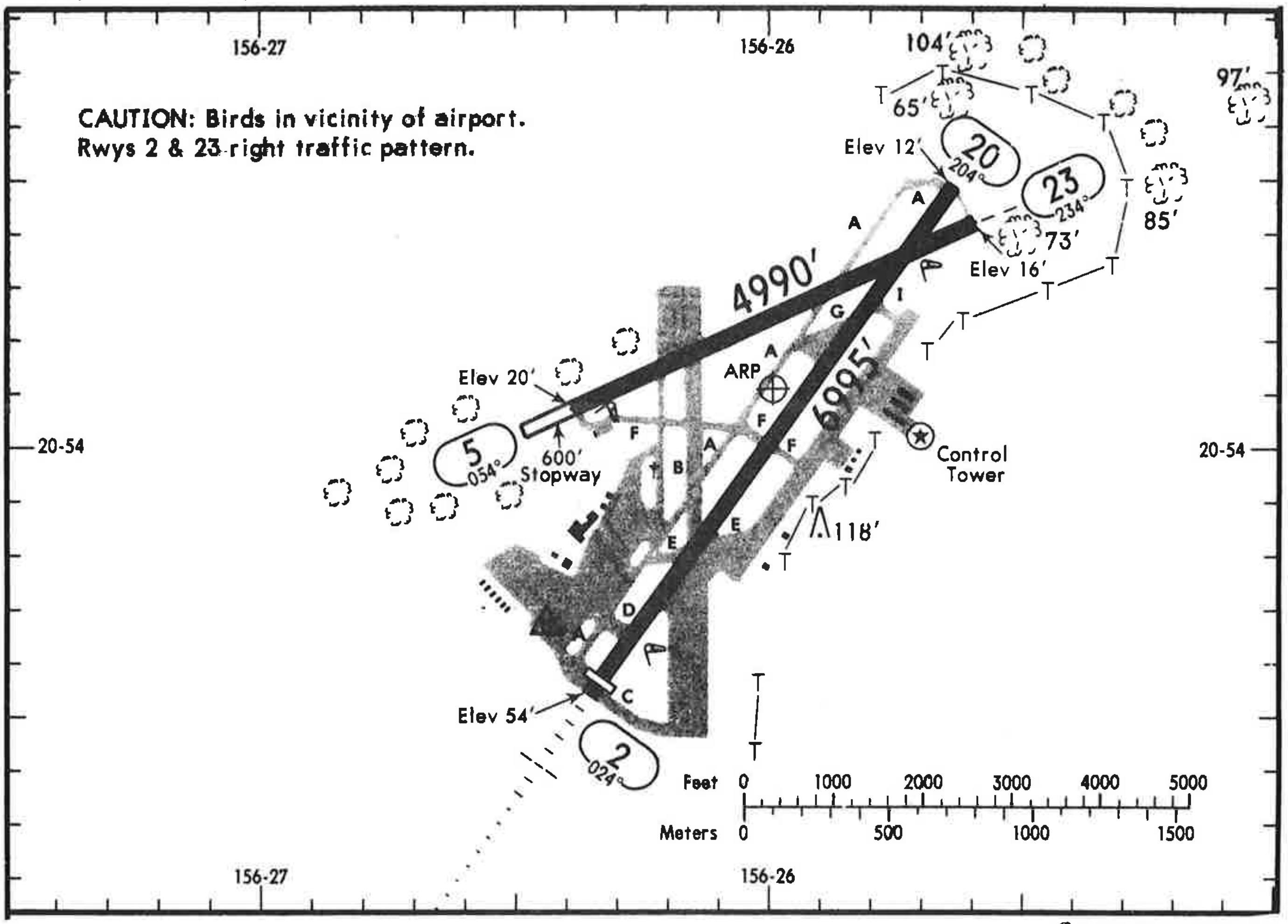


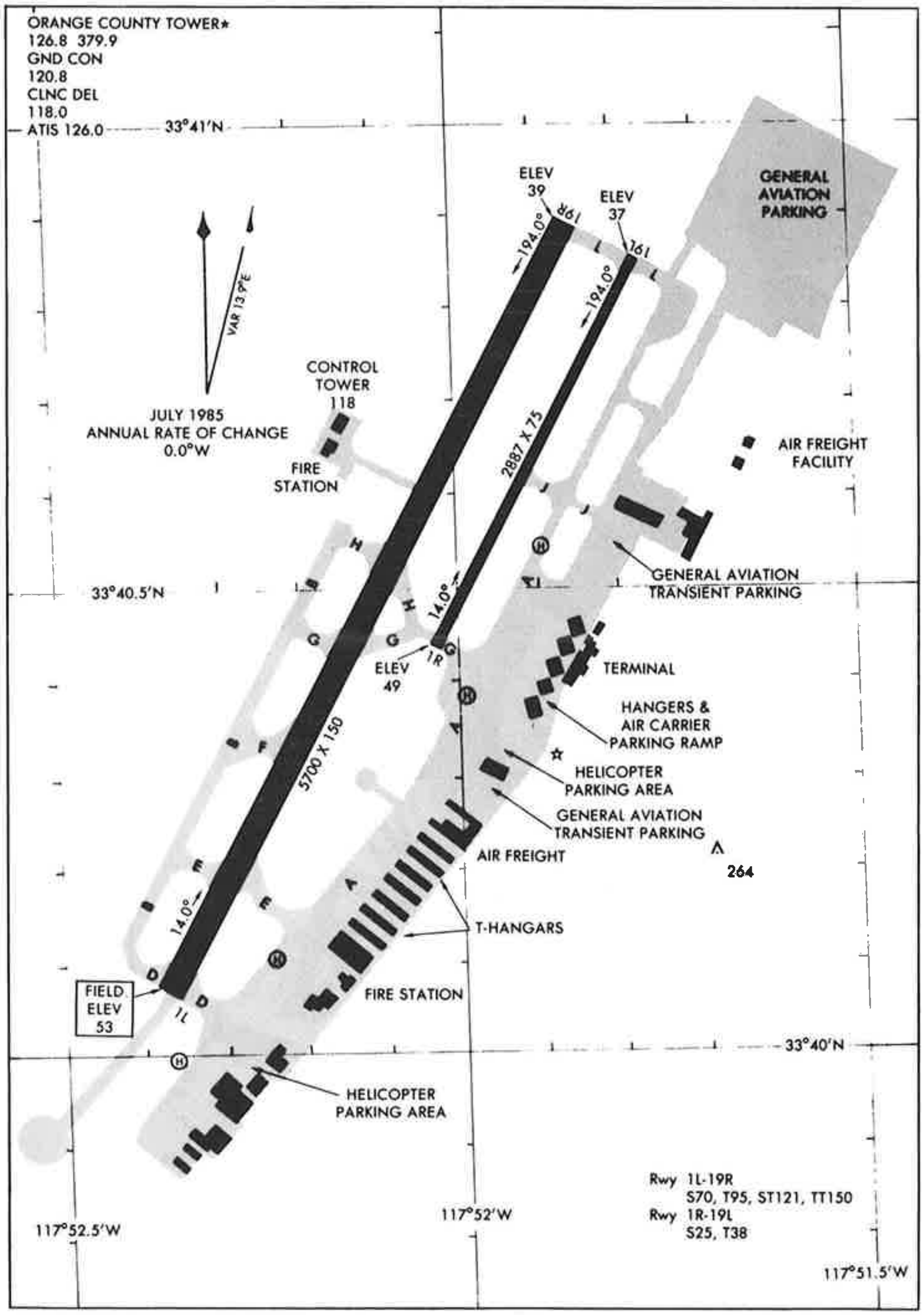
KAHULUI, HAWAII

KAHULUI

N20 54.1 W156 26.0

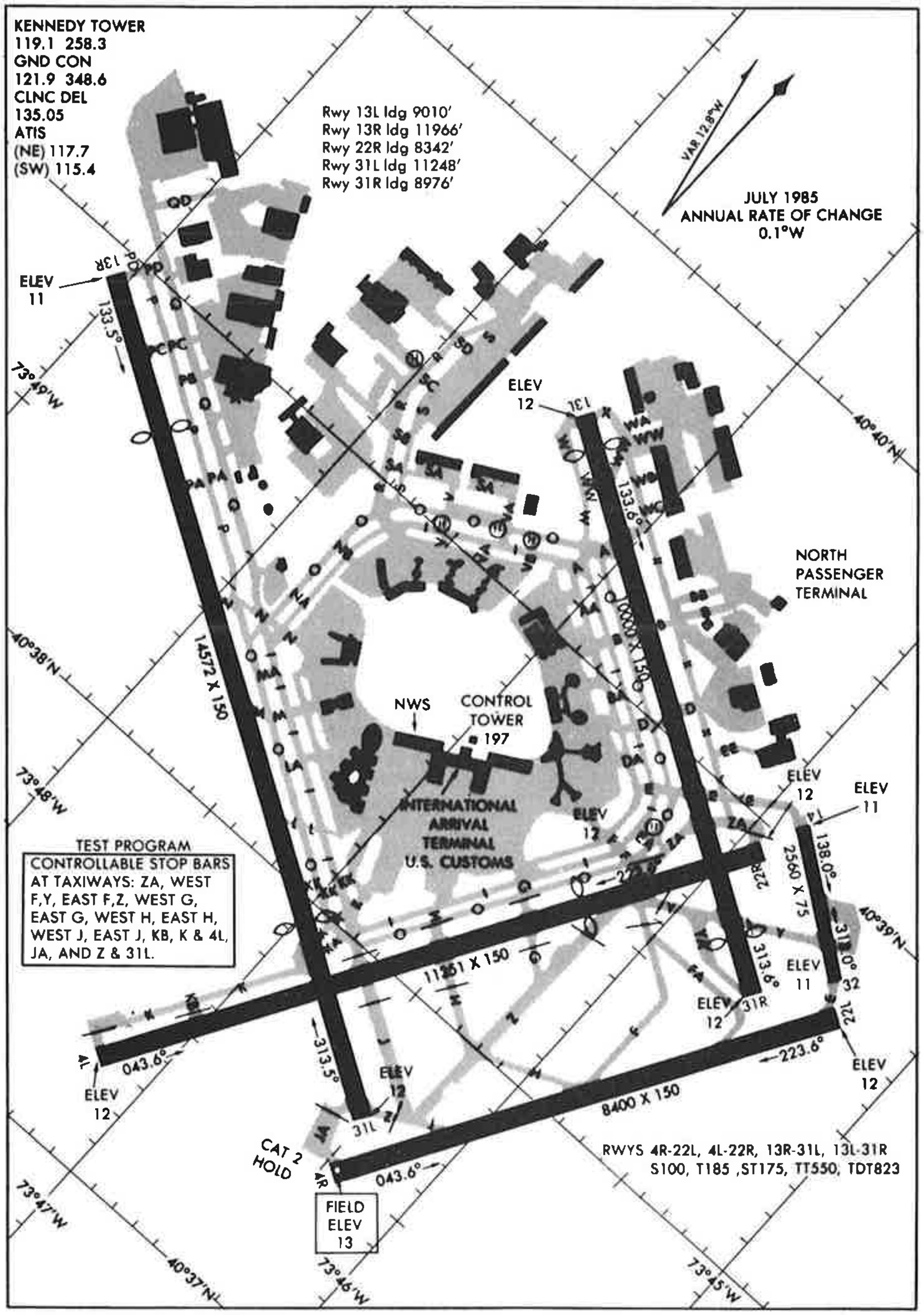
Elev 54′ *Var* 11°E





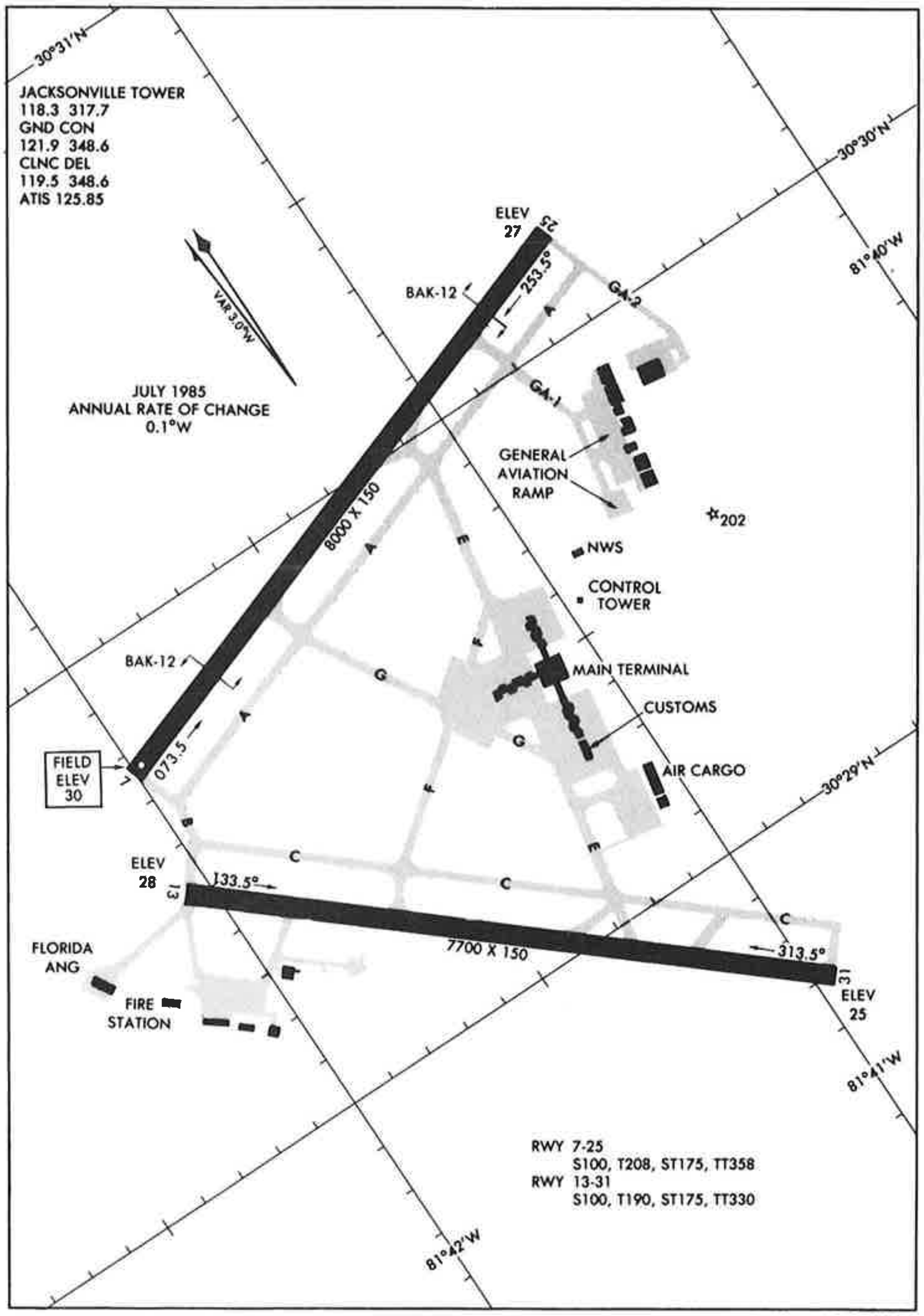
AIRPORT DIAGRAM

SANTA ANA, CALIFORNIA
SANTA ANA/JOHN WAYNE ARPT-ORANGE COUNTY (SNA)



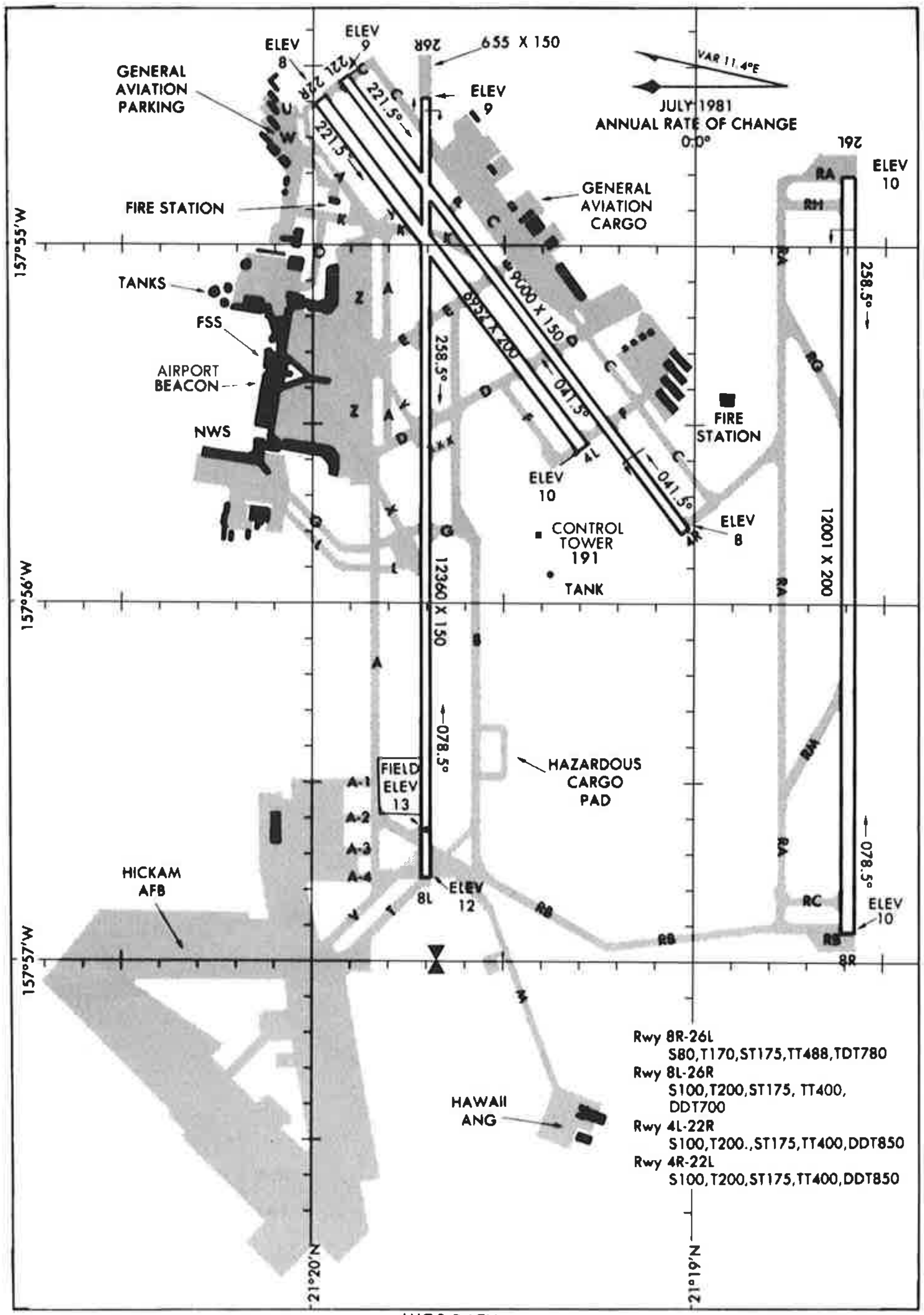
AIRPORT DIAGRAM

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



AIRPORT DIAGRAM

JACKSONVILLE, FLORIDA
JACKSONVILLE INTL (JAX)



AIRPORT DIAGRAM

WGS DATUM

HONOLULU, HAWAII

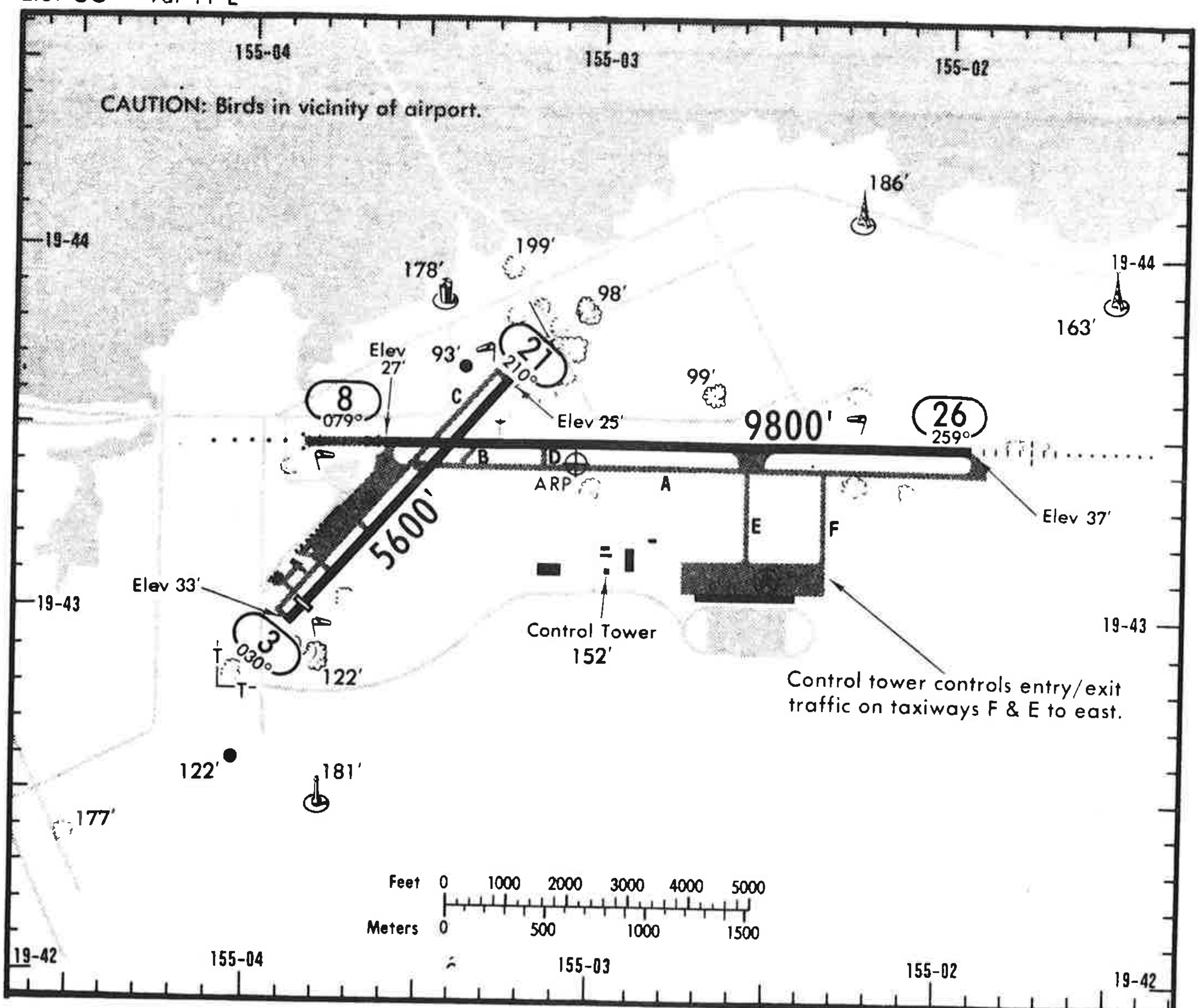
HONOLULU INTERNATIONAL AIRPORT (HNL)

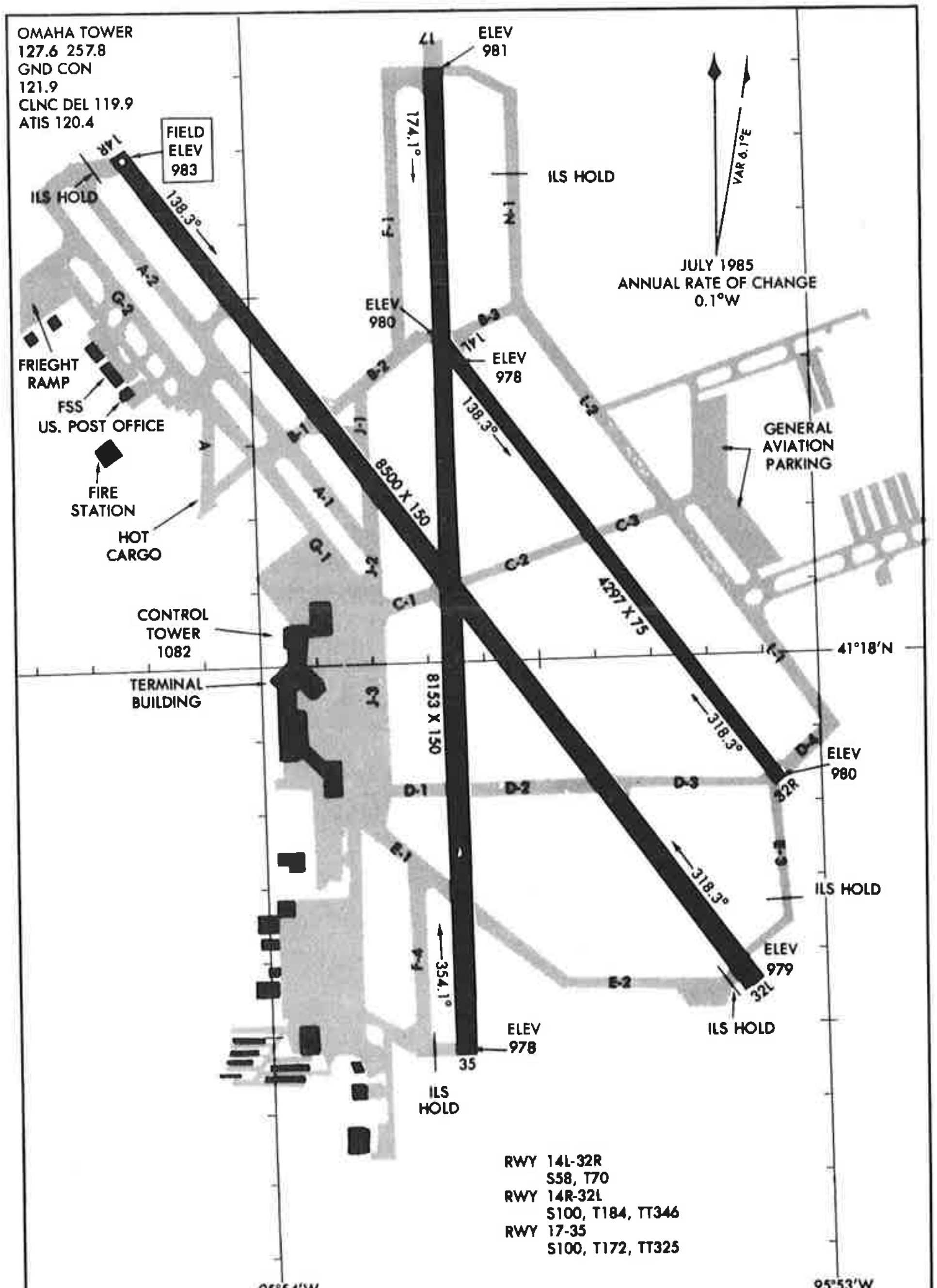
HILO, HAWAII

GENERAL LYMAN

N19 43.4 W155 03.1

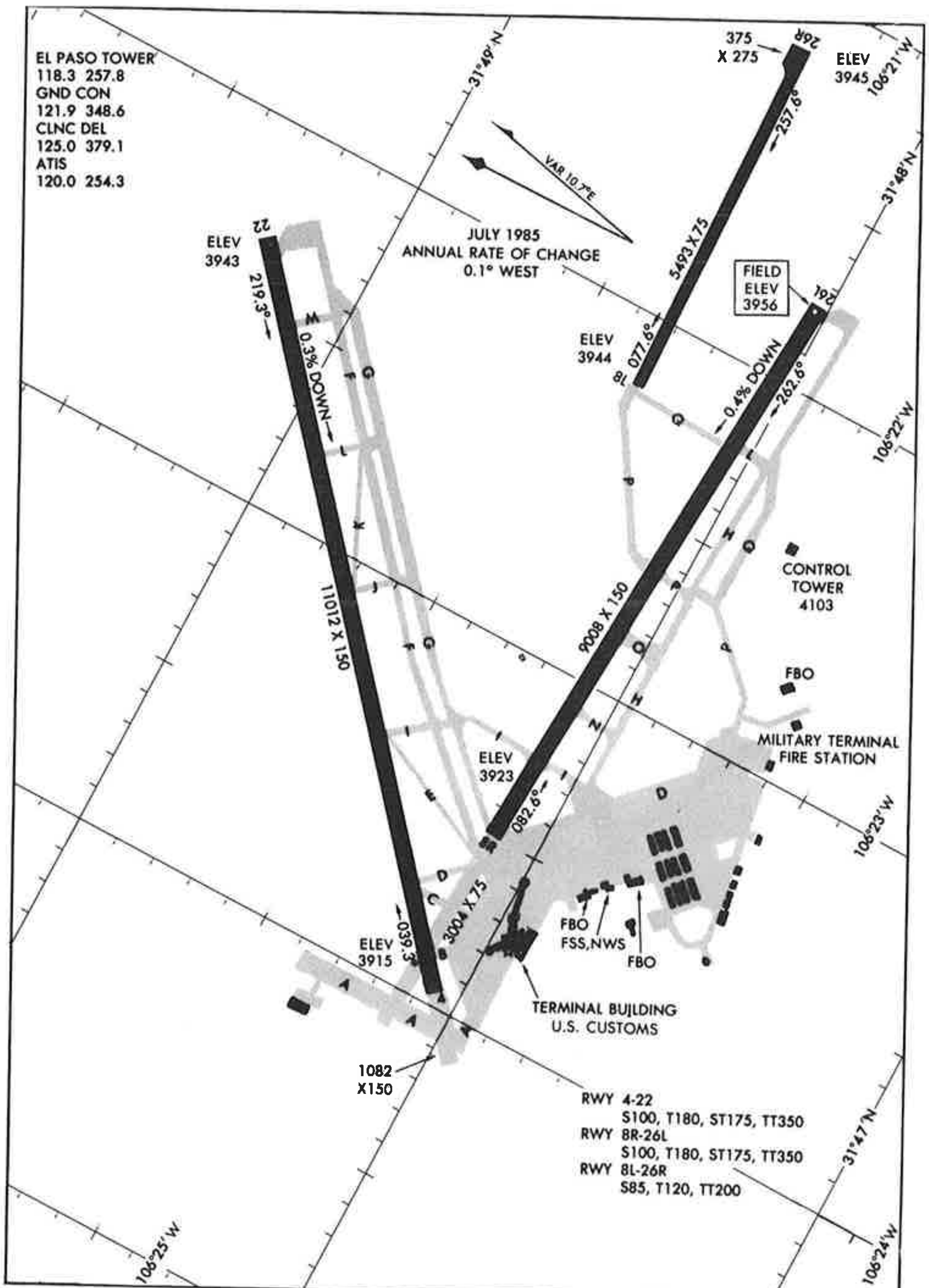
Elev 38′ *Var* 11°E





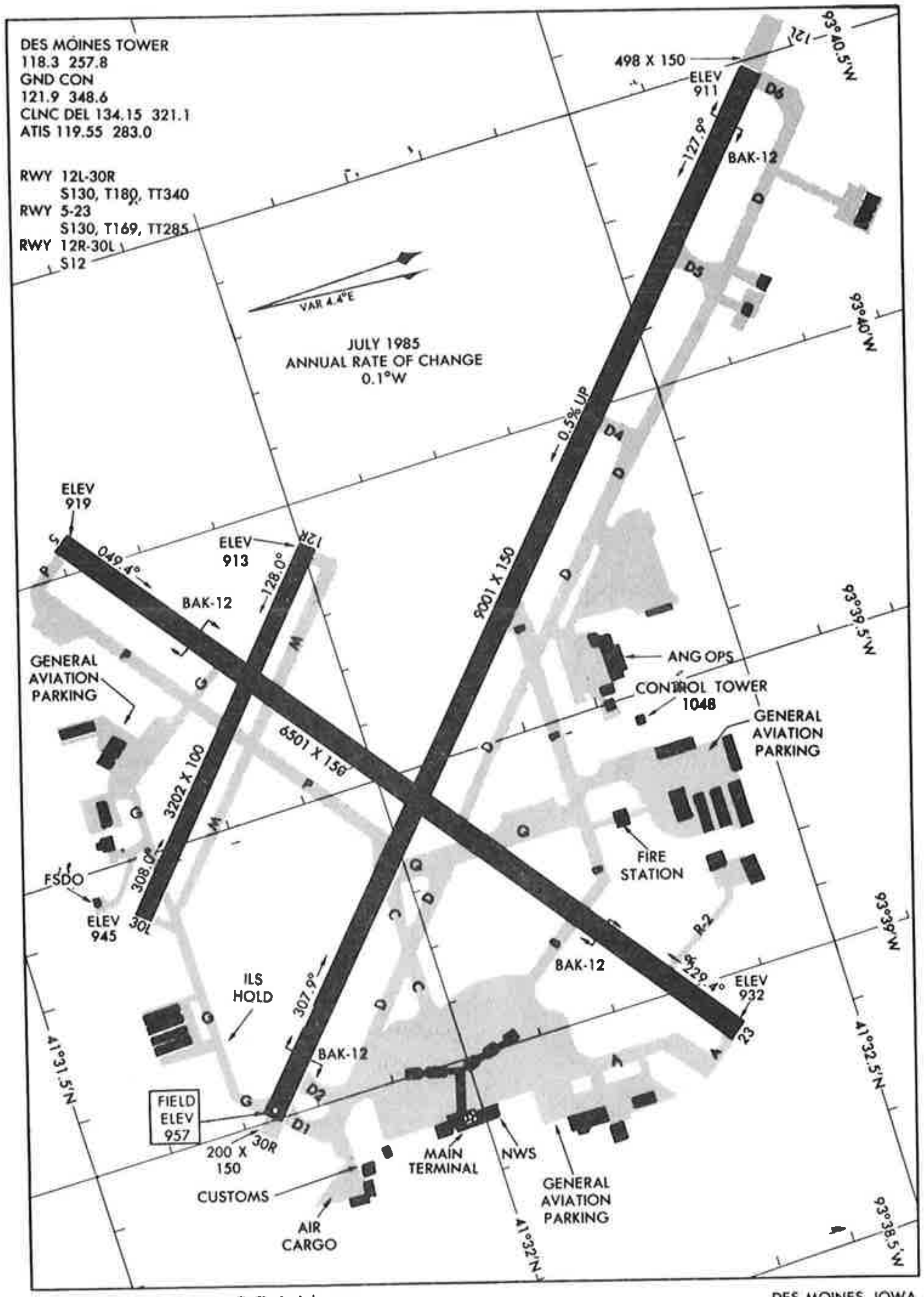
AIRPORT DIAGRAM

OMAHA, NEBRASKA
OMAHA/EPPLEY AIRFIELD (OMA)



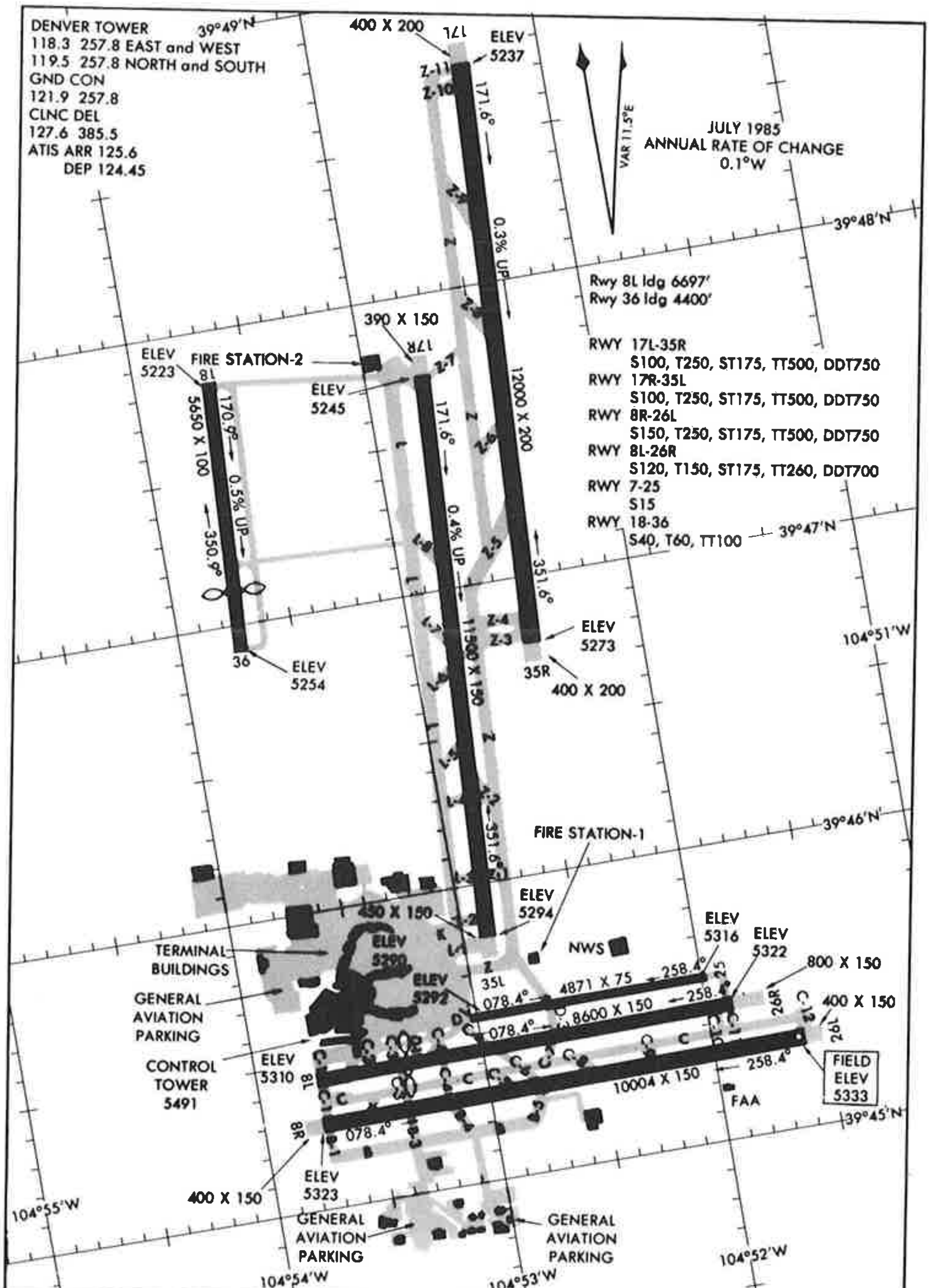
AIRPORT DIAGRAM

EL PASO, TEXAS
EL PASO INTL (ELP)



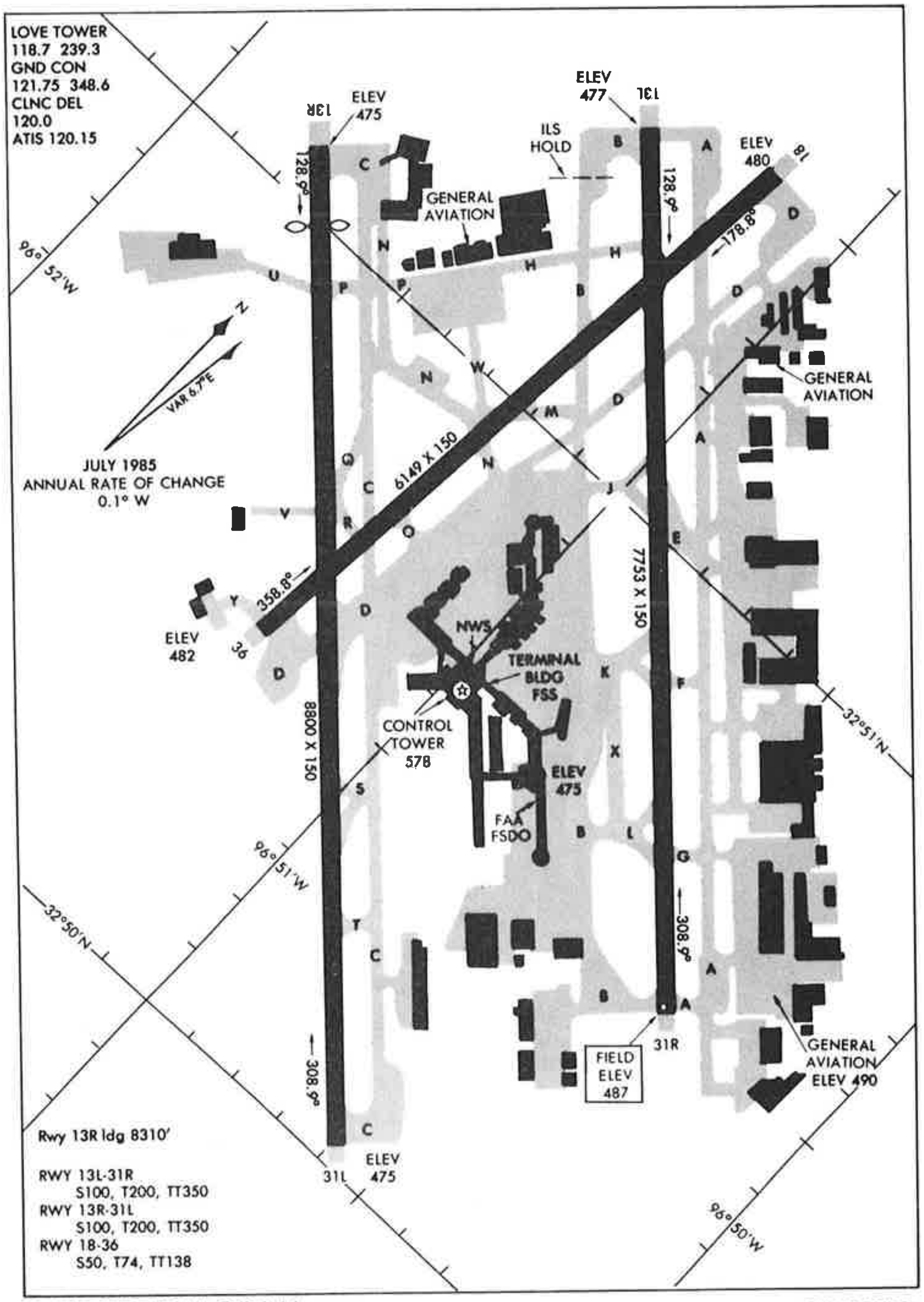
AIRPORT DIAGRAM

DES MOINES, IOWA
DES MOINES INTL (DSM)



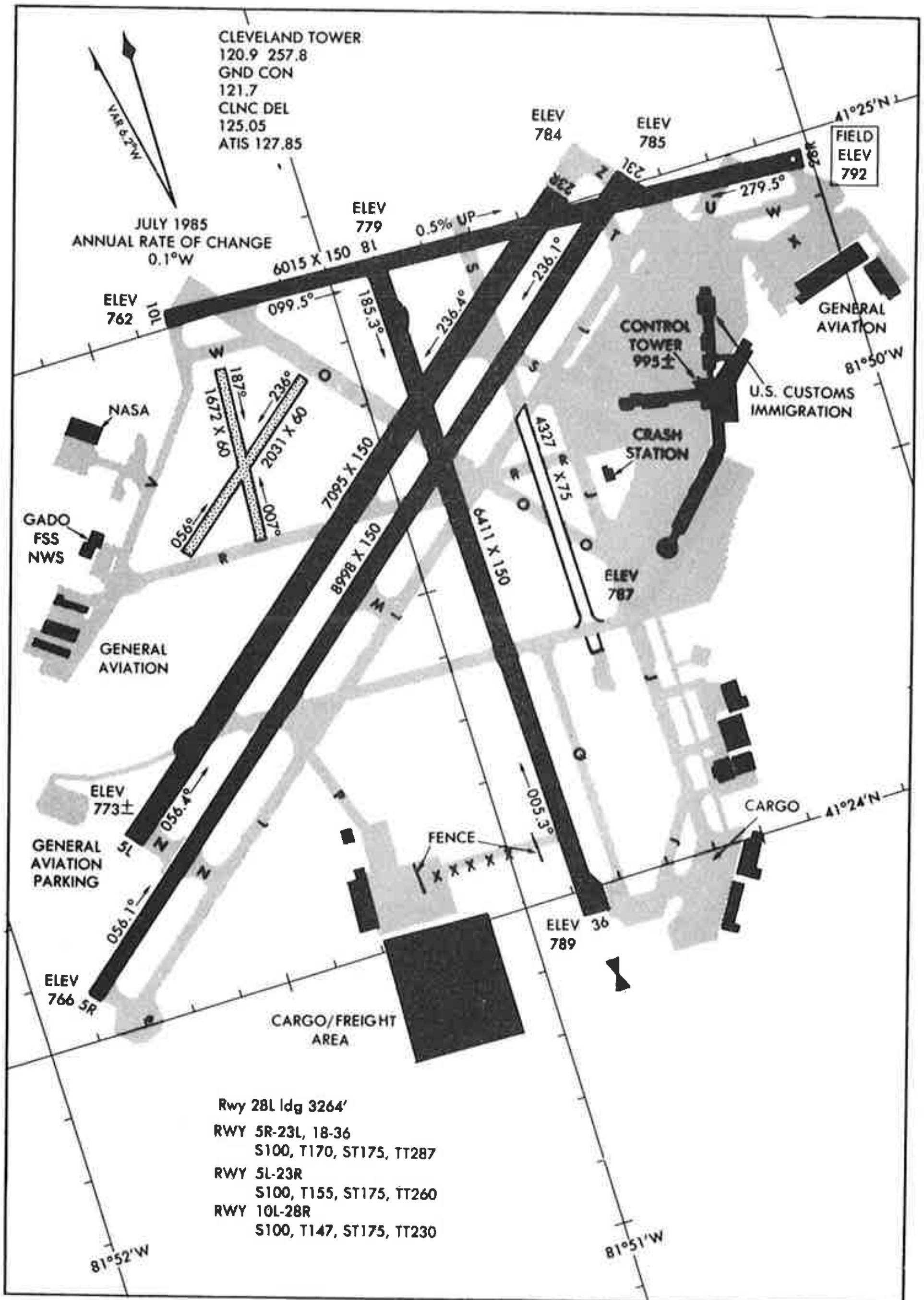
AIRPORT DIAGRAM

DENVER, COLORADO
DENVER/STAPLETON INTL AIRPORT (DEN)



AIRPORT DIAGRAM

DALLAS, TEXAS
DALLAS-LOVE FIELD (DAL)



Rwy 28L ldg 3264'

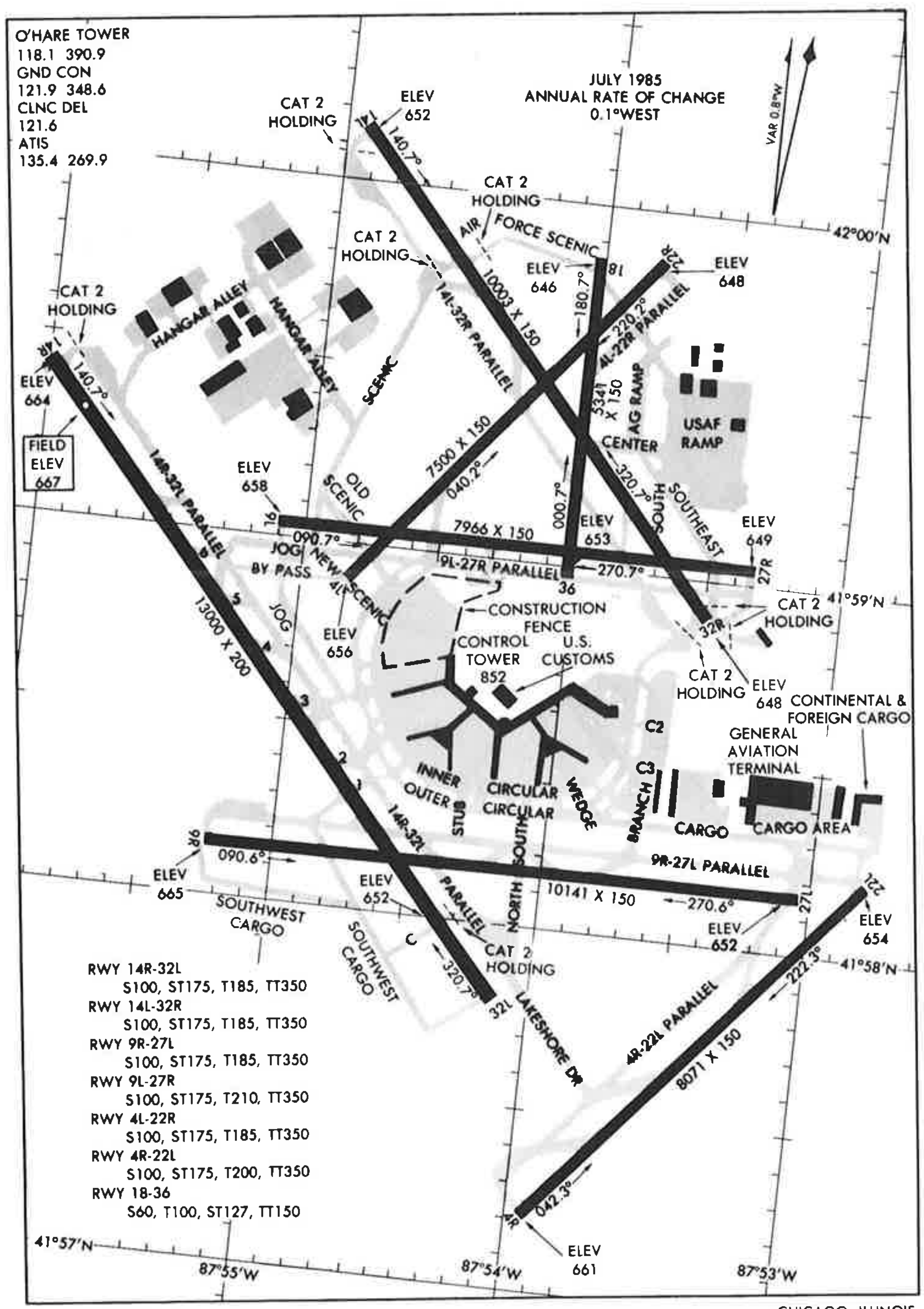
RWY 5R-23L, 18-36
S100, T170, ST175, TT287

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

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

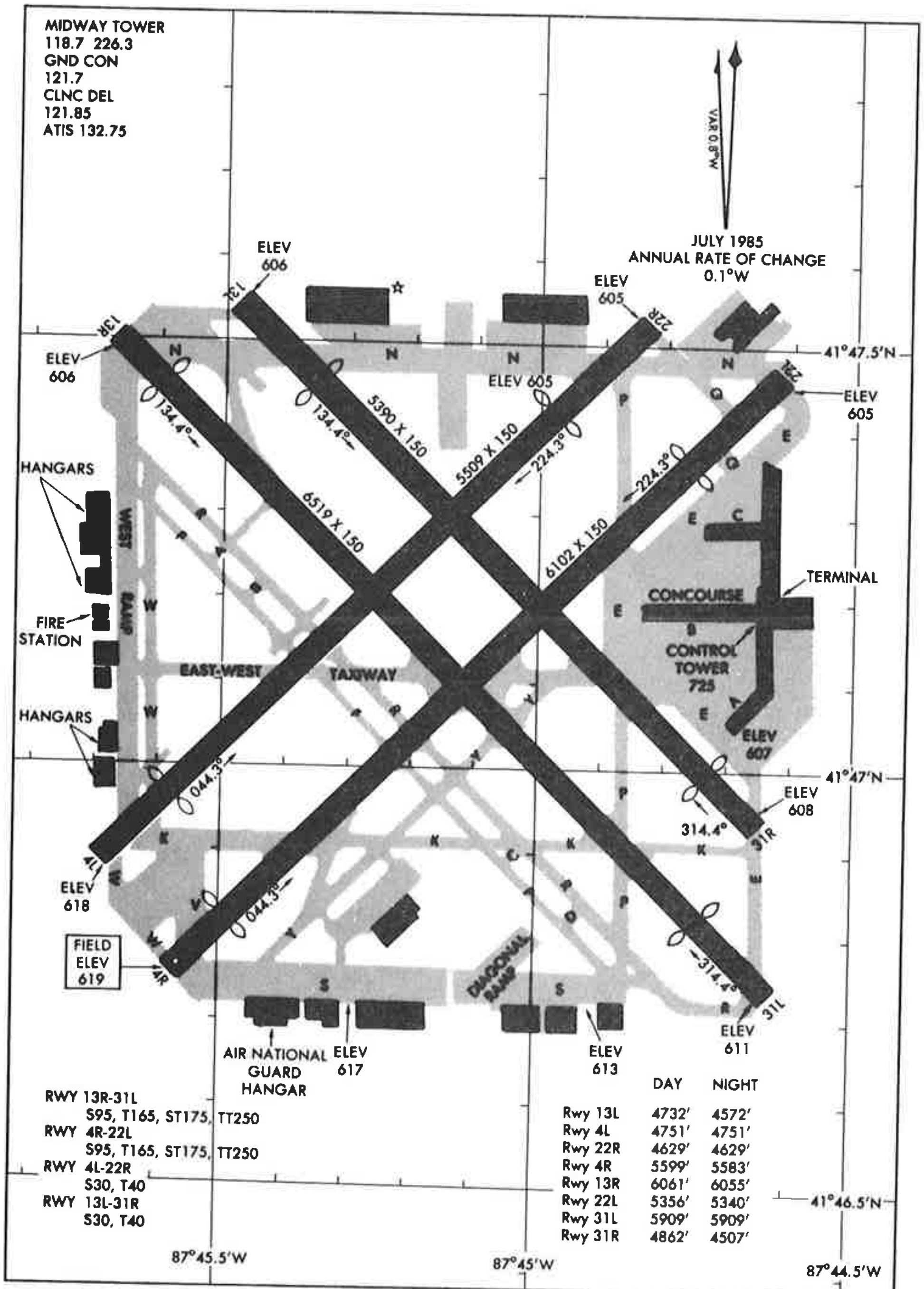
AIRPORT DIAGRAM

CLEVELAND, OHIO
CLEVELAND-HOPKINS INTL (CLE)



AIRPORT DIAGRAM

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



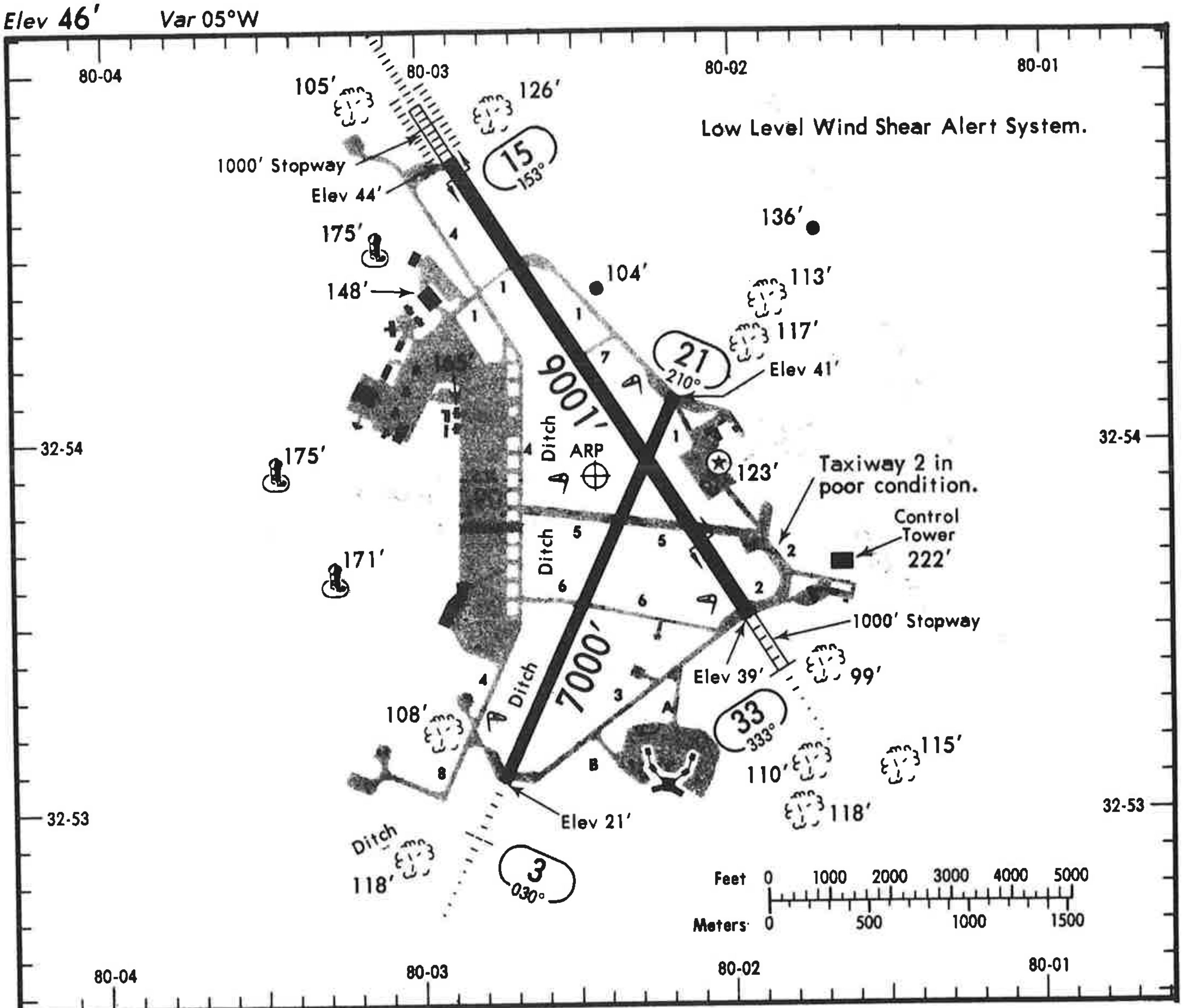
AIRPORT DIAGRAM

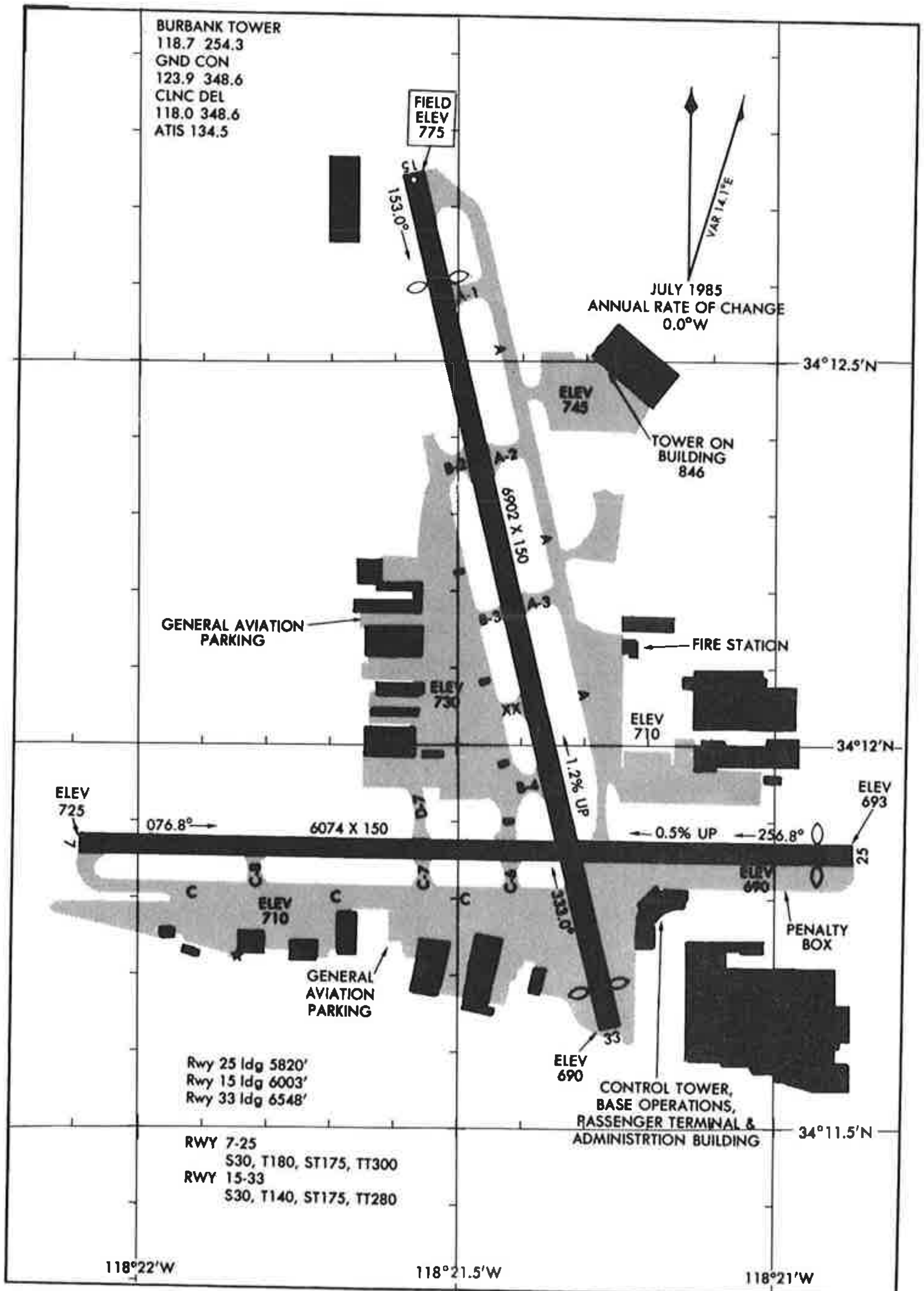
CHICAGO, ILLINOIS
CHICAGO MIDWAY (MDW)

CHARLESTON, S CAR
CHARLESTON AFB/INTL

N32 53.9 W080 02.4 CHS 113.5 - On Airport

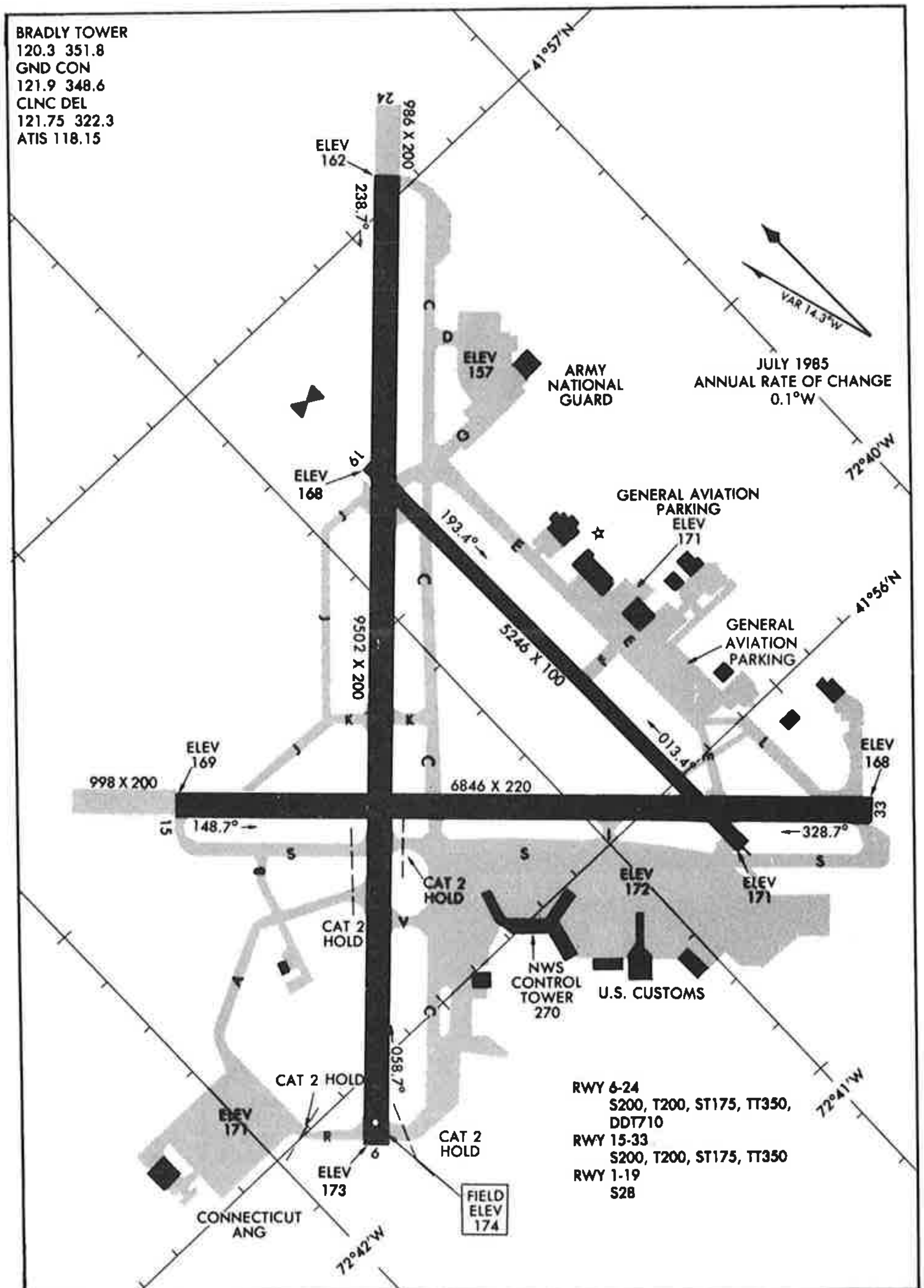
Elev 46' *Var* 05°W





AIRPORT DIAGRAM

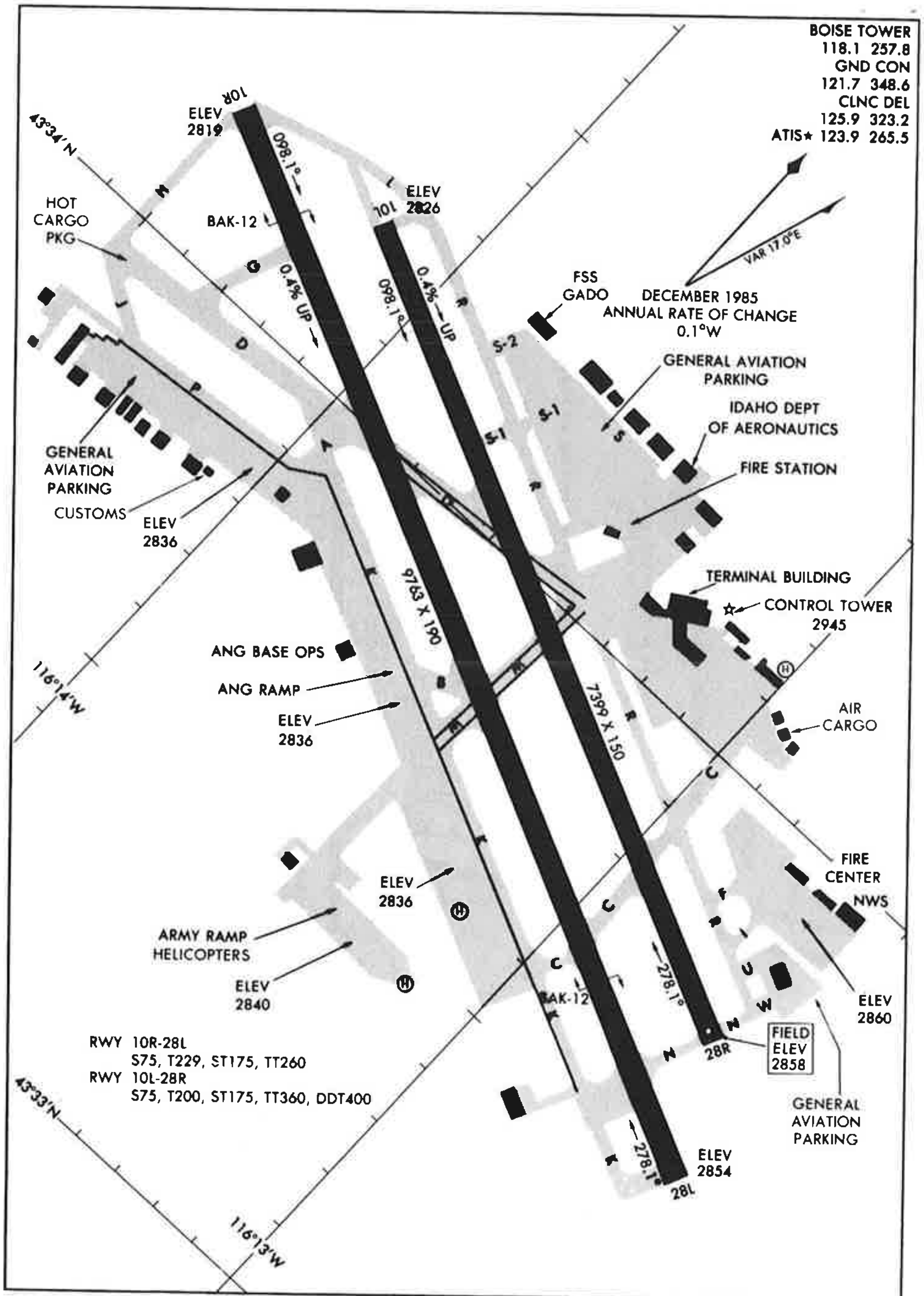
BURBANK, CALIFORNIA
BURBANK-GLENDALE-PASADENA (BUR)



AIRPORT DIAGRAM

WINDSOR LOCKS, CONNECTICUT

WINDSOR LOCKS/BRADLEY INTL (BDL)



AIRPORT DIAGRAM

BOISE, IDAHO
BOISE AIR TERMINAL (GOWEN FIELD)(BOI)

AIRPORT

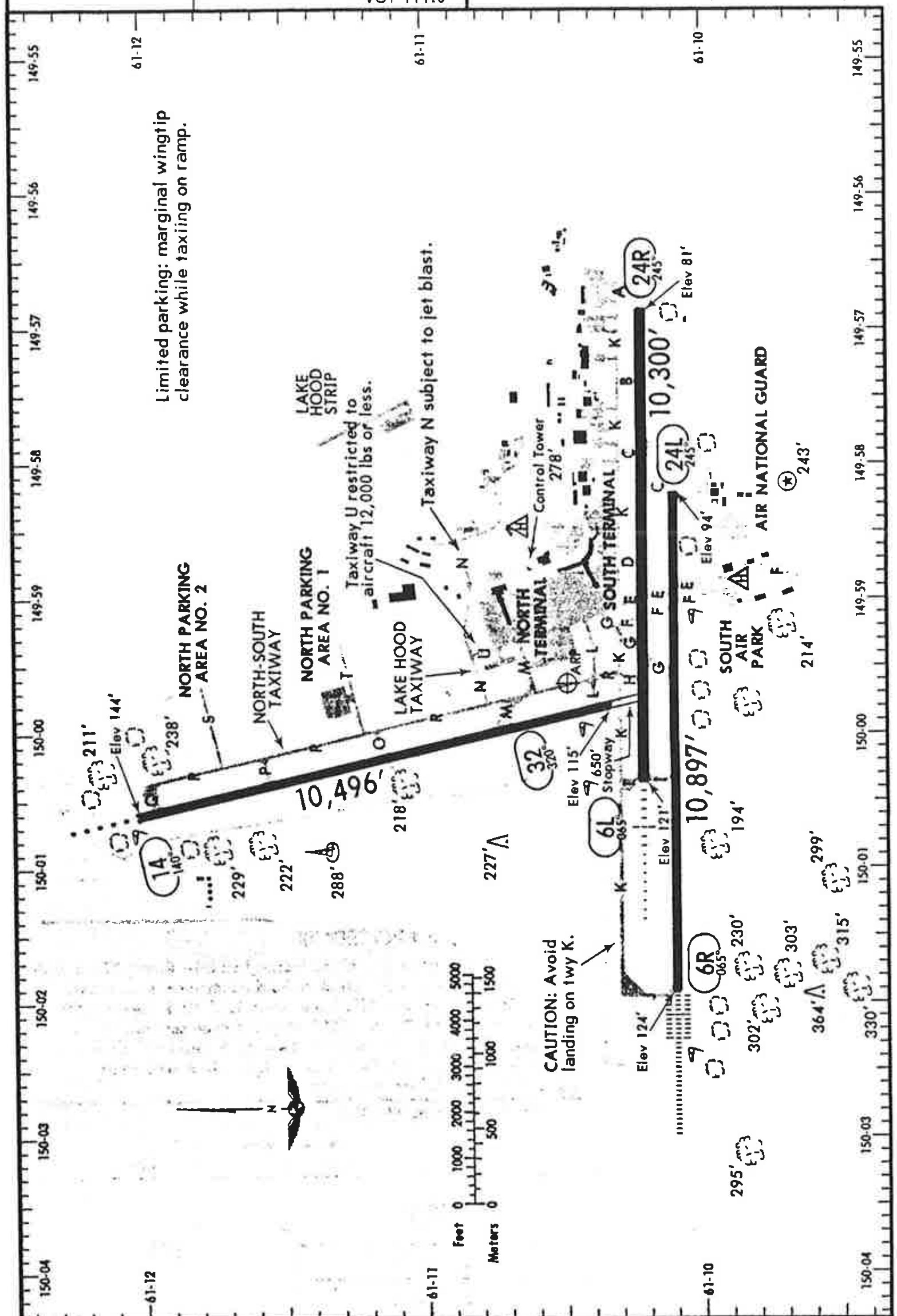
ANCHORAGE, ALASKA

ANCHORAGE INTL

ATIS 118.4 ANCHORAGE Clearance 119.4 Ground 121.9 Tower 118.3	ANCHORAGE Departure (R) 330° -065° 3000' & above 118.6 330° -065° below 3000' 119.1 066° -169° 4000' & above 123.8 066° -169° below 4000' 126.4 170° -244° 123.8 245° -329° 118.6 VOT 111.0

051.9°/6.3 From ANC 114.3 N61 10.5 W149 59.6

Var 25°E *Elev* 144'

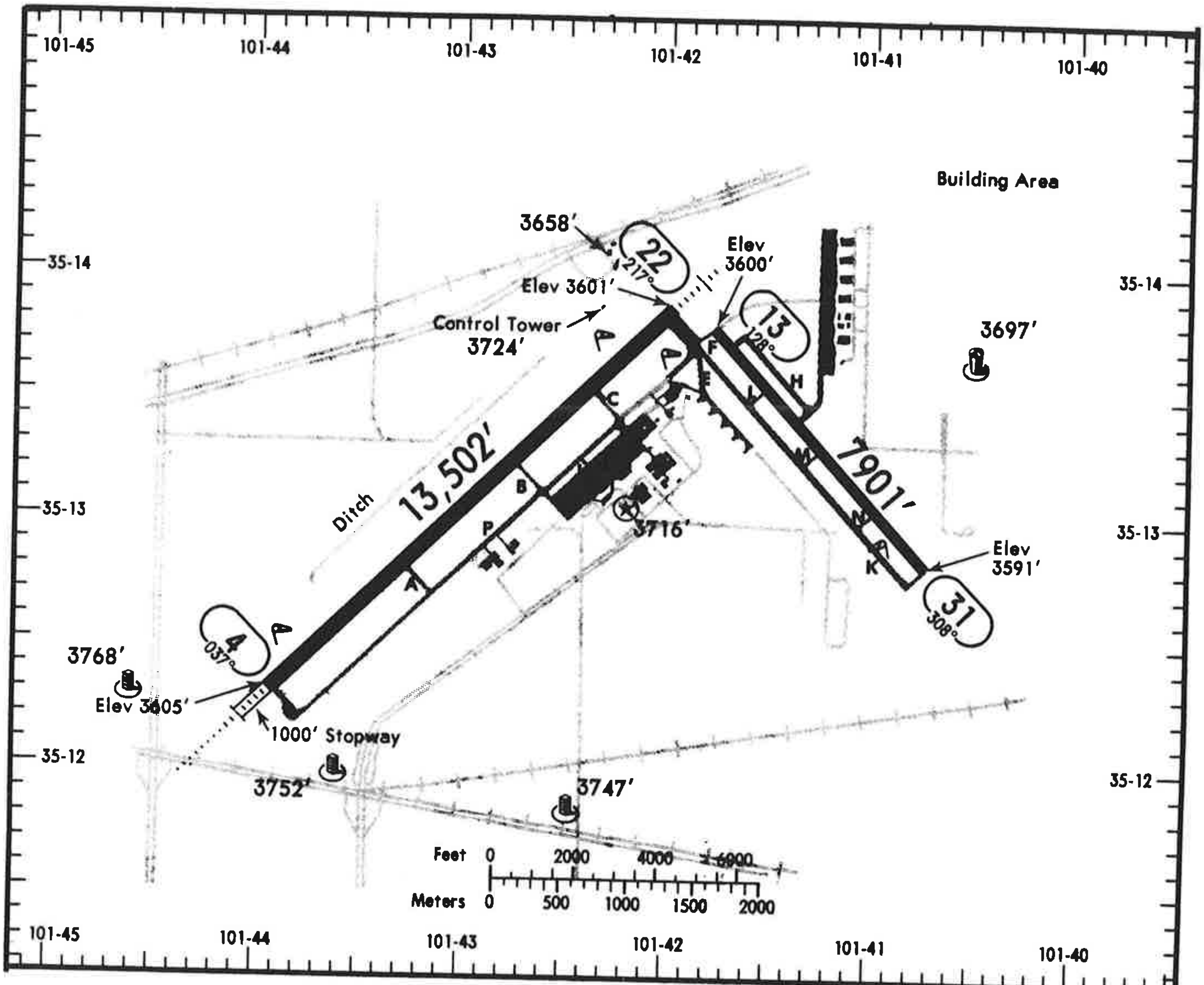


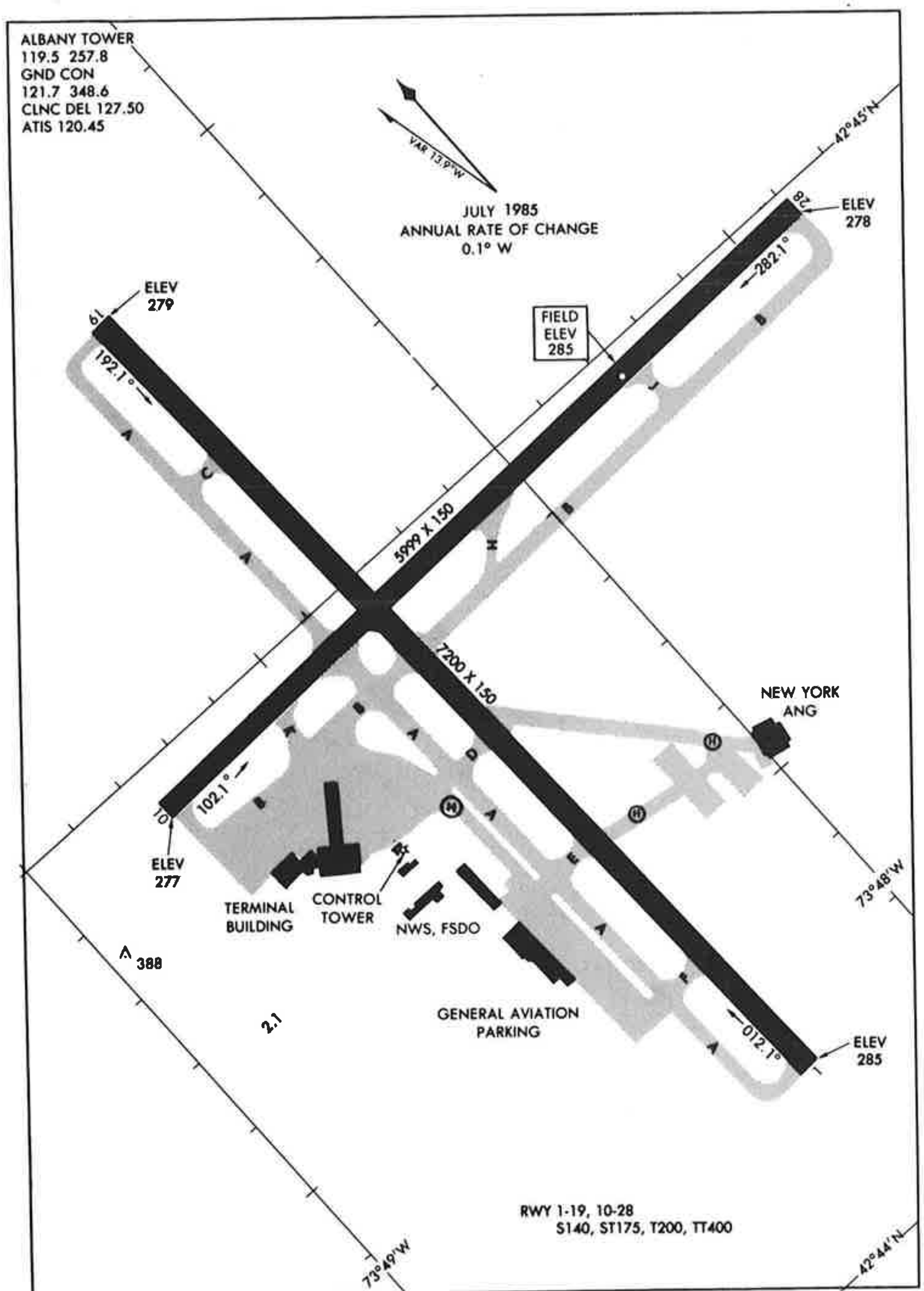
AMARILLO, TEXAS

AMARILLO INTL

N35 13.2 W101 42.3 207.8°/5.2 From AMA 117.2

***Elev* 3605′ *Var* 09°E**





AIRPORT DIAGRAM

ALBANY, NEW YORK
ALBANY COUNTY (ALB)

TABLE B-3. RUNWAY EXIT ADVISORY SYSTEM

EXPECTED COMPLETION DATE:	Ongoing	
FUNDS	FY 1989	*FY 1990
	$534,000	-0-

Statement Of Research Issue

The time an arriving aircraft remains on the runway before turning off onto a taxiway affects the capacity of the airport by blocking the next arriving or departing aircraft. Methods to reduce ROT and increase an airport's capacity.

Research Approach

The selection of a runway exit is based on previous traffic flow, pilot preference, and runway surface conditions including slush and snow. Improved runway slush and snow sensors will be evaluated for system accuracy and will be evaluated for system accuracy and reliability. New alternative designs for taxiing routes and geometrics will be developed and tested and compared with existing design. A softground arresting system based on foam and gravel materials will be field tested.

FY 1989 Activities

- Development of slush/snow detection measurement systems.
- Evaluations of effectiveness of current taxiway geometrics and new alternative designs to improve traffic flow.
- Evaluation of soft-ground materials for stopping aircraft overrunning runways.

---

* This project is related to B-1, Airport Design and Configuration and is combined into a new project, B-23, Reduced Runway Occupancy Time in FY 1990.

TABLE B-4. AIRPORT SAFETY PLANNING

EXPECTED COMPLETION DATE:	Ongoing	
FUNDS	FY 1989 $602,000	FY 1990 $663,000

Statement Of Research Issue

Improve capacity and safety at airports by reducing effects of birds and wildlife on airport operations.

Research Approach

A computer data base will be developed with information on bird and animal strikes. In addition, a study on the physiological response of birds to different types of aircraft is being conducted. This information will be used to develop a bird hazard assessment model which will be used in predicting the probability of bird strike occurrences, given the bird density, aircraft frontal area, number of operations, and/or frequency of flight through areas of known bird concentrations.

FY 1989 Activities

Collection of bird strike data and study on physiological response of birds to different types of aircraft for development of Bird Hazard Assessment Model to be completed in FY 1991.

TABLE B-5. AIRPORT SURFACE VISUAL CONTROL (LIGHTING)

EXPECTED COMPLETION DATE:	Ongoing	
FUNDS	FY 1989	FY 1990
	$677,000	$1,149,000

Statement Of Research Issue

- Improve safe on-airport aircraft movement and control by improving airport lighting and marking during runway entry and turn-off, departure and crossing.

FY 1989 Activities

- Development of standards for visual aids in different visibility conditions.
- Evaluate lighted signs for IFR operations.
- Development of lighting and marking for taxiway intersections.
- In-service evaluation of lighted holdlines at an operational airport.

FY 1990 Activities

- Continue research effort to develop standards for visual aids in different visibility conditions.

This effort will be completed in 1991 with the development of standards for signs and lights for taxiways, taxiway intersections, and runway exits. This project will provide implaned signs and lights for capacity improvement demonstration projects.

TABLE B-6. AIRPORT SAFETY SUPPORT SYSTEMS

EXPECTED COMPLETION DATE:	Ongoing	
FUNDS	FY 1989	FY 1990
	$356,000	$666,000

Statement Of Research Issue

Reduce or prevent passenger injuries and fatalities associated with postcrash fires and to improve the cost effectiveness of present and future firefighting services.

FY 1989 Activities

- Continue evaluation of foam auxiliary and special-purpose firefighting agents, equipment, and procedures to reduce capital costs and manpower requirements that will be completed in FY 1990.

- Continue to investigate effectiveness of various combinations of agents for improved firefighting capability that will be completed in FY 1992.

FY 1990 Activities

- Initiate test and evaluation of hand-held cabin penetration devices used to introduce agents into the cabin, and performance of new firefighting vehicles.

TABLE B-7. PRECISION RUNWAY MONITOR-HIGH DATA RATE

EXPECTED COMPLETION DATE: 1993--First Operational Site

FUNDS		FY 1989	FY 1990
		$5,400,000	$2,966,000
	F&E	5,000,000	
		$10,400,000	

Statement Of Research Issue

Evaluation of the use of a high data rate precision beacon radar system at Raleigh-Durham, North Carolina, allowing radar separation of aircraft on simultaneous independent approaches under instrument meteorological conditions to parallel runways separated by less than 4,300 feet.

FY 1989 Activities

- In FY 1989, field demonstrations, data collection, and evaluation will be continued.

- Evaluation of the system will continue in FY 1989/1990 with preparation of procurement specifications and requests for proposals for production units.

TABLE B-8. PRECISION RUNWAY MONITOR-BACK-TO-BACK

EXPECTED COMPLETION DATE:	1991-First operational site	
FUNDS	FY 1989	FY 1990
	$3,097,000	$13,500,000

Statement Of Research Issue

Evaluate the use of a back-to-back Mode S antenna precision radar system at Memphis, Tennessee, allowing radar separation of aircraft on simultaneous independent approaches under instrument meteorological conditions to parallel runways separated by less than 4,300 feet and converging runways.

FY 1989 Activities

- Data reduction will be completed and procurement specifications will be prepared for incorporating the back-to-back antennas in production Mode-S systems. Funds ($13.5 million) have been included in the FY-90 Facilities and Equipment budget for procurement and installation of the first operational system at Memphis in 1991. The remaining six airports having parallel runways that are to receive this type monitor (Mode-S with back-to-back antennas) will be funded in subsequent years.

TABLE B-9. TERMINAL/LANDSIDE TRAFFIC MODELING

EXPECTED COMPLETION DATE:	1993	
FUNDS	FY 1989 $350,000	FY 1990 $350,000

Statement Of Research Issue

There is a significant need to improve/enhance the terminal groundside capacity of airports in moving passengers through the terminal between modes of transportation. Airport capacity gains and delay reduction can be accomplished through more efficient terminal design and planning. Analytical simulation tools are needed in evaluating and optimizing terminal designs.

Research Approach

The agency currently has high-technology computer simulations to evaluate the airfield designs, but computer simulation capabilities for terminal designs are not available. Once these simulation capabilities are available, airports can be evaluated as to their combined efficiency.

An analysis and evaluation of existing computer simulation models for terminal design will first be completed. Several airport designs will be tested if it is determined that any existing simulation model can perform this work. If adequate models are not available, an evaluation of existing software programs will be made to determine if the essential aspects of terminal design can be analyzed using existing software programs.

FY 1989 Activities

- Analysis/evaluation of two known existing simulation models.
- Preparation of a report on existing simulation models and run at least two test locations if any models can perform adequate simulation.
- Recommendation of improvements of existing or new components for new software programs.

FY 1990 Activities

Work will proceed on the development of a documented microcomputer-based, dynamic terminal building simulation model.

TABLE B-10. AIRPORT CAPACITY ENHANCEMENT PLANNING

EXPECTED COMPLETION DATE:	Ongoing	
FUNDS	FY 1989	FY 1990
	$635,000	$1,447,000

Statement Of Research Issue

There is a continuing requirement to identify potential capacity enhancements and their benefits and to report on the status of new airport capacity initiatives.

Research Approach

Prepare the annual Airport Capacity Enhancement Plan, collect and analyze data on the Nation's capacity problem, and survey locations for possible application of new technology. These efforts use the combined resources of FAA, the Transportation Systems Center, and contractor support. This planning process is continuous, adapting as necessary to respond to changes in available airport capacity. The Airport Capacity Enhancement Plan is published annually and identifies approaches to improve airport capacity at the Nation's top 100 airports. Benefits can also be realized at other airports. The plan focuses attention on needed airport improvements and provides the status of measures anticipated by the FAA to increase capacity.

FY 1989 Activities

Data collection, analysis, and publication of the Airport Capacity Enhancement Plan.

FY 1990 Activities

Work will continue in performing analytical studies of benefits of capacity enhancement projects including new air traffic procedures, new systems and equipment, new planning techniques, airport development at specific airports, and publication of the Airport Capacity Enhancement Plan for 1990.

TABLE B-11. SIMULATION MODEL DEVELOPMENT AND EVALUATION

EXPECTED COMPLETION DATE:	Ongoing	
FUNDS	FY 1989	FY 1990
	$1,568,000	$1,465,000

Statement Of Research Issue

In past years, several computer models have been developed that enable airport planners to simulate air traffic in the terminal area and on the airport surface. The models have proven critical in identifying and evaluating airport capacity enhancements. In 1989, work will continue on enhancing these models and adding features that will make them easier and more efficient to use.

Research Approach

SIMMOD has been used to analyze operational constraints of contemplated improvements to airspace and airports and their effect at a variety of locations. However, the program is costly and labor intensive to run. Additionally, a user-friendly public version is needed so that the entire aviation community can benefit from its variety of applications.

FY 1989/1990 Activities

- Completion of a public version of SIMMOD with 27 specific enhancements to make it user friendly (prototype Public Version FY-89).
- Training course/manual updating (FY 1989/1990).
- Development of graphic capability (FY 1990).
- Debugging and system support (FY 1989).

TABLE B-12. AIRPORT CAPACITY TASK FORCE STUDIES

EXPECTED COMPLETION DATE:	Ongoing	
FUNDS	FY 1989	FY 1990
	$913,000	$565,000

Statement Of Research Issue

Task forces composed of representatives from the airlines, airport operators, the military, airport consultants, ATA, FAA, ALPA and other users and AOPA are convened at congested airports to explore methods of enhancing airport capacity and reducing aircraft delay. Simulation models of airport airside operations are used. Output from these models enables the task force to determine the benefits of proposed improvements in terms of capacity increases, delay reductions, and costs.

The goal of each task force is to produce a final report containing an action plan detailing the results of the task force effort. This action plan contains the recommended improvements with capacity increases and annual delay cost reductions resulting from implementation of the improvements.

Research Approach

The FAA has established a multi-year program to study eight high density airports per year.

FY 1989 Activities

Complete and/or start studies at Miami, Memphis, Boston, Phoenix, Salt Lake City, Kansas City, Washington-Dulles, Seattle, Philadelphia, Los Angeles, Houston, Orlando, and Chicago.

FY 1990 Activities

Start six new airport capacity task force studies at Las Vegas, Tampa, Philadelphia, Cincinnati, Minneapolis, and Pittsburgh.

TABLE B-13. CAPACITY DEVELOPMENT

EXPECTED COMPLETION DATE:	Ongoing	
FUNDS	FY 1989 $1,808,000	FY 1990 $2,984,000

Statement Of Research Issue

Improve airport capacity by exploring methods of more effectively utilizing the capacity of multiple runway configurations in Instrument Meteorological Conditions.

Research Approach

Continuation of concept development and benefit assessment to support ultimate capacity enhancement procedures relating to closely spaced parallel runways, converging approaches and operations to triple parallel runways.

FY 1989 Activities

- Collection and analysis of data on aircraft navigation performance during independent approaches to closely spaced parallels. The final product will be a technical report to be completed in 1990.

- Real-time controller simulation of dependent approaches to closely spaced parallel runways from two to one and a half mile separation. Final product will be a technical report to be completed in FY 1990.

- Real-time controller simulation of independent approaches to closely spaced parallel runways. Final product will be a technical report to be completed in FY 1990.

- Development and analysis of procedures for dependent instrument approaches to converging runways. Final product will be a draft ATC procedure and technical report to be completed FY 1989.

- Development and analysis of triple IFR procedure. Final produce will be procedural development and identification of candidate U.S. airports for triple application, and a technical report to be completed in FY 1989.

- Real-time controller simulation of triple IFR procedure. Final product will be a technical report to be completed in FY 1989.

- Flight demonstration of triple IFR procedure. Final product will be a flight demonstration at a selected airport in FY 1991.

- Development of a goal-oriented methodology for focusing FAA's overall airport capacity R&D programs. Final product will be a technical report to be completed in FY 1989.

TABLE B-14. WAKE VORTEX

EXPECTED COMPLETION DATE:	Ongoing	
FUNDS	FY 1989	FY 1990
	$1,699,000	$570,000

Statement Of Research Issue

The objective of the Wake Vortex Project is to minimize the adverse effects of the aircraft trailing vortex hazard on the flow of air traffic, particularly arrivals and departures at congested airports, to maximize airport capacity while assuring safe operations.

Research Approach

Short term goals for this program will address areas such as: (1) aircraft separation standards; (2) vortices from new generation aircraft, and (3) possible use of LLWAS data for vortex detection at airports.

The last major wake vortex data collection was completed in 1980, and data is required for new generation aircraft (the B-757, B-767, A-310, A-320, etc.) to be used with reduced separation procedures. New data is also needed as part of the effort to allow radar separation of aircraft on simultaneous independent approaches under instrument meteorological conditions to parallel runways separated by less than 4,300 feet and converging runways.

FY 1989 Activities

The following activities will start in FY 1989:

- Upgrade facility, lateral array and laser Doppler velocimeter for data collection.
- Flight testing of B-757/B-767/A-300/BK-117/B-0105 and wake vortex data collection/analysis.
- Continued work on vortex detection systems.
- Complete feasibility study of LLWAS air movements.
- Complete feasibility report on meteorological factors affecting wake vortex behavior.

FY 1990 Activities

- Field testing of LLWAS equipment to detect wake vortex movement.
- Field testing of meteorological factors affecting wake vortices.
- Continue upgrade of the Laser Doppler Velocimeter system.
- Continue flight testing of new generation aircraft.

TABLE B-15. SEPARATION STANDARDS

EXPECTED COMPLETION DATE:	Ongoing	
FUNDS	FY 1989	FY 1990
	$3,557,000	-0-

Statement Of Research Issue

Both the domestic and international aviation user communities have proposed that the vertical separation standard above 29,000 feet be reduced from 2,000 feet to 1,000 feet. 1,000 feet is the current standard below 29,000 feet. If this reduction can be safely accomplished, it is estimated that the domestic user community will save approximately $60 million per year through reduced fuel consumption. In FY 1988, the United States submitted to the ICAO the FAA's safety verification analysis which will be combined with the worldwide effort for international approval and implementation. In parallel with this effort, a data package to support rulemaking within the U.S. was prepared.

In FY 1988, draft guidance material was presented to ICAO on aircraft Minimum Navigation Performance Standards (MNPS) to support horizontal separation standards in airspace without radar monitoring.

In FY 1988, work continued on this draft ICAO guidance material for worldwide Air Navigation (RNAV) procedures and separation standards. The results will be completed and submitted to ICAO for international approval by the end of FY 1989.

FY 1989 Activities

An effort will be initiated by the United States and ICAO to prepare worldwide guidance material for implementing reduction of vertical separation standards above 29,000 feet to 1,000 feet.

This project will be removed from the 08 System Capacity and Airports category in compliance with House/Senate Committees on Appropriations direction to include only direct airport capacity enhancement programs in this category.

TABLE B-16. TERMINAL AIRSPACE ASSESSMENT

EXPECTED COMPLETION DATE:	1990	
FUNDS	FY 1989	FY 1990
	$1,600,000	-0-

Statement Of Research Issue

Airline deregulation, "hubbing," several new airport proposals, and other compelling factors have prompted the redesign of large segments of the Nation's air route structure.

Research Approach

The FAA has developed and improved several computer-based models for analyzing airport capacity. SIMMOD has been used to study airspace problems around major terminal areas such as San Francisco and Boston. In the Dallas Metroplex, modeling is being used to examine options for redesign of airspace and interaction between terminal and en route traffic flows. The results of these studies provide more effective airspace utilization and enhance capacity of the affected airports and airspace system.

FY 1989 Activities

The $1,600,000 for this program will address new critical capacity issues or continue ongoing efforts to evaluate airspace requirements for the proposed new airport at Denver; evaluate airspace for a possible third airport in Chicago; evaluate airspace impacts resulting from the major expansion of the Dallas/Ft. Worth airport, and evaluate major airspace reconfigurations at Los Angeles and Kansas City.

TABLE B-17. LONG TERM AIRPORT SYSTEM PLAN

EXPECTED COMPLETION DATE:	1989	
FUNDS	FY 1989	FY 1990
	$400,000	-0-

Statement Of Research Issue

This project is a study of airport system requirements for the 21st century. It will identify the expansion necessary for the airport system to carry increased levels of traffic, describe the measures that must be taken, such as new airport construction, estimate the cost and timing of those measures, and highlight actions that should be taken now, such as landbanking in order to facilitate future airport development. The project will result in several reports on airport system requirements in the 21st century. The reports will reveal what measures should be taken now to ensure that the airport system can be expanded to meet future demand.

FY 1989 Activities

Publish final Long-Term Airport System Capacity Plan - 12/89.

TABLE B-18. COCKPIT TRAFFIC INFORMATION

EXPECTED COMPLETION DATE:	*1989	
FUNDS	FY 1989 $200,000	*FY 1990

Statement Of Research Issue

Bring airport capacity under IMC as close as possible to the capacity routinely achieved under VMC.

Research Approach

Evaluate effectiveness of cockpit traffic information technology for enhancing terminal area efficiency and capacity.

FY 1989 Activities

A study will be undertaken to determine the feasibility of using TCAS type technology for application to this issue.

---

* Completion date and future costs will be determined after FY 1989 feasibility study.

TABLE B-19. REGIONAL AIRPORT CAPACITY TASK FORCE SUPPORT

EXPECTED COMPLETION DATE:	1989	
FUNDS	FY 1989	FY 1990
	$800,000	-0-

Statement Of Research Issue

The airport capacity task force effort is a continuing program to study the 40-50 capacity impacted airports (see B-12, Airport Capacity Task Force Studies). There is a continuing need for the FAA Regions to implement the results of these studies on a local level, including new technology efforts.

FY 1989 Activities

This funding is to provide technical support to the regions during a transition period until the regions can support these ongoing efforts through knowledge and expertise gained during the transition.

TABLE B-20. NATIONAL AIRSPACE SYSTEM PERFORMANCE ANALYSIS CAPABILITY (NASPAC)

EXPECTED COMPLETION DATE:	FY 1990 and Ongoing
FUNDS	FY 1990, $2,500,000

Statement Of Research Issue

There is a need to develop a long-term analysis capability to study the system-wide performance of the NAS and to provide a quantitative formulation of decisions related to system improvements. NASPAC will allow identification of NAS performance limiters and evaluation of alternative solutions for reducing the impact of these limiters.

Research Approach

NASPAC is based on computer models and operations research techniques. Two models are under development: a queuing and a simulation. The queuing model will provide quick results by airport for long-term, steady state conditions of NAS performance. The simulation model will provide a detailed analysis of NAS components including en route and terminal airspace segments and local airport conditions.

FY 1989 Activities

- Identify and incorporate additional NASPAC enhancements.
- Develop user friendly version.
- Validate NASPAC for FAA application, including NAS performance forecasts in 1995.
- Evaluate the impacts of airline hubbing, proposed new airports (i.e., Denver and third Chicago) and reduced aircraft separation on NAS throughput.

TABLE B-21. AIRSPACE SYSTEM MODELS

EXPECTED COMPLETION DATE:	Ongoing
FUNDS	FY 1990, $773,000

Statement Of Research Issue

This project will develop analytic models, including computer simulations, for evaluating future national airspace system impact of new NAS equipment, ATC procedure changes, revised airspace configuration, and controller workload.

Research Approach

This project is an initial effort toward developing a comprehensive NAS simulation model. In FY 1990, models will be developed to assist on the design of NAS improvements, including the design of en route ATC sectors. Models will also analyze ATC procedural changes and evaluate controller workload under different airspace design options.

FY 1990 Activities

- Initial system design requirements defined.
- Model requirements definition.
- Prototype model developed for en route ATC environment.

TABLE B-22. TERMINAL AIR TRAFFIC CONTROL AUTOMATION

EXPECTED COMPLETION DATE:	Ongoing
FUNDS	FY 1990 $3,593,000

Statement Of Research Issue

There are a number of opportunities to provide airport capacity improvements in the near term through the application of ATC automation techniques in the terminal area. The objective of this effort is to focus on specific opportunities to exploit and to carry out the necessary development work to assure that viable operational improvements are implemented in the near future.

Research Approach

The FAA ha established a multi-year research and development effort to systematically develop automation improvements for the terminal area as a means for improving airport capacity and improving the efficiency of aircraft operations in the terminal area. Improvements will be developed through analysis of current operations, design, and validation of automation aids in rapid prototype laboratories, and field evaluation of aids prior to implementation. Representatives of airlines, the FAA Air Traffic organization, the FAA Flight Standards organization, and FAA engineering offices participate in monitoring and guiding the research effort.

FY-1990 Activities

- The converging runway approach aid will be installed at St. Louis for field evaluation.

- A real-time, rapid prototype simulation of the traffic planning and advisory aid will be established at Lincoln Laboratory to facilitate the design and validation of the controller-machine interface.

TABLE B-23. REDUCED RUNWAY OCCUPANCY TIME

EXPECTED COMPLETION DATE:	Ongoing
FUNDS	FY 1990 $1,006,000

Statement Of Research Issue

The time an arriving aircraft remains on the runway before turning off onto a taxiway affects the capacity of the airport by blocking the next arriving or departing aircraft. Methods to reduce ROT and decrease taxiing time to the gate will therefore increase an airport's capacity.

Research Approach

With the development of efficient runway exit designs, improved taxiway routings, and using proper airport lighting and marking systems, the entire system will require simulation, field test, and evaluation. Simulation tests of improved designs for specific airports will be conducted prior to field evaluation.

FY 1990 Activities

- Verification of efficient runway exit design algorithm tested through simulation for a specific airport demonstration.
- Evaluation of current taxiway geometries and new alternative designs to improve traffic flow (completion date 1992).
- Development and evaluation of slush and snow detection and measurement systems including data transmission methods to report conditions to ATC towers (completion date 1992).
- Initiate development of design criteria for soft- ground overruns.

TABLE B-24. AIRPORT SURFACE TRAFFIC AUTOMATION

EXPECTED COMPLETION DATE:	Ongoing
FUNDS	FY 1990 $2,343,000

Statement Of Research Issue

There is increasing concern within the FAA and the aviation community about runway incursions and the frequency and potential consequences of aircraft collisions on the ground. The NAS Plan is implementing a number of facilities that potentially will contribute to a reduction in the hazard of aircraft collisions in the near term. Later phases of the project will develop techniques to improve the management of surface traffic as a means for improving airport capacity.

Research Approach

The FAA established a multiyear research and development effort to systematically develop automation improvements for the airport surface. Improvements will be developed through analysis of current operations, design and validation of automation aids in rapid prototype laboratories, and field evaluation of aids prior to implementation. Representatives of FAA air traffic, flight operations, and engineering organizations participate in monitoring and guiding the research effort.

FY 1990 Activities

- Automation features based on ASDE-3 improvements and on Mode-S will be developed to reduce runway incursions.

- Development will begin on departure management techniques building on earlier departure flow management work in FAA.

APPENDIX C

CAPACITY DEVELOPMENT AT THE TOP 100 AIRPORTS

Location and Description of Planned or Recommended New Runways and Runway Extensions

The following information on the location of planned new runways and runway extensions at the top 100 airports was obtained by talking to staff members of FAA Regional and District Offices, as well as responses through a letter to the airports themselves. Since there was not a 100% response rate, the information is a synthesis of all of the sources available. Recommendations from completed and on-going task forces at several individual airports were included as well (See Chapter Four for a more complete discussion of the airport capacity enhancing task forces.) Estimates of IFR arrival capacity increases are based on information contained in MTR-87W203 ("Estimates of Potential Increases in Airport Capacity Through ATC System Improvements in the Airport and Terminal Area"). This report indicates that the IFR arrival capacity of any single runway that can be operated independently is 26 arrivals/hour; a dependent parallel pair, 36 arrivals/hour; and independent parallels, 52 (two x a single runway) arrivals/hour. Other configurations are multiples of the above. These values are provided to illustrate approximate magnitude of the capacity increase possible. They should not be taken as the exact capacity of a particular airport since site-specific conditions (e.g., varying fleet mixes) can result in differences.

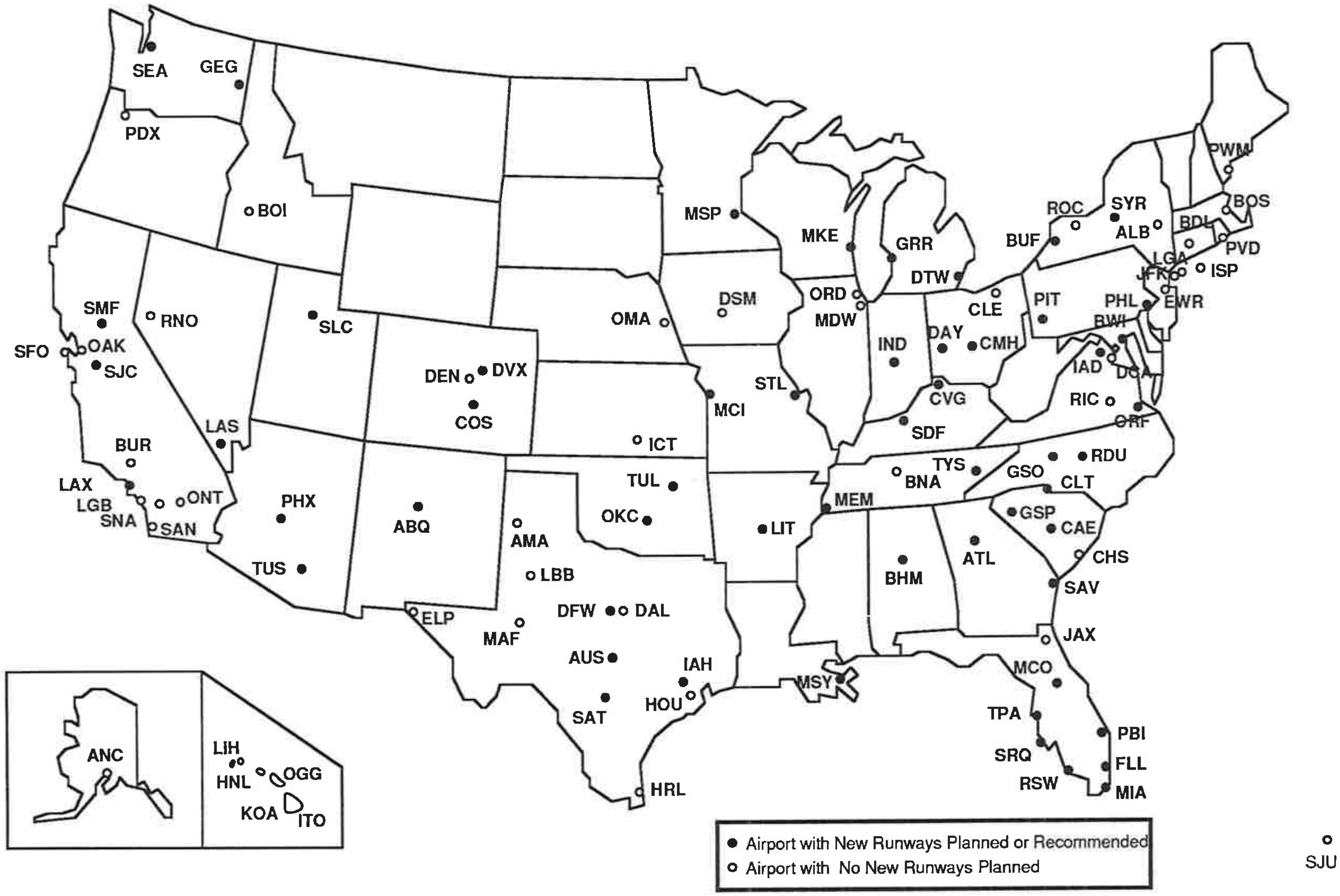
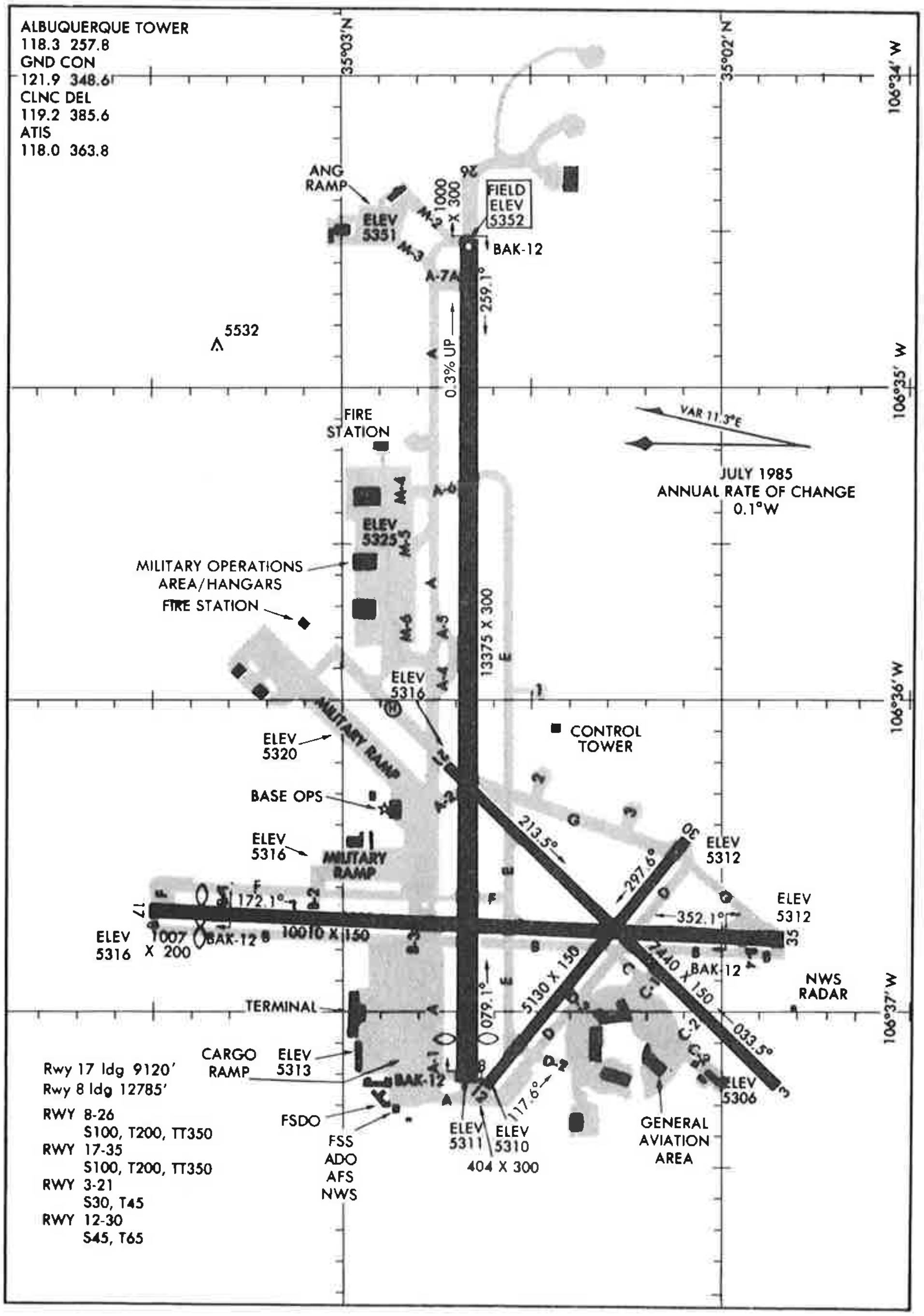


FIGURE C-1. NEW OR EXTENDED RUNWAYS PLANNED OR RECOMMENDED AMONG THE TOP 100 AIRPORTS

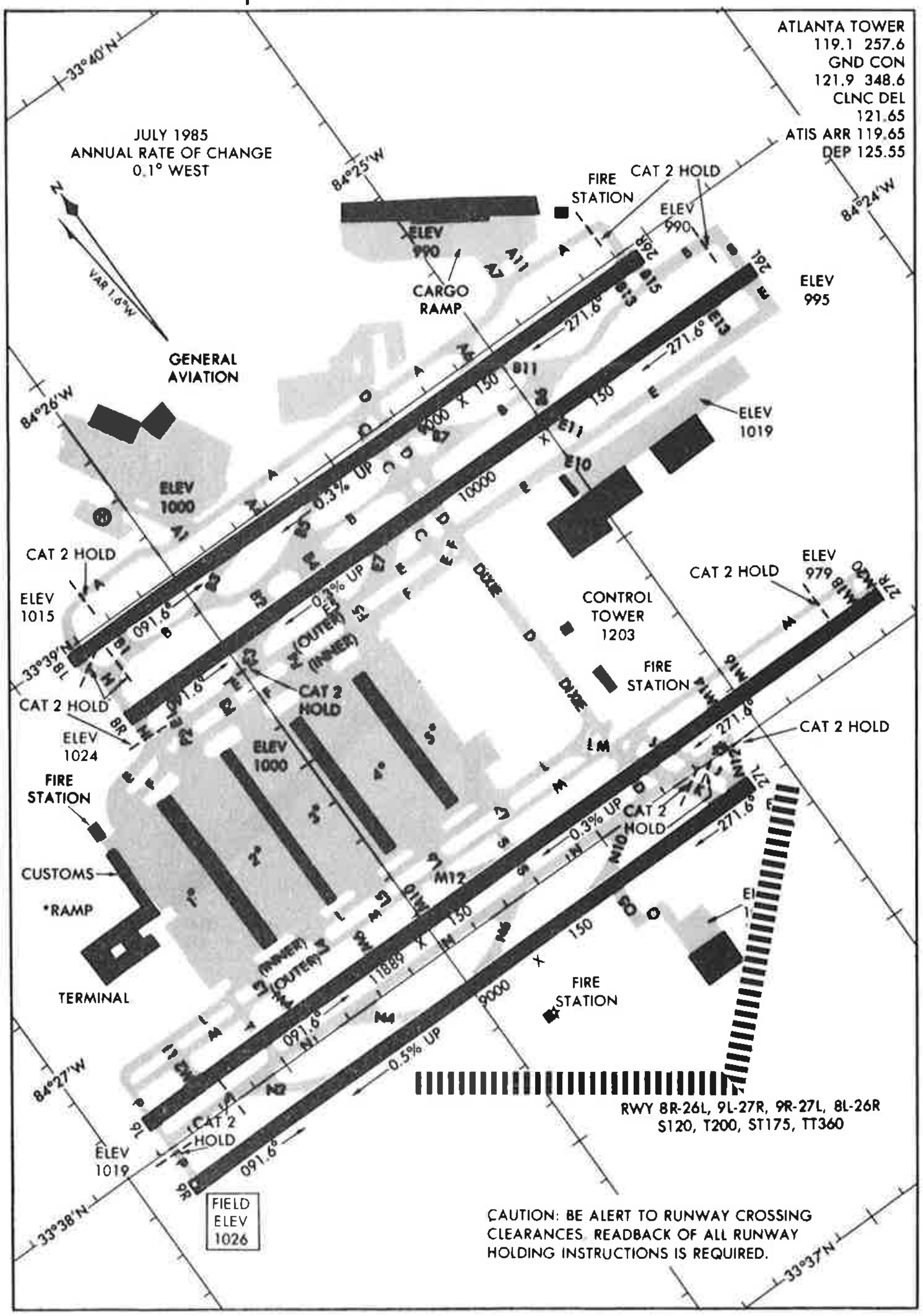
Albuquerque (ABQ)

A multi-year proposal is underway to extend Runway 3/21. The extension will add 3,200 feet to the southwest end of the runway. The work will provide an 8,800 foot runway that does not cross Runway 8/26. The threshold of Runway 21 will be relocated to the southwest eliminating the intersection with Runway 8/26. Airport Aid Funding has been provided and construction will start in the summer of 1989. The expected date of completion is early 1991. The cost of the runway and parallel taxiway is estimated at $12 million.



Atlanta (ATL)

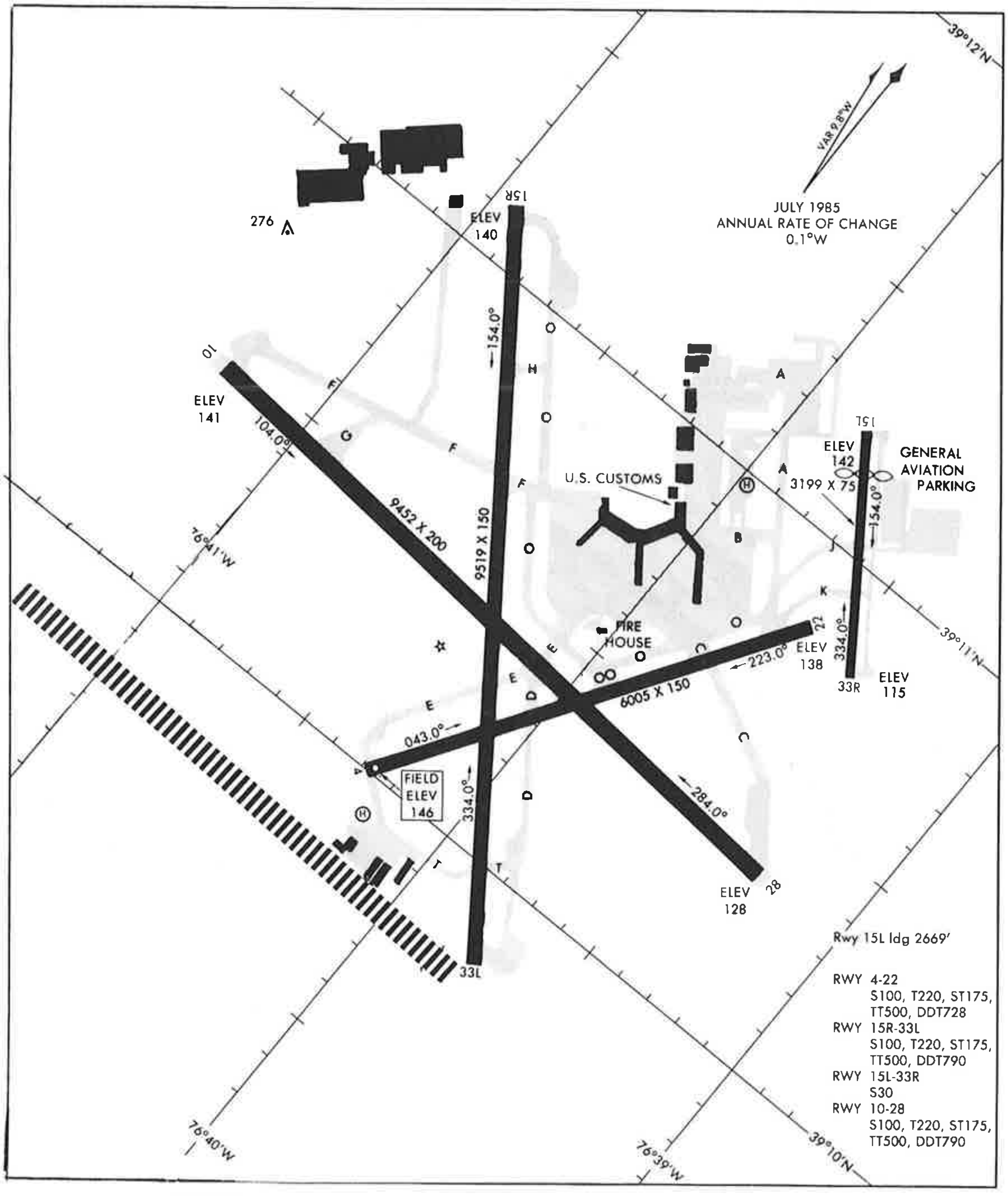
Two options are being considered to add runways: (1) converging runways 6/24 and 12/30, each of which would converge with Runway 9R/27L at a 30 degree angle, and (2) a parallel runway 5,500 feet long and 3,000 feet south of Runway 9R/27L. Federal Aviation Administration Technical Center (FAATC)/Atlanta are simulating each to determine whether Category I ILS minimums can be achieved. Converging runways are preferred. The decision date is estimated to be early 1990. Both should increase VFR capacity by more than one third. The first alternative will not increase IFR arrival capacity under current procedures. The second alternative should increase it from 52 to 63 arrivals per hour. The total estimated cost is $100 million. The estimated operational date is 1995.



PLANNED OR RECOMMENDED NEW RUNWAYS
(LOCATION APPROXIMATED - BASED ON CURRENT INFORMATION)

Baltimore (BWI)

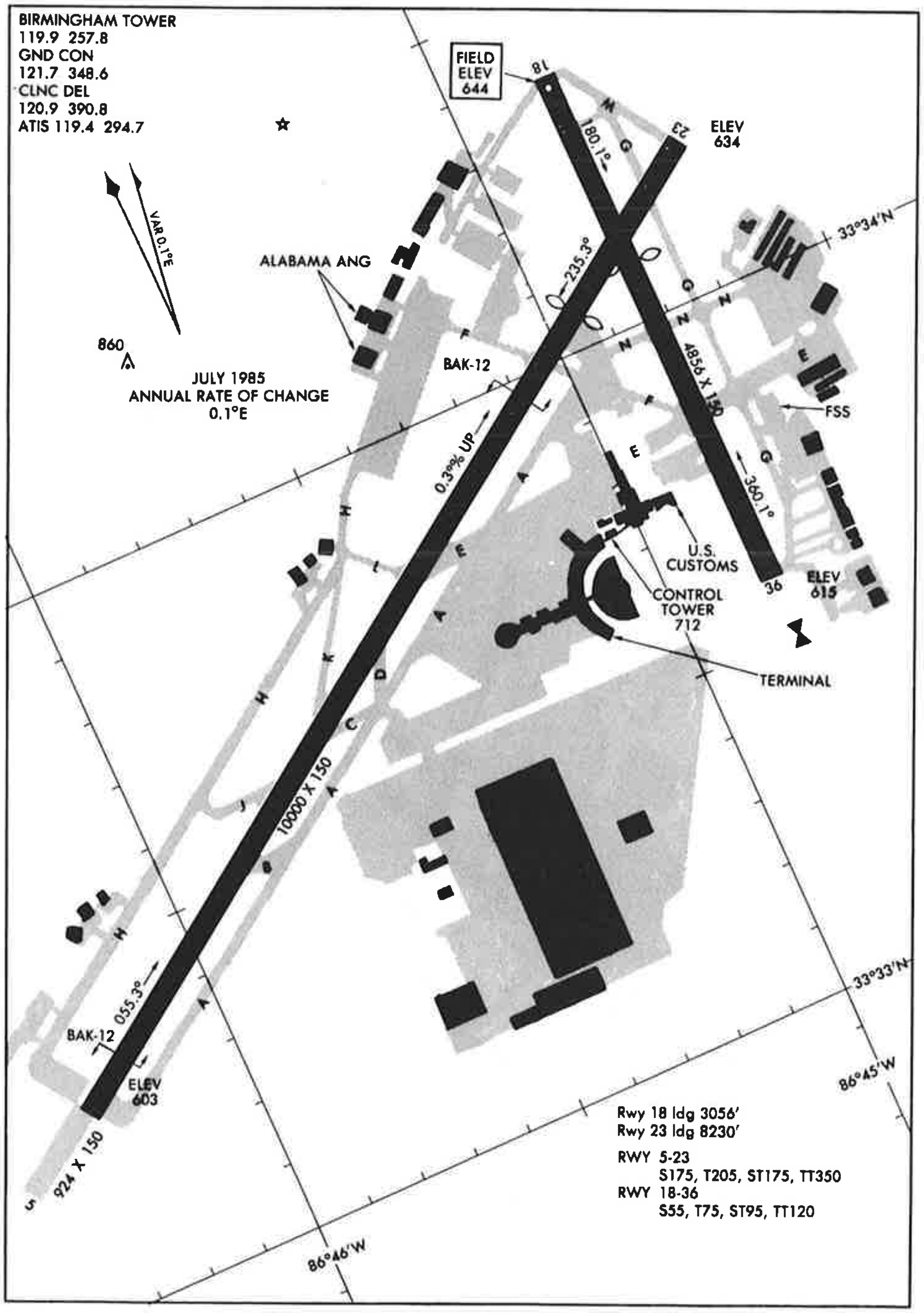
A new 7,800-foot runway, Runway 10R/28L will be constructed 3,500 feet south of 10/28. The runway is planned for 1992. When 10R/28L is constructed, Runway 4/22 will convert to a taxiway. A runway extension for 15L/33R to a 5,000 foot length and 100 foot width, restricted to 60,000 lbs of gross weight, is estimated to be operational in the end of 1989. A dual ILS is planned for the new parallel runway and an MLS is planned for Runway 15L/33R after the extension is completed. The new parallel should permit IFR dependent operations, increasing hourly arrivals from 26 to 36.



PLANNED OR RECOMMENDED NEW RUNWAYS
(LOCATION APPROXIMATED - BASED ON CURRENT INFORMATION)

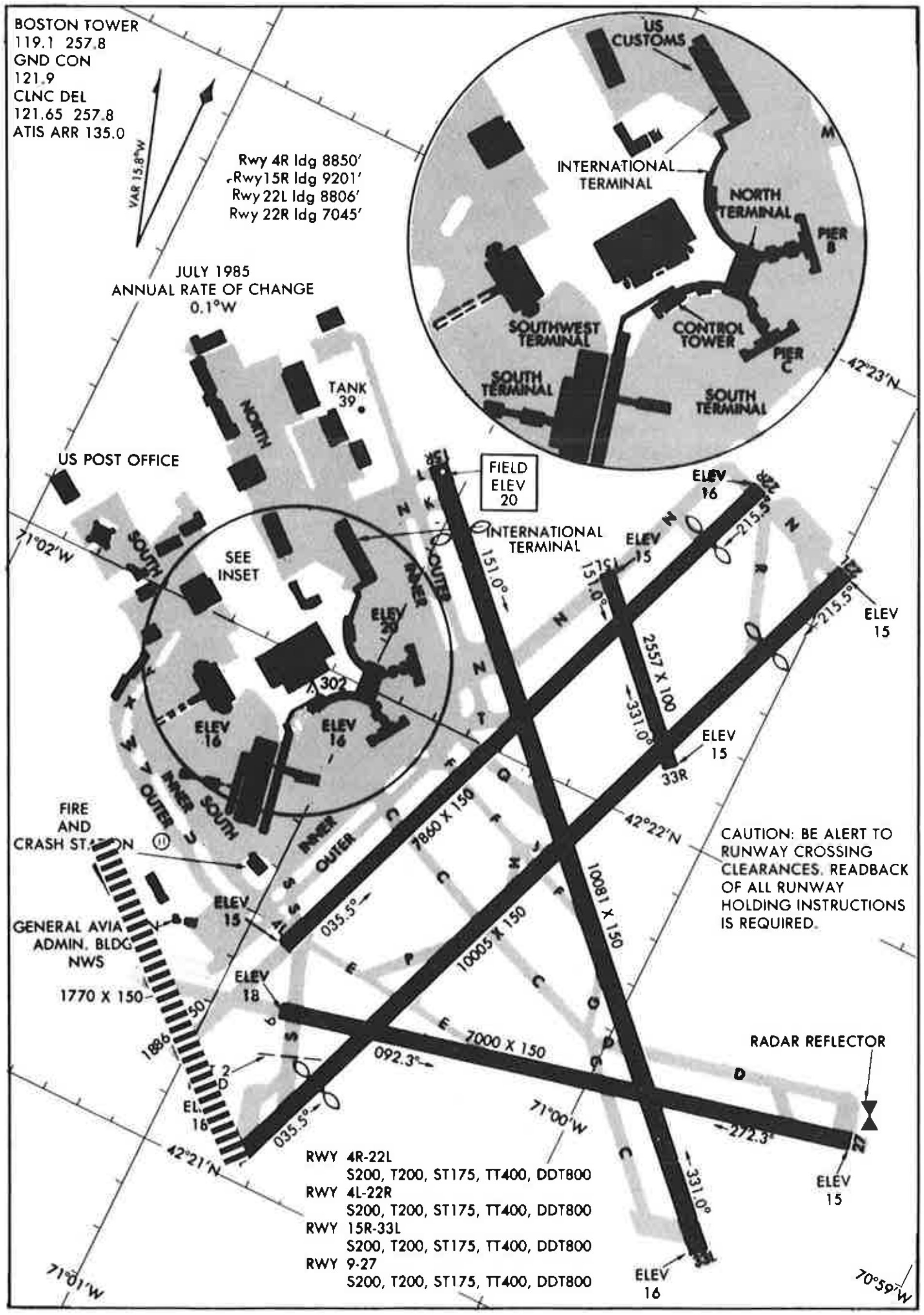
Birmingham (BHM)

Runway 18/36 will be extended from 4,800 feet to 7,500 feet. Construction is expected to be completed in 1995, at an approximate cost of $40 million. Birmingham Airport Authority projects a 30% capacity increase.



Boston (BOS)

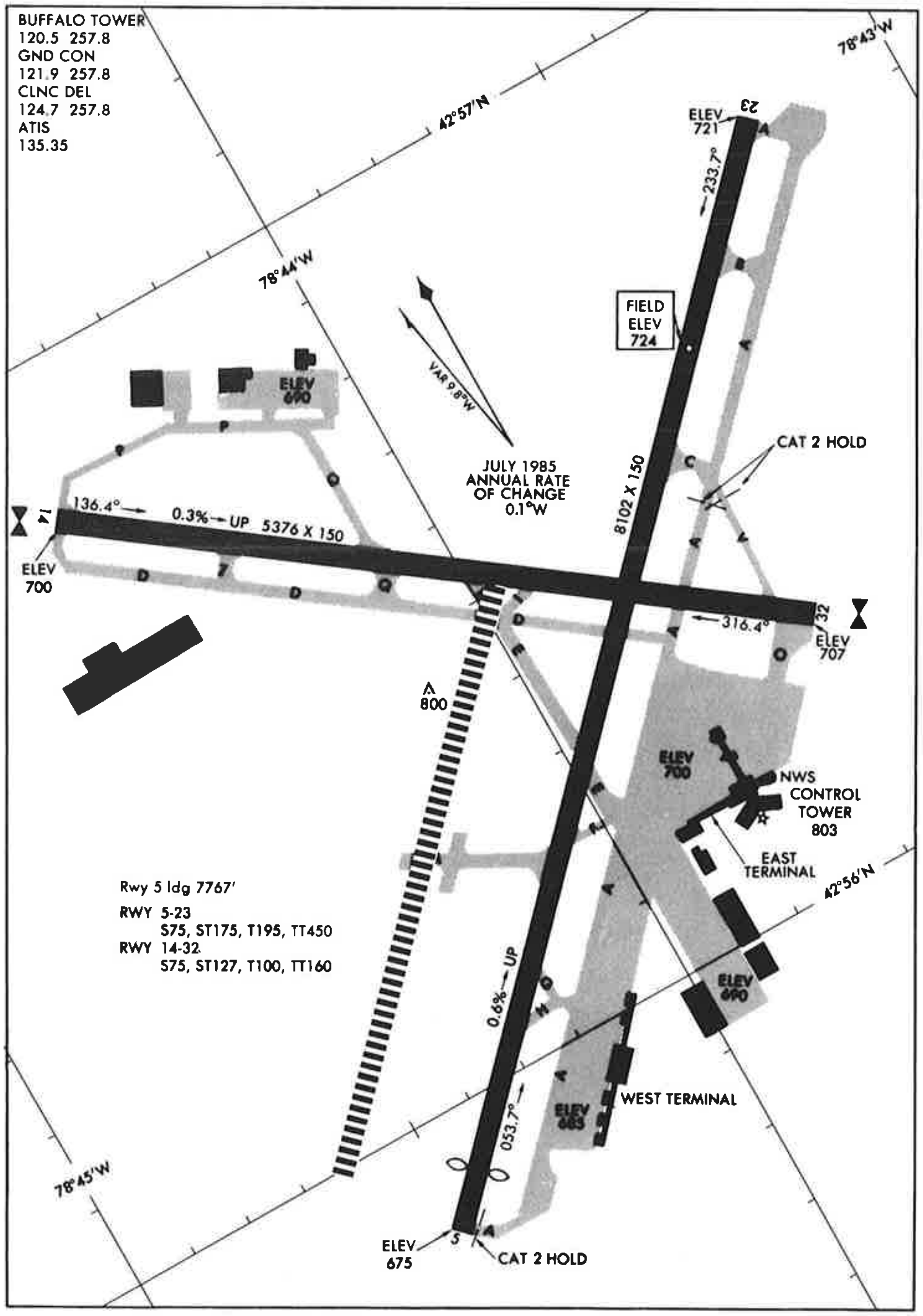
Potential improvements being considered by an ongoing task force at Boston-Logan International Airport include a new 4,300-foot Runway 14/32, approximately 5,200 feet southwest of 15R/33L. Also suggested are an extension to Runway 15L/33R to approximately 3,500 feet, as well as a 400 foot extension to Runway 9/27 to the west, and a 125 foot extension to the east permitting hold short operations. There is no timeframe or no cost estimate for these potential improvements.



PLANNED OR RECOMMENDED NEW RUNWAYS
(LOCATION APPROXIMATED - BASED ON CURRENT INFORMATION)

Buffalo (BUF)

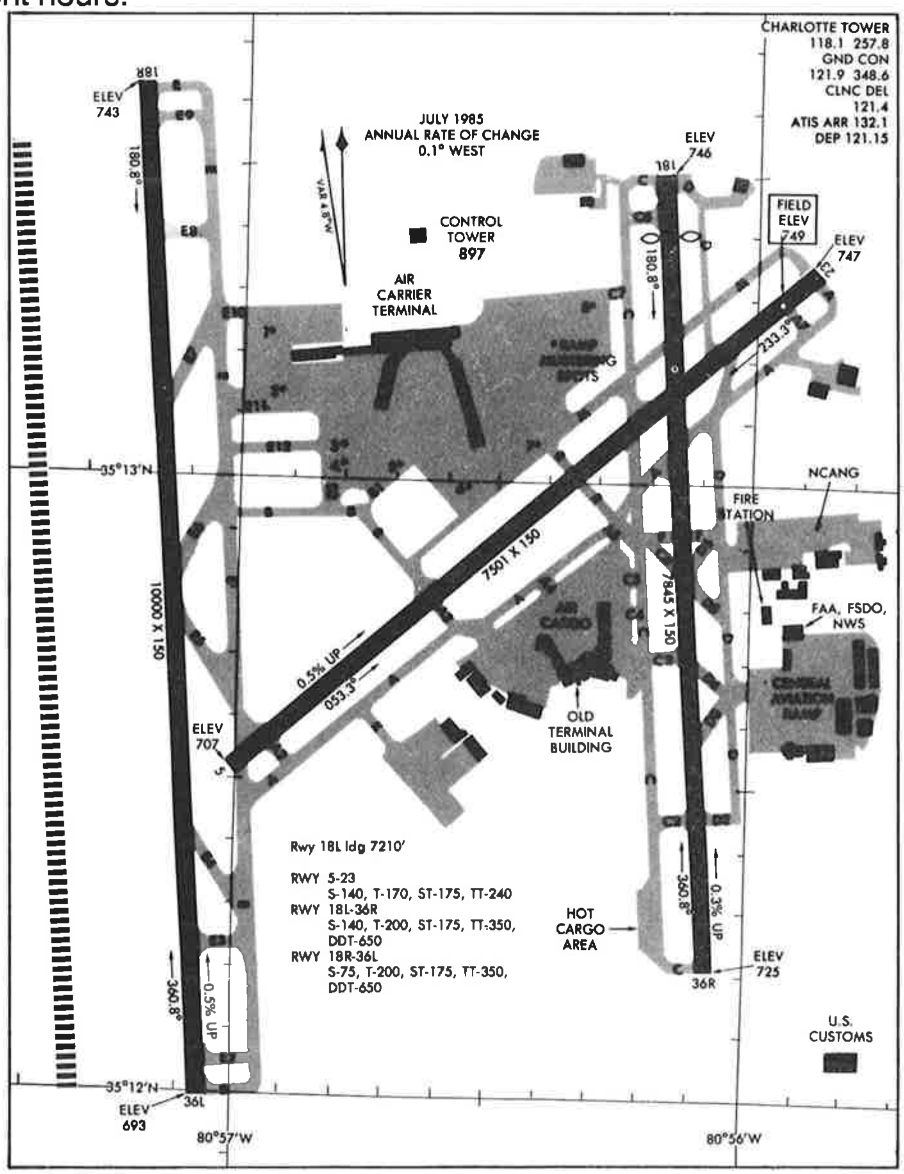
Runway 14/32 will be shifted 300 feet southeast. A draft Master Plan shows a new parallel runway, Runway 5L/23R, 3,800 feet by 75 feet, located 700 feet northwest of Runway 5/23. It is planned for 1999-2000. No increase in IFR arrival capacity will be provided.



PLANNED OR RECOMMENDED NEW RUNWAYS
(LOCATION APPROXIMATED - BASED ON CURRENT INFORMATION)

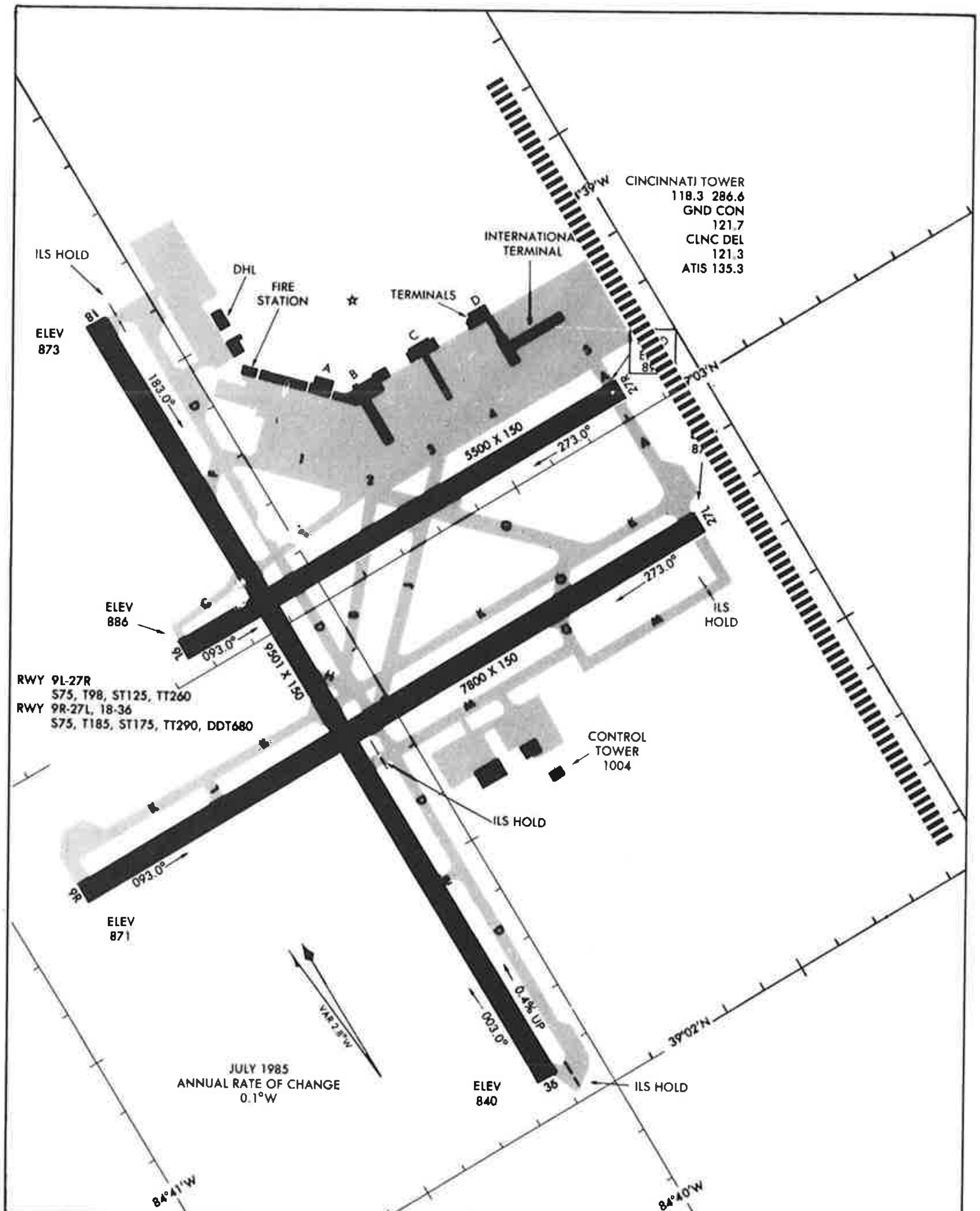
Charlotte (CLT)

The airport can presently accommodate independent parallel IFR Category I arrivals on Runway 36L and Runway 36R but does not do so during noise abatement hours (11 p.m. to seven a.m. and school days) unless absolutely necessary. Three schools are situated north of runways 36L and 36R. Noise proofing is being investigated. An environmental assessment to extend Runway 36R 1,000 feet south to give simultaneous approach capability during noise abatement hours is being submitted. It is intended to use converging approaches on runways 5 and 36R for noise abatement beginning in 1990. This should increase IFR arrival capacity from 26 to 52 per hour during noise abatement hours but with minima higher than Category I. The total estimated cost is $12 million. An environmental assessment of a third parallel runway is underway. It is planned to be situated 1,200 feet west of 36L with a minimum length of 8,000 feet and is estimated to be operational in 1995-1996. The new Runway 36L should provide independent IFR arrivals on Runways 36L and 36R and departures on Runway 36C (present 36L). This would increase IFR arrivals per hour from 26 to 52 at Category I minima during noise abatement hours.



Cincinnati (CVG)

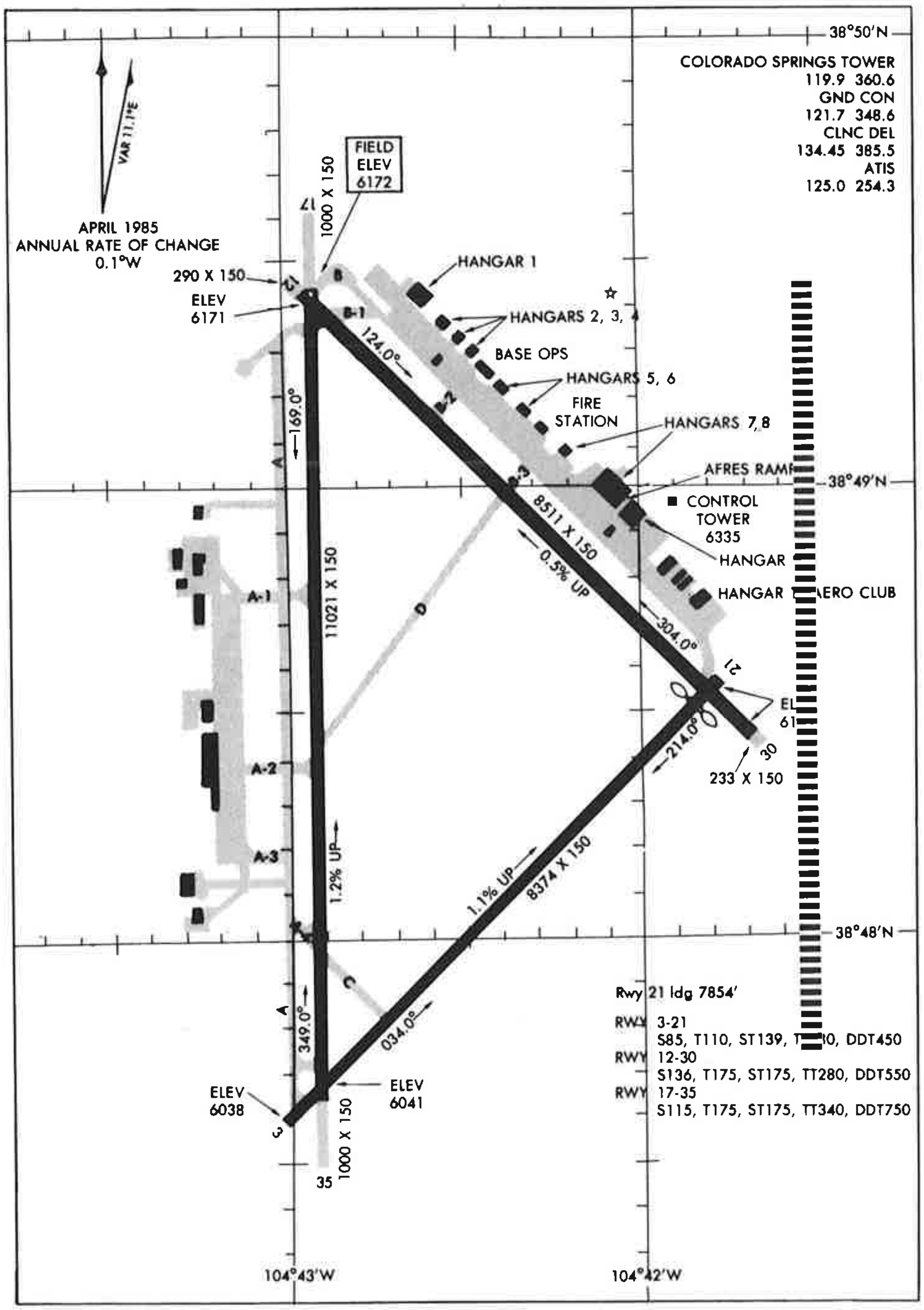
A new Runway 18L/36R, parallel to and 6,200 feet away from the existing runway 18/36 is underway for CVG. This runway will have the potential for allowing independent IFR parallel operations, doubling IFR arrival capacity from 26 to 52 per hour. A grant has been issued and the new runway is estimated to be operational in 1990. The estimated cost for the runway and the associated taxiway and roadways, including design, inspection, construction, and CAT III instrumentation is approximately $65 million.



PLANNED OR RECOMMENDED NEW RUNWAYS
(LOCATION APPROXIMATED - BASED ON CURRENT INFORMATION)

Colorado Springs (COS)

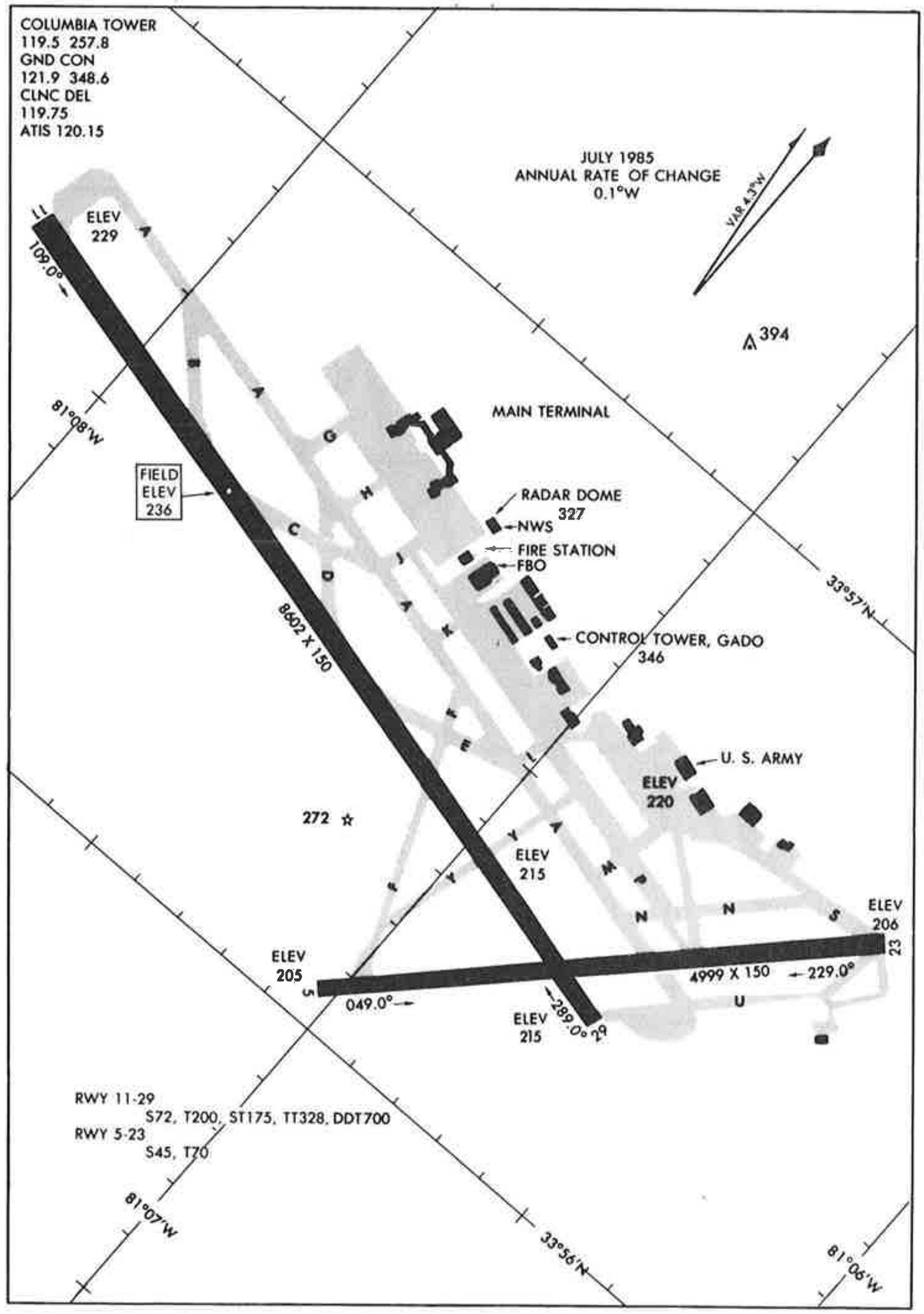
A new Runway 17L/35R, will be constructed 8,600 feet east of existing Runway 17/35. This should permit dual instrument approaches during IFR conditions, increasing arrival capacity from 26 to 52 per hour. Grading has been completed and the new runway could be operational by 1992, but money is needed. The estimated cost of terminal expansion and the new runway is $142 million of which $28-30 million will be requested from the federal government.



PLANNED OR RECOMMENDED NEW RUNWAYS
(LOCATION APPROXIMATED - BASED ON CURRENT INFORMATION)

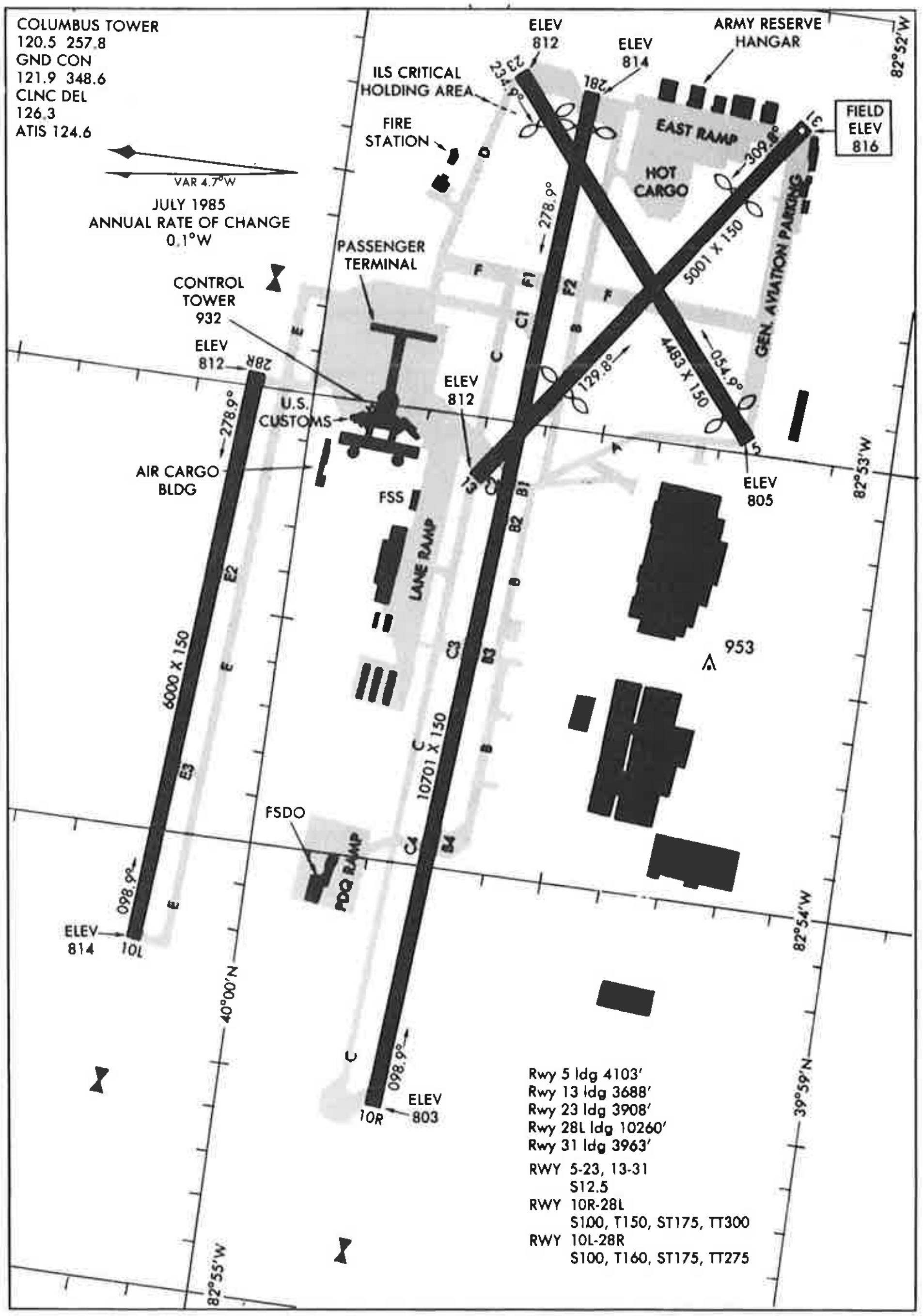
Columbia (CAE)

Runway 23 is being extended 7,000 feet to the southwest to a length of 12,000 feet. The estimated cost of construction is $14 million. The estimated operational date is summer 1990. If dependent converging approaches become authorized, IFR capacity could increase from 26 to 36.



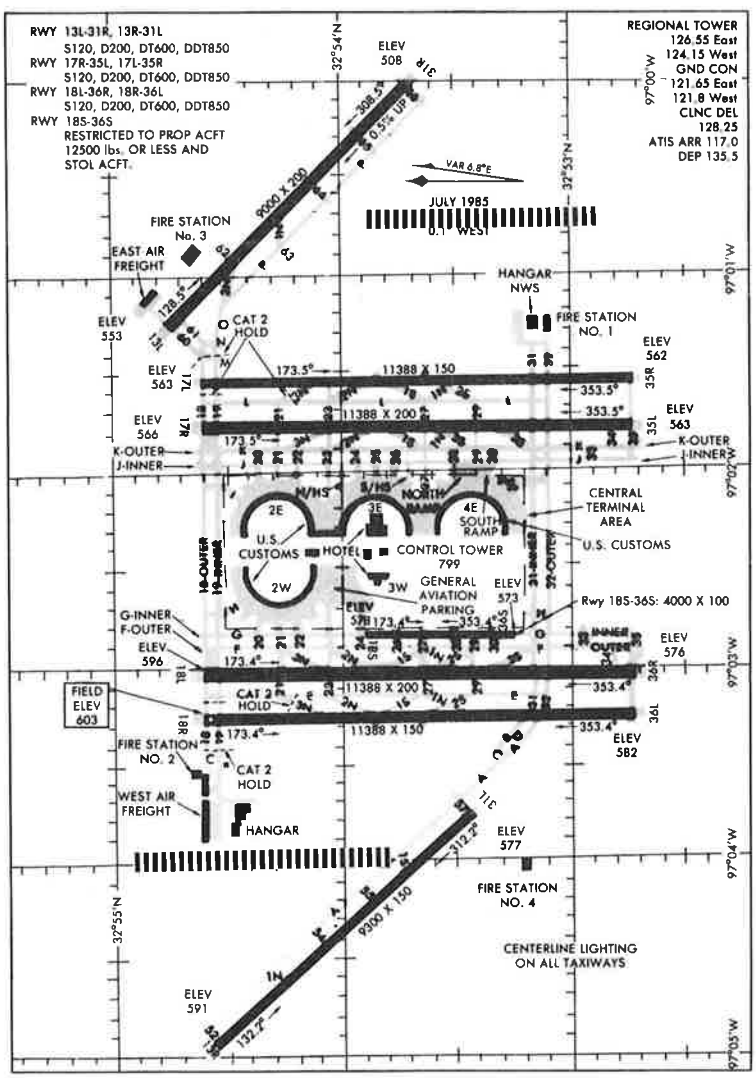
Columbus (CMH)

An environmental assessment is being conducted for the extension of Runway 10L/28R from 6,000 to 8,000 feet. It is planned to be operational by 1992. An FY89 preapplication will include Runway 10L clearzone land acquisition at a cost of $1,130,027. An FY90 preapplication will include widening runway 10L/28R and a westerly 1,000 foot extension to 7,000 feet. The former will cost $2,625,000, while the latter will cost $2,133,750. The FY91 preapplication will include an easterly extension of 1,000 feet for Runway 10L/28R to 8,000 feet presuming the previous extension at a cost of $2,360,250. Other airfield improvements include an upgrade of the 10,700 foot Runway 10R/28L with a Category II ILS; various taxiway construction and reconstruction; and extension of the terminal ramp area.



Dallas-Ft. Worth (DFW)

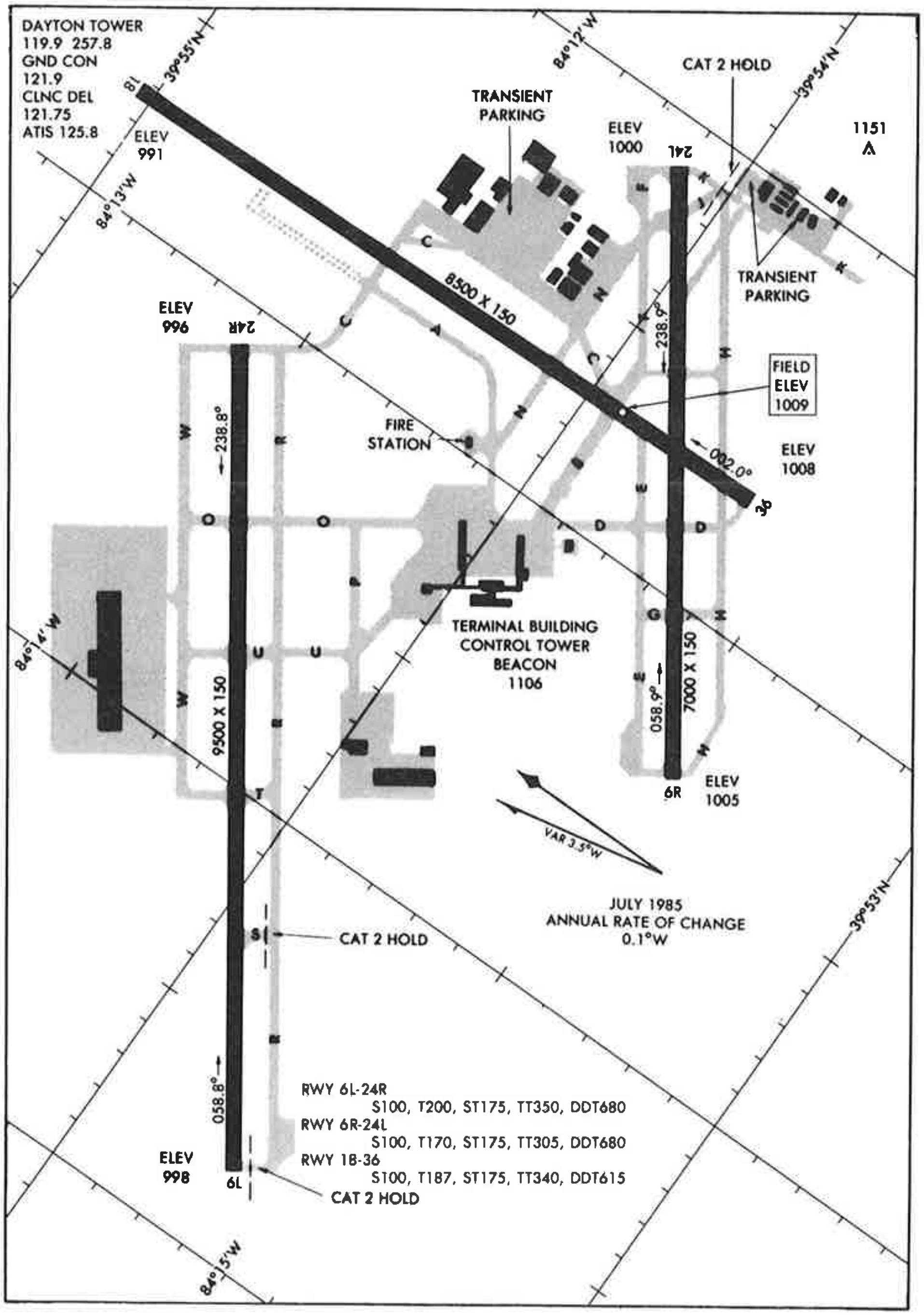
Several improvement projects aimed at expanding total airport capacity are being considered. These include 2,000 foot extensions to Runways 17R and 18L, providing an overall length of 13,400 feet for each. Each extension is estimated to cost $26 million. Tentative completion dates are July 1991 and December 1992, respectively. Two more parallel runways are planned, 16L/34R and 16R/34L. Construction of both runways is dependent upon a favorable environmental finding, not expected until mid-1990. The east runway, Runway 16L/34R, encompasses a two-stage action. Initially, a 6,000-foot runway will be constructed for ultimate phased extension to 8,500 feet. It will be located 5,000 feet east of and parallel to Runway 17L/35R. Estimated cost is $110 million. The 6,000-foot runway will be operational by 1993. The west runway, Runway 16R/34L, is in a post-2000 timeframe and estimated cost is $70 million. It will be located west of Runway 18R/36L. This should permit triple IFR arrivals although the new runway will be restricted. IFR arrival capacity should increase from 52 to 78 per hour.



PLANNED OR RECOMMENDED NEW RUNWAYS
(LOCATION APPROXIMATED - BASED ON CURRENT INFORMATION)

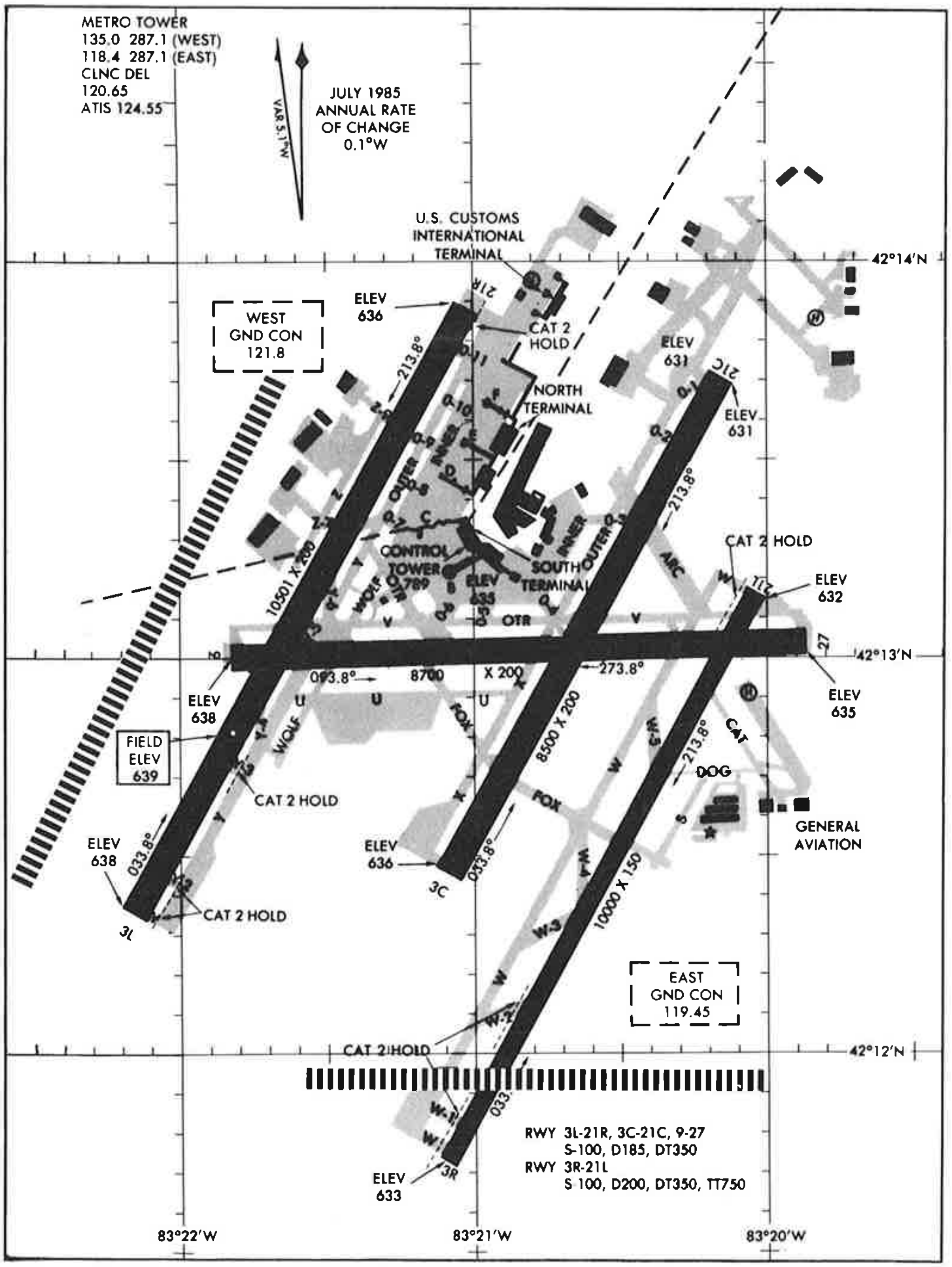
Dayton (DAY)

A 1,500 extension to Runway 18/36 was recently completed. Construction cost was $8.8 million. Runway 6L/24R is being extended (from 9,500 to 10,900 feet) and overlayed from March until December of 1989. The estimated cost of construction is $10.7 million. A Master Plan shows a later extension of Runway 6L/24R to 11,000 feet to accommodate overseas departures. The 1,400 foot extension to Runway 6L/24R and associated taxiways will cost approximately $3.5 million.



Detroit (DTW)

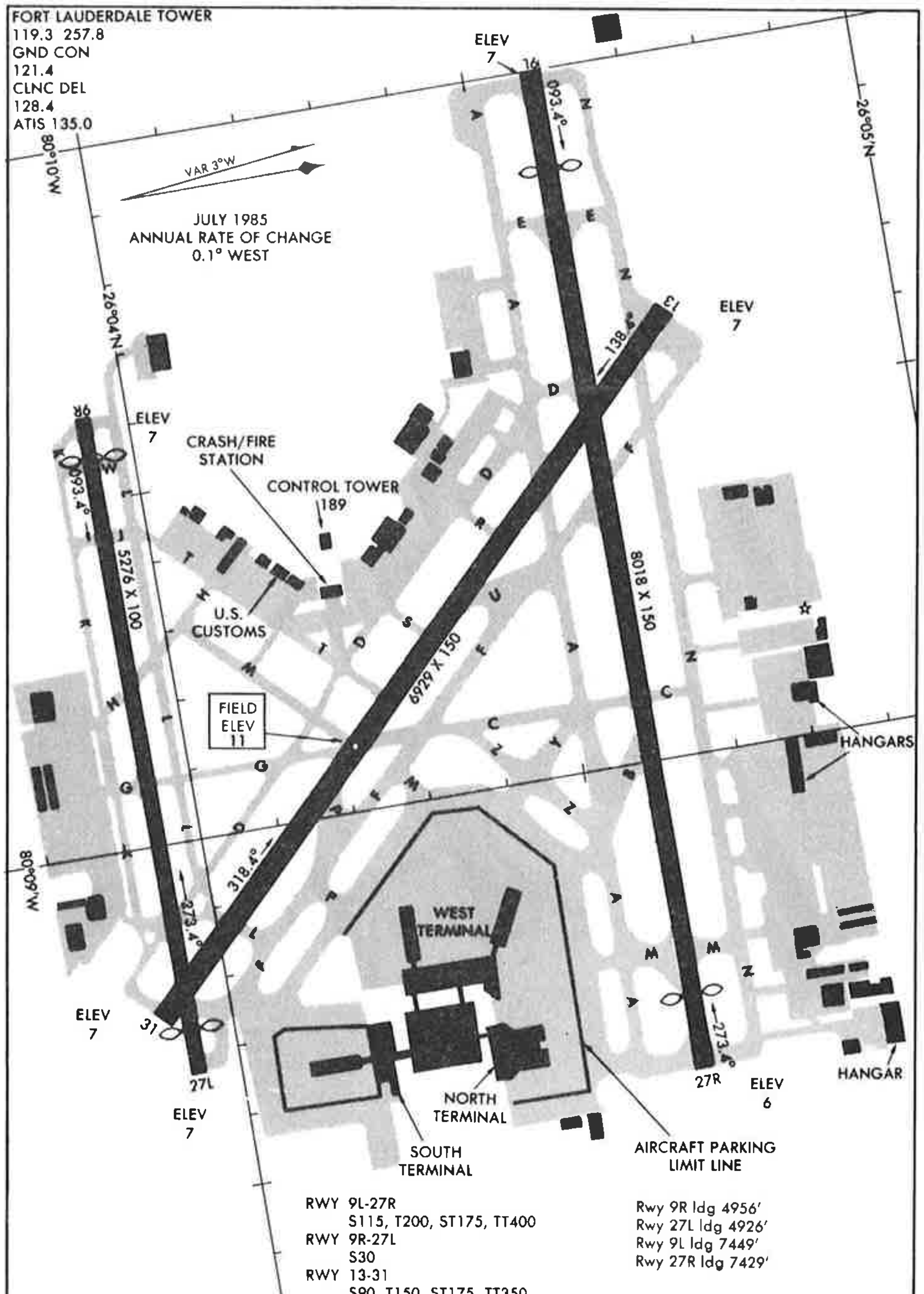
A new runway, Runway 9R/27L, is planned, located more than 4,300 feet apart and parallel to existing Runway 9/27. The estimated cost is $69.1 million. This new runway will allow DTW to run independent parallel IFR approaches in an east-west configuration, thus matching their current north-south IFR arrival capabilities. An environmental assessment is being prepared for 9R/27L with construction estimated to begin in late 1989 or early 1990. An Environmental Impact Statement is being initiated for a fourth north-south parallel 2,500 feet west of 3L/21R. This runway should permit triple IFR arrivals with one each dependent and independent pairing thus increasing capacity from 52 to 63 per hour. This north-south parallel runway is under consideration in a Master Plan update. The estimated cost is $58.2 million.



PLANNED OR RECOMMENDED NEW RUNWAYS
(LOCATION APPROXIMATED - BASED ON CURRENT INFORMATION)

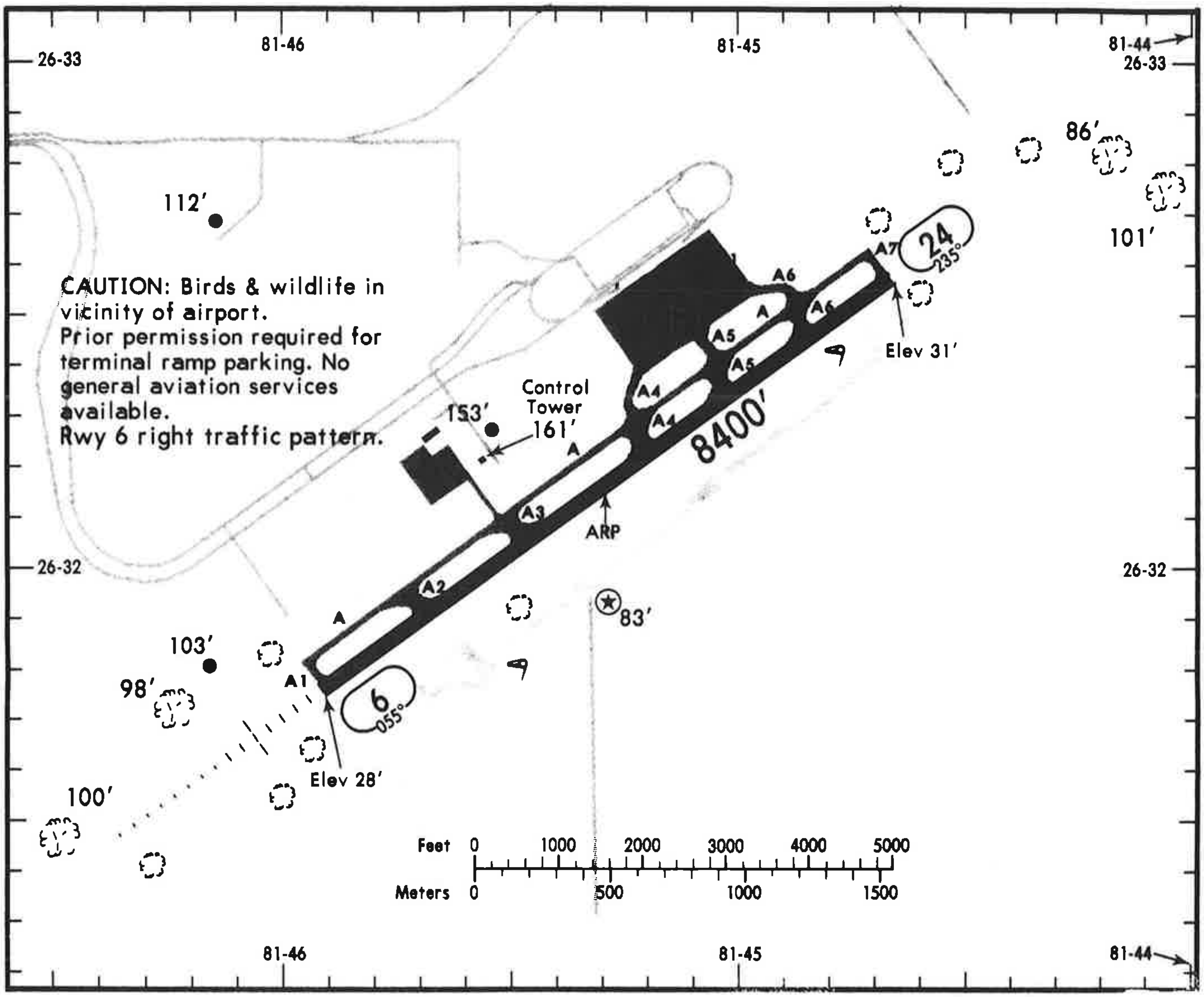
Fort Lauderdale (FLL)

Runway 9L/27R will be extended 982 feet to a length of 9,000 feet and strengthened in one year. The estimated cost is $8 million. An extension of Runway 9R/27L, to 6,000 feet by 150 feet wide is planned in 1991 to provide the airport with a second parallel air carrier runway. The estimated cost of construction is $26 million and the anticipated operational date is 1995. No opposition exists to the extension of the long parallel 9L/27R, but significant, organized local opposition is expected for the extension of the short parallel, Runway 9R/27L. Extension of this short parallel runway would permit IFR arrival capacity to increase from 26 to 52 per hour in an independent parallel operation, without restricting it to commuters.



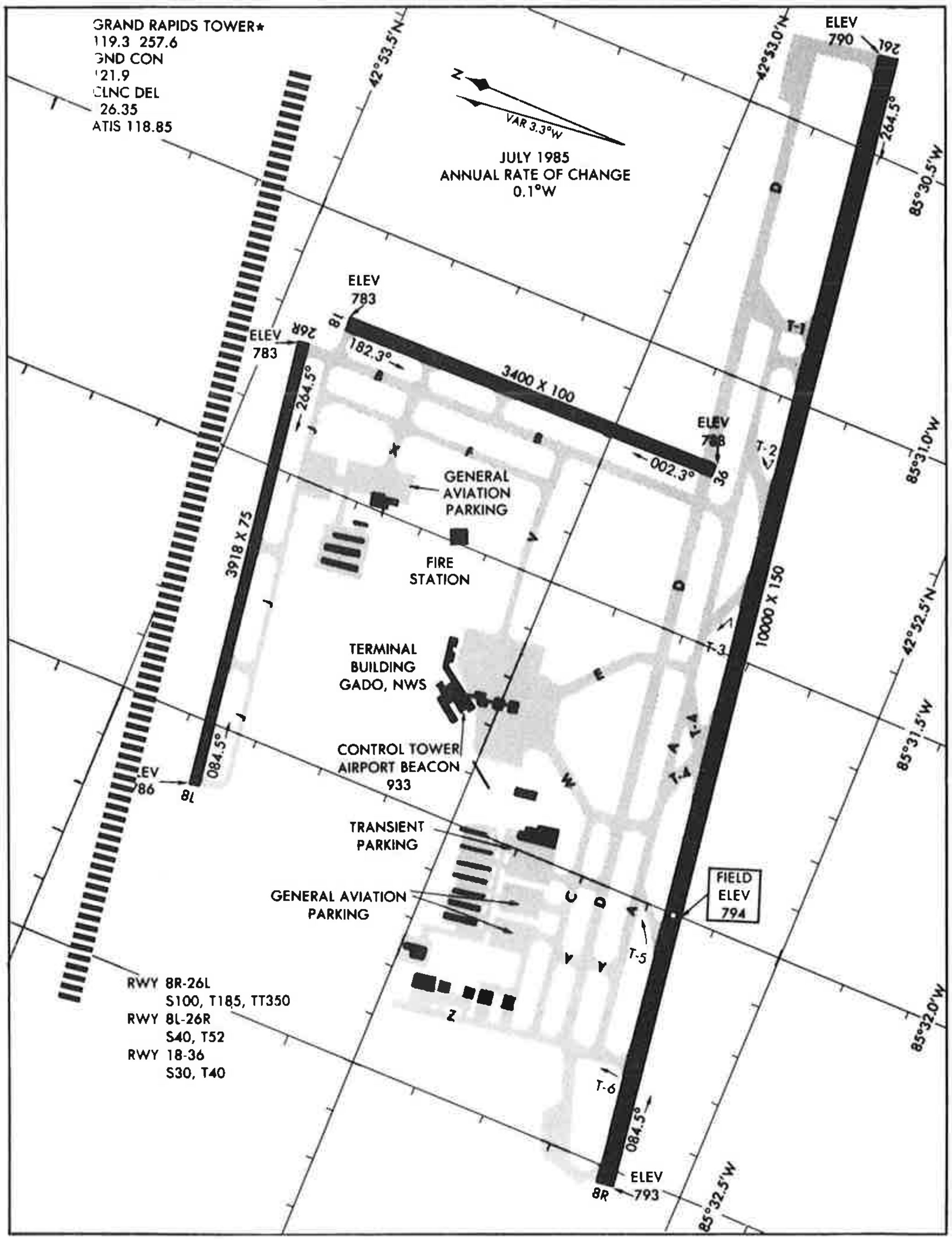
Fort Myers (RSW)

Planning has begun for a 9,000 to 10,000-foot long new parallel runway, Runway 6R/24L, 4,300 feet or more from existing air carrier runway, estimated to be operational by 1996 at a cost of $40 million. This would provide independent parallel operation with potential to increase IFR hourly arrival capacity from 26 to 52. An environment assessment has begun for an extension of Runway 6/24 from 8,400 feet to 10,600 feet. The estimated cost of the extension is $6 million and the estimated operational date is 1991.



Grand Rapids (GRR)

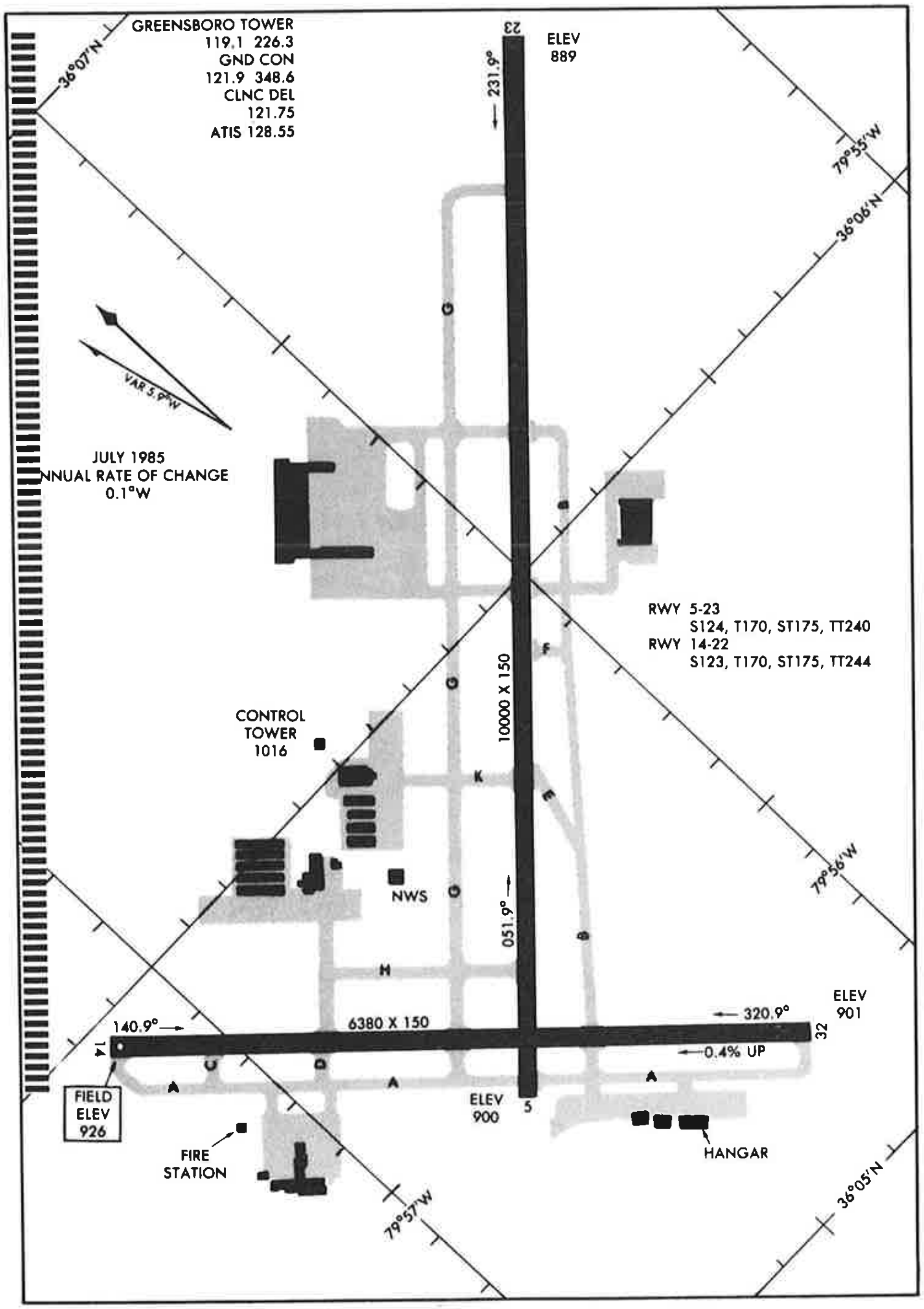
A Master Plan update is considering two alternatives. An extension of the crosswind Runway 18/36 from 3,400 feet to 6,600 feet, crossing an existing air carrier runway, with an estimated cost of is $30 million, and a new 7,000-foot parallel, Runway 8L/26R, 5,000 feet from Runway 8R/26L. The current 3,918-foot Runway 8L/26R would become a taxiway. This runway will potentially double hourly IFR arrival capacity from 26 to 52. The estimated cost is $31.3 million. The plan update will be completed early in 1990. Both runway improvements are expected to be completed by 1995.



PLANNED OR RECOMMENDED NEW RUNWAYS
(LOCATION APPROXIMATED - BASED ON CURRENT INFORMATION)

Greensboro (GSO)

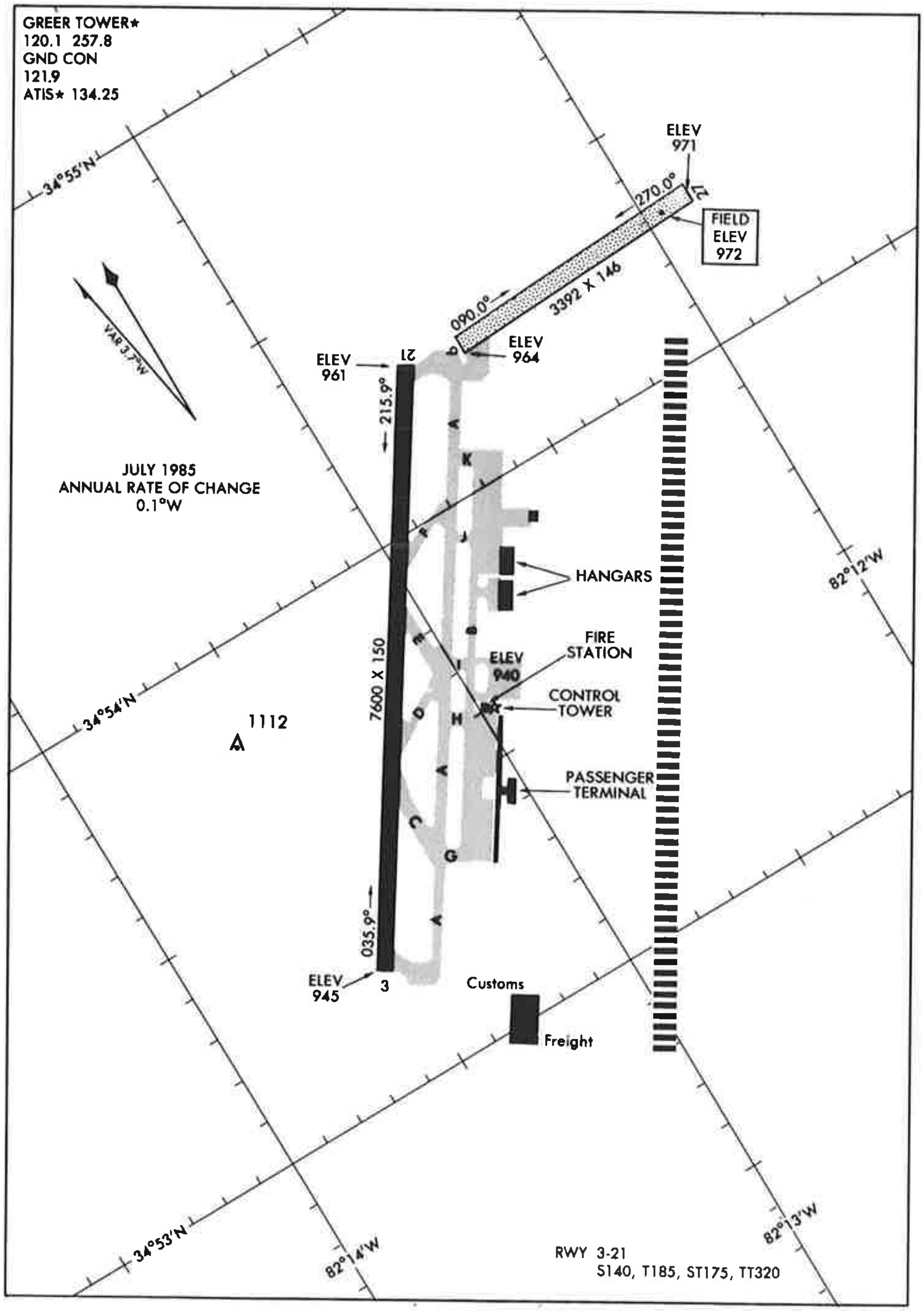
The airport layout plan shows a new parallel Runway 5/23, 5,000 feet northwest of the existing Runway 5/23. This new runway would permit independent parallel operations potentially doubling hourly IFR arrival capacity from 26 to 52. The Master Plan update should be complete in July 1989.



PLANNED OR RECOMMENDED NEW RUNWAYS
(LOCATION APPROXIMATED - BASED ON CURRENT INFORMATION)

Greenville-Spartanburg (S.C.)

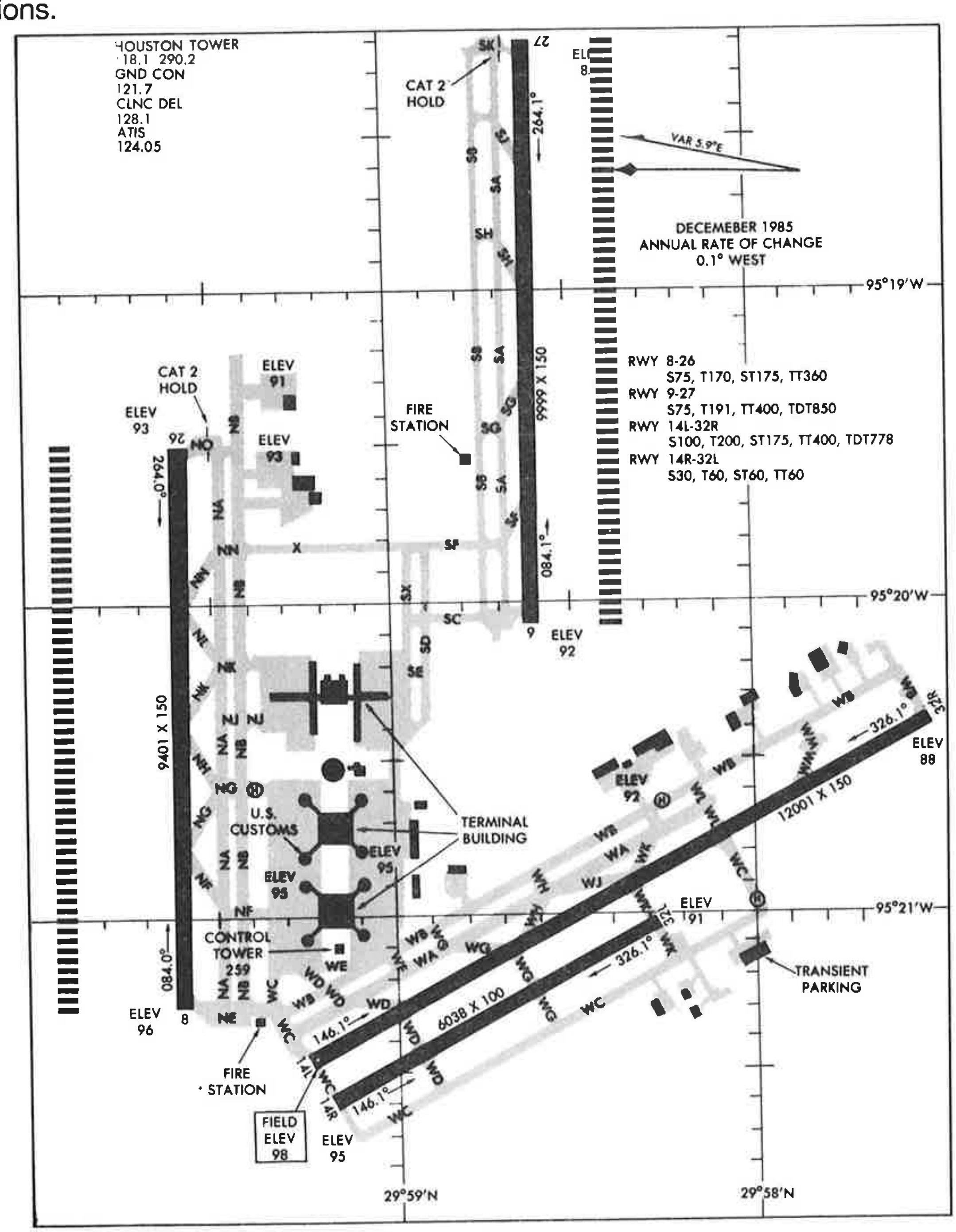
The Horizon Plan, part of a Master Plan update to be finished in 1989, proposes an 8,000 foot parallel runway situated 4,500 feet from the existing runway. It is planned to be operational in 1995 with an estimated cost of construction of about $25 million. This would potentially double hourly IFR arrival capacity from 26 to 52.



PLANNED OR RECOMMENDED NEW RUNWAYS
(LOCATION APPROXIMATED - BASED ON CURRENT INFORMATION)

Houston (IAH)

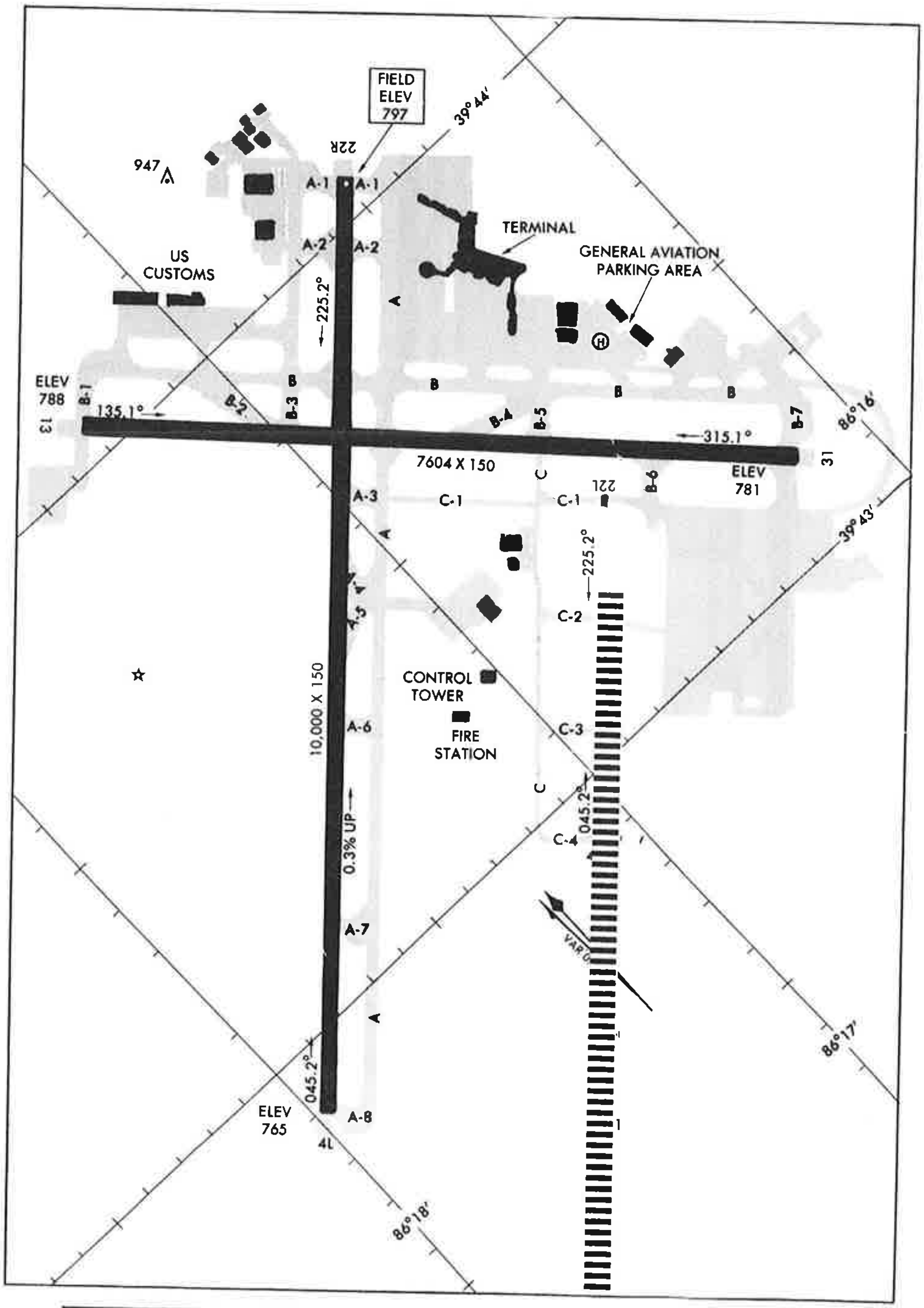
A new runway, Runway 8L/26R, is planned within the next 10 years. This runway will be parallel to and north of existing Runway 8/26. The spacing between these two runways will be 3,500 feet. This runway, in conjunction with Runways 9/27 and 8/26, has the potential for allowing triple IFR approaches increasing hourly IFR arrival capacity from 52 to 78. Another new runway, parallel to and south of Runway 9/27, is also planned. This runway will be separated by only 1,000 feet, ruling out the potential for additional IFR multiple approach applications.



PLANNED OR RECOMMENDED NEW RUNWAYS
(LOCATION APPROXIMATED - BASED ON CURRENT INFORMATION)

Indianapolis (IND)

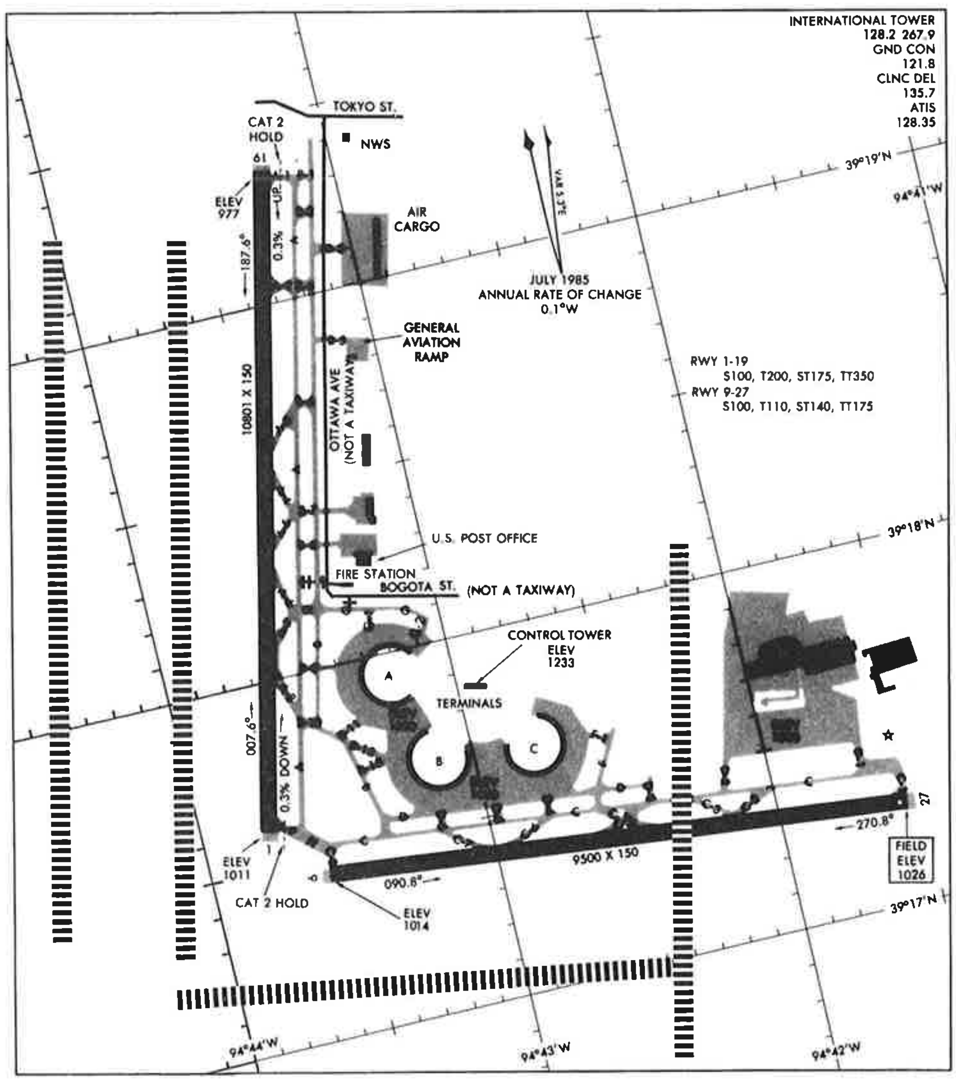
A new Runway 4R/22L, parallel to and 2,800 feet away from the existing Runway 4L/22R is planned. Dimensions are 10,000 feet by 150 feet. This may permit dependent parallel operations, increasing hourly IFR arrival capacity from 26 to 36. The first grant was issued this year for grading and drainage. A letter of intent has been issued for construction to be completed within the next four years. The estimated operational date is 1993. Total development costs are estimated to be $38 million with an additional cost of six million dollars for an ILS.



IIIIIIIIIIIIIIIIIII PLANNED OR RECOMMENDED NEW RUNWAYS
(LOCATION APPROXIMATED - BASED ON CURRENT INFORMATION)

Kansas City (MCI)

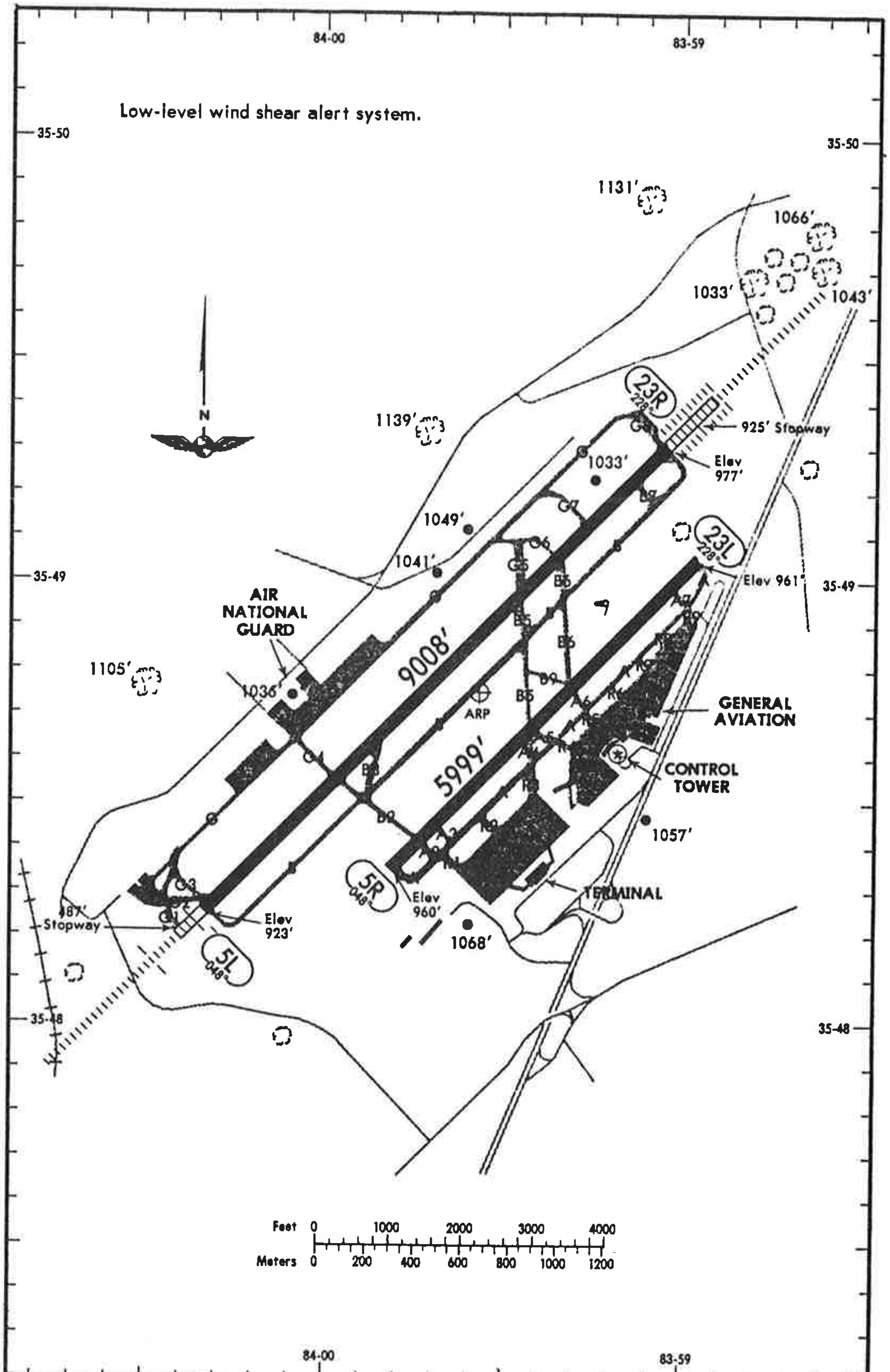
A total of four new runways are planned for MCI. Runway 1R/19L, will be constructed parallel to and east of existing Runway 1/19. The spacing between these two runways will be 6,575 feet, allowing independent parallel IFR operations and increasing hourly IFR arrival capacity from 26 to 52. Construction starts in August 1989 and is expected operational in 1992. The estimated cost is $50 million. A new Runway 9R/27L will be constructed 1,400 feet south of existing runway 9/27. This runway is planned for sometime during the next 10 years, and will not allow additional multiple approach IFR procedures. The runway will allow dual VFR arrival streams when winds prevent use of the north-south runways. The estimated cost is $60 million. Runway 18L/36R, is planned to be constructed in more than 10 years. This runway will be 1,400 feet west of existing Runway 1/19, 7,975 feet from 1R/19L, presenting the potential for multiple IFR approaches. The estimated cost is $65 million. A fifth runway, Runway 18R/36L, may be constructed in the long term. This runway would be located 6,200 feet west of Runway 18L/36R. The construction of this runway could potentially allow triple IFR approaches increasing hourly IFR arrival capacity from 52 to 78. The estimated cost is $90 million.



PLANNED OR RECOMMENDED NEW RUNWAYS
(LOCATION APPROXIMATED - BASED ON CURRENT INFORMATION)

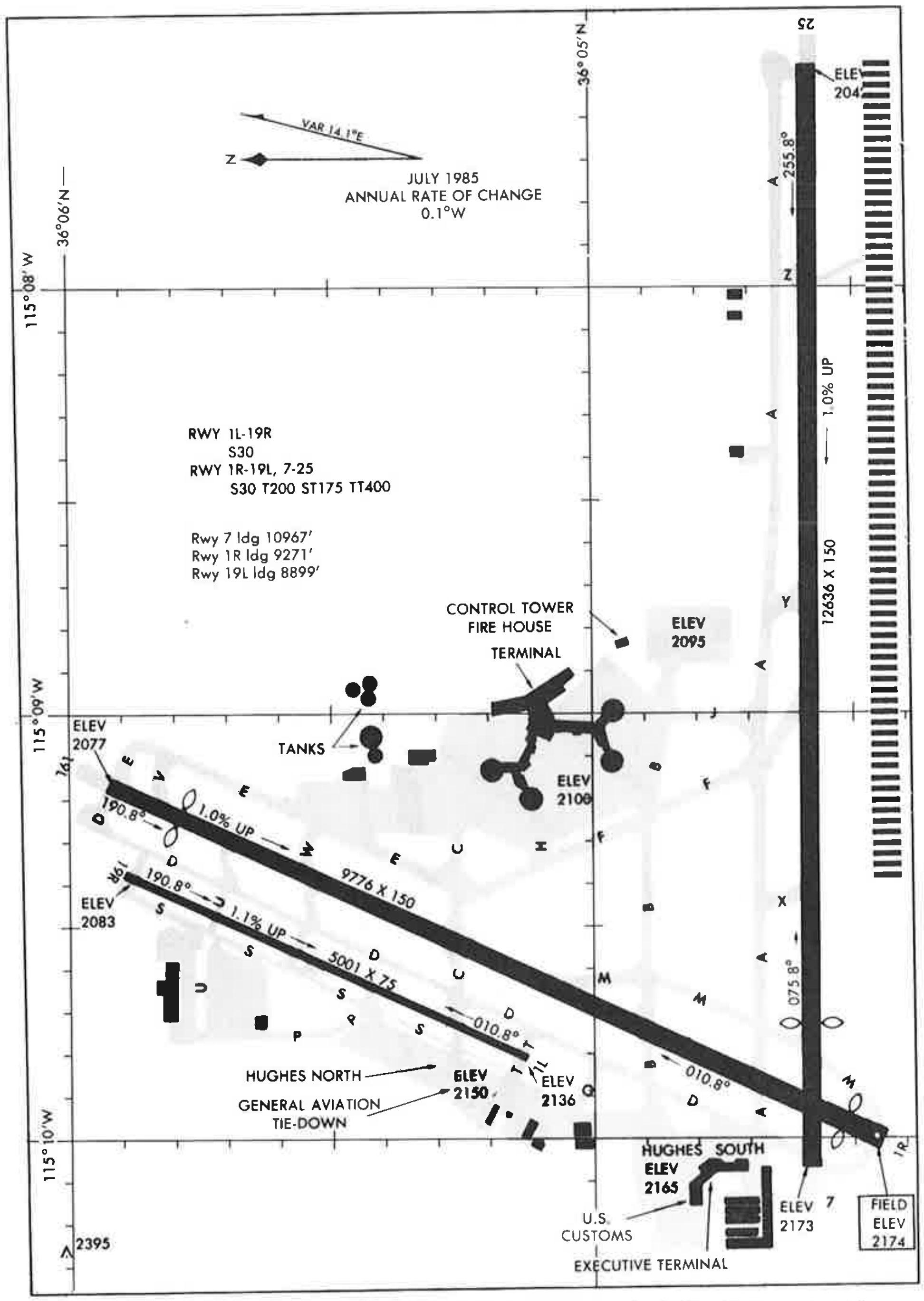
Knoxville (TYS)

An extension of Runway 5R/23L from 6,000 to 9,000 feet is under multi-year grant. The sponsor is in the process of redesigning the project within the available funds. Construction will begin in the spring of 1989 and estimated completion is in mid- 1991. The projected estimated cost is approximately $17 million.



Las Vegas (LAS)

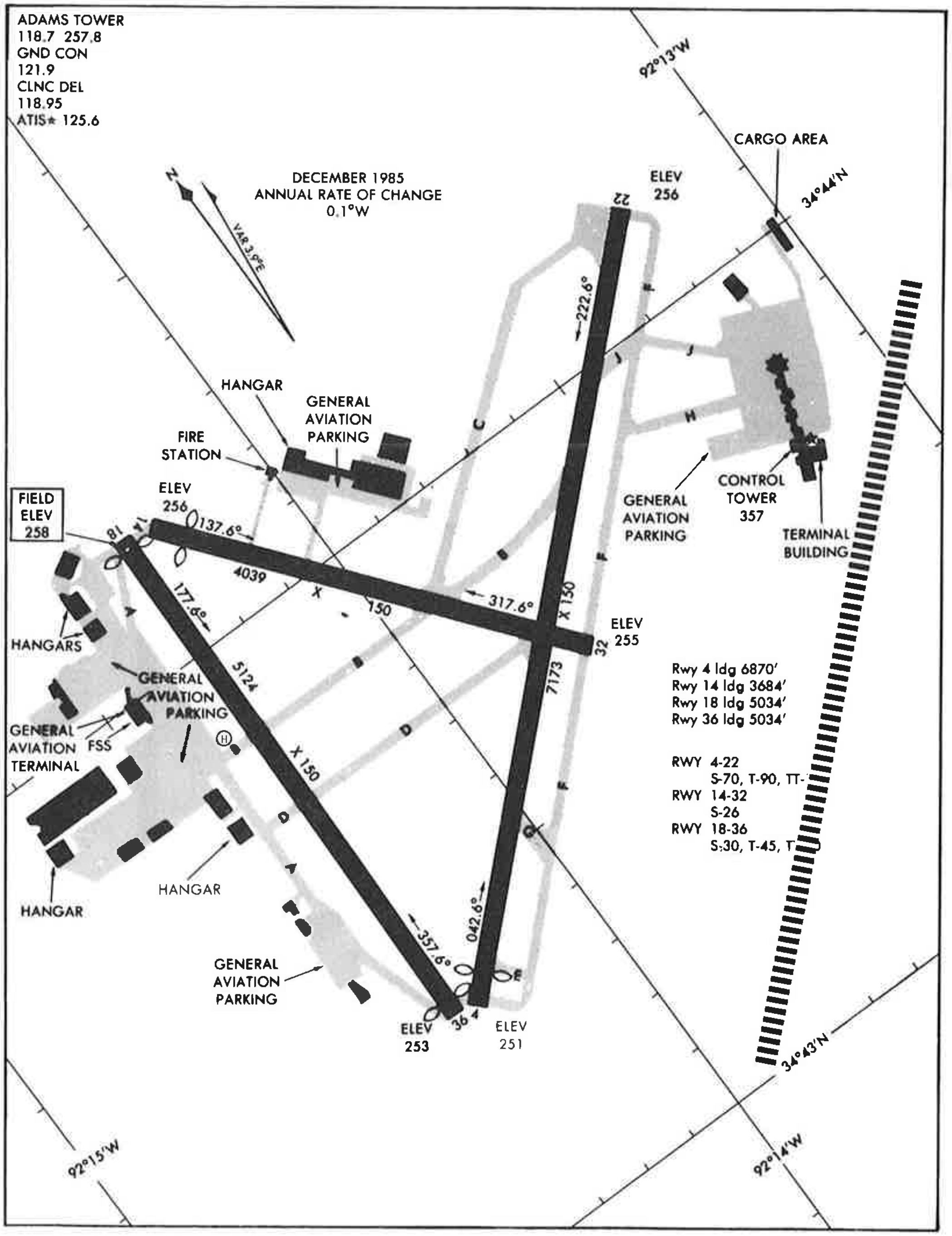
A new 8,900 foot runway, Runway 7R/25L, will be constructed parallel to and 1,000 feet south of Runway 7/25. It is expected to be operational in mid-1990. While this ill increase departure capacity, no increase in hourly IFR arrival capacity will be provided. The estimated cost for the new runway is $32 million.



PLANNED OR RECOMMENDED NEW RUNWAYS
(LOCATION APPROXIMATED - BASED ON CURRENT INFORMATION)

Little Rock (LIT)

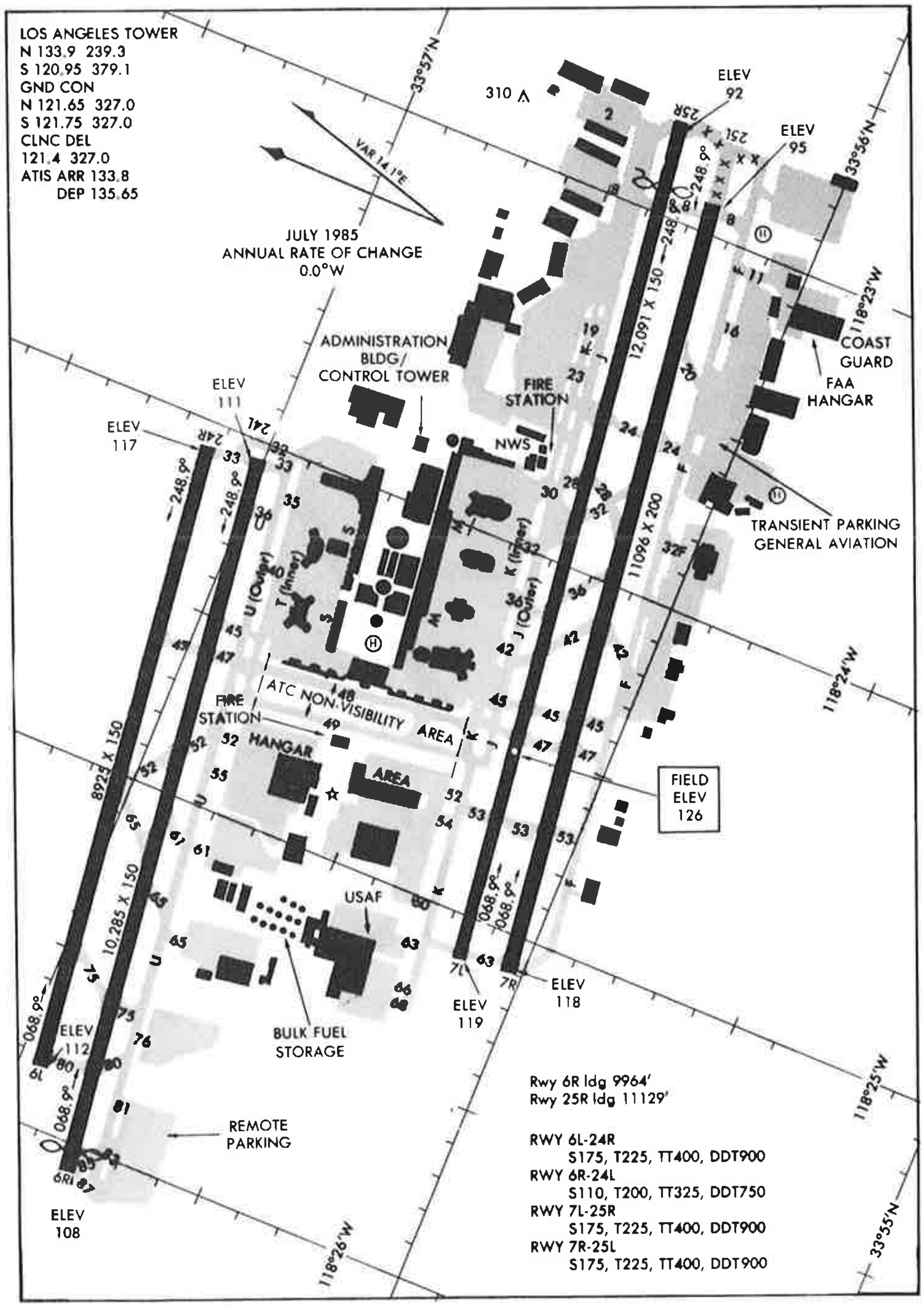
Parallel Runway 4R/22L, separated from Runway 4/22 by 4,300 feet is under construction and estimated to be operational in December 1990. This should allow independent parallel IFR operations, increasing hourly IFR arrival capacity from 26 to 52. The construction currently underway will not permit operations by air carriers. A second project to increase the strength of the surface will be necessary to permit operations by all air carriers. This will be completed in early 1991.



PLANNED OR RECOMMENDED NEW RUNWAYS
(LOCATION APPROXIMATED - BASED ON CURRENT INFORMATION)

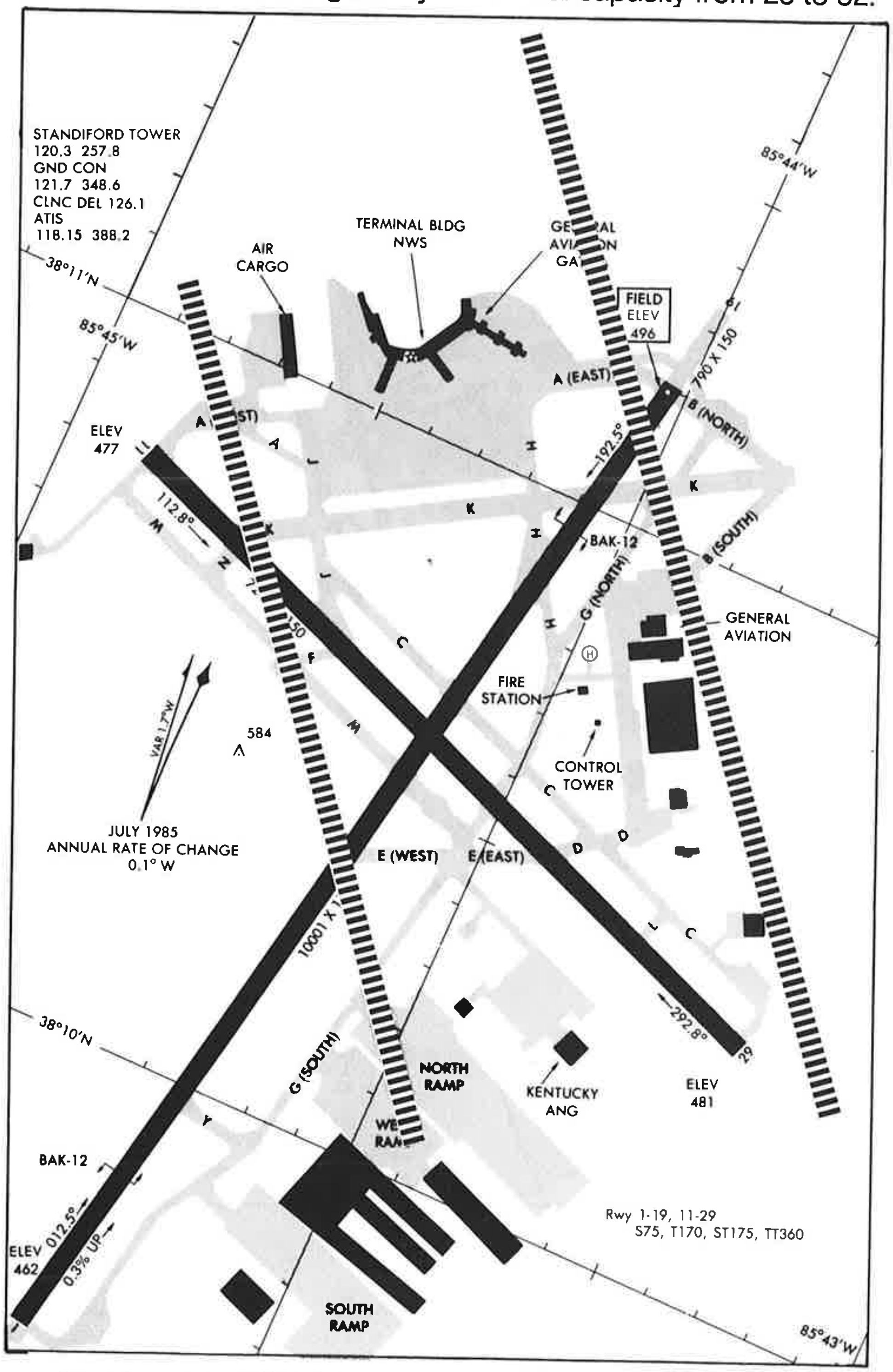
Los Angeles (LAX)

Runway 6L/24R is planned to be extended 1,360 feet to the west to a length of 10,285 feet. This will improve the take-off capability of Runway 24R to equal that of Runway 24L. This will require a taxiway extension as well. The estimated cost of construction is approximately $4 million and the estimated date of completion is June 1991.



Louisville (SDF)

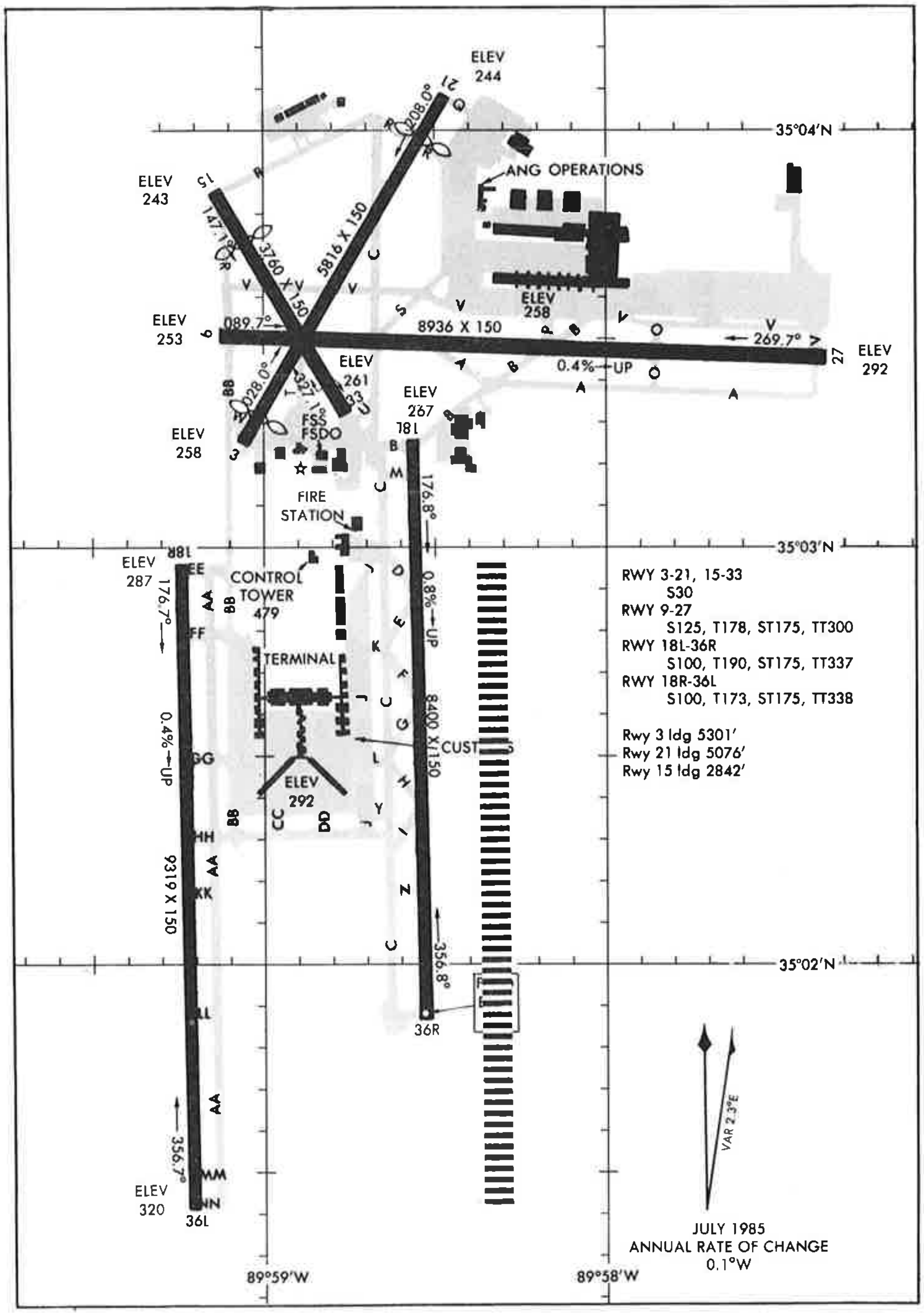
Plans were recently announced for two new parallel runways with northwest/southeast alignment 10,000 and 7,775 feet long and 4,800 feet apart. These would replace runway 1/19 which would then be closed. The UPS facility and passenger terminals would be between the runways. The estimated cost is $300 million; construction would start in 1991 and both would be operational by 1995. An environmental assessment is underway. Independent parallel IFR operations will be possible, increasing hourly IFR arrival capacity from 26 to 52.



PLANNED OR RECOMMENDED NEW RUNWAYS
(LOCATION APPROXIMATED - BASED ON CURRENT INFORMATION)

Memphis (MEM)

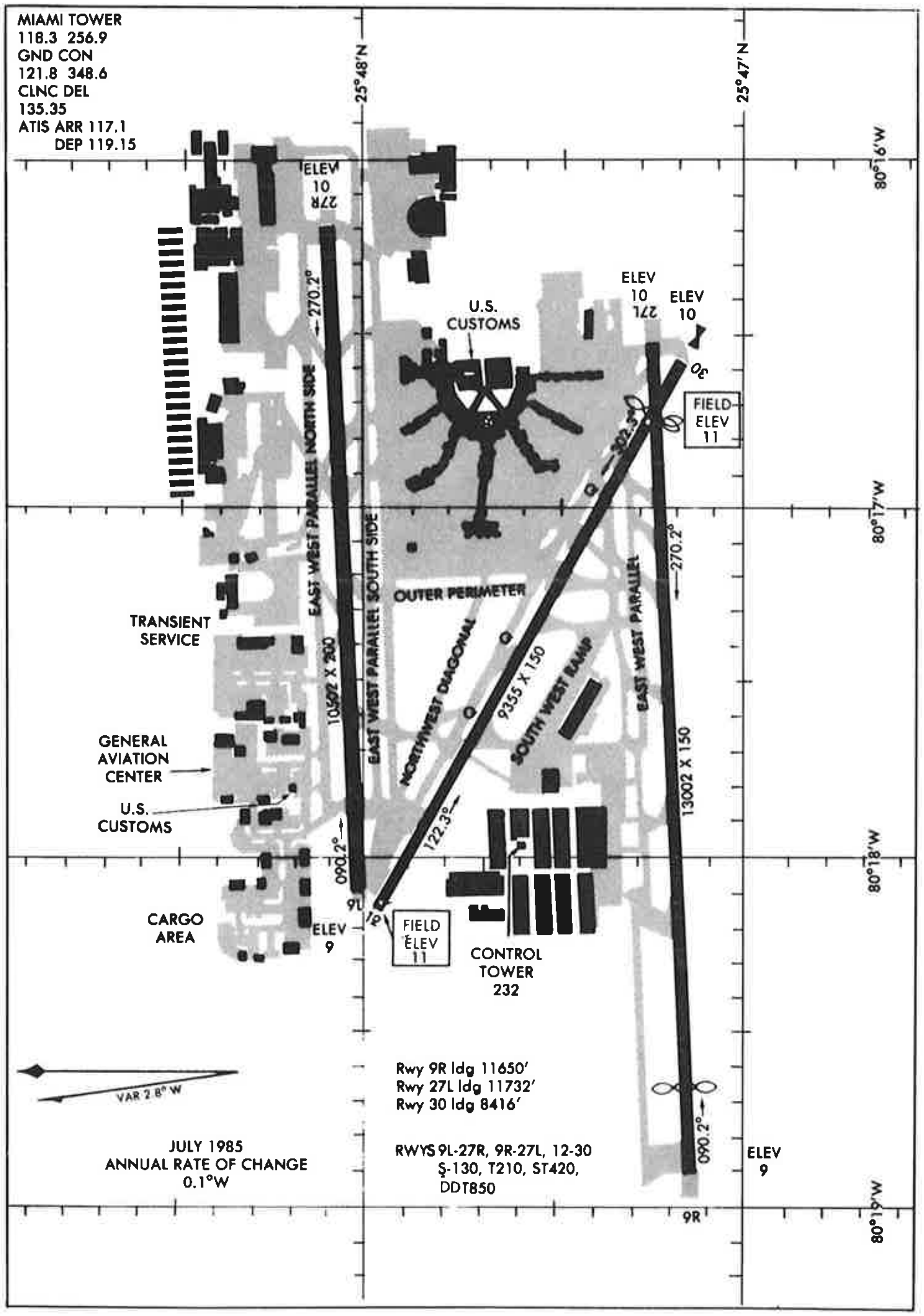
A new north-south runway, 17/35, is planned. This new runway will be parallel to the existing pair of runways. It will be 8,990 feet by 150 feet, and will tentatively be located 900 feet east of Runway 18L/36R; this puts the runway 4,300 feet apart from Runway 18R/36L, thus allowing independent parallel approaches under current rules. This would increase present hourly IFR arrival capacity from 26 to 52. An environmental assessment is underway. Construction is estimated to be completed in 1995. The estimated cost is $70 million.



IIIIIIIIIIIIIIIIIIII	PLANNED OR RECOMMENDED NEW RUNWAYS (LOCATION APPROXIMATED - BASED ON CURRENT INFORMATION)

Miami (MIA)

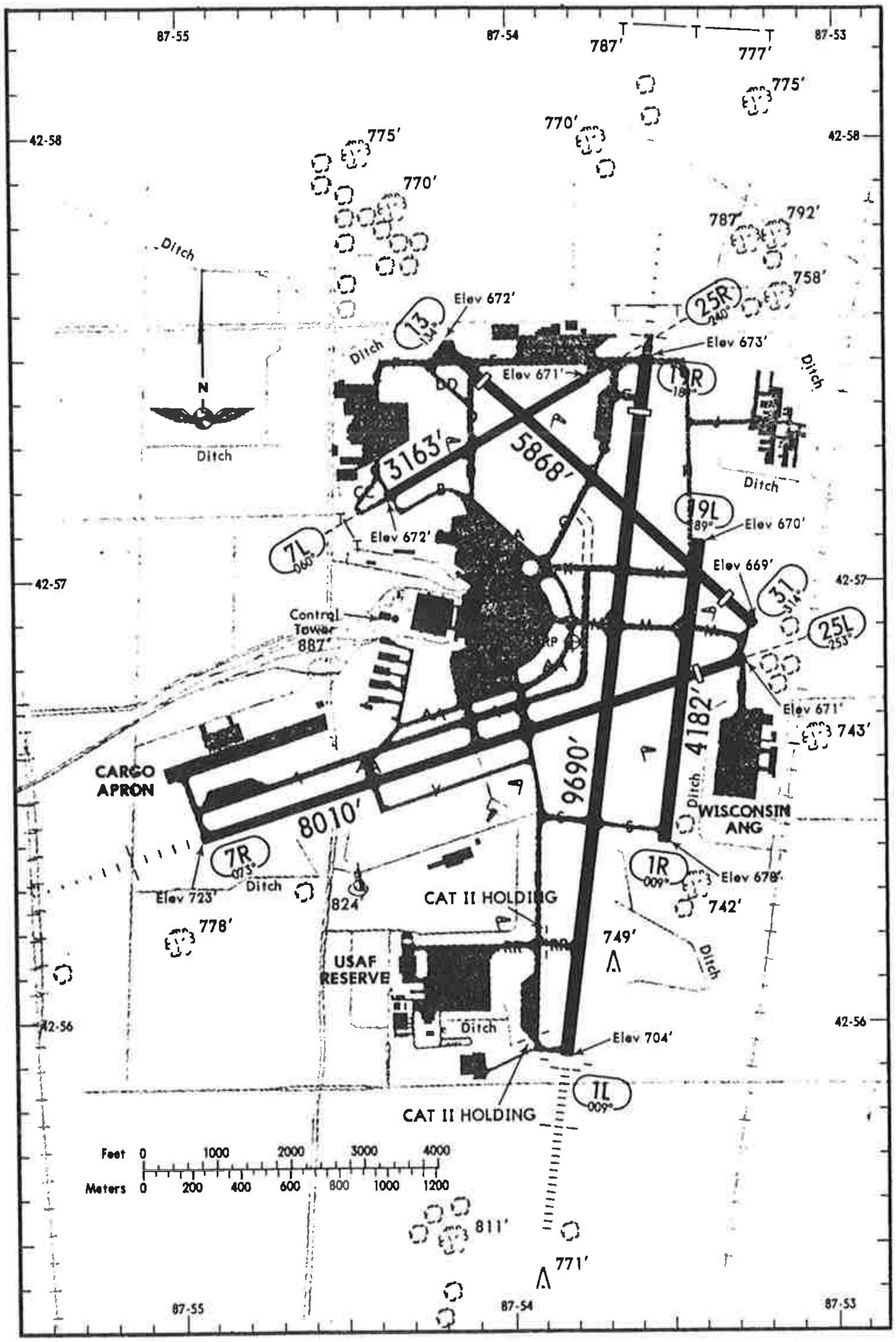
Recommendations reported by a completed task force at Miami International Airport include the construction of a new 3,600-foot commuter runway, 1,000 feet north of Runway 9L/27R. The estimated cost is $5 million and the runway is not expected to be operational until 2010.



PLANNED OR RECOMMENDED NEW RUNWAYS
(LOCATION APPROXIMATED - BASED ON CURRENT INFORMATION)

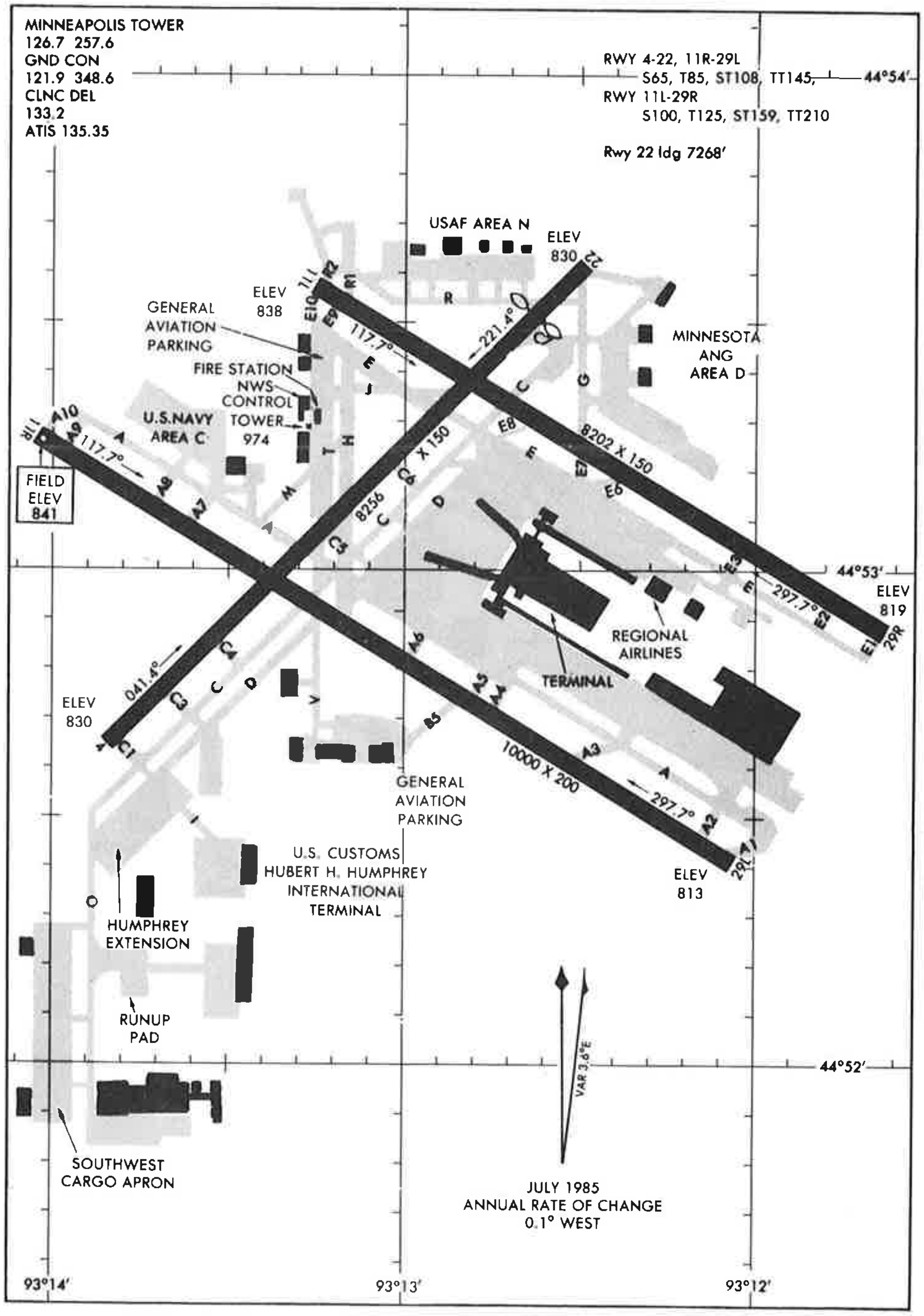
Milwaukee (MKE)

A Master Plan update is underway. Runway 1L/19R is proposed to be extended 1,900 feet to the south bringing the length to 11,600 feet. It will increase the VFR hourly capacity to 112 operations in a north flow condition. To increase IFR capacity, a new 6,000 foot parallel Runway 7L/25R is identified as being needed. This runway most likely would be a dependent parallel and could increase IFR hourly capacity to 36 operations. No cost estimates are available.



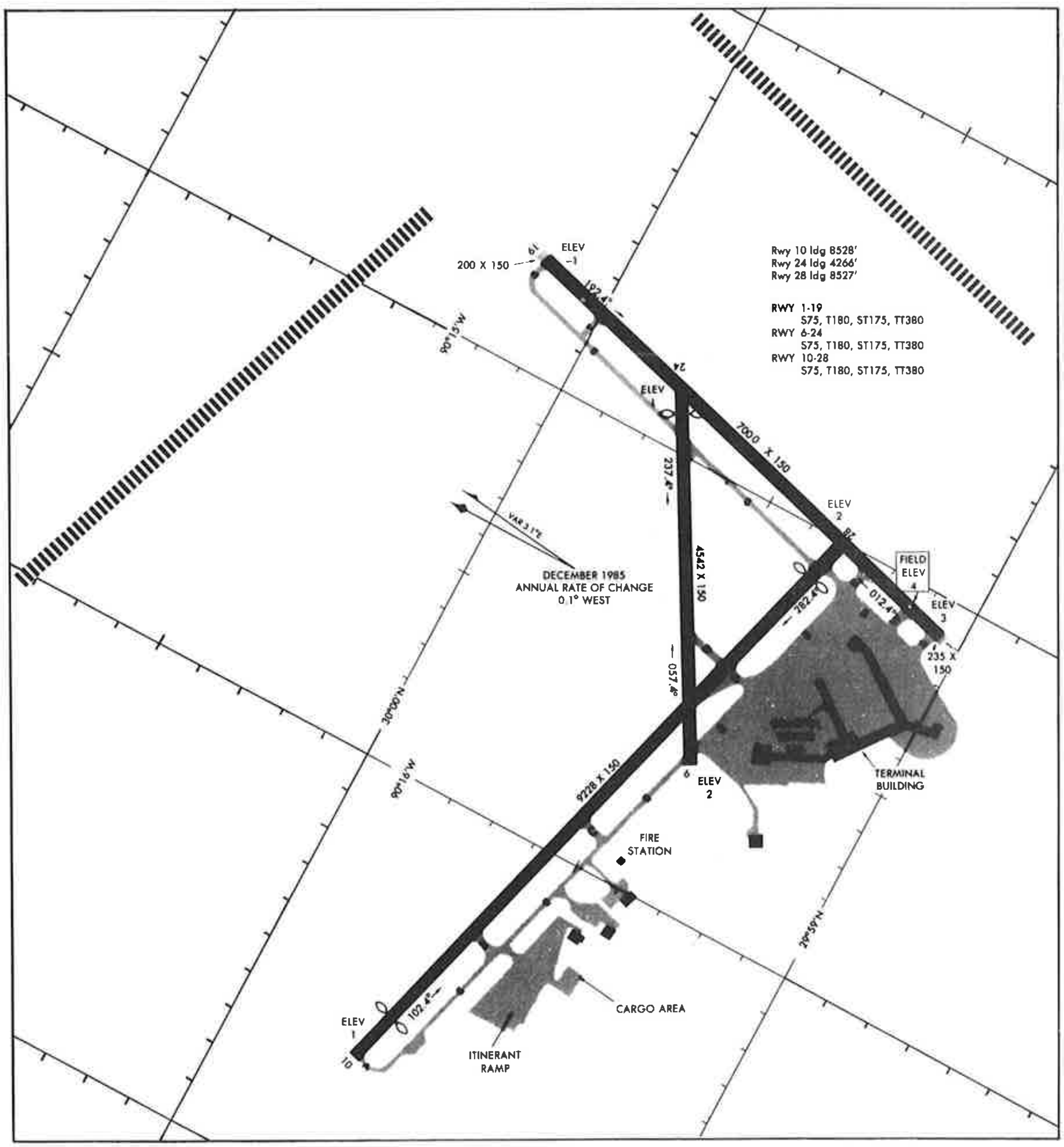
Minneapolis (MSP)

An extension of Runway 4/22 2,750 feet to the southwest is proposed for 1990. This will bring the runway length to 11,000 feet. An environmental impact statement is presently being prepared. The estimated cost is $11 million. Improvements will enable a preferential runway system for noise mitigation, potentially enhancing hourly VFR capacity in the cross-wind configuration from 60 to 80. The 11,000 foot runway will also allow operation of fully loaded long-haul carrier aircraft.



New Orleans (MSY)

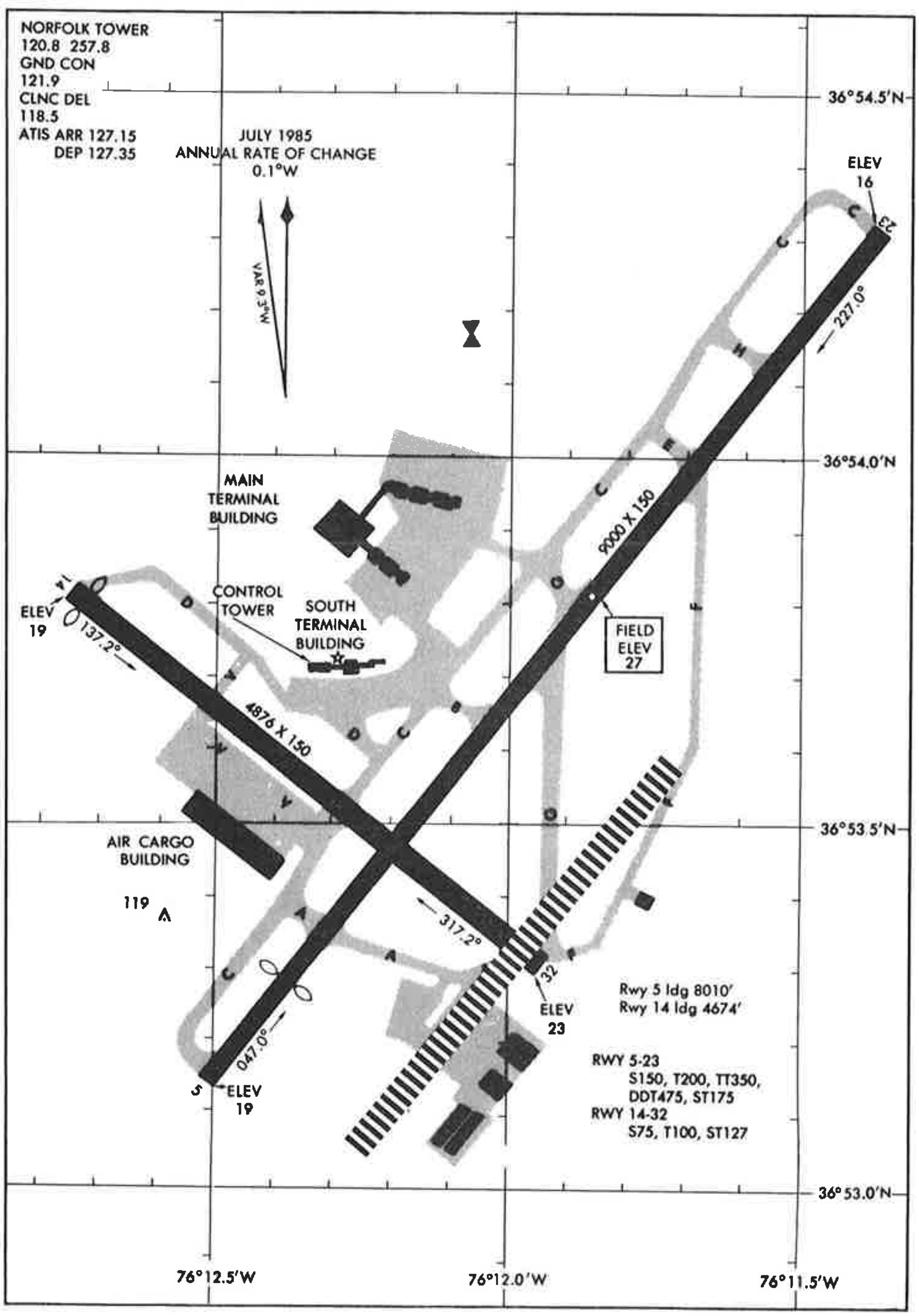
A new north-south runway is planned. This new runway will be parallel to existing Runway 1/19 and will be located beyond the threshold of Runway 10, 8,000 feet away from Runway 1/19. This may allow independent parallel operations, increasing IFR hourly arrival capacity from 26 to 52. Revision of the Master Plan may defer the new runway to beyond 1995. The Master Plan will also consider a new airport as a alternative. The sponsor is also considering construction of a 6,000 foot runway approximately 10,000 north of and parallel to Runway 10/28. This has not had an environmental assessment. If plans continue satisfactorily, it could be built by 1992.



PLANNED OR RECOMMENDED NEW RUNWAYS
(LOCATION APPROXIMATED - BASED ON CURRENT INFORMATION)

Norfolk (ORF)

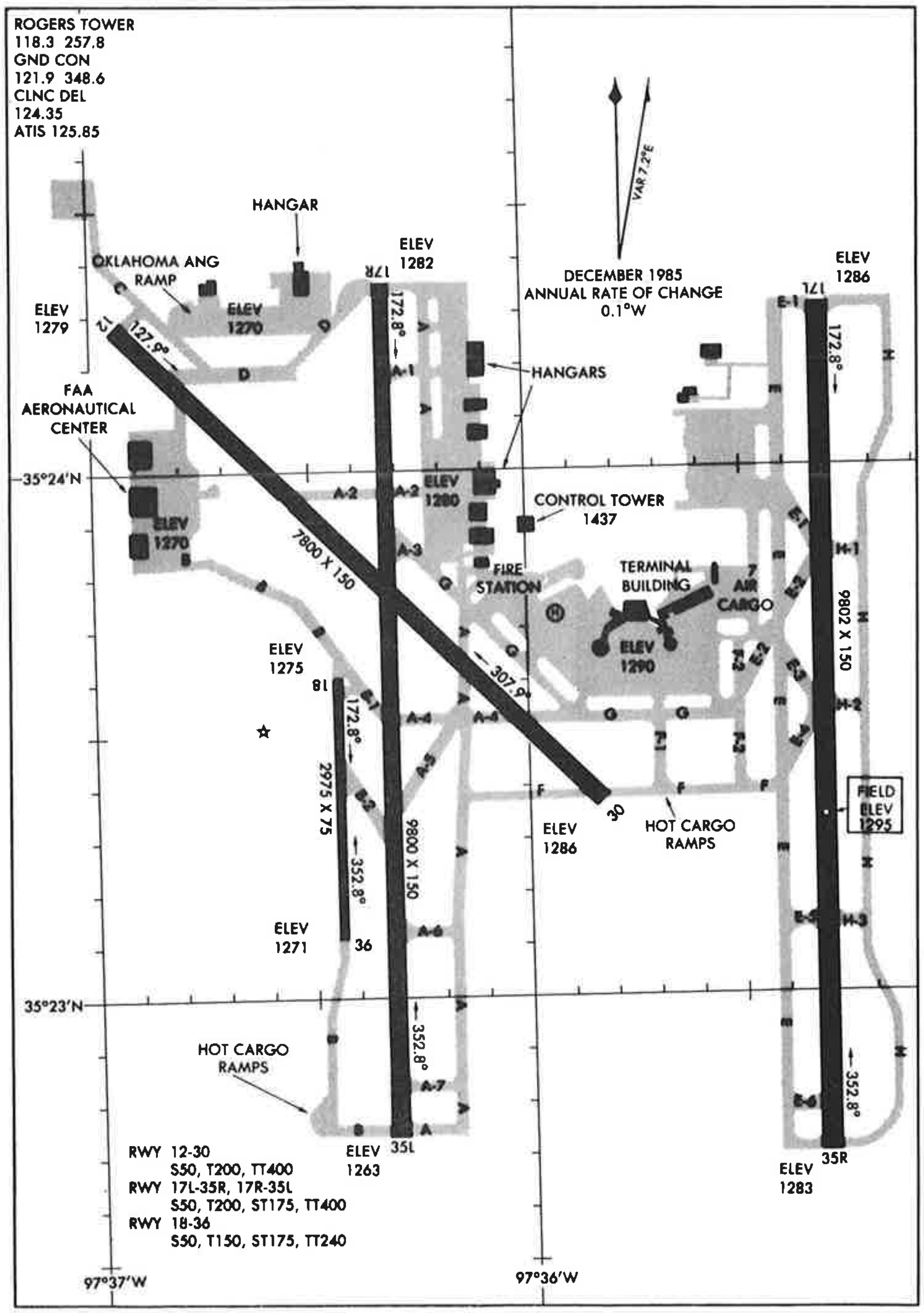
A Master Plan update will be completed in mid-1989. A new 3,600 foot, Runway 5R/23L, parallel to and 900 feet southeast of the main Runway 5/23, is being reconsidered in the update. Completion of this new parallel would not increase hourly IFR arrival capacity. There is no date for construction and cost estimates are not available.



PLANNED OR RECOMMENDED NEW RUNWAYS
(LOCATION APPROXIMATED - BASED ON CURRENT INFORMATION)

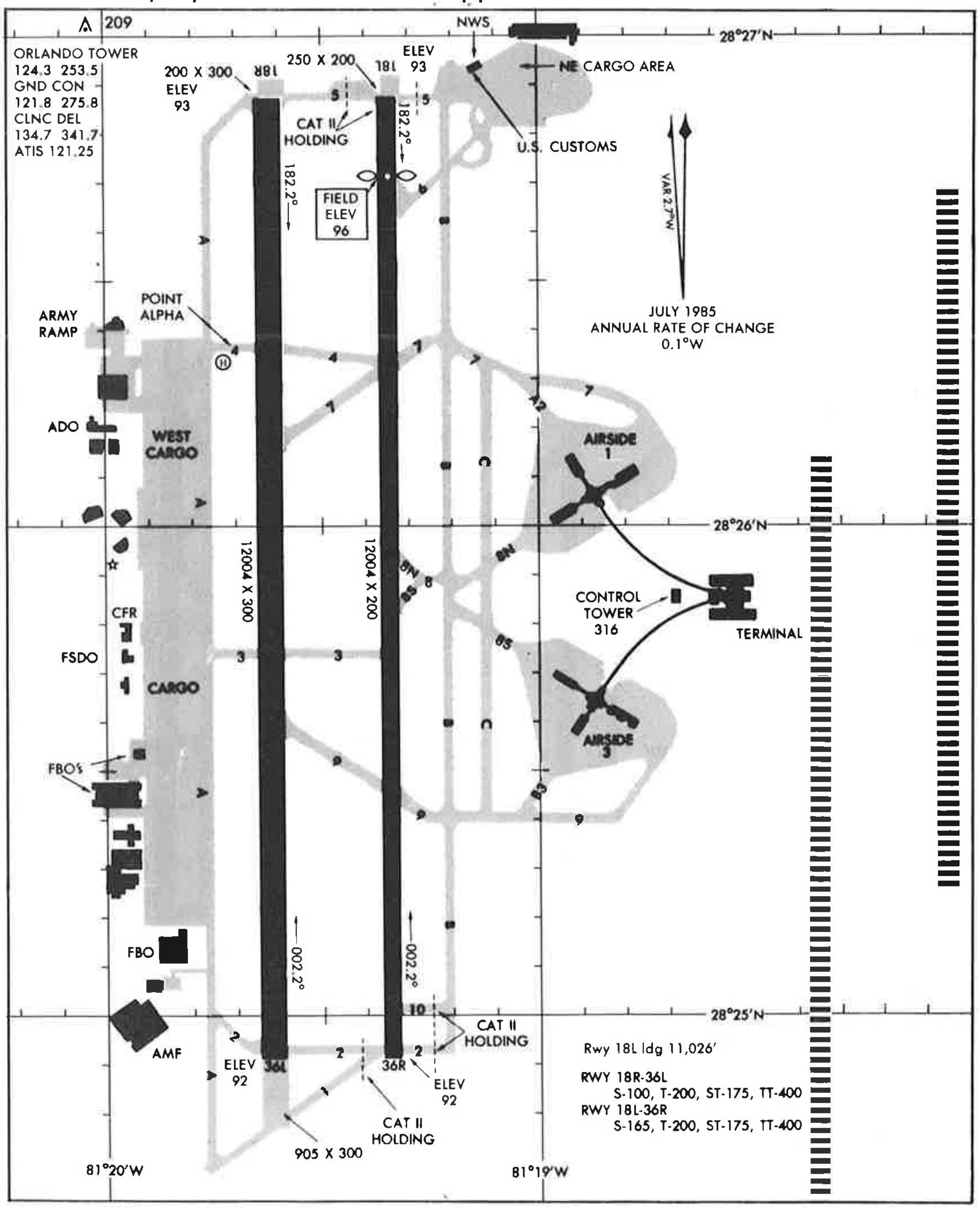
Oklahoma City (OKC)

Capacity enhancing projects planned for Will Rogers World Airport. Included are extensions to both north-south runways to 12,500 feet, as well as an extension to the northwest-southeast runway to 8,500 feet. The major limitation to capacity is in the critical area of ILS approaches. The Airport needs parallel ILS approaches to the north as well as MLS or future state-of-the-art equipment.



Orlando (MCO)

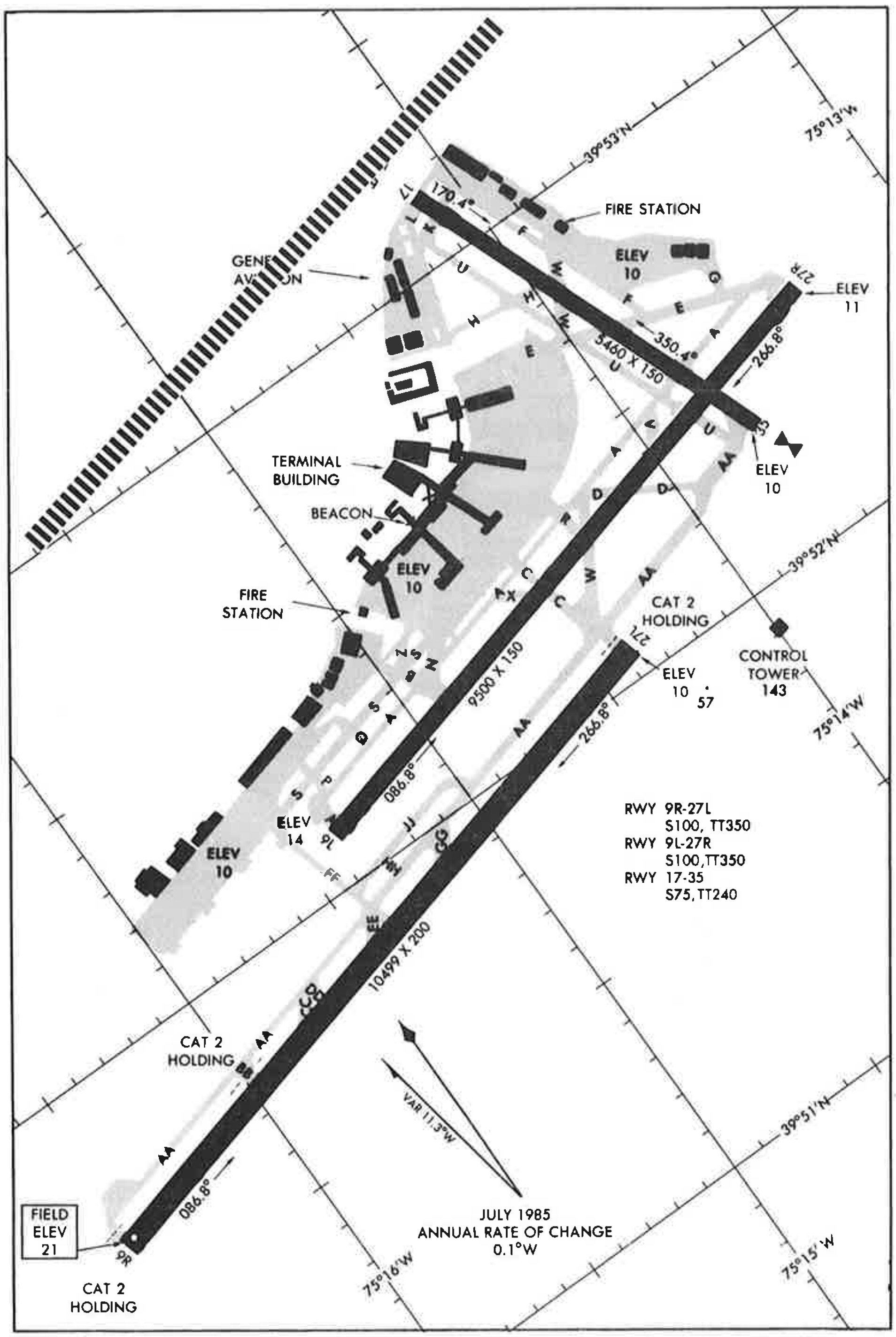
A new runway is planned 8,450 feet east of existing Runway 18L/36R. This new Runway 17L/35R is currently under construction and expected to be operational by September 1, 1989. This may allow independent parallel IFR approaches, increasing hourly IFR arrival capacity from 26 to 52. The estimated cost of the runway and taxiways are $65 million. A fourth north-south Runway 17R/35L, is expected to be operational in a 1993-94 timeframe. It will be located 4,300 east of Runway 17L/35R. This may permit triple independent IFR operation increasing hourly IFR arrival capacity from 52 to 78. The estimated cost of construction of this runway, not including outside taxiways, is $68-69 million. A fifth Runway 17C/35C, has been proposed but does not appear in the Master Plan.



PLANNED OR RECOMMENDED NEW RUNWAYS
(LOCATION APPROXIMATED - BASED ON CURRENT INFORMATION)

Philadelphia (PHL)

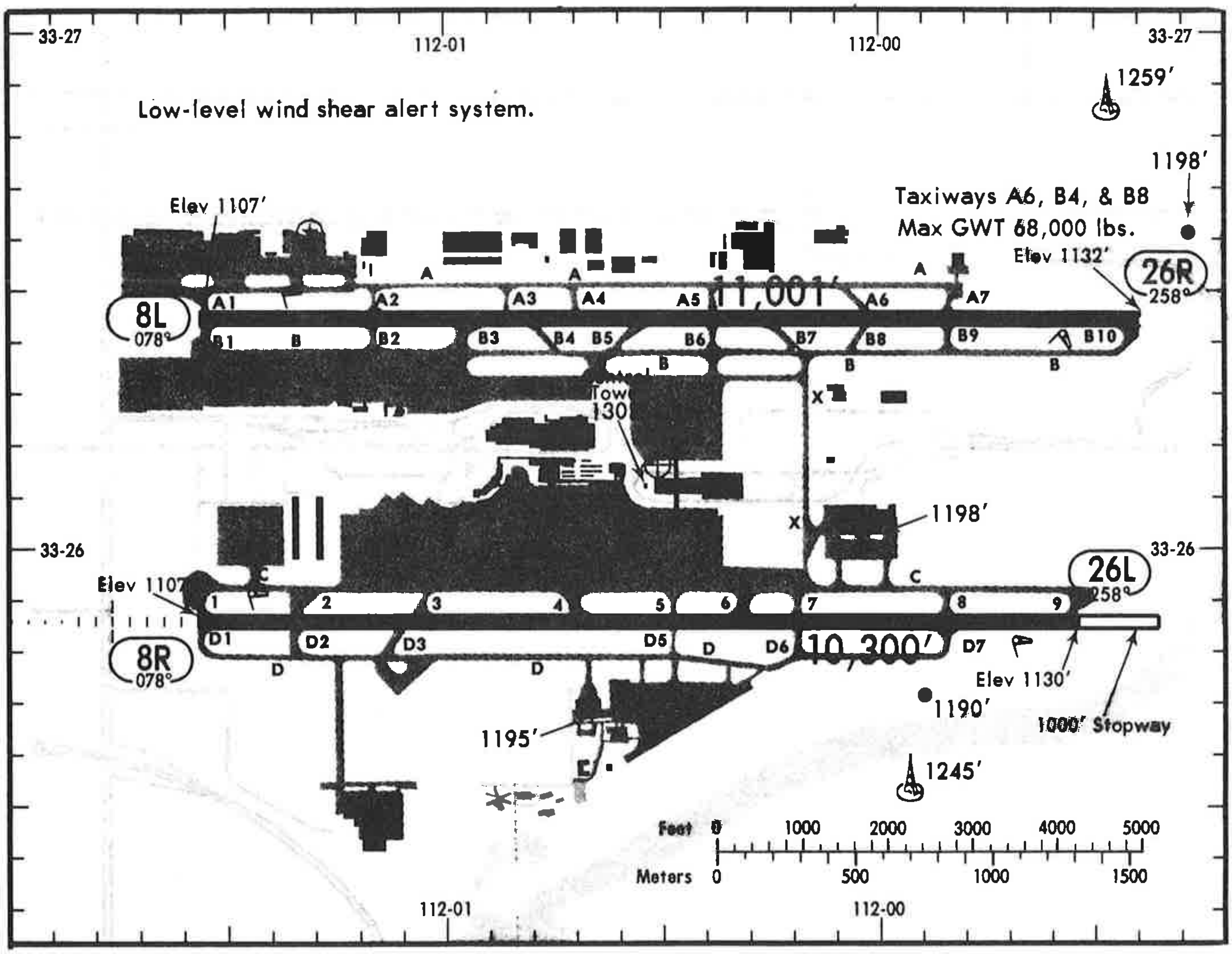
The airport will undergo total redevelopment. A third parallel runway and an extension to the crosswind runway are in early planning with operation estimated by 1993. The inner parallel will shift 600 feet south, closer to 9R/27L. The 1,000 foot extension of 17/35 may not occur due to obstructions/noise. The new parallel located in the northeast quadrant could be spaced as wide as 4,300 feet from the relocated inner parallel. This could provide independent parallel IFR operations. The hourly IFR arrival capacity would remain at 52 as presently provided by independent converging IFR capability but IFR minima would lower significantly to Category I. Major road relocations will be required.



PLANNED OR RECOMMENDED NEW RUNWAYS
(LOCATION APPROXIMATED - BASED ON CURRENT INFORMATION)

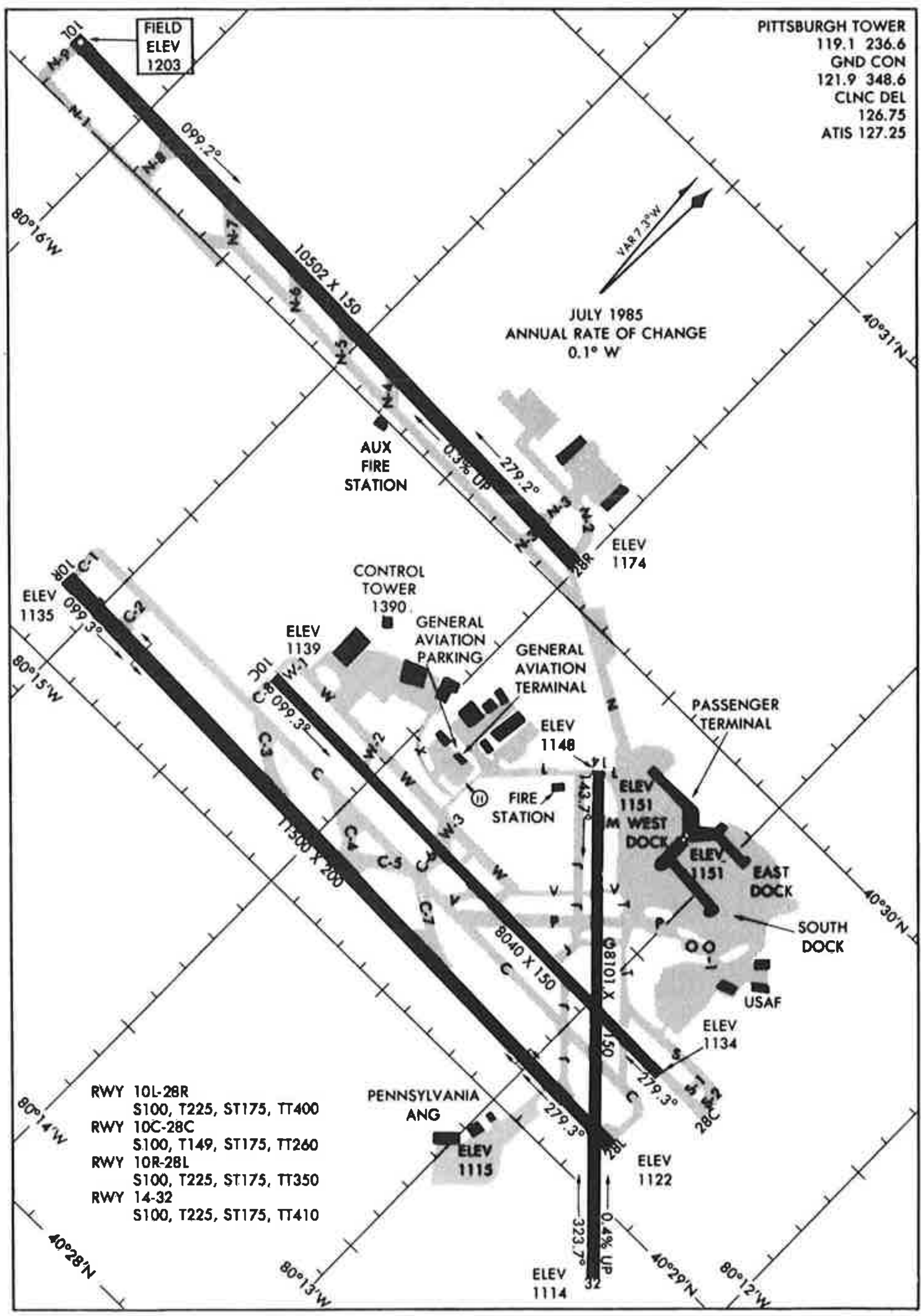
Phoenix (PHX)

A Master Plan study for Phoenix Sky Harbor International Airport has just been completed. The study confirms the conclusion of the current adopted Master Plan that a third parallel runway will be required. It was established that the third runway will be needed in the 1993-98 timeframe. The analysis identified 9,500 feet as an optimal length for the runway, but recognized that construction costs and environmental issues could affect the feasibility of construction to that length. The study also indicated that a length of 7,800 feet would provide the needed additional capacity, though not the operational flexibility of a 9,500 foot runway. Average aircraft delays would reach unacceptable levels and that air service would be severely restricted if the third runway is not constructed. Cost of the initial 8,800 foot runway is in excess of $50 million. The runway would be located 800 feet south of runway 8R/26L.



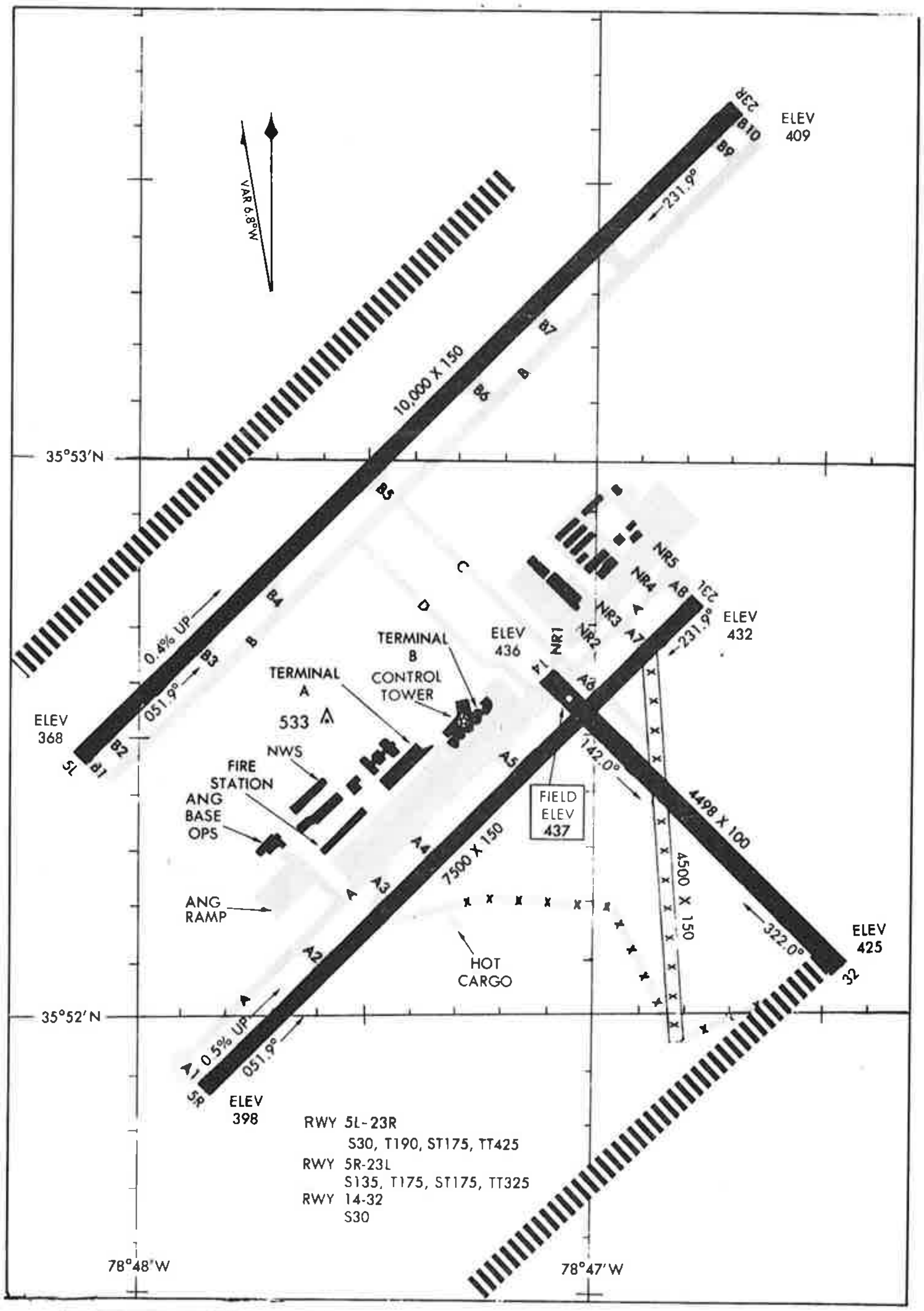
Pittsburgh (PIT)

Construction of a fifth runway (the second crosswind runway) is scheduled to begin in 1992. It will be more than 4,300 feet from the existing crosswind runway. No increase in IFR hourly arrival capacity will be provided. The county is also considering a fourth parallel, that may take earlier priority. Expressway relocation is an issue. The crosswind runway may be deferred in favor of the new parallel.



Raleigh-Durham (RDU)

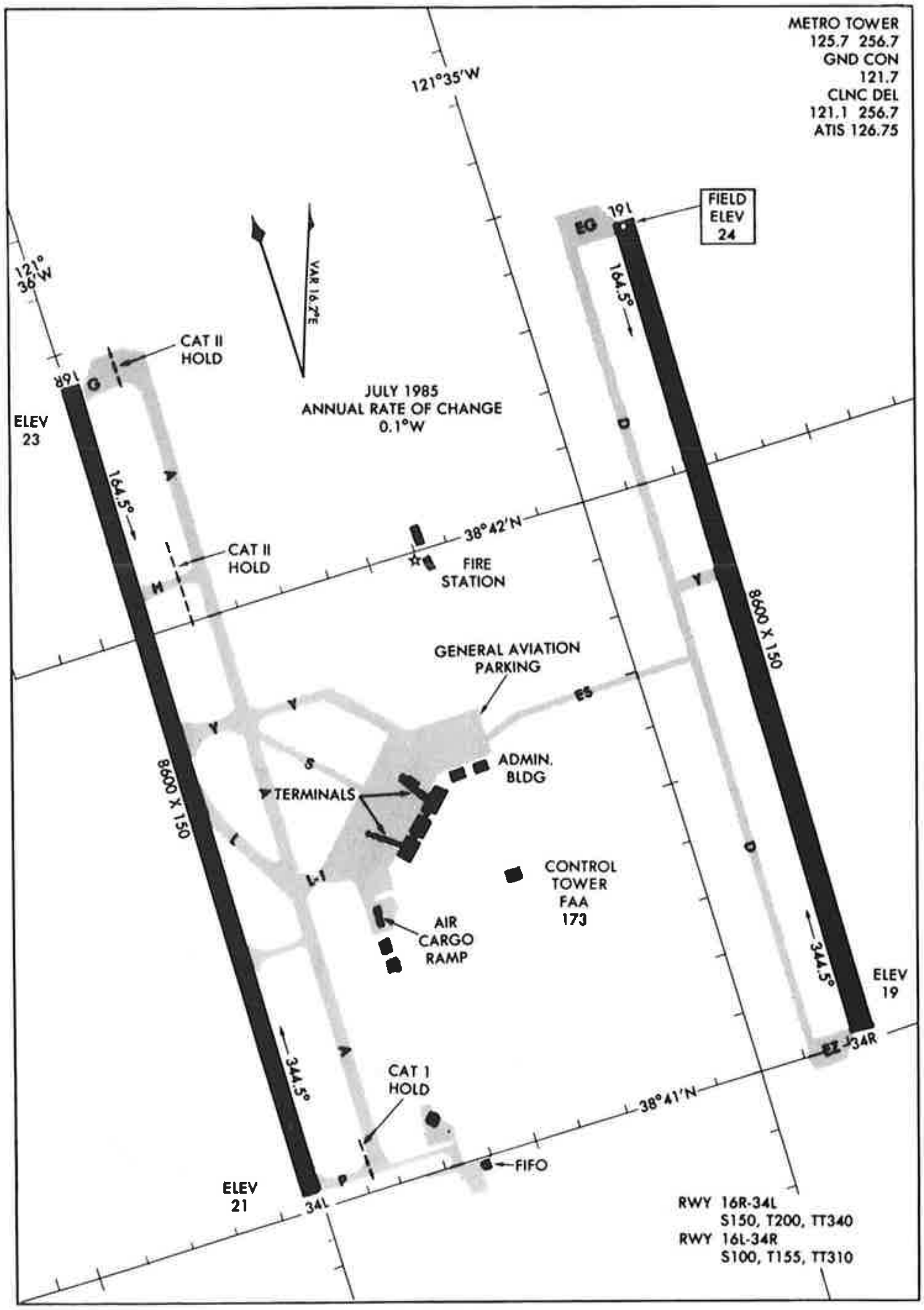
The airport layout plan shows a new runway, parallel to and southeast of Runway 5R/23L separated by 4,000 feet. It will be 5,500 feet long and limited to 60,000 pounds gross weight. A Master Plan update which will determine whether this runway is adequate as proposed and where it should be located will be completed in 1989. It is likely that the new runway will be extended to 8,000 feet to permit dual independent IFR approaches potentially increasing hourly IFR arrival capacity from 26 to 52. In a triple configuration, it could conceivably operate at 63 arrivals per hour. The estimated operational date is 1992-1993 and the estimated cost is $5 million.



IIIIIIIIIIIIIIIIIII	PLANNED OR RECOMMENDED NEW RUNWAYS (LOCATION APPROXIMATED - BASED ON CURRENT INFORMATION)

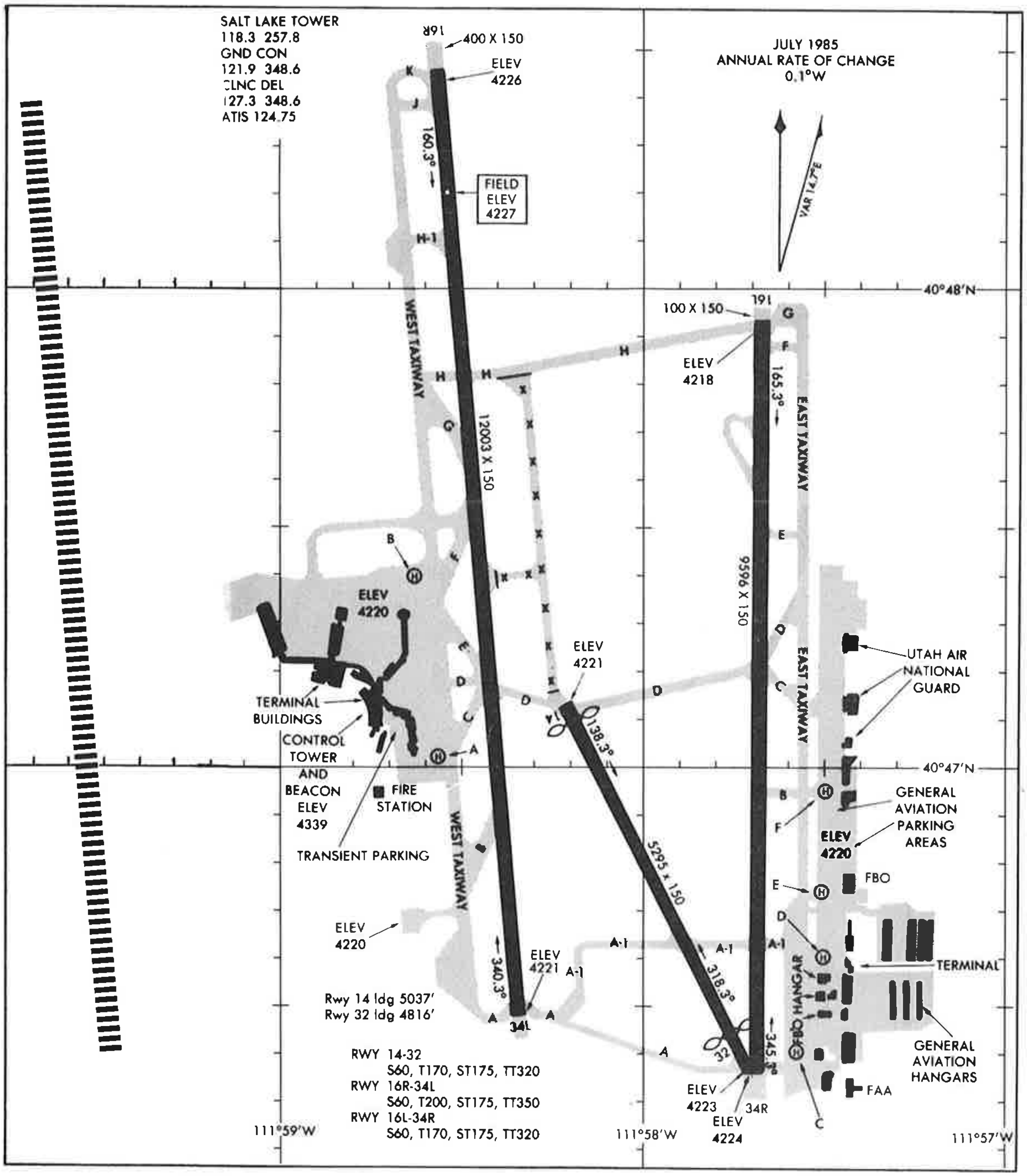
Sacramento (SMF)

Runway 16L/34R has been recently completed and is currently operational. It is a parallel runway separated by 6,000 feet. An ILS capability is planned for both ends of the new runway. Installation of the ILS should allow hourly IFR arrival capacity to increase from 26 to 52.



Salt Lake City (SLC)

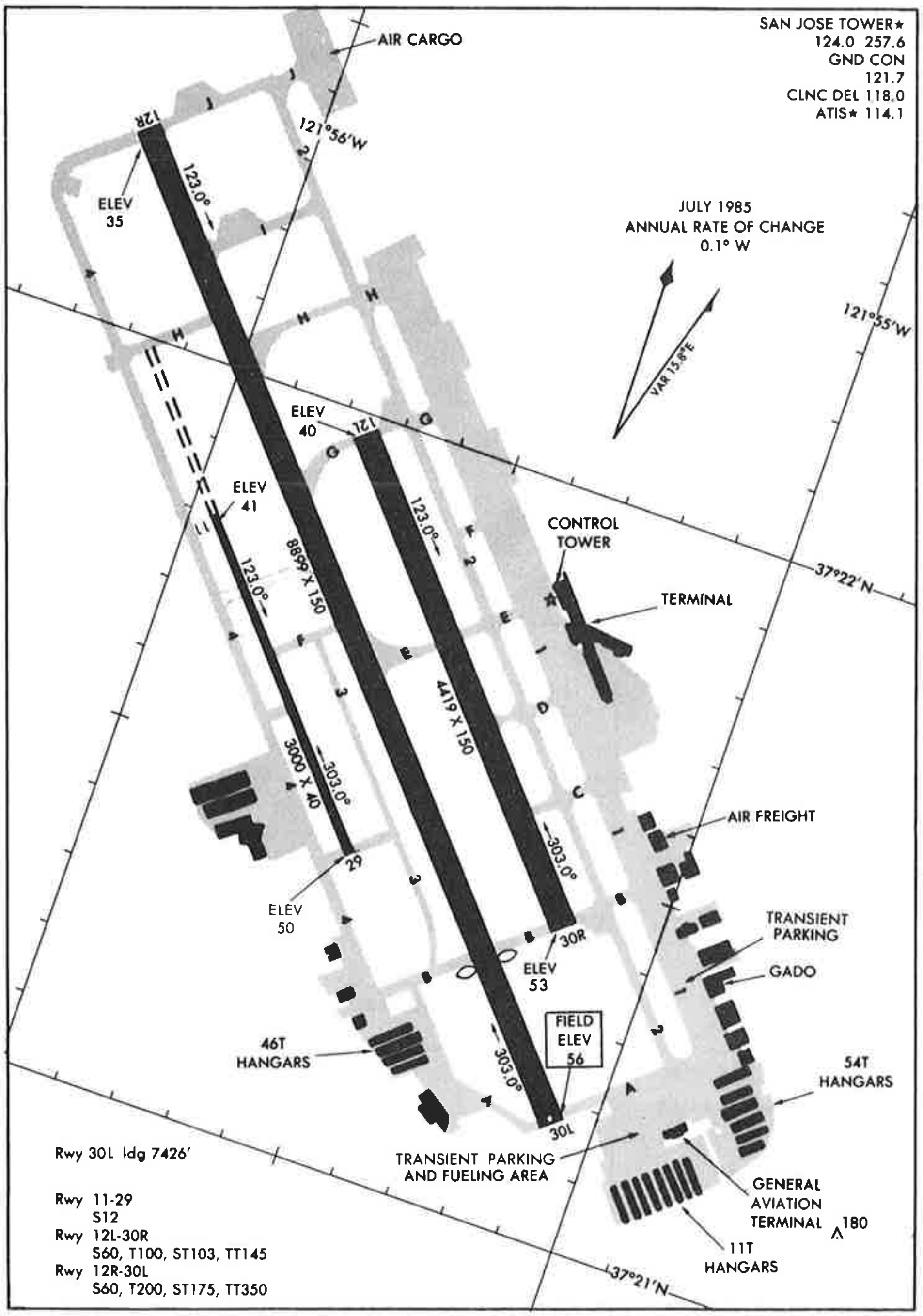
A new 12,000 foot runway parallel Runway 16R/34L is planned. Spacing between these runways is planned to be 6,300 feet. The new runway is on the recently completed Master Plan and is expected to be operational by 1995. This may permit triple IFR operation with one each dependent and independent pairing, increasing hourly IFR arrival capacity from 36 to 63.



PLANNED OR RECOMMENDED NEW RUNWAYS
(LOCATION APPROXIMATED - BASED ON CURRENT INFORMATION)

San Jose (SJC)

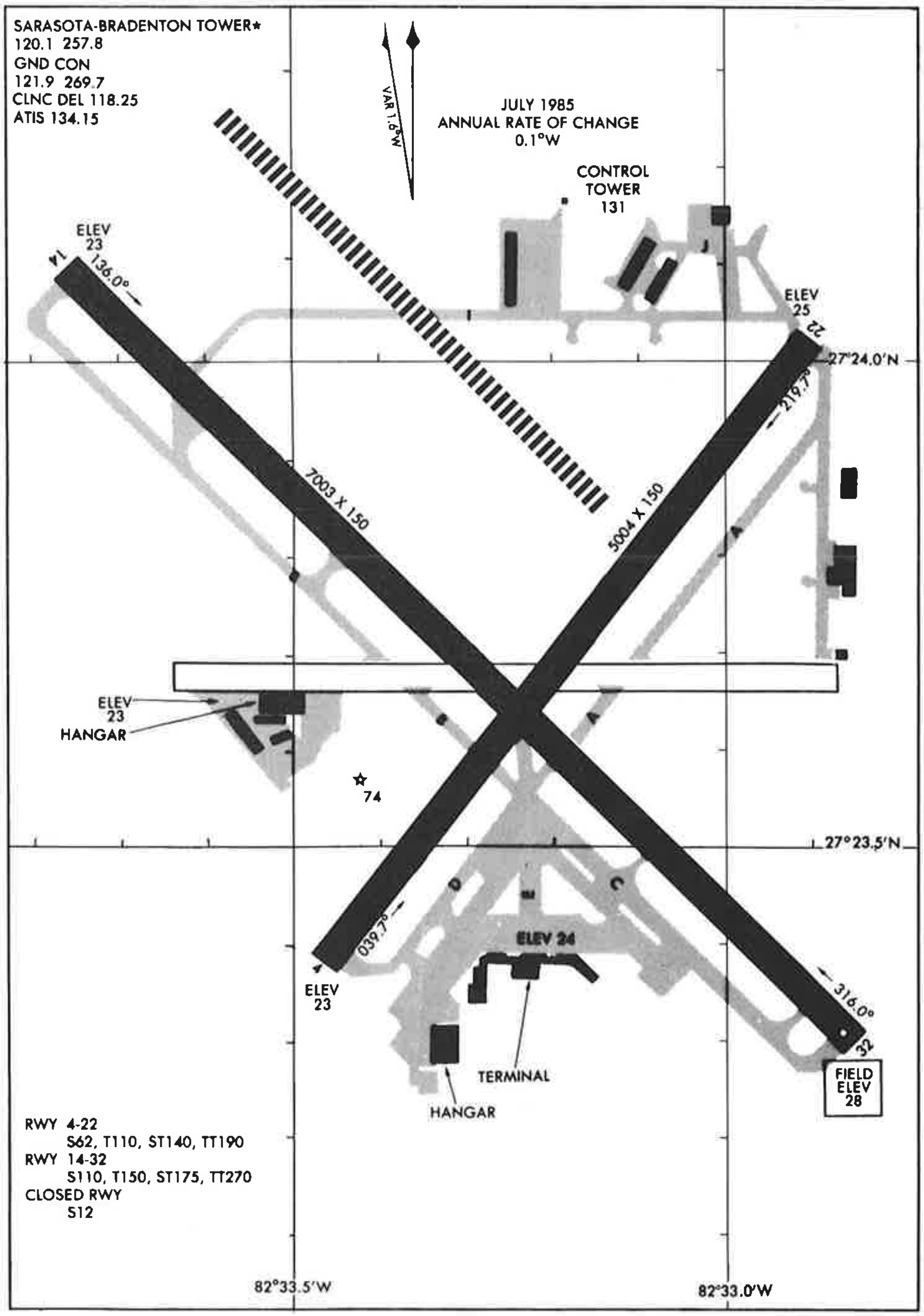
Construction will begin soon on a new 4,600 foot runway 700 feet southwest of Runway 30L/12R to replace existing Runway 11/29. The estimated operational date is summer 1989. This will relieve Runway 30R/12L of business jet traffic but will probably not increase hourly IFR arrival capacity of the airport. Consideration is also being given to extend Runway 30R/12L for air carrier capability. The airport layout plan shows this for a five year time frame but it could be operational in two years with fully-expedited action.



IIIIIIIIIIIIIIIIIIIIII	PLANNED OR RECOMMENDED NEW RUNWAYS (LOCATION APPROXIMATED - BASED ON CURRENT INFORMATION)

Sarasota-Bradenton (SRQ)

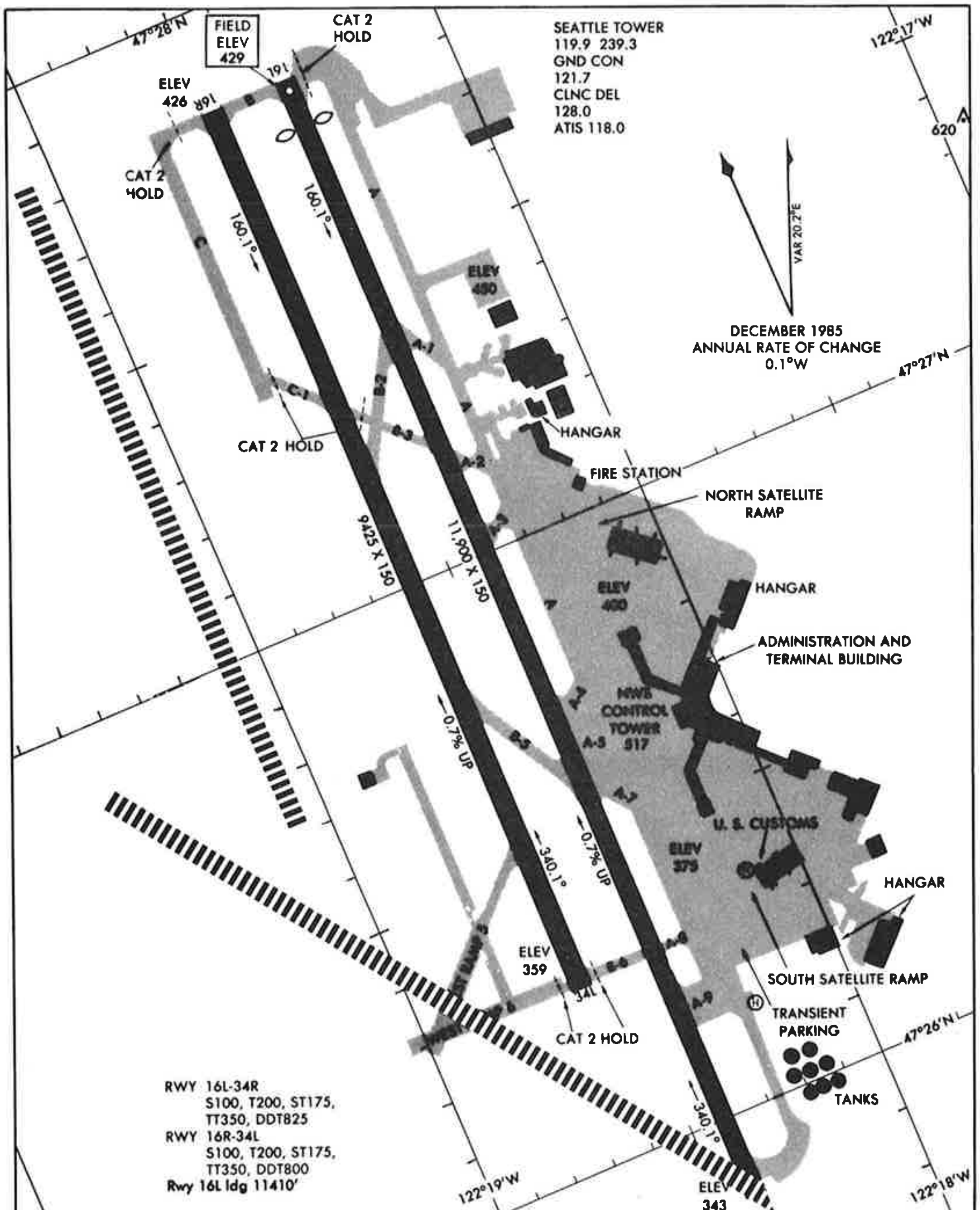
An environmental assessment for a short Runway 14L/32R,parallel to existing Runway 14/32, is expected to begin. This new parallel runway would be spaced 1,230 feet away and will be for commuters. No increase in hourly IFR arrival capacity will be provided, but VFR gains are expected by segregating smaller aircraft from the large aircraft arrival streams.



PLANNED OR RECOMMENDED NEW RUNWAYS
(LOCATION APPROXIMATED - BASED ON CURRENT INFORMATION)

Seattle (SEA)

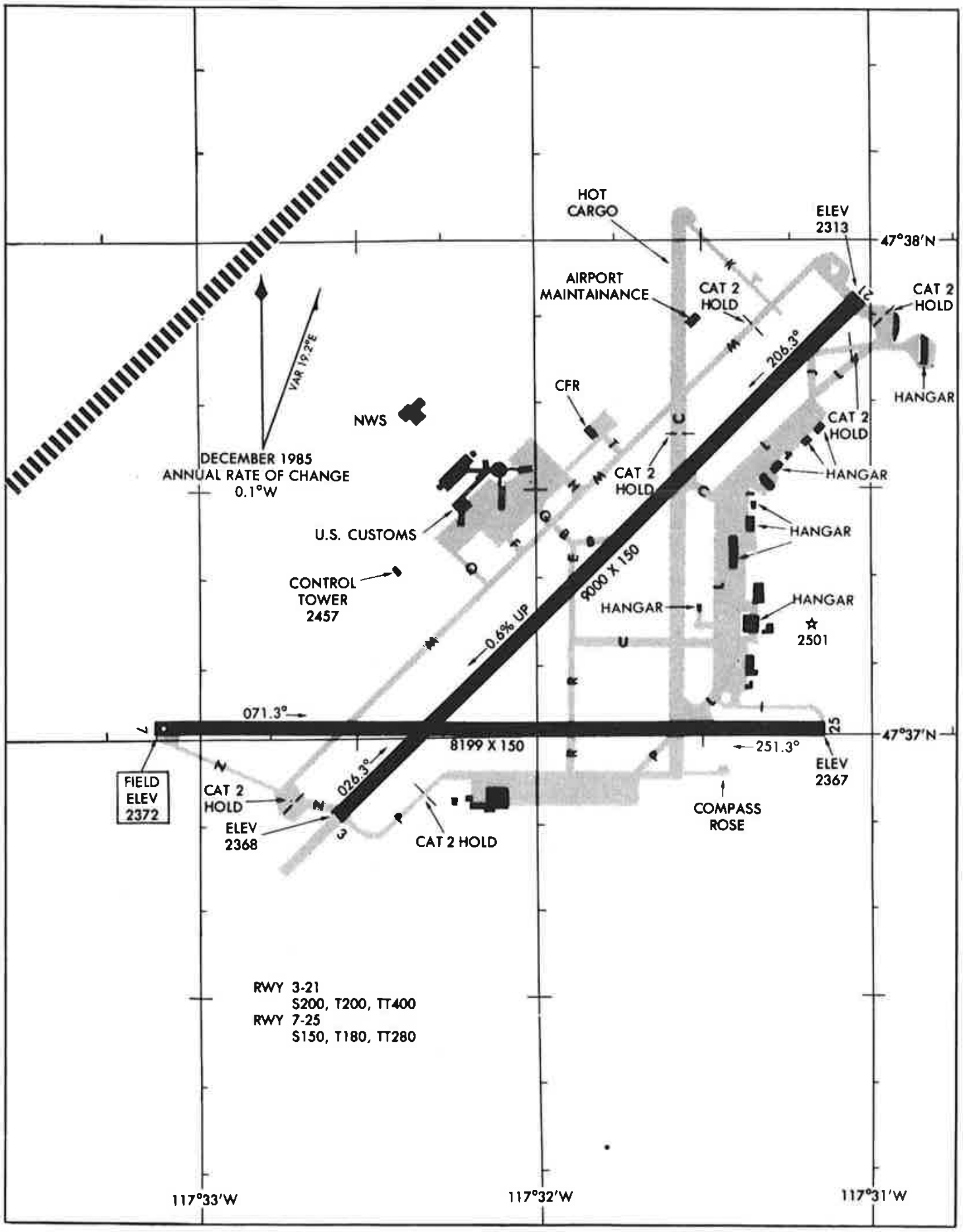
Potential improvements as recommended by an ongoing task force at Seattle-Tacoma International Airport include a new 7,000-foot Runway 16/34, 2,500 feet from Runway 16L/34R, an interim commuter runway using an existing taxiway, ILS's, and arrival and departure changes. There is no timeframe or no cost estimate for these potential improvements.



PLANNED OR RECOMMENDED NEW RUNWAYS
(LOCATION APPROXIMATED - BASED ON CURRENT INFORMATION)

Spokane (GEG)

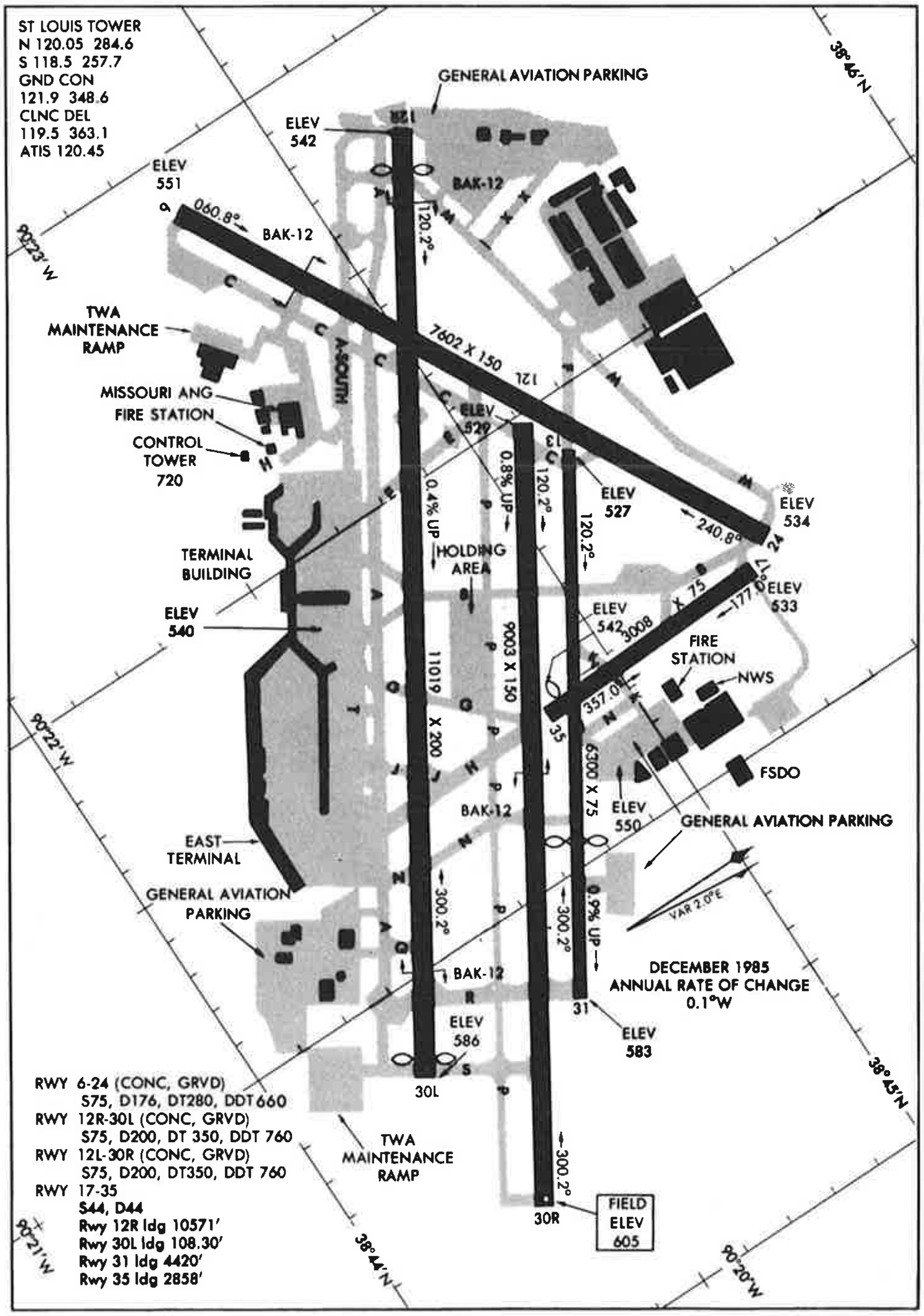
Future projects for capacity enhancement include the construction of a parallel Runway 3L/21R. The new runway will be 8,800 feet by 150 feet, and will be separated from Runway 3R/21L by 4,300 feet. This will potentially enable independent parallel operations, increasing IFR arrival capacity from 26 operations per hour, to 52. The estimated cost of the new runway and associated taxiway system, lighting, and markings is approximately $12 million.



PLANNED OR RECOMMENDED NEW RUNWAYS
(LOCATION APPROXIMATED - BASED ON CURRENT INFORMATION)

St. Louis (STL)

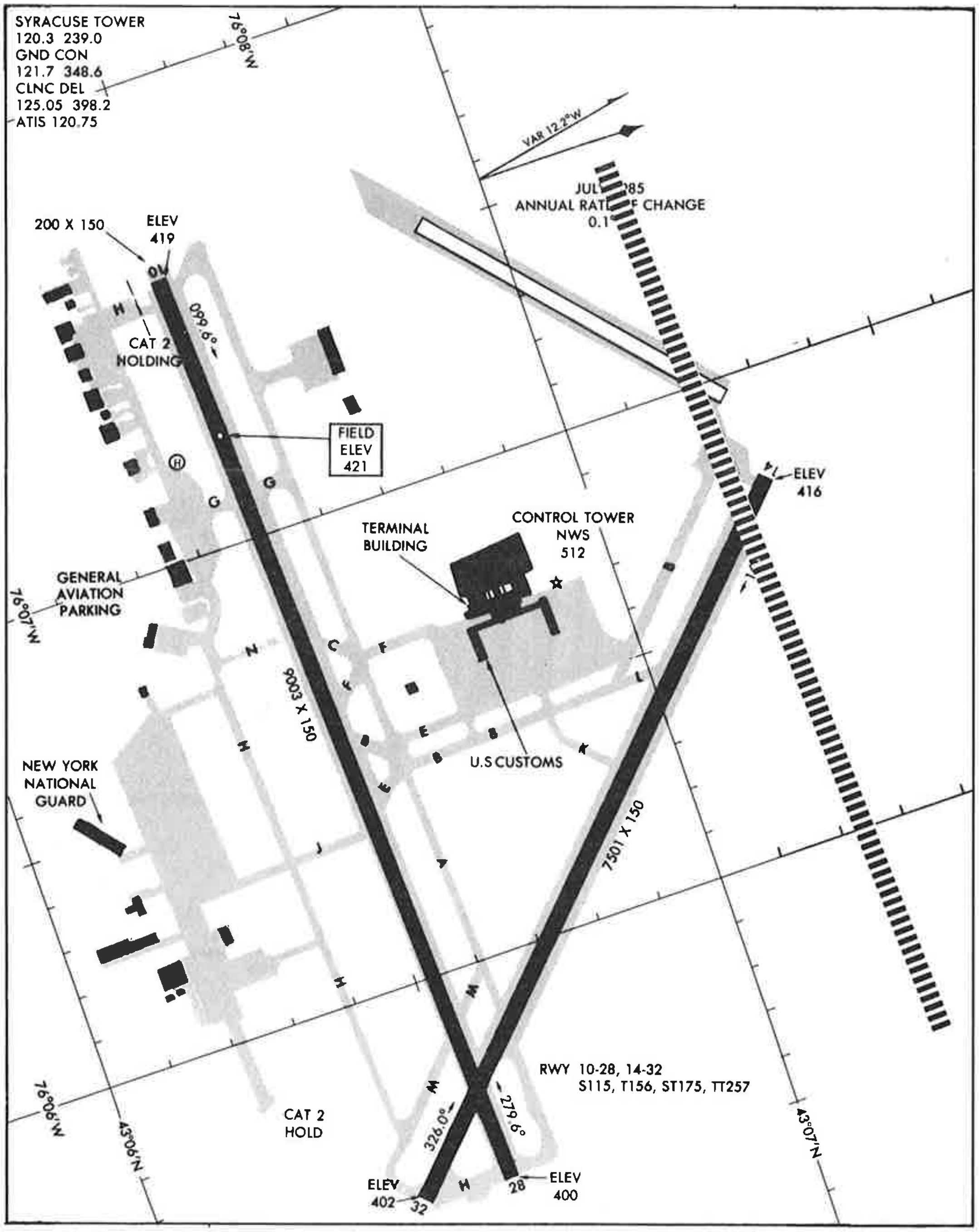
Taxiway F, which has been used as a VFR daytime only runway on a temporary basis for over a year has been permanently designated as Runway 13/31 limited to 16,000 pounds gross weight. Reconstruction is scheduled to begin in June 1989, with final completion in the fall of 1989. A preliminary cost estimate is $1.2 million. A completed task force recommends three options for a new parallel runway to Runway 12L/30R. No cost estimates or timeframes are available.



PLANNED OR RECOMMENDED NEW RUNWAYS
(LOCATION APPROXIMATED - BASED ON CURRENT INFORMATION)

Syracuse (SYR)

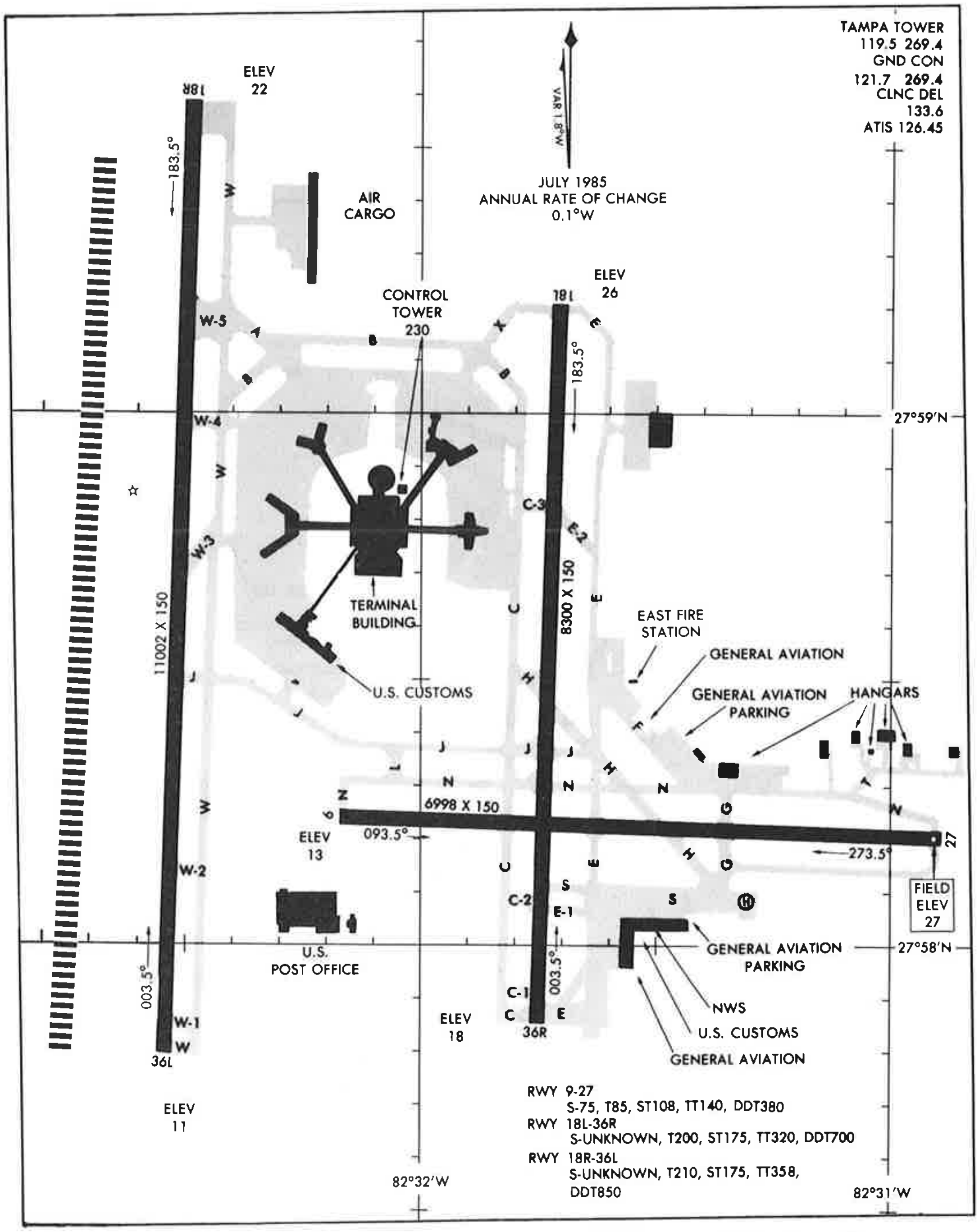
There is a potential for a parallel runway if the Air Force (ANG) vacates the airport as expected. The new Runway 10L/28R, will be 9,000 feet long, and separated by 4,300 feet from the existing runway. This should provide independent parallel IFR operations increasing hourly IFR arrival capacity from 26 to 52. The status of the new runway is tentative due to land transfer details. The expected operational date is 1993.



PLANNED OR RECOMMENDED NEW RUNWAYS
(LOCATION APPROXIMATED - BASED ON CURRENT INFORMATION)

Tampa (TPA)

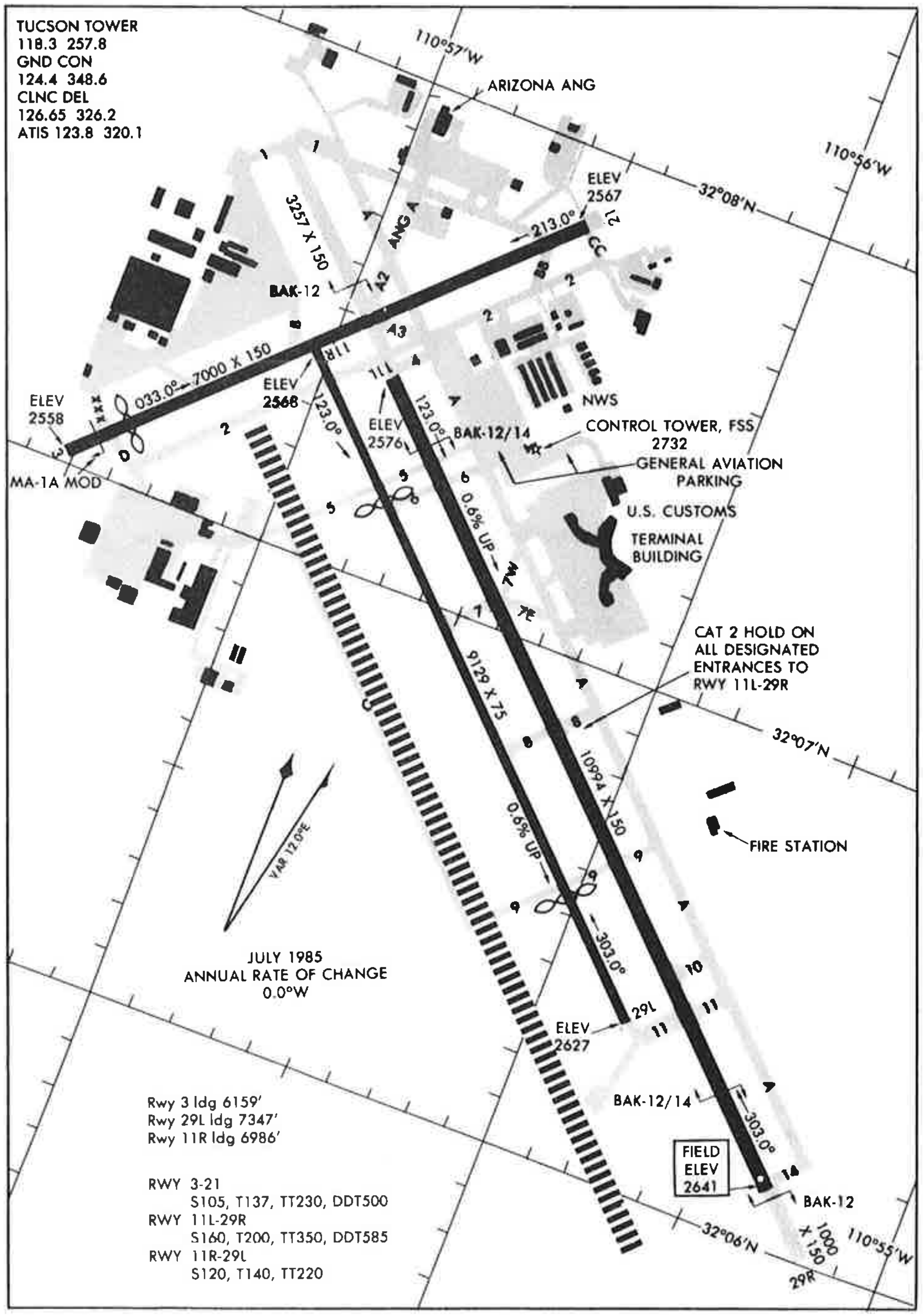
An environmental assessment to develop a new parallel Runway 17/35, will start in the next two years. The new runway will be 700 feet west of runway 18R/36L and 9,650 feet long. No increase in hourly IFR arrival capacity will be provided, however, VFR capacity will increase.



PLANNED OR RECOMMENDED NEW RUNWAYS
(LOCATION APPROXIMATED - BASED ON CURRENT INFORMATION)

Tucson (TUS)

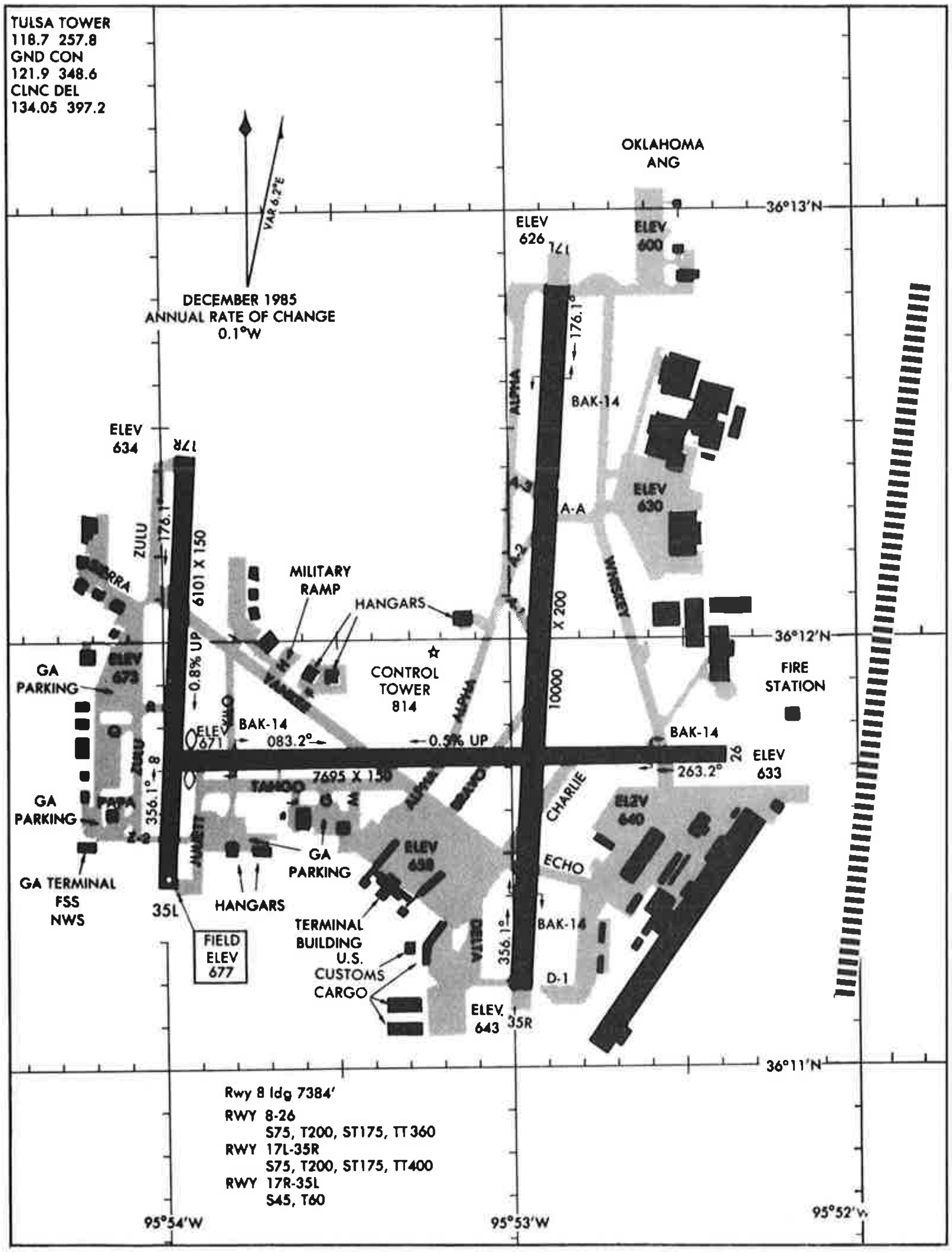
The Tucson Airport Authority is pursuing funding for an additional runway. It will be an additional parallel air carrier runway. Upon completion of the new Runway 11R/29L, the current Runway 11R/29L general aviation runway will revert to its original taxiway status. Construction is dependent on land acquisition and land compatibility. An environmental assessment is underway. The new runway will be phased; within the next five years it will be built to the length of 5,300 feet, upgrading to an 11,000-foot air carrier runway in approximately ten years. The total estimated cost to construct the 5,300 foot runway is $38 million. It is expected that the acquisition program and runway construction can begin in 1989 and continue through 1992.



IIIIIIIIIIIIIIIIIIII	PLANNED OR RECOMMENDED NEW RUNWAYS (LOCATION APPROXIMATED - BASED ON CURRENT INFORMATION)

Tulsa (TUL)

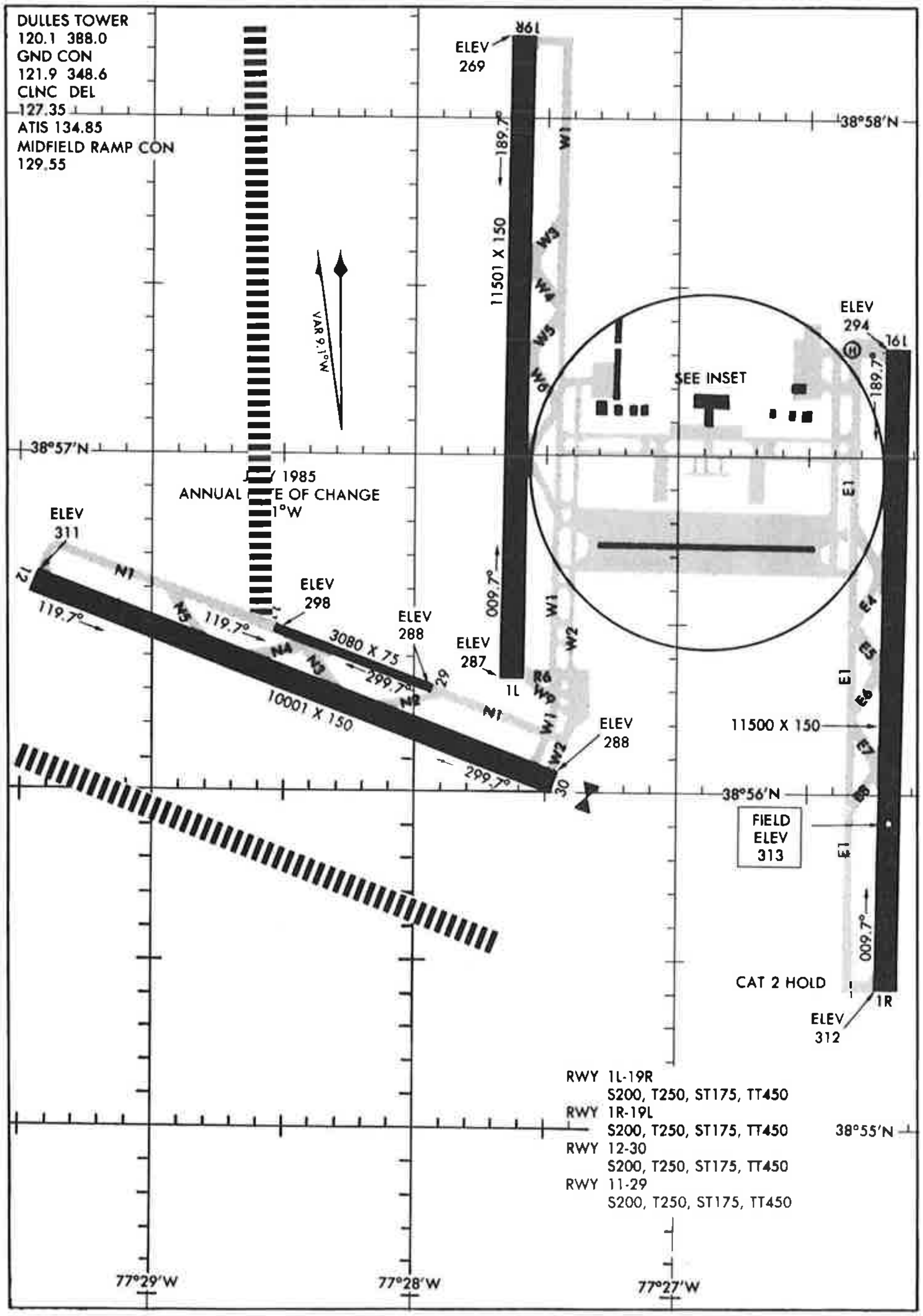
A new parallel Runway 17L/35R, will be constructed 5,200 feet east of present Runway 17L/35R and will be 9,600 feet long. An environmental assessment is being prepared. An estimated operational date has not been determined. The new runway should permit IFR triple independent approaches to Runways 17L, 17C, and 17R potentially increasing hourly IFR arrival capacity from 52 to 78.



PLANNED OR RECOMMENDED NEW RUNWAYS
(LOCATION APPROXIMATED - BASED ON CURRENT INFORMATION)

Washington (IAD)

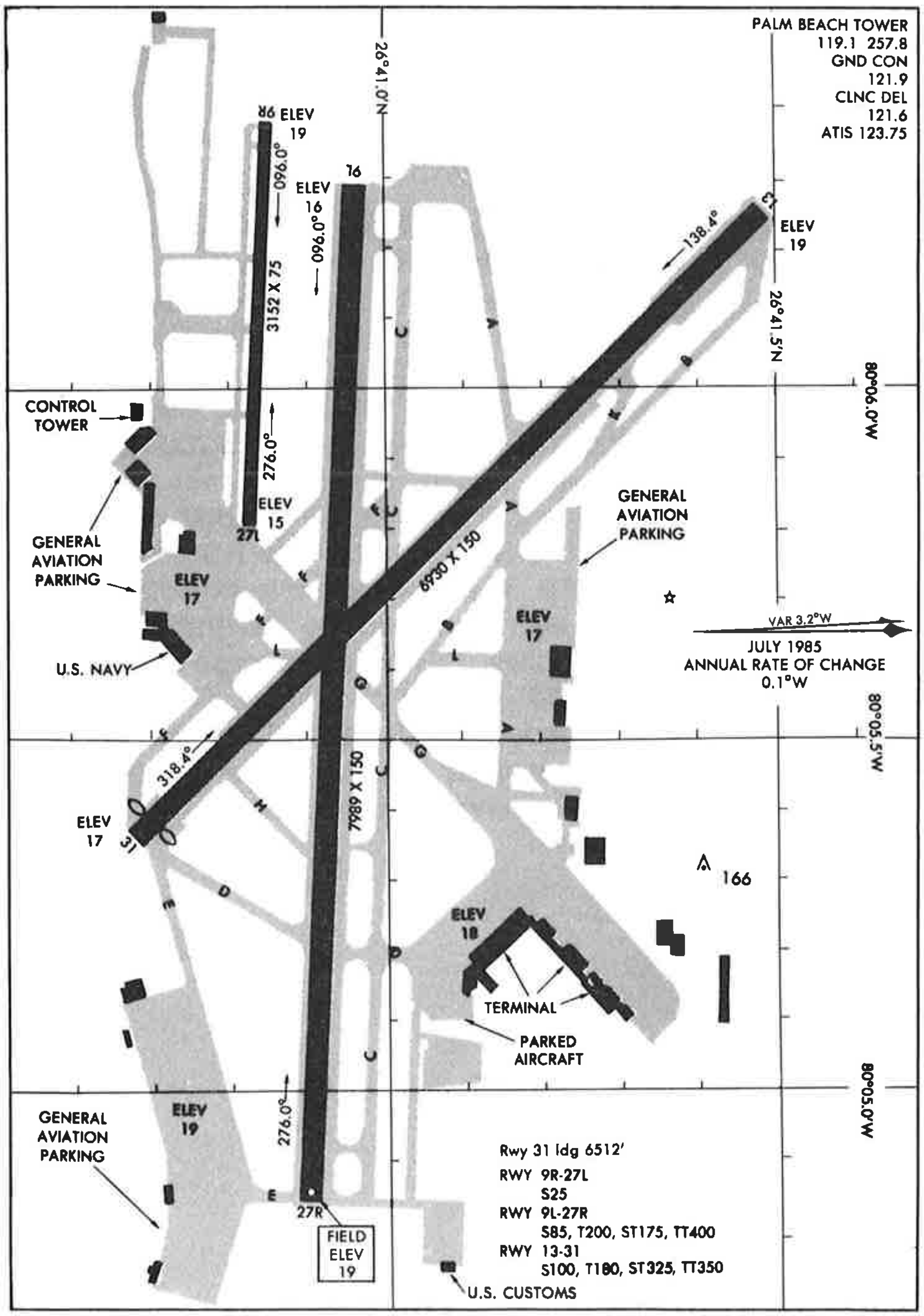
Two new parallel runways are under consideration. A north-south parallel west of existing parallels by more than 4,300 feet and north of Runway 12/30 should create triple independent parallels increasing hourly IFR arrival capacity from 52 to 78. Land is being purchased but environmental issues exist on 2,500-3,000 feet of the new parallel. A second parallel is proposed 4,300 feet south of Runway 12/30. No increase in hourly IFR arrival capacity would be provided. Runway construction is not scheduled to begin before 1993.



PLANNED OR RECOMMENDED NEW RUNWAYS
(LOCATION APPROXIMATED - BASED ON CURRENT INFORMATION)

West Palm Beach (PBI)

The environmental process to extend runway 9L/27R on both ends has been completed. It will be extended 1,200 feet to the west and 811 feet to the east; currently 7,989 feet long, it will be 10,000 feet in the future. Construction is estimated to be completed within the next five years. The total estimated project cost is approximately five million dollars. The city intends to start construction on a new large GA airport in North Palm Beach county in the next year, which will have two parallel runways and one crosswind.



Austin (AUS)

The community has approved the sale of revenue bonds for the development of a new airport. The environmental assessment for the new airport site has been approved. The present airport cannot be expanded. The new airport site will accommodate parallel runways and dual instrument approaches, which will potentially double the IFR arrival capacity from 26 (at Robert Mueller Airport) to 52 per hour. Since Robert Mueller Airport will close upon completion of the new airport, no capacity enhancements are planned at Mueller.

Denver (DVX)

The initial build of the new Denver airport will consist of six runways. The current plan involves four north-south parallels and two east-west parallels. Runway 17C/35C is the farthest west of the four north-south parallels of the initial build. It is located 3,100 feet west of Runway 17L/35R and 10,700 feet west of Runway 18R/36L. Runway 18R/36L and Runway 18L/36R will be separated by 5,700 feet. East-west parallels, Runways 8L/26R and 9R/27L will have centerlines 13,500 feet apart. Runway 8L/26R is south of Runways 17C/35C and 17L/35R. Runway 9R/27L is north of Runway 18R/36L and 18L/36R. The new airport is expected to be operational by 1993 and approved by air traffic service for triple IFR approaches. This would increase Denver IFR arrival capacity from 52 to 78 per hour. Conceivably, if and when independent quadruple IFR approaches are approved, IFR arrival capacity could increase to 104 arrivals per hour. A future second build proposes the construction of six more runways.

APPENDIX D

CAPACITY BENEFIT PROVIDED BY FACILITIES AND EQUIPMENT

In order for a runway to be used in adverse weather conditions, different types of electronic equipment must be provided to enable the aircraft to navigate to the runway. Table D-1 shows the availability of precision landing equipment (or lack thereof) needed to implement existing or proposed approach procedures at the top 100 airports. Table D-2 shows the benefits of some of these types of equipment as measured by the weather minima under which landings and takeoffs can continue if the equipment is available.

TABLE D-1. CURRENT AND PROPOSED IFR APPROACH PROCEDURE CONFIGURATIONS AND PRECISION LANDING SYSTEM (PLS) EQUIPMENT NEEDED AT THE TOP 100 U.S. AIRPORTS[1]

	CURRENT BEST IFR ARRIVAL CONFIGURATION[2]			PROPOSED IFR ARRIVAL CONFIGURATION[3] AIRPORT		
LOCATION AND CODE	Procedure:	Rwys:	PLS (Y/N/P)[4]:	Procedure:	Rwys:	PLS (Y/N/P)[5]:
Albany ALB	S S	1 19	(Y) (Y)	DC	1/28	(Y/N)
Albuquerque ABQ	S S	8 26	(Y) (N)		———	
Amarillo AMA	S S	4 22	(Y) (N)		———	
Anchorage ANC	S S	6R 24L	(Y) (N)	IC	6R/14	(Y/N)
Atlanta ATL	IP IP	8L/9R 26R/27L	(Y/Y) (Y/Y)	T	PLANNED	
Austin AUS	S S	13R 31L	(Y) (Y)	DC	31L/35	(Y/N)
Baltimore BWI	S S	15R 33L	(Y) (Y)	IP	PLANNED	
Birmingham BHM	S S	5 23	(Y) (N)		———	
Boise BOI	S S	10R 28L	(Y) (N)		———	
Boston BOS	S S	15R 33L	(Y) (Y)	DP	22L/22R	(Y/N)
Buffalo BUF	S S	5 23	(Y) (Y)	DC	5/14	(Y/N)

TABLE D-1. CURRENT AND PROPOSED IFR APPROACH PROCEDURE CONFIGURATIONS AND PRECISION LANDING SYSTEM (PLS) EQUIPMENT NEEDED AT THE TOP 100 U.S. AIRPORTS[1] (Continued)

	CURRENT BEST IFR ARRIVAL CONFIGURATION[2]			PROPOSED IFR ARRIVAL CONFIGURATION[3] AIRPORT		
LOCATION AND CODE	Procedure:	Rwys:	PLS (Y/N/P)[4]:	Procedure:	Rwys:	PLS (Y/N/P)[5]:
Burbank BUR	S	S 25	7 (N)	(Y) DC	7/15	(Y/P)
Charleston CHS	S S	15 33	(Y) (Y)	DC	3/33	(N/Y)
Charlotte CLT	IP IP	18L/18R 36L/36R	(P/Y) (Y/Y)		———	
Chicago MDW	S S	13R 31L	(Y) (Y)		———	
Chicago ORD	IP IP	14L/14R 32L/32R	(Y/Y) (Y/Y)	T	9L/9R/4R	(Y/Y/Y)
Cincinnati CVG	S S	18 36	(Y) (Y)	IP	PLANNED	
Cleveland CLE	S S	5R 23L	(Y) (Y)	DC	5R/10L	(Y/N)
Colorado Springs COS	S S	17 35	(Y) (Y)	IC	30/35	(N/Y)
Columbia CAE	S S	11 29	(Y) (Y)	DC	11/23	(Y/N)
Columbus CMH	DP DP	10L/10R 28L/28R	(Y/Y) (Y/N)	IC	28R/31	(N/N)
Dallas DAL	DP DP	13L/13R 31L/31R	(Y/Y) (Y/Y)	IP	13L/13R	(Y/Y)

TABLE D-1. CURRENT AND PROPOSED IFR APPROACH PROCEDURE CONFIGURATIONS AND PRECISION LANDING SYSTEM (PLS) EQUIPMENT NEEDED AT THE TOP 100 U.S. AIRPORTS[1] (Continued)

	CURRENT BEST IFR ARRIVAL CONFIGURATION[2]			PROPOSED IFR ARRIVAL CONFIGURATION[3] AIRPORT		
LOCATION AND CODE	Procedure:	Rwys:	PLS (Y/N/P)[4]:	Procedure:	Rwys:	PLS (Y/N/P)[5]:
Dallas-Fort Worth DFW	IP IP	17L/18R 36L/35R	(Y/Y) (Y/Y)	T	PLANNED	
Dayton DAY	IP IP	6L/6R 24L/24R	(Y/N) (Y/Y)		———	
Denver DEN	IC	8R/17L	(Y/Y)		———	
Des Moines DSM	S S	12L 30R	(Y) (Y)	DC	5/12L	(N/Y)
Detroit DTW	IP IP	3L/3R 21L/21R	(Y/Y) (Y/Y)	T	PLANNED	
El Paso ELP	S S	4 22	(N) (Y)	IC	22/26L	(Y/N)
Fort Lauderdale FLL	S S	9L 27R	(Y) (Y)	IP	9L/9R	(Y/P)
Fort Myers RSW	S S	6 24	(Y) (N)	IP	PLANNED	
Grand Rapids GRR	S S	8R 26L	(Y) (Y)	IP	PLANNED	
Greensboro GSO	S S	5 23	(Y) (Y)	IP	PLANNED	
Greer GSP	S S	3 21	(Y) (Y)		———	

TABLE D-1. CURRENT AND PROPOSED IFR APPROACH PROCEDURE CONFIGURATIONS AND PRECISION LANDING SYSTEM (PLS) EQUIPMENT NEEDED AT THE TOP 100 U.S. AIRPORTS[1] (Continued)

	CURRENT BEST IFR ARRIVAL CONFIGURATION[2]			PROPOSED IFR ARRIVAL CONFIGURATION[3] AIRPORT		
LOCATION AND CODE	Procedure:	Rwys:	PLS (Y/N/P)[4]:	Procedure:	Rwys:	PLS (Y/N/P)[5]:
Harlingen HRL	S S	17R 35L	(Y) (N)	IC	26/31	(N/N)
Hilo ITO	S S	8 26	(N) (Y)	DC	3/26	(N/Y)
Honolulu HNL	IP IP	8L/8R 26L/26R	(Y/N) (N/N)		———	
Houston HOU	S S	12R 30L	(Y) (P)	DC	22/31L	(N/N)
Houston IAH	IP IP	8/9 26/27	(Y/Y) (Y/Y)	T	PLANNED	
Indianapolis IND	S S	4L 22R	(Y) (Y)	DP	PLANNED	
Islip ISP	S	S 24	6 (Y)	(Y) DC	24/28	(Y/N)
Jacksonville JAX	S S	13 31	(Y) (N)	IC	25/31	(P/N)
Kahului OGG	S S	2 20	(Y) (N)	DC	2/5	(Y/N)
Kailua-Kona KOA	S S	17 35	(Y) (N)		———	
Kansas City MCI	S S	1 19	(Y) (Y)	IC	19/27	(Y/P)

TABLE D-1. CURRENT AND PROPOSED IFR APPROACH PROCEDURE CONFIGURATIONS AND PRECISION LANDING SYSTEM (PLS) EQUIPMENT NEEDED AT THE TOP 100 U.S. AIRPORTS[1] (Continued)

	CURRENT BEST IFR ARRIVAL CONFIGURATION[2]			PROPOSED IFR ARRIVAL CONFIGURATION[3] AIRPORT		
LOCATION AND CODE	Procedure:	Rwys:	PLS (Y/N/P)[4]:	Procedure:	Rwys:	PLS (Y/N/P)[5]:
Knoxville TYS	S S	5L 23R	(Y) (Y)	DP	5L/5R	(Y/N)
Las Vegas LAS	S S	7 25	(N) (Y)	DC	19R/25	(N/Y)
Lihue LIH	S S	17 35	(N) (Y)	IC	3/35	(N/Y)
Little Rock LIT	S	S 22	4 (Y)	(Y) IC	18/22	(N/Y)
Long Beach LGB	S S	12 30	(N) (Y)	IP	7L/7R	(N/N)
Los Angeles LAX	IP IP	6L/7R 24R/25L	(Y/Y) (Y/Y)		———	
Louisville SDF	S S	1 19	(Y) (Y)	IP	PLANNED	
Lubbock LBB	S S	17R 35L	(Y) (N)		———	
Memphis MEM	DP DP	18L/18R 36L/36R	(Y/Y) (Y/Y)	IC	27/36L	(Y/Y)
Miami MIA	IP IP	9L/9R 27L/27R	(Y/Y) (Y/Y)	———		
Midland MAF	S S	10 28	(Y) (N)	IC	16R/22	(N/N)

TABLE D-1. CURRENT AND PROPOSED IFR APPROACH PROCEDURE CONFIGURATIONS AND PRECISION LANDING SYSTEM (PLS) EQUIPMENT NEEDED AT THE TOP 100 U.S. AIRPORTS[1] (Continued)

	CURRENT BEST IFR ARRIVAL CONFIGURATION[2]			PROPOSED IFR ARRIVAL CONFIGURATION[3] AIRPORT		
LOCATION AND CODE	Procedure:	Rwys:	PLS (Y/N/P)[4]:	Procedure:	Rwys:	PLS (Y/N/P)[5]:
Milwaukee MKE	S S	1L 19R	(Y) (Y)	IC	7R/13	(Y/N)
Minneapolis-St. Paul MSP	DP DP	11L/11R 29L/29R	(Y/Y) (Y/Y)	IP	11L/11R	(Y/Y)
Nashville BNA	S S	13 31	(N) (Y)	IP	PLANNED	
New Orleans MSY	S S	10 28	(Y) (Y)	IC	10/19	(Y/P)
New York JFK	DP DP	13L/13R 31L/31R	(Y/P) (Y/Y)	IC	4R/13L	(Y/Y)
New York LGA	S S	4 22	(Y) (Y)	DC	4/31	(Y/P)
Newark EWR	S S	4R 22L	(Y) (Y)	IC	4L/11	(Y/P)
Norfolk ORF	S S	5 23	(Y) (Y)	DC	14/23	(N/Y)
Oakland OAK	S S	11 29	(Y) (Y)	IC	27R/29	(Y/Y)
Oklahoma City OKC	IP IP	17L/17R 35L/35R	(N/Y) (N/Y)		———	
Omaha OMA	S S	14R 32L	(Y) (Y)	DP	14L/14R	(P/Y)

TABLE D-1. CURRENT AND PROPOSED IFR APPROACH PROCEDURE CONFIGURATIONS AND PRECISION LANDING SYSTEM (PLS) EQUIPMENT NEEDED AT THE TOP 100 U.S. AIRPORTS[1] (Continued)

	CURRENT BEST IFR ARRIVAL CONFIGURATION[2]			PROPOSED IFR ARRIVAL CONFIGURATION[3] AIRPORT		
LOCATION AND CODE	Procedure:	Rwys:	PLS (Y/N/P)[4]:	Procedure:	Rwys:	PLS (Y/N/P)[5]:
Ontario ONT	S S	8L 26R	(Y) (Y)		______	
Orlando MCO	S S	18R 36L	(Y) (N)	T	PLANNED	
Philadelphia PHL	IC	9R/17	(Y/Y)		______	
Phoenix PHX	S S	8R 26L	(Y) (P)	IP	8L/8R	(P/Y)
Pittsburgh PIT	IP IP	10L/10R 28L/28R	(Y/Y) (Y/Y)		______	
Portland PDX	DP DP	10L/10R 28L/28R	(N/Y) (N/Y)	IP	28L/28R	(N/Y)
Portland PWM	S S	11 29	(Y) (Y)	DC	11/18	(Y/N)
Providence PVD	S S	5R 23L	(Y) (Y)	DP	5L/5R	(N/Y)
Raleigh-Durham RDU	DP DP	5L/5R 23L/23R	(Y/Y) (Y/Y)	T	PLANNED	
Reno RNO	S S	16R 34L	(Y) (N)	DC	16R/25	(Y/N)
Richmond RIC	S S	16 34	(Y) (Y)	IC	2/34	(Y/Y)

TABLE D-1. CURRENT AND PROPOSED IFR APPROACH PROCEDURE CONFIGURATIONS AND PRECISION LANDING SYSTEM (PLS) EQUIPMENT NEEDED AT THE TOP 100 U.S. AIRPORTS[1] (Continued)

	CURRENT BEST IFR ARRIVAL CONFIGURATION[2]			PROPOSED IFR ARRIVAL CONFIGURATION[3] AIRPORT		
LOCATION AND CODE	Procedure:	Rwys:	PLS (Y/N/P)[4]:	Procedure:	Rwys:	PLS (Y/N/P)[5]:
Rochester ROC	S S	4 22	(Y) (Y)	IC	22/25	(Y/N)
Sacramento SMF	IP IP	16L/16R 34L/34R	(P/Y) (Y/P)		———	
Salt Lake City SLC	DP DP	16L/16R 34L/34R	(Y/Y) (Y/P)	T	PLANNED	
San Antonio SAT	S S	12R 30L	(Y) (Y)	IC	PLANNED	
San Diego SAN	S	S 27	9 (P)	(Y)	———	
San Francisco SFO	S S	10L 28R	(N) (Y)	DC	10L/1R	(N/N)
San Jose SJC	S S	12R 30L	(Y) (Y)		———	
San Juan SJU	S S	8 26	(Y) (N)	IC	26/28	(N/N)
Santa Ana SNA	S S	1L 19R	(N) (Y)		———	
Sarasota-Bradenton SRQ	S S	14 32	(Y) (Y)		———	
Savannah SAV	S S	9 27	(Y) (N)	IP	PLANNED	

TABLE D-1. CURRENT AND PROPOSED IFR APPROACH PROCEDURE CONFIGURATIONS AND PRECISION LANDING SYSTEM (PLS) EQUIPMENT NEEDED AT THE TOP 100 U.S. AIRPORTS[1] (Continued)

	CURRENT BEST IFR ARRIVAL CONFIGURATION[2]			PROPOSED IFR ARRIVAL CONFIGURATION[3] AIRPORT		
LOCATION AND CODE	Procedure:	Rwys:	PLS (Y/N/P)[4]:	Procedure:	Rwys:	PLS (Y/N/P)[5]:
Seattle SEA	S S	16L 34R	(N) (Y)		————	
Spokane GEG	S S	3 21	(Y) (Y)	DC	21/25	(Y/N)
St. Louis STL	S S	12R 30L	(Y) (Y)	IC	24/30R	(Y/Y)
Syracuse SYR	S S	10 28	(Y) (Y)	IP	PLANNED	
Tampa TPA	IP IP	18L/18R 36L/36R	(Y/Y) (Y/N)		————	
Tucson TUS	S S	11L 29R	(Y) (N)		————	
Tulsa TUL	IP IP	17L/17R 35L/35R	(Y/Y) (N/Y)	T	PLANNED	
Washington DCA	S S	18 36	(P) (Y)	DC	33/36	(P/Y)
Washington IAD	IP IP	1L/1R 19L/19R	(Y/Y) (Y/Y)	T	12/19R/19L	(Y/Y/Y)
West Palm Beach PBI	S S	9L 27R	(Y) (N)	DC	13/9L	(N/Y)
Wichita ICT	IP IP	1L/1R 19L/19R	(Y/Y) (Y/Y)		————	

TABLE D-1. CURRENT AND PROPOSED IFR APPROACH PROCEDURE CONFIGURATIONS AND PRECISION LANDING SYSTEM (PLS) EQUIPMENT NEEDED AT THE TOP 100 U.S. AIRPORTS[1] (Continued)

	CURRENT BEST IFR ARRIVAL CONFIGURATION[2]			PROPOSED IFR ARRIVAL CONFIGURATION[3] AIRPORT		
LOCATION AND CODE	Procedure:	Rwys:	PLS (Y/N/P)[4]:	Procedure:	Rwys:	PLS (Y/N/P)[5]:
Windsor Locks BDL	S S	6 24	(Y) (Y)		—	

1 Top 100 U.S. airports based on 1987 enplanement figures. Precision Landing System (PLS) information as of December 1988.

2 From Table 7-9: current best configuration (in terms of capacity) based on existing runways using approvable approach procedures.Environmental restrictions and PLS availabilty is not considered here.Runways in this column are a sample (other runways may also be used).Approach procedure abbreviations are the same used in Table 7-9.

3 From Table 7-9: proposed configuration based on new, capacity-enhancing approach procedures on either existing or planned runways.Runways in this column are a sample (other runways may also be used for the proposed approach procedure). Approach procedure abbrevations are the same used in Table 7-9.

4 PLS installed: Y = yes; N = no; P = planned

5 PLS installed: Y = yes; N = no; P = planned

TABLE D-2. LOWER MINIMA ENABLED BY INSTALLATION OF FACILITIES AND EQUIPMENT

	CAPACITY BENEFIT PROVIDED	
PRECISION LANDING SYSTEM (PLS)	ARRIVAL MINIMA	DEPARTURE MINIMA
CAT I	200' Decision Height (DH) 3/4 Mi. Visibility	None
CAT II	150' DH or Lower	None
CAT IIIa	No DH 700' RVR or Lower	
Approach Light Systems		
MALSR	1/2 Mi. Visibility	None
SSALR	1/2 Mi. Visibility	None
ALSF-I	1/2 Mi. Visibility	None
ALSF-II	150' DH or Lower 1600' RVR or Lower	None
Runway Visual Range (RVR)		
Touchdown	2400 RVR or Lower	1600' RVR or Lower
Midpoint	100' DH and 1200' RVR or Lower	Less than 1600' RVR
Rollout	100' DH and 1200' RVR or Lower	Less than 1600' RVR

TABLE D-2. LOWER MINIMA ENABLED BY INSTALLATION OF FACILITIES AND EQUIPMENT (Continued)

	CAPACITY BENEFIT PROVIDED	
PRECISION LANDING SYSTEM (PLS)	ARRIVAL MINIMA	DEPARTURE MINIMA
In-Runway Lighting /Marking		
Centerline (CLL)*	2000' RVR or Lower	1/4 Mile
Touchdown Zone (TDZ)*	2000' RVR or Lower	None
Runway Centerline Marking (RCM)*	None	1/4 Mile
High Intensity Runway* Lighting (HIRL)	None	1/4 Mile

* Not F&E Budgeted Items.

APPENDIX E

ALTERNATE ORIGINATION AND DESTINATION AIRPORTS FOR DELAY-PROBLEM AIRPORTS

Evaluation Approach

1. For each of the 38 airports projected to exceed 20,000 hours aircraft delay in 1997, this appendix identifies Commercial Service Airports in the National Plan for Integrated Airport Systems (NPIAS) within approximately 50 nautical miles of delay-encumbered airport but does not include another delay-encumbered airport.

   PR - Primary, enplanements greater than or equal to 10,000 per year.

   CM - Other at least 2500 annual enplanements.

2. It then identifies instrument approach capability (NPIAS).

   I ILS Category I
   II ILS Category II
   III ILS Category III
   NP Nonprecision

3. Next it identifies stage length support capability (NPIAS):

   S Short haul (less than 500 miles)
   M Medium haul (500 to 1500 miles)
   L Long haul (over 1500 miles)

   Highlights state development plans for increased capabilities.

4. It identities airports that have been evaluated for multiple instrument approach concepts.

5. All PR candidates within 50 miles of the forecast delay-problem airport are selected for further evaluation. CM candidates are selected where there are no such PR candidates. If there are neither PR or CM candidates within 50 miles, then the closest airport is selected.

6. The number and length of hard-surface runways are determined.

7. For airports not previously evaluated to identify potential multiple approach capability is identified by inspection (VFR and IFR).

8. Potential operations per year are estimated based upon IFR approach capability. Assuming adequate groundside capacity is created, the runway layout could accept this volume with no significant delay.

   Dependent (Dep) IFR approach 200,000.

   Independent (Indep) IFR approach 300,000.

9. Unused Capacity is an estimate of the number of aircraft operations that could be added to this runway configuration without incurring delays and is determined by subtracting 1987 operations from potential operations per year determined above. (In parenthesis, the number indicates airports may already be operating at or near its capacity.)

   This analysis provides an identification of potential alternate origination and destination airports to the airports forecast to become delay-problem airports by 1997.

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997

Atlanta (ATL)

Hours of Delay: Greater than 100,000

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Columbus (CSG)	67	1	0			No	No	62,000		
Macon (MCN)	68	2	0	5/23(5)		Dep	Yes	200,000	50,000	150,000

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

Baltimore-Washington (BWI) **Hours of Delay:** 20,000 to 49,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Hagerstown (HGR) (CM)	63	1	0			No	No		76,000	
Wilmington (ILG) (CM)	57	3	0			Yes	Yes	200,000	194,000	6,000
Dover (DOV) (CM)	56	0	2			Yes	Yes	200,000		200,000
Lancaster (LNS) (PR)	59	1	0			No	Yes		164,000	

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

Boston (BOS)

Hours of Delay: 50,000 to 74,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
New Bedford (EWB)	41	2	0	5/23(5)		No	Yes		130,000	
Providence (PVD)	42	0	2			Dep	Yes	200,000	212,000	(12,000)
Manchester (MHT)	35	1	1	17R/35L(5)		Yes	Yes	200,000	167,000	33,000

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

Charlotte-Douglas (CLT)

Hours of Delay: 20,000 to 49,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Hickory (HKY) (CM)	38	1	0			No	Yes			

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

Chicago (ORD)

Hours of Delay: Greater than 100,000

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Midway (MDW)	13	4	0			Dep	Yes	200,000	257,000	(57,000)
Milwaukee (MKE)	57	1	2	1R/19L(5) 1L/19R(5)	7L/25R(5)	Indep	Yes	300,000	190,000	110,000

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

Cleveland-Hopkins (CLE)

Hours of Delay: 20,000 to 49,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Akron-Canton (CAK) (PR)	34	3	0			Yes	Yes	200,000	138,000	62,000
Youngstown (YNG) (PR)	52	0	1			No	Yes		119,000	

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

Cincinnati (CVG)

Hours of Delay: 50,000 to 74,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Lexington (LEX)	63	0	1			No	No		123,000	
Louisville (SDF)	69	0	2			Dep	Yes	200,000	155,000	45,000
Dayton (DAY)	61	0	3	6L/24R(5) 18/36(10)		Indep	Yes	300,000	201,000	99,000

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

Columbus (CMH)

Hours of Delay: 20,000 to 49,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Mansfield (MFD) (CM)	54	1	1			Yes	Yes	200,000	53,000	143,000
Dayton (DAY) (PR)	68	1	2			Yes	Yes	300,000	201,000	99,000

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

Dallas-Ft. Worth (DFW)

Hours of Delay: 75,000 to 99,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Dallas (DAL)	8	1	2			Indep	Yes	300,000	227,000	73,000

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

Denver (DEN)

Hours of Delay: Greater than 100,000

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	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	163,000	147,000

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

Detroit (DTW)

Hours of Delay: 20,000 to 49,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Flint (FNT)	48	0	2		9R/27L(T)	Dep	Yes	200,000	124,000	76,000
Detroit (DET)	19	1	0			No	No		168,000	
Toledo (TOL)	42	1	1		16/34(5)	Dep	Yes	200,000	114,000	86,000

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

Fort Lauderdale (FLL)

Hours of Delay: 20,000 to 49,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
West Palm Beach (PBI)	36	1	1			Yes	Yes	200,000	230,000	(30,000)

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

Honolulu (HNL)

Hours of Delay: 20,000 to 49,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
No Alternate Airports on OAHU Island										

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

Houston Hobby (HOU)

Hours of Delay: 20,000 to 49,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
No suitable alternate exists										

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

Houston Intercontinental (IAH)

Hours of Delay: 20,000 to 49,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	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	279,000	21,000

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

Indianapolis (IND)

Hours of Delay: 20,000 to 49,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Bloomington (BMG) (CM)	38	1	0			No	Yes		39,000	
Terre Haute (HUF) (CM)	46	1	1			Yes	Yes	200,000	77,000	123,000
Lafayette (LAF) (PR)	51	1	0			No	Yes		140,000	
Muncie (MIE) (CM)	51	2	0			No	Yes		53,000	

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

Kansas City (MCI)

Hours of Delay: 20,000 to 49,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Topeka (FOE)	47	0	2			Dep	Yes	200,000	66,000	134,000
Kansas City (MKC)	6							Not Selected for Evaluation		
Lawrence (3LA)	28							Not Selected for Evaluation		

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

Los Angeles (LAX)

Hours of Delay: 75,000 to 99,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Santa Ana (SNA)	31	1	0	1L/9R(5)		No	No		527,000	
Long Beach (LGB)	14	2	1			Indep	Yes	300,000	438,000	(138,000)
Burbank (BUR)	17	2	0			Dep	Yes	200,000	243,000	(43,000)
Oxnard (OXR)	42							Not Selected		
Palmdale (PMD)	45	0	2			Indep	Yes	300,000	71,000	229,000

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

Las Vegas (LAS)

Hours of Delay: 20,000 to 49,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
No suitable alternate exists										

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

Memphis (MEM)

Hours of Delay: 20,000 to 49,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Jackson TN (MKL)	61					No	No			
Tupelo (TUP)	76					No	No			

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

Miami (MIA)

Hours of Delay: 75,000 to 99,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	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	230.000	(30,000)

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

Milwaukee-Mitchell (MKE)

Hours of Delay: 20,000 to 49,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Jainesville (JVL) (CM)	58	3	0			Yes	Yes	200,000	74,000	126,000
Madison (MSN) (PR)	64	1	1			Yes	Yes	300,000	150,000	150,000
Sheboygan (SBM) (CM)	50	1	0			No	Yes			

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

Minneapolis-St. Paul (MSP)

Hours of Delay: 20,000 to 49,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Rochester (RST)	71	1	1	2/20(5)	13R/31L(5)	Dep	Yes	200,000	61,000	139,000
Mankato (MKT)	48							Not Selected		

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

Nashville (BNA)

Hours of Delay: 20,000 to 49,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Huntsville (HSV)	89	0	2			Indep	Yes	300,000	81,000	219,000
Muscle Shoals (MSL)	91							Not Selected		

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

Newark (EWR)

Hours of Delay: 75,000 to 99,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Trenton (TNT)	38	1	0			No	No		161,000	
Islip (ISP)	48	3	0	6/24(5) 15R/33L(1)	6R/24L(5)	Indep	Yes	300,000	229,000	71,000
White Plains (HPN)	31	1	0		16R/34L(5)	No	No		207,000	
Newburgh (SWF)	49	1	1			Dep	Yes	200,000	106,000	94,000

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

New York Kennedy (JFK)

Hours of Delay: 50,000 to 74,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Trenton (TTN)	51	1	0			No	No		161,000	
Islip (ISP)	31	3	0	6/24(5) 15R/33L(1)	6R/24L(5)	Indep	Yes	300,000	229,000	71,000
White Plains (HPN)	27	1	0		16R/34L(5)	No	No		207,000	
Newburgh (SWF)	55	1	1			Dep	Yes	200,000	106,000	94,000
New Haven (HVN)	55	1	0			No	No		128,000	

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

New York La Guardia (LGA)

Hours of Delay: 50,000 to 74,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Trenton (TTN)	52	1	0			No	No		161,000	
Islip (ISP)	34	3	0	6/24(5) 15R/33L(1)	6R/24L(5)	Indep	Yes	300,000	229,000	71,000
White Plains (HPN)	18	1	0		16R/34L(5)	No	No		207,000	
Newburgh (SWF)	44	1	1			Dep	Yes	200,000	106,000	94,000
Poughkeepsie (POU)	50	1	0	6/24(5)		No	No		147,000	
New Haven (HVN)	52	1	0			No	No		128,000	

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

Ontario (ONT)

Hours of Delay: 20,000to 49,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Palm Springs (PSP)	59	0	1	12L/30R(5)	12L/30R(5)	No	No		104,000	
Santa Ana (SNA)	25	1	0	1L/19R(5)		No	No		527,000	
Burbank (BUR)	38	2	0	7/25(5)		Dep	Yes	200,000	243,000	(43,000)
Long Beach (LGB)	30	2	1			Indep	Yes	300,000	438,000	(138,000)
Palmdale (PMD)	40	0	2			Indep	Yes	300,000	71,000	229,000

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

Orlando (MCO)

Hours of Delay: 50,000 to 74,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Daytona Beach (DAB)	47	0	1		6R/24L(5)	No	No		207,000	
Tampa (TPA)	69	1	2	18R/36L(5)		Indep	Yes	300,000	247,000	53,000
Melbourne (MLB)	40	0	1	9L/27R(5)	9L/27R(5)	No	No		266,000	

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

Philadelphia (PHL)

Hours of Delay: 50,000 to 74,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	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	123,000	77,000
Lancaster (LNS)	50	1	0			No	No		164,000	
Reading (RDG)	44	2	0		13L/31R(5)	Dep	Yes	200,000	115,000	85,000
Trenton (TTN)	31	1	0			No	No		161,000	
Atlantic City (ACY)	39	1	1			Dep	Yes	200,000	92,000	108,000

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

Phoenix (PHX)

(PHX) Hours of Delay: 50,000 to 74,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
No suitable alternate exists										

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

Pittsburgh (PIT)

Hours of Delay: 20,000 to 49,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	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	119,000	81,000
Akron (CAK)	61	3	0			Dep	Yes	200,000	138,000	62,000

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

Raleigh-Durham (RDU)

Hours of Delay: 50,000 to 74,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Greensboro (GSO)	58	1	1	14/32(5)	5L/23R(5)	Indep	Yes	300,000	150,000	150,000
Fayetteville (FAY)	53	0	1		3R/21L(5)	No	No		62,000	
Kinston (ISO)	67	2	0			Dep	Yes	200,000	48,000	152,000

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

Salt Lake City (SLC)

Hours of Delay: 20,000 to 49,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	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

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

San Jose (SJC)

Hours of Delay: 20,000 to 49,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Monterey (MRY)	48	1	0		10L/28R(5)	No	No		112,000	
Stockton (SCK)	45	0	1		11L/29R(5)	No	No		123,000	
Oakland (OAK)	26	2	1			Indep	Yes	300,000	398,000	(98,000)
Sacramento (SMF)	81	0	2		16L/34R(5)	Indep	Yes	300,000	163,000	137,000
Modesto (MOD)	45							Not Selected		

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

San Francisco (SFO)

Hours of Delay: 50,000 to 74,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Oakland (OAK)	9	2	1			Indep	Yes	300,000	398,000	(98,000)
Monterey (MRY)	67	1	0		10L/28R(5)	No	No		112,000	
Stockton (SCK)	58	0	1		11L/29R(5)	No	No		123,000	
Sacramento (SMF)	73	0	2		16L/34R(5)	Indep	Yes	300,000	163,000	137,000

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

Seattle-Tacoma (SEA)

Hours of Delay: 20,000 to 49,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
No suitable alternative exists										

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

St. Louis-Lambert (STL)

Hours of Delay: 50,000 to 74,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Columbia (COU)	81	1	0			No	No		55,000	
Springfield (SPI)	69	2	1			Dep	Yes	200,000	125,000	75,000
Decatur (DEC)	91	3	0			Indep	Yes	300,000	85,000	215,000

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997 (Continued)

Washington-Dulles (IAD)

Hours of Delay: 50,000 to 74,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Baltimore (BWI)	39	1	2			Dep	Yes	200,000	291,000	(91,000)
Hagerstown (HGR)	48					No	No		76,000	

TABLE E-1. POTENTIAL ALTERNATIVE AIR CARRIER AIRPORTS FOR THOSE AIRPORTS FORECAST TO EXCEED 20,000 HOURS AIRCRAFT DELAY IN 1997

Washington National (DCA)

Hours of Delay: 20,000 to 49,999

POTENTIAL ALTERNATIVES	DISTANCE	NUMBER RUNWAYS		PLANNED RUNWAYS		POTENTIAL: DUAL APPROACH WITH PRESENT RWYS		POTENTIAL: OPERAT'NS / YEAR	1987 OPERAT'NS	POTENTIAL UNUSED CAPACITY
		5000-7000 FT.	OVER 7000 FT.	EXTENSION	NEW	IFR	VFR			
Baltimore (BWI)	25	1	2			Dep	Yes	200,000	291,000	(91,000)
Hagerstown (HGR)	62					No	No		76,000	

APPENDIX F

DETERMINANTS OF AIRPORT CAPACITY

Capacity

Airport capacity can be defined as 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 time as the airport conditions change, the capacity of an airport is not a single value. Rather it is a set of values, each associated with a particular combination of active runways (runway configuration), airport operating conditions, (including ceiling and visibility) the mix of aircraft types using the airport, and the proportions of arrivals and departures.

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. The capacity of a single runway is determined by many performance parameters. For example, in IMC, radar separation minima must be applied by the radar controller to separate a trailing aircraft from the aircraft ahead. The primary determinants of single runway capacity in instrument conditions are the minimum allowable separations between trailing and leading aircraft referred to as in-trail separations, departure separation minima, and the ROTS. The variability of in-trail separation, expressed as interarrival time variability, and that of the runway occupancy time also affect the capacity of the single runway because variability in achieving the minimum required separations results in needless gaps in the arrival stream.

Where multiple runways can be operated simultaneously, several factors in addition to the capacity of a single runway combine to determine airport capacity. These factors include lateral separation criteria, surveillance monitoring accuracy and update rates, and diagonal separation minima. In either instrument or visual conditions, specified minimum separations must be maintained between aircraft landing on parallel approach courses. Where multiple runways exist whose centerlines or extended centerlines are not parallel but converge and intersect, procedures must be specified to ensure that approach and missed approach paths do not permit two aircraft on simultaneous approaches to operate too close to each other.

The annual capacity of a single runway is also reduced when ceilings or visibilities are below instrument approach minima. These minima are the lowest, permitting the greatest annual capacity, when electronic precision approach navigation equipment can be properly sited and used. Finally, runway surfaces wear out and must be repaired. The closing of an operating runway reduces average annual airport capacity by making the runway unavailable. Actions to extend the service life of pavement will reduce the frequency of shut downs and the consequent loss of capacity.

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 of such restrictions may be severe when restrictions are placed on those runway configurations with the highest capacity.

Capacity, Demand, and Delay

Capacity cannot be observed directly. Instead, throughput and demand are observed and, taken together, may be used to measure how close to its capacity a particular airport is operating. Throughput is simply the number of aircraft operations that are processed by a runway configuration under a combination of specific demand and operating conditions.

Demand is the number and type of aircraft requesting service (landing or departing) per unit of time. 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 also aircraft demand is split unevenly between departures and arrivals. This means that procedures are required to manage either mostly arrivals or mostly departures.

Congestion and Delay

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.

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 such as 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.

Delay is difficult to measure and there is no industry-wide agreement on an appropriate definition of delay. However, because one of the main uses for a measure of delay is to determine trends (whether delay is increasing or decreasing), any consistent measure of relative changes in delay is useful. The FAA maintains two types of data on delay--delay by cause and delay by phase of flight. It would be too costly to measure all of the delay, so data are collected for a relatively small sample of aircraft and used to estimate the total delay.

As demand increases, delays rise at an increasing rate. This relationship between capacity, demand, and delay is depicted in Figure F-1. 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 previous level, delays will be reduced.

The shortage in capacity addressed through technological improvements is the difference in airport capacity between visual and instrument conditions illustrated by the horizontal arrow in Figure 1. While the delays due to this difference do not represent all aircraft delays, they do constitute a large portion.

Most of the delays in the ATC system that can potentially be reduced through technological approaches are caused by the fact that (ground based) radar separation requirements reduce the capacity of major airports from that which is available when (airborne) visual separation techniques can be applied. By using visual separation techniques in VMC, pilots are able to observe other aircraft and tighten the separation distances achieving a higher capacity than when operating in IMC. Consequently, when the weather conditions at an airport deteriorate to the point that radar separation must be used, the capacity of the airport is reduced accordingly. This results in both arrival and departure delays if the demand at the airport is above the IMC capacity.

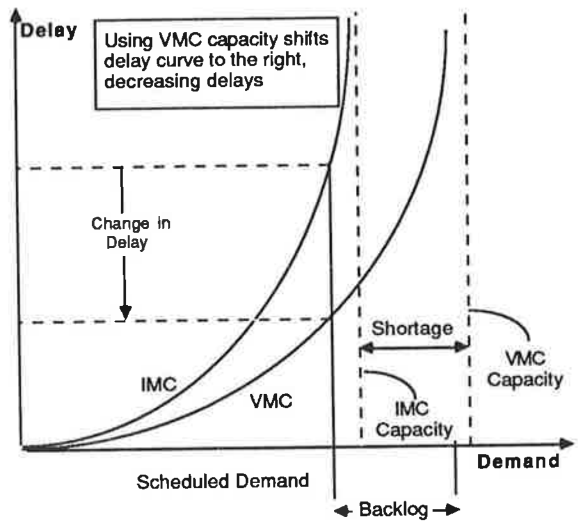


FIGURE F-1. IMC/VMC CAPACITY

The demand at major congested airports is sometimes greater than the IMC capacity but less than the VMC capacity. Consequently, queues of unaccommodated aircraft arrivals and departures start to build immediately at congested airports in instrument conditions. Once these queues build, the delays may outlast the duration of instrument conditions. This is because, even when the airport returns to the higher capacity visual conditions, the queues that have formed represent added demand to the normal schedule which often exceeds the airport's VMC capacity. Again, this relationship is depicted in Figure F-1.

APPENDIX G

AIRPORT DIAGRAMS[1]

[1] Some airport diagrams provided courtesy of Jeppeson Sanderson Corporation.

AIRPORT DIAGRAMS