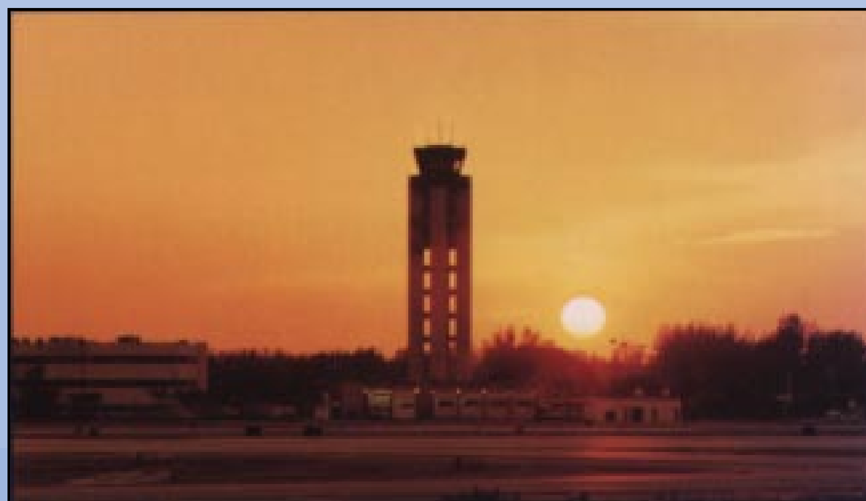
Fort Lauderdale-Hollywood International Airport

Capacity Enhancement Plan



Fort Lauderdale-Hollywood International Airport

Capacity Enhancement Plan

October 1993

Prepared jointly by the U.S. Department of Transportation, Federal Aviation Administration, the Broward County Aviation Department, and the airlines and general aviation serving Fort Lauderdale-Hollywood International Airport.

Figure 1. Fort Lauderdale-Hollywood International Airport

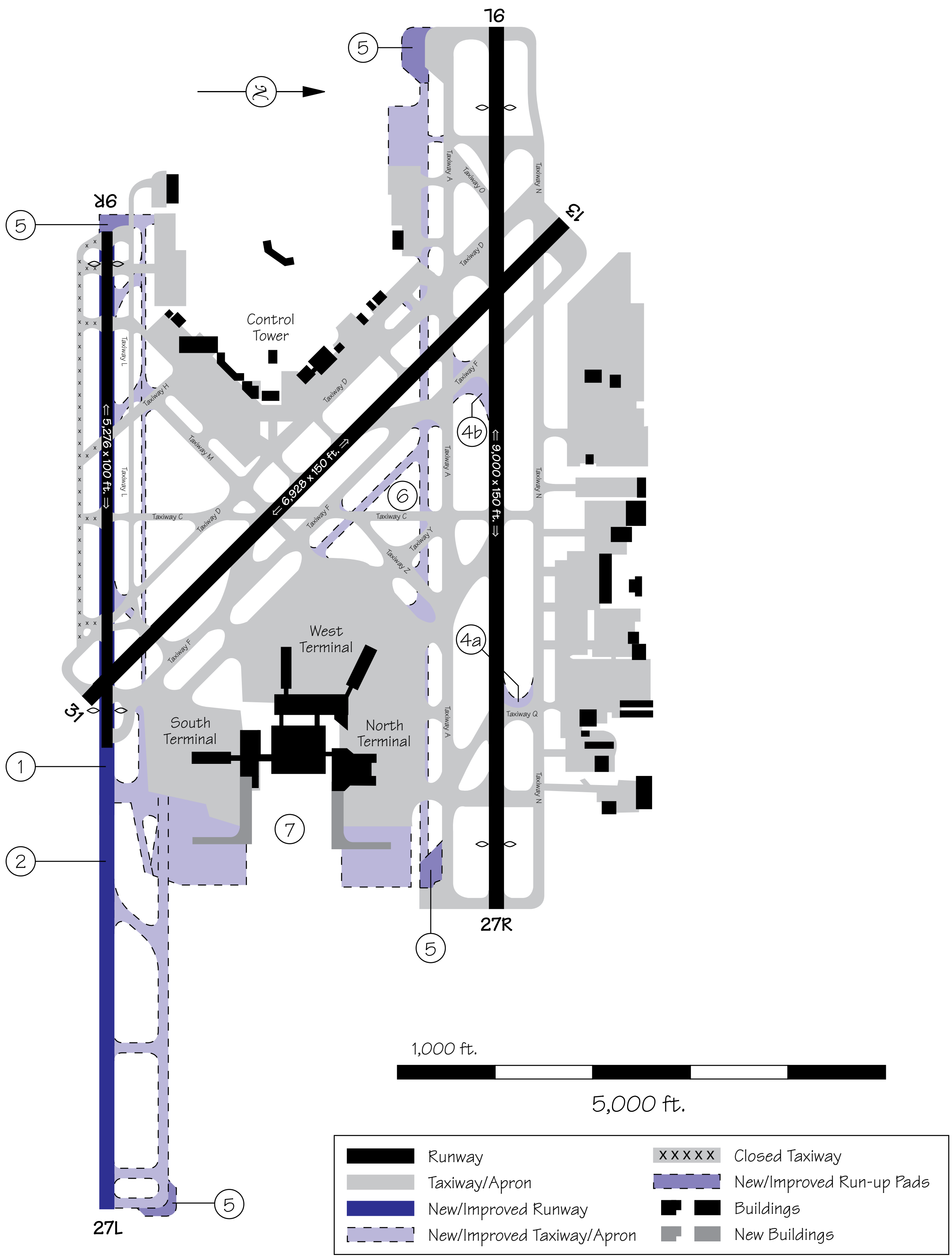


Figure 2. Capacity Enhancement Alternatives and Annual Delay Savings

Alternatives	Project Cost ($ M)	Estimated Annual Delay Savings[1] (in hours and millions of 1990 dollars) Baseline (219,000)	Future 1 (294,000)	Future 2 (350,000)
Airfield Improvements				
1. Extend Runway 9R/27L — 6,000 ft. long, 150 ft. wide, and CAT I ILS				
1a. 2 nm stagger in IFR	$89[2]	†	†	7,294/$11.41
1b. 1.5 nm stagger in IFR (17)	$89[2]		††	
1c. Simultaneous parallel IFR approaches (with PRM)	$95[2]	†	†	8,914/$13.94
(savings over 1a)				*1,620/$2.53*
1d. Simultaneous approaches, 2.5 nm minimum, in IFR (1c and 16)	$95[2]		††	
2. Extend Runway 9R/27L — 10,000 ft. long, 150 ft. wide, and CAT I ILS				
2a. 2 nm stagger in IFR	$253[3]	1,298/$1.55	7,590/$10.67	19,878/$31.09
2b. 1.5 nm stagger in IFR (17)	$253[3]	1,322/$1.58	7,769/$10.92	20,251/$31.67
(savings over 2a)		*24/$0.03*	*179/$0.25*	*373/$0.58*
2c. Simultaneous parallel IFR approaches (with PRM)	$259[3]	1,335/$1.59	7,862/$11.05	20,533/$32.11
(savings over 2a)		*37/$0.04*	*272/$0.38*	*655/$1.02*
2d. Simultaneous approaches, 2.5 nm minimum, in IFR (2c and 16)	$259[3]	1,355/$1.62	7,910/$11.12	20,680/$32.34
(savings over 2a)		*57/$0.07*	*320/$0.45*	*802/$1.25*
3. Extend Runway 9R/27L to 10,000 ft; operate under restricted use				
3a. 2 nm stagger in IFR	$251.5[3]	†	†	16,498/$25.80
3b. Simultaneous parallel IFR approaches (with PRM)	$257.5[3]	†	†	17,285/$27.03
(savings over 3a)				*787/$1.23*
4. Improve angled exits				
4a. Widen fillets at Exit Q Runway 9L	$0.092	†	—[4]	—[4]
4b. Widen angled exit on Runway 27R, south, at Taxiway F	$0.045	66/$0.08	105/$0.15	124/$0.19
5. Add or expand run-up pads to stage departures	$1.5		†	
6. Taxiway improvement package	$8.64		†	
7. Expand terminal (international and air carrier)	$433	†	—[4]	—[4]

1. The delay savings of these alternatives are not necessarily additive.
2. Includes cost of removing hotel, $60 million, and installing ILSs.
3. Includes cost of relocating utility transmission lines, $10 million, and installing ILS(s).
4. These alternatives have been included in the basic airport configuration or aircraft schedule as though in place.

†† These improvements were not simulated. The Capacity Team considered alternatives 1a and 1c sufficient for comparison of alternatives 1 and 2.

Figure 2. Capacity Enhancement Alternatives and Annual Delay Savings (cont)

Alternatives	Project Cost ($ M)	Estimated Annual Delay Savings[1] (in hours and millions of 1990 dollars) Baseline (219,000)	Future 1 (294,000)	Future 2 (350,000)
Facilities and Equipment Improvements				
8a. CAT I ILS on Runway 9R (at 5,300 ft.)	$61.5[2]	207/$0.25	864/$1.21	1,383/$2.16
8b. CAT I ILS on Runway 27L (at 5,300 ft.)	$1.5[6]	620/$.74	2,593/$3.65	4,150/$6.49
9. CAT I ILS on Runway 31	$1.5[6]	602/$0.72	2,595/$3.65	4,842/$7.57
10. CAT II/IIIA ILS on Runway 27R	$2.5[6]	†	575/$0.81	630/$0.99
11. Precision Runway Monitor (PRM)	$6.0	—[5]	—[5]	—[5]
12. Upgrade FLL radar — commission ASR-9	$6.8		†	
13. Relocate TVOR/VOR off Airport	$2.3		†	
14. Vortex Advisory System (VAS)	—[7]		†	
15. Low Level Wind Shear Alert System (LLWAS)	$1.5		†	
Operational Improvements				
16. Reduce minimum in-trail separation to 2.5 nm	$0	322/$0.38	817/$1.15	1,082/$1.69
17. Reduce stagger to 1.5 nm in IFR	$0		†	
18. Unrestricted use of Runway 13/31 for departures (Cost of noise restrictions on use of Runway 13/31)	$0	303/$0.292	238/$0.287	295/$0.408
19. Unrestricted use of Runway 13 for arrivals (Impact of FXE operations on FLL)	$0		†	
20. Conduct a study of South Florida airspace and implement airspace management	—[7]		†	
21. Increase/enhance reliever airports	—[7]	†	†	1,877/$2.94
22. Redistribute traffic more uniformly within the hour	$0		†	

5. The delay savings of the PRM are reflected in the savings of alternative 1c over 1a, the savings of alternative 2c over 2a, and the savings of alternative 3b over 3a.
6. Does not include cost of removing obstructions.
7. Project costs were not estimated.
† These improvements were not simulated. Therefore, no dollar figures are available. There is a description of each of these items in Section 2 — Capacity Enhancement Alternatives.

Summary

The Federal Aviation Administration (FAA), airport operators, and aviation industry groups have initiated joint Airport Capacity Design Teams at various major air carrier airports throughout the U.S. These Capacity Teams identify and evaluate alternative means to enhance existing airport and airspace capacity to handle future demand. A Capacity Team for Fort Lauderdale-Hollywood International Airport (FLL) was formed in 1991.

Steady growth at FLL has made it one of the busiest airports in the country. Activity at the airport has increased from 2,632,000 passenger enplanements in 1983 to 4,553,583 in 1990, a 73 percent increase. In 1990, the airport handled 224,703 aircraft operations, of which 219,000 were itinerant. (One takeoff or one landing equals one operation.)

The FLL Capacity Team identified and assessed various actions which, if implemented, would increase FLL's capacity, improve operational efficiency, and reduce aircraft delays. The purpose of the process was to determine the technical merits of each alternative action and its impact on flight delays. Additional studies will be needed to assess environmental, socioeconomic, or political issues associated with these actions.

Selected alternatives identified by the Capacity Team were tested using computer models developed by the FAA to quantify the benefits provided. Different levels of activity were chosen to represent growth in aircraft operations in order to compare the merits of each action. These annual activity levels are referred to throughout this report as: Baseline – 219,000 operations; Future 1 – 294,000 operations; and Future 2 – 350,000 operations. An additional traffic level of 416,500 annual operations, Future 3, was established to further evaluate the relative merits of two of the airfield improvement alternatives considered by the Capacity Team.

If no improvements are made at FLL (the Do Nothing scenario), the annual delay cost will increase from 5,275 hours or $6.29 million at the Baseline level of operations to 39,454 hours or $61.71 million by Future 2.

The major recommendations resulting from the FLL study include:

Alternative	Future 2 Annual Delay Savings* Hours	Future 2 Annual Delay Savings* Millions of 1990 $
• Extend Runway 9R/27L to 10,000 feet		
– with simultaneous IFR approaches (with PRM)	20,533	$32.11
– with 2 nm stagger in IFR	19,878	$31.09
• CAT I ILS on Runway 31	4,842	$7.57
• CAT I ILS on Runway 27L	4,150	$6.49
• Reduce minimum in-trail separation to 2.5 nm	1,082	$1.69

* Note: The delay savings of these alternatives are not necessarily additive.

At the estimated Future 3 demand level of 416,500 operations per year, the extension of Runway 9R/27L to 10,000 feet would save at least $59 million more each year than the extension to 6,000 feet.

Figure 3. Airport Capacity Curves — Hourly Flow Rate Versus Average Delay

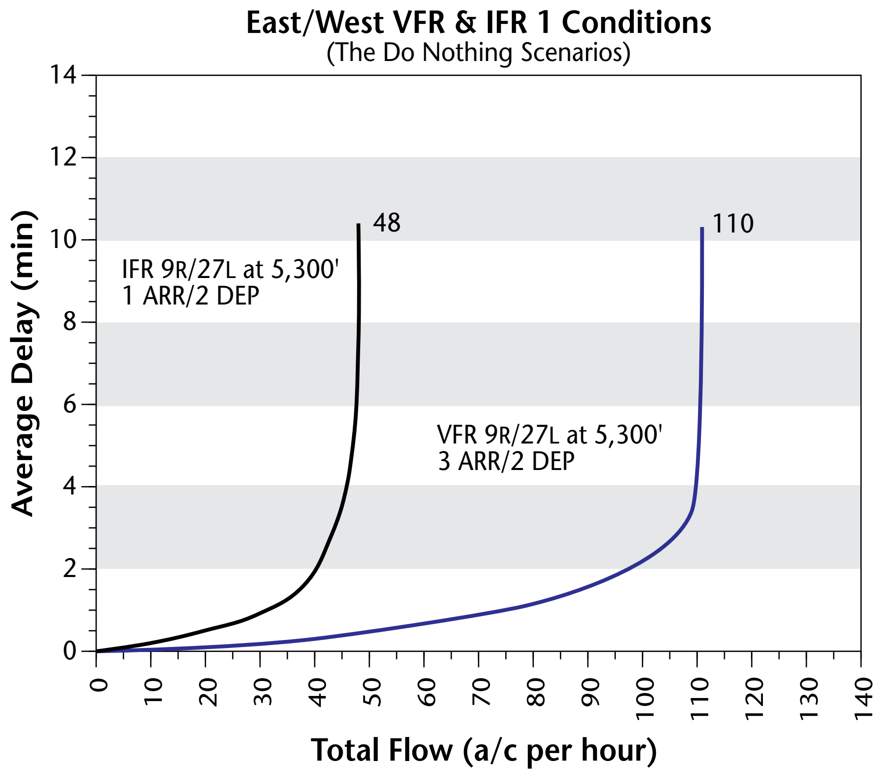


Figure 4. Profile of Daily Demand — Hourly Distribution

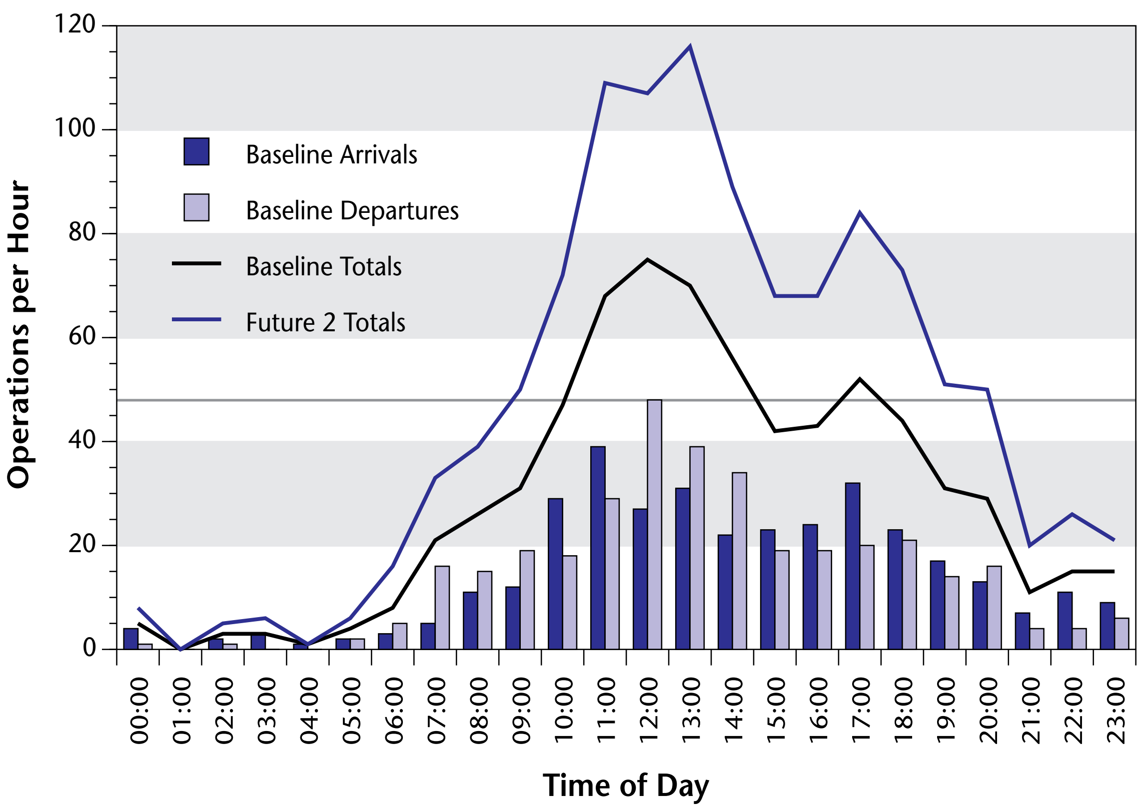


Figure 5. Annual Delay Costs — Capacity Enhancement Alternatives

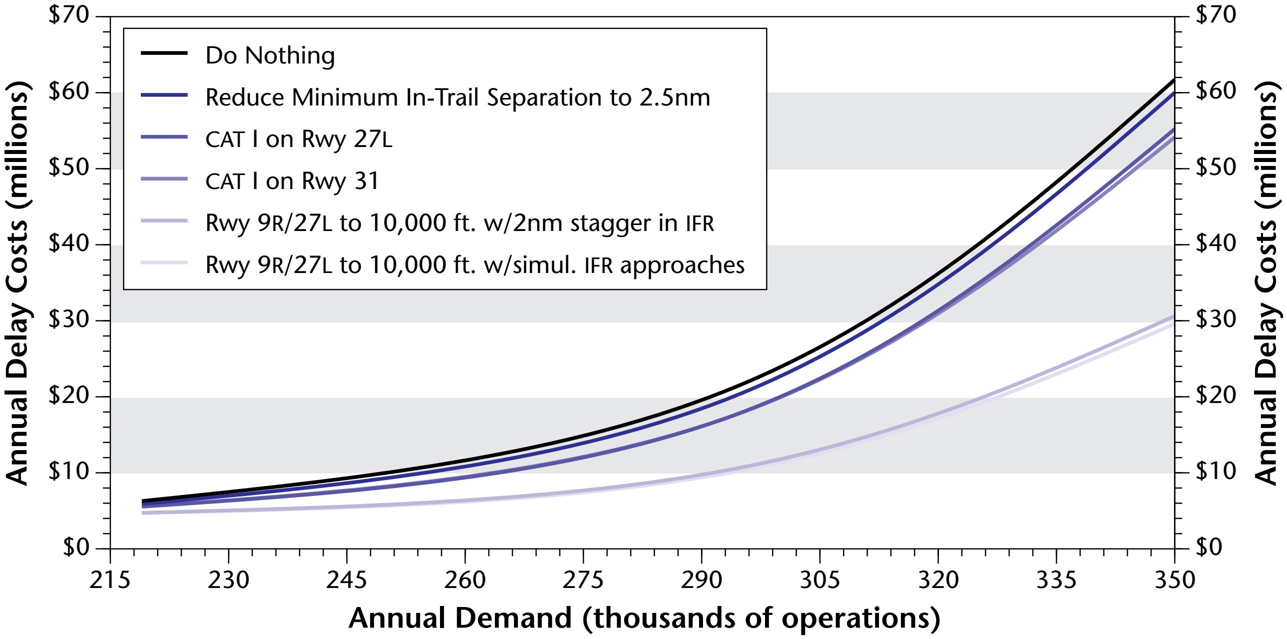


Figure 3 illustrates the capacity and delay curves for the current airfield configuration at FLL under both visual flight rules (VFR) and instrument flight rules (IFR 1), with a 50/50 split of arrivals and departures and balanced flow rates. It shows that aircraft delays will begin to escalate rapidly as hourly demand exceeds 48 operations per hour under IFR 1. Figure 4 shows that, while hourly demand exceeds 48 operations during certain hours of the day at Baseline demand levels, 48 operations per hour is frequently exceeded at the demand levels forecast for Future 2.

Figure 5 shows how delay costs will continue to grow at a substantial rate as demand increases if there are no improvements made in airfield capacity, i.e., the Do Nothing scenario. Annual delay costs will increase from $6.29 million at the Baseline level of operations to $61.71 million by Future 2. The graph also shows that the greatest delay savings would be provided by:

- Extending Runway 9R/27L to 10,000 feet
  - with simultaneous IFR approaches (with PRM)
  - with 2 nm stagger in IFR
- CAT I ILS on Runway 31
- CAT I ILS on Runway 27L
- Reducing minimum in-trail separation to 2.5 nm

Note: The delay savings of these alternatives are not necessarily additive.

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Section 1 Introduction

Background

The National air transportation system is being called on to handle unprecedented growth and ever increasing activity. The challenge for the air transportation industry in the nineties is to enhance existing airport and airspace capacity and to develop new facilities to handle future demand. As environmental, financial, and other constraints continue to restrict the development of new airport facilities in the U.S., an increased emphasis has been placed on the redevelopment and expansion of existing airport facilities.

To begin to meet this challenge, the FAA, along with airport operators and aviation industry groups throughout the country, have initiated joint Airport Capacity Design Teams to study airport capacity enhancement at the major air carrier airports in the U.S. The objectives of these studies are to identify various alternatives for increasing capacity and to evaluate their potential for reducing delays.

In the past decade, Fort Lauderdale-Hollywood International Airport (FLL) has been one of the nation's busiest airports. Enplanements at FLL rose from 2,632,000 in 1983 to 4,553,583 in 1990, a 73 percent increase. FLL's total aircraft operations reached 224,703 in 1990, of which 219,000 were itinerant.

This report has established benchmarks for development based upon traffic levels and not upon any definitive time schedule, since actual growth can vary year to year from projections. As a result, the report should retain its validity until the highest traffic level is attained regardless of the actual dates paralleling the development.

A Baseline benchmark of 219,000 aircraft operations (one takeoff or one landing equals one operation) was established based on the annual itinerant traffic level for 1990, the base year of the study. Two future traffic levels, Future 1 and Future 2, were established at 294,000 and 350,000 annual aircraft operations respectively, based on Capacity Team consensus of potential traffic growth at Fort Lauderdale-Hollywood. An additional traffic level of 416,500 annual operations, Future 3, was established to further evaluate the relative merits of two of the airfield improvement alternatives considered by the Capacity Team.

If no improvements are made at FLL, annual delay levels and delay costs are expected to increase from an estimated 5,275 hours and $6.29 million at the Baseline activity level to 39,454 hours and $61.71 million by the Future 2 demand level.

The Capacity Team studied various proposals with the potential for increasing capacity and reducing delays at FLL. The improvements evaluated by the Capacity Team are delineated in Figure 2 and described in some detail in Section 2 — Capacity Enhancement Alternatives.

Objectives

The major goal of the Capacity Team was to identify improvements that would increase airport capacity, improve airport efficiency, and reduce aircraft delays. In achieving this objective, the Capacity Team:

- Assessed the current airport capacity and the causes of delay associated with the airfield, the immediate airspace, and the apron and gate-area operations
- Evaluated capacity and delay benefits of alternative air traffic control (ATC) procedures, navigational improvements, airfield development, and operational improvements

Scope

The Capacity Team limited its analyses to aircraft activity within the terminal area airspace and on the airfield. They considered the technical and operational feasibility of the proposed airfield improvements, but did not address environmental, socioeconomic, or political issues regarding airport development. These issues need to be addressed in future airport environmental and master planning studies, and the data generated by the Capacity Team can be used in such studies.

Methodology

The Capacity Team met periodically for review and coordination. The FAA Technical Center's Aviation Capacity Branch provided expertise in airport simulation modeling and capacity and delay analysis. Other Capacity Team members contributed suggested improvement options, data, text, and capital cost estimates.

Initial work consisted of gathering data and formulating assumptions required for the capacity and delay analysis and modeling. Where possible, assumptions were based on actual field observations at FLL. Proposed improvements were analyzed in relation to current and future demands with the help of two computer models, the Runway Delay

Simulation Model (RDSIM) and the Airport and Airspace Simulation Model (SIMMOD). Appendix B briefly explains these models.

The simulation models considered air traffic control procedures, airfield improvements, and traffic demands. Alternative airfield configurations were prepared from present and proposed airport layout plans. Various configurations were evaluated to assess the benefit of projected improvements. Air traffic control procedures and system improvements determined the aircraft separations to be used for the simulations under both VFR and IFR.

Air traffic demand levels were derived from *Official Airline Guide* data, historical data, and Capacity Team and other forecasts. Aircraft volume, mix, and peaking characteristics were considered for each of the three different demand levels (Baseline, Future 1, and Future 2). From this, annual delay estimates were determined based on implementing various improvements. These estimates took into account historic variations in runway configuration, weather, and demand. The annual delay estimates for each configuration were then compared to identify delay reductions resulting from the improvements. Following the evaluation, the Capacity Team developed a plan of recommended alternatives for consideration, which is included in Figure 6.

Late in the study, the Capacity Team obtained 10 years of detailed FLL weather data from KPMG Peat Marwick, the Aviation Department's Master Plan consultant. The FAA Technical Center analyzed this data and verified that the team's weather assumptions were valid. Using independent analysis techniques, the Technical Center verified that the standard techniques used for the Capacity Study accurately estimated the delays at FLL.

Figure 6. Capacity Enhancement Alternatives and Recommended Actions

Alternatives	Action	Time Frame
Airfield Improvements		
1. Extend Runway 9R/27L — 6,000 ft. long, 150 ft wide, and CAT I ILS	Approved in Current Master Plan	—
2. Extend Runway 9R/27L — 10,000 ft. long, 150 ft wide, and CAT I ILS	Recommended	Future 2
3. Extend Runway 9R/27L to 10,000 ft; operate under restricted use	***	—
4. Improve angled exits		
4a. Widen fillets at Exit Q on Runway 9L	Approved in Current Master Plan	—
4b. Widen angled exit on Runway 27R, south, at Taxiway F	Recommended	Baseline
5. Add or expand run-up pads to stage departures	Recommended	Baseline**
6. Taxiway improvement package	Recommended	Baseline
7. Expand terminal (international and air carrier)	Study*	—
Facilities and Equipment Improvements		
8a. CAT I ILS on Runway 9R (at 5,300 feet)	Not Recommended	—
8b. CAT I ILS on Runway 27L (at 5,300 feet)	Recommended	Baseline
9. CAT I ILS on Runway 31	Recommended	Baseline
10. CAT II/IIIA ILS on Runway 27R	Recommended	Baseline
11. Precision Runway Monitor (PRM)	Recommended	Baseline
12. Upgrade FLL radar — commission ASR-9	Under Construction	—
13. Relocate TVOR/VOR off Airport	Recommended	Baseline
14. Vortex Advisory System (VAS)	Recommended	Baseline
15. Low Level Wind Shear Alert System (LLWAS)	Recommended	Baseline
Operational Improvements		
16. Reduce minimum in-trail separations to 2.5 nm	Recommended	Baseline
17. Reduce stagger to 1.5 nm in IFR	Recommended	Baseline
18. Unrestricted use of Runway 13/31 for departures (cost of noise restrictions on use of Runway 13/31)	Study*	—
19. Unrestricted use of Runway 13 for arrivals (impact of Ft. Lauderdale Executive (FXE) operations)	Study*	—
20. Conduct a study of South Florida airspace and implement airspace management	Recommended	Baseline
21. Increase/enhance reliever airports	Recommended	Baseline
22. Redistribute traffic more uniformly within the hour	Not Recommended	—

*** The Design Team does not recommend this alternative because it would not maximize the capacity of FLL. However, the team recognizes that in addition to maximizing capacity, the Broward County Aviation Department must consider other factors when making a decision about implementing the proposed operating restrictions.

** Note: Recommended for Runway 9L/27R at Baseline. Run-up pad for Runway 9R/27L should be constructed when runway is extended to 10,000 feet.

* The term "Study" suggests that a specific study be conducted or that it become part of a larger planning effort, such as a Master Plan update or a FAR Part 150 Airport Noise Compatibility Study. These individual proposals require further investigation at a level of detail that is beyond the scope of this effort.

Section 2 Capacity Enhancement Alternatives

Figure 1 shows the current layout of the airport, plus the airfield improvements considered by the Capacity Team.

Figure 2 lists the capacity enhancement alternatives evaluated by the Capacity Team and presents the estimated annual delay savings benefits for selected improvements. The annual savings are given for the activity levels Baseline, Future 1, and Future 2, which correspond to annual aircraft operations of 219,000, 294,000 and 350,000 respectively. The delay savings benefits of the improvements are not necessarily additive.

Figure 6 presents the recommended action and suggested time frame for each capacity enhancement alternative considered by the Capacity Team.

The capacity enhancement alternatives are categorized and discussed under the following headings:

- Airfield Improvements
- Facilities and Equipment Improvements
- Operational Improvements

Airfield Improvements

1. Extend Runway 9R/27L — 6,000 feet long, 150 feet wide, and CAT I ILS.

Approved in current Master Plan.

This project would extend Runway 9R/27L to 6,000 feet and widen the runway from 100 to 150 feet to support air carrier operations. It would provide air traffic control greater flexibility in the use of runways and thus enhance capacity. In addition, it would include upgrading Taxiways D and L and removing a hotel and other obstructions.

To conduct operations under Instrument Meteorological Conditions (IMC), Runway 9R/27L would require the installation of Instrument Landing Systems (ILSs) (see alternatives 8a and 8b).

In the computer simulations, use of the 6,000 foot runway was based on information provided by the air carriers. Under VFR, air carrier jets would land on Runway 9R/27L during periods of heavy arrival delay, i.e., between noon and 1:00 PM. Under IFR, air carrier jets could not land on the 6,000 foot runway because the landing roll distance would be reduced to an unacceptable length due to the location of the ILS glide path touchdown points.

Estimated 1991 project cost is $89 million, which includes the cost of acquiring and removing the hotel, $60 million, and installing the ILSs, $3 million. There would be an additional cost of $6 million for the Precision Runway Monitor (PRM) for alternatives 1c and 1d.

1a. 2 nautical mile (nm) stagger in IFR.

Runway 9R/27L is separated from Runway 9L/27R by 3,960 feet. Currently, if parallel runway centerlines are less than 4,300 feet apart, the runways are considered dependent under Instrument Flight Rules (IFR), and aircraft on approach to the two runways must be staggered by at least 2 nm.

Annual savings at Future 2 activity levels would be 7,294 hours or $11.41 million. At Future 3 activity levels, which represents 416,500 annual operations, annual savings would be at least 21,736 hours or $34.0 million.

1b. 1.5 nm stagger in IFR (see alternative 17).

This alternative was not simulated. The Capacity Team considered alternatives 1a and 1c sufficient for comparison of alternatives 1 and 2.

1c. Simultaneous parallel IFR approaches (with PRM).

Runway 9R/27L has the potential to support simultaneous independent air carrier operations under IFR. Currently, the separation between parallel runways must be at least 4,300 feet for independent operations in all weather conditions. However, a developmental program known as the Precision Runway Monitor (PRM) has demonstrated the potential for reducing parallel runway spacing requirements. Procedures have been published for simultaneous parallel approaches to runways that have centerlines separated by 3,400 to 4,300 feet with the use of a PRM (see alternative 11). Two independent arrival streams would significantly increase the capacity of the airport under IFR.

Annual savings at Future 2 activity levels would be 8,914 hours or $13.94 million. This represents an annual savings of 1,620 hours or $2.53 million at the Future 2 level over alternative 1a. At Future 3 activity levels, which represents 416,500 annual operations, annual savings would be at least 26,595 hours or $41.6 million. This represents an annual savings of 4,859 hours or $7.6 million at the Future 3 level over alternative 1a. The increase in savings of alternative 1c over alternative 1a would be identical to the savings obtained by installing a PRM with the existing 5,300 foot runway.

The annual savings for the PRM would be greater for the 6,000 foot runway than the 10,000 foot runway. With the longer runway, there would be a more uniform mix of aircraft types, an improved ability to utilize staggered approaches, and a corresponding reduction in delays even before the effects of the PRM were applied.

1d. Simultaneous approaches and 2.5 nm minimum in-trail separation in IFR (combines alternatives 1c and 16).

This alternative was not simulated. The Capacity Team considered alternatives 1a and 1c sufficient for comparison of alternatives 1 and 2.

2. Extend Runway 9R/27L — 10,000 feet long, 150 feet wide, and CAT I ILS.

Recommended.

Extending Runway 9R/27L to 10,000 feet and widening the runway from 100 to 150 feet to support air carrier operations would provide the capability to handle larger and heavier aircraft and further enhance flexibility in the use of runways. In addition, it would include upgrading Taxiways D and L, relocating utility transmission lines, and removing other obstructions.

To conduct operations under IMC, Runway 9R/27L would require the installation of an ILS (see alternatives 8a and 8b). It would also require displacing the Runway 9R threshold by 2,500 feet to avoid removing a hotel. This would have the added benefit of reducing some of the effects of noise west of the airport.

Estimated 1991 project cost is $253 million, which includes land acquisition, relocation of utility transmission lines, $10 million, and installation of the ILSs, $3 million. There would be an additional cost of $6 million for the PRM for alternatives 2c and 2d.

2a. 2 nautical mile (nm) stagger in IFR.

With Runway 9R/27L separated from Runway 9L/27R by 3,960 feet, the runways are considered dependent under instrument flight rules (IFR), and aircraft on approach to the two runways must be staggered by at least 2 nm.

Annual savings at the Baseline activity level would be 1,298 hours or $1.55 million, and, at Future 2 activity levels, 19,878 hours or $31.09 million. At Future 3 activity levels, which represents 416,500 annual operations, annual savings would be at least 59,455 hours or $93.0 million. At Future 3, the 10,000 foot runway would save at least $59 million more each year than the 6,000 foot runway.

2b. 1.5 nm stagger in IFR (see alternative 17).

Annual savings at the Baseline activity level would be 1,322 hours or $1.58 million, and, at Future 2 activity levels, 20,251 hours or $31.67 million. This represents an annual savings of 24 hours or $0.03 million at the Baseline level and 373 hours or $0.58 million at the Future 2 level over alternative 2a.

2c. Simultaneous parallel IFR approaches (with PRM).

Currently, the separation between parallel runways must be at least 4,300 feet for independent operations in all weather conditions. However, a developmental program known as the Precision Runway Monitor (PRM) has demonstrated the potential for reducing parallel runway spacing requirements. Procedures have been published for simultaneous parallel approaches to runways that have centerlines separated by 3,400 to 4,300 feet with the use of a PRM (see alternative 11). Two independent arrival streams would significantly increase the capacity of the airport under IFR.

Annual savings at the Baseline activity level would be 1,335 hours or $1.59 million, and, at Future 2 activity levels, 20,533 hours or $32.11 million. This represents an annual savings of 37 hours or $0.04 million at the Baseline level and 655 hours or $1.02 million at the Future 2 level over alternative 2a. At Future 3 activity levels, which represents 416,500 annual operations, annual savings would be at least 61,373 hours or $96.0 million. This represents an annual savings of at least 1,918 hours or $3.0 million at the Future 3 level over alternative 2a.

2d. Simultaneous approaches and 2.5 nm minimum in-trail separation in IFR (combines alternatives 2c and 16).

Installing a PRM (alternative 11) and reducing the minimum in-trail separation to 2.5 nm (alternative 16) would increase capacity and reduce delays at FLL under IFR.

Annual savings at the Baseline activity level would be 1,355 hours or $1.62 million, and, at Future 2 activity levels, 20,680 hours or $32.34 million. This represents an annual savings of 57 hours or $0.07 million at the Baseline level and 802 hours or $1.25 million at the Future 2 level over alternative 2a.

3. Extend Runway 9R/27L to 10,000 feet; operate under restricted use.

See Figure 6.

This improvement would be the same as alternative 2 except that use of the runway would be restricted so that no heavy or large jets would be allowed to arrive on Runway 9R or depart on Runway 27L due to noise impacts west of the airport.

Estimated 1991 project cost is $251.5 million, which includes land acquisition, relocation of utility transmission lines, $10 million, and installation of an ILS on Runway 27L, $1.5 million. There would be an additional cost of $6 million for the PRM for alternative 3b.

3a. 2 nm stagger in IFR.

Annual savings at Future 2 activity levels would be 16,498 hours or $25.80 million.

3b. Simultaneous parallel IFR approaches (with PRM).

Annual savings at Future 2 activity levels would be 17,285 hours or $27.03 million. This alternative would save $1.23 million more annually than alternative 3a.

4. Improve angled exits.

Constructing improved, angled exits would reduce runway occupancy times, enhance capacity, and increase the likelihood of reducing the minimum in-trail separation to 2.5 nm (alternative 16).

4a. Widen fillets at Exit Q on Runway 9L.

Approved in current Master Plan.

Widening the fillets at Taxiway Q would make it easier for wide-body aircraft to exit the runway at this taxiway. Larger cargo and general aviation aircraft, gated north of Runway 9L/27R, would benefit from the widened fillets.

Estimated 1991 project cost is $0.092 million.

4b. Widen angled exit on Runway 27R, south, at Taxiway F.

Recommended.

A widened angle exit would enable larger aircraft to exit Runway 27R at Taxiway F instead of traveling further up the runway to the reverse high-speed exit at Taxiway D or the angled exit at Taxiway O. Runway occupancy times and taxi times for these aircraft would be reduced, enabling them to arrive at their gates approximately one minute earlier.

Departures would also benefit from the widened exit. The sooner an arriving aircraft exits the runway, the sooner a departing aircraft can take off, thus increasing the likelihood that departures can take advantage of the inter-arrival gap.

Estimated 1991 project cost is $0.045 million.

Annual savings for arrivals at the Baseline activity level would be 66 hours or $0.08 million, and, at Future 2 activity levels, 124 hours or $0.19 million.

If there is a departure that can take off earlier whenever an arrival reduces its runway occupancy time, the potential additional annual savings for departures at the Baseline activity level would be 17 hours or $0.02 million, and, at Future 2 activity levels, 31 hours or $0.05 million.

5. Add or expand run-up pads to stage departures.

Recommended.

Air traffic flow control often dictates that aircraft hold at the runway thresholds before take-off because of departure flow restrictions. Expanding the staging areas at the ends of the runways on Runways 9R/27L and 9L/27R would improve the ability of departing aircraft to bypass those aircraft waiting for departure clearance. It would also reduce the length of departure queues on the parallel taxiways.

Estimated 1991 project cost is $1.5 million.

6. Taxiway improvement package.

Recommended.

These improvements include constructing a full-length dual parallel taxiway south of Runway 9L/27R and a partial dual parallel taxiway east of Runway 13/31. This alternative would increase flexibility for air traffic controllers in routing aircraft on the ground and reduce the length of departure queues on the taxiways.

Estimated 1991 project cost is $8.0 million for a full-length parallel taxiway south of Taxiway A and $0.64 million for all other taxiway improvements.

7. Expand terminal (international and air carrier).

Study.

This project would provide a total of 76 gates in two phases to accommodate the expected increase in aircraft operations at FLL. The Capacity Team has recommended that a complete gate analysis be done as a part of the Master Plan Update.

Estimated 1991 project cost is $148 million for 37 new gates and $285 million for approximately 400,000 square feet of new terminal space.

Facilities and Equipment Improvements

8a. CAT I ILS on Runway 9R, with the runway 5,300 feet long.

Not recommended.

Although instrument meteorological conditions (IMC) restricting operations occur less than 2.0 percent of the time, the impact of the associated delays can be significant. Installing CAT I ILS on Runway 9R would enhance operational flexibility and ensure integrity of operations in response to wind and other limiting conditions. In order to support operations down to CAT I visibility minimums, certain obstructions must be removed (including a hotel). This alternative was simulated using a 2 nm stagger and assuming no obstructions.

Estimated 1991 project cost is $61.5 million, which includes the cost of removing the hotel, $60 million.

Annual savings at the Baseline activity level would be 207 hours or $0.25 million, and, at Future 2 activity levels, 1,383 hours or $2.16 million. These savings were based on one full day of IFR 1, using a 2 nm stagger in IFR 1, with Runway 9R/27L at 5,300 feet in length, and with all obstructions removed.

8b. CAT I ILS on Runway 27L, with the runway 5,300 feet long.

Recommended.

Although instrument meteorological conditions (IMC) restricting operations occur less than 2.0 percent of the time, the impact of the associated delays can be significant. Installing CAT I ILS on Runway 27L would enhance operational flexibility and ensure integrity of operations in response to wind and other limiting conditions. In order to support operations down to CAT I visibility minimums, certain obstructions must be removed. This alternative was simulated using a 2 nm stagger and assuming no obstructions.

Estimated 1991 project cost is $1.5 million, which does not include the cost of removing obstructions.

Annual savings at the Baseline activity level would be 620 hours or $0.74 million, and, at Future 2 activity levels, 4,150 hours or $6.49 million. These savings were based on three full days of IFR 1, using a 2 nm stagger in IFR 1, with Runway 9R/27L at 5,300 feet in length, and with all obstructions removed.

9. CAT I ILS on Runway 31.

Recommended.

The addition of a capability to land on Runway 31 under CAT I conditions would also serve to enhance operational flexibility and ensure integrity of operations in response to wind and other limiting conditions. In order to support operations down to CAT I visibility minimums, certain obstacles must be removed (including signal arms located at a railroad crossing). This alternative was simulated using a 2 nm stagger and assuming no obstructions.

Estimated 1991 project cost is $1.5 million, which does not include the cost of removing obstructions.

Annual savings at the Baseline activity level would be 602 hours or $0.72 million, and, at Future 2 activity levels, 4,842 hours or $7.57 million. The savings were based on three full days of IFR 1, with Runway 9R/27L at 5,300 feet in length, using a 2 nm stagger, and with all obstructions removed.

10. CAT II/IIIa ILS on Runway 27R.

Recommended.

FLL experiences CAT II/IIIa conditions about 15 hours each year. Under these conditions, the airport must be closed because it does not have a CAT II/IIIa ILS equipped runway. Upgrading ILS on Runway 27R to CAT II/IIIa and installing the necessary runway visual range (RVR), touchdown zone lights, and centerline lights would reduce visibility minimums and thereby help to maintain capacity when weather minimums are less than CAT I. FLL could serve as a reliever airport for Miami International Airport (MIA) in CAT II weather.

The analysis of this alternative assumed that commuters and small/slow aircraft could not operate in these conditions either because they were not equipped or because their paired cities had CAT II/III weather but were not CAT II/III equipped.

Estimated 1991 project cost is $2.5 million, which does not include the cost of removing obstructions.

Annual savings at the Future 1 activity level would be 575 hours or $0.81 million, and, at Future 2 activity levels, 630 hours or $0.99 million. Departure delay savings provided at least 70 percent of the annual delay savings at each demand level. The departure delay savings are the result of the RVR required for CAT II/III operations. The analysis didn't take such costs as disruption of service, canceled flights, or missed connections into account.

11. Precision Runway Monitor (PRM).

Recommended.

The capacity of FLL would be significantly increased by the ability to conduct simultaneous independent parallel approaches in all weather conditions. With current radar equipment, this requires 4,300 feet between parallel runway centerlines. FLL's parallel runways are only 3,960 feet apart.

A developmental program known as the Precision Runway Monitor (PRM) has demonstrated the potential to reduce the spacing required between runways to support simultaneous independent parallel approaches in all weather conditions. This program relies on improved radar surveillance with higher update rates of aircraft positions and a new air traffic controller display system. In fact, procedures have recently been published for simultaneous parallel approaches to runways that have centerlines separated by 3,400 to 4,300 feet with the use of a PRM.

When PRM equipment becomes available, installing it at FLL would allow simultaneous independent parallel IFR approaches to be implemented. The delay savings associated with the PRM are included in the savings estimates for alternatives 1c, 2c, 2d, and 3b.

Estimated 1991 project cost is $6.0 million.

12. Upgrade FLL radar — commission ASR-9.

Under construction.

Airport surveillance radars provide range and bearing data that supports radar vectoring for final approach to an airport. ASR-4/5/6 radars are in the process of being replaced. The ASR-9 radar would provide the latest state-of-the-art equipment.

Estimated 1991 project cost is $6.8 million. The equipment installation is in progress.

13. Relocate TVOR/VOR off Airport.

Recommended.

The VOR is currently highly restricted due to electronic interference, and the VOR/DME location is in the way of the proposed parallel taxiway for Runway 9L/27R. Moving the VOR to a new location would eliminate the electronic restrictions and, by making way for the new taxiway, improve the airport capacity to handle taxiing aircraft. Judicious selection of an off-airport site would allow the VOR's critical area to be expanded so that the facility could be used as an en route NAVAID.

Estimated 1991 project cost is $2.3 million.

14. Vortex Advisory System (VAS).

Recommended.

The turbulence created by heavy aircraft at landing and take-off speeds can be hazardous to trailing aircraft. The FAA has established minimum separations to eliminate the hazards of wake vortices, but these aircraft spacing requirements limit the arrival and departure capacities of an airport. By providing the ability to predict wake turbulence, installation of a vortex advisory system would allow for improved separation.

15. Low Level Wind Shear Alert System (LLWAS).

Recommended.

Wind shear conditions occurring at low altitude in the terminal area are hazardous to aircraft encountering them during takeoff or final approach. The Low Level Wind Shear Alert System provides a capability to monitor winds in the terminal area and alert the pilot, through the air traffic controller, when hazardous wind shear conditions are detected.

Upgrading the LLWAS to a Phase III system would increase the number of wind sensors and extend coverage in the approach and departure corridors. The upgrade would also increase the height of the sensors to reduce the effects of sheltering. These improvements would increase the LLWAS's capability to detect wind shear.

Estimated 1991 project cost is $1.5 million.

Operational Improvements

16. Reduce minimum in-trail separation to 2.5 nm.

Recommended.

Existing procedures for instrument flight rules (IFR) require that arriving aircraft be separated by 3 nm or more. Reducing separation minimums to 2.5 nm for aircraft of similar class and less than 300,000 pounds would increase arrival rates and runway capacity. Most of the savings occur at the highest demand levels under IFR, but, if the runway exits are not visible from the tower, the 2.5 nm separation cannot be applied. Runway occupancy times must be kept at 50 seconds or below.

Annual savings at the Baseline activity level would be 322 hours or $0.38 million, and, at Future 2 activity levels, 1,082 hours or $1.69 million.

17. Reduce stagger to 1.5 nm under IFR.

Recommended.

The current separation requirement for dependent parallel approaches requires a 2 nm stagger between adjacent arrival streams. Reducing the stagger during final approaches to 1.5 nm would reduce the in-trail spacing between successive arrivals, improve arrival acceptance rates, and increase runway capacity for both arrivals and departures. Demonstration programs have shown this separation can be safely changed to 1.5 nm for runways at least 2,500 feet apart.

18. Unrestricted use of Runway 13/31 for departures (cost of Noise Restrictions on use of Runway 13/31).

Study.

With the unrestricted use of Runway 13/31 for departures, the reduction in taxi times would provide an annual savings at the Baseline activity level of 303 hours or $0.292 million, and, at Future 2 activity levels, 295 hours or $0.408 million. These savings represent the cost of noise restrictions on Runway 13/31. The annual savings in taxi times are lower at Future 1 and Future 2 activity levels than at the Baseline level because of changes in aircraft fleet mix.

Unrestricted use of Runway 13 for departures would significantly increase noise impacts over noise sensitive areas in the city of Dania. A mitigation program to acquire the affected properties would not be feasible given the cost and the impact on the city's current land use plan for that area.

Unrestricted use of Runway 31 for departures would significantly increase the environmental impact on residential areas in the city of Ft. Lauderdale. A mitigation program to acquire the affected properties would not be feasible given the cost and the impact on the city's current land use plan for that area.

19. Unrestricted use of Runway 13 for arrivals (impact of Fort Lauderdale Executive (FXE) operations on FLL).

Study.

Currently, there are operational conditions that affect FLL's ability to use Runway 13 for arrivals under IFR 1. Published straight-in approaches to Runway 13 at FLL conflict with downwind patterns for aircraft landing on Runway 8 at FXE. There is also an instrument approach to FXE's Runway 8 that intersects with the straight-in approach to Runway 13 at FLL. No procedures currently exist to run ILS approaches to both runways simultaneously.

The Capacity Team was unable to determine the benefits of this alternative. It will be studied in the Master Plan update process.

20. Conduct a study of South Florida airspace and implement airspace management.

Recommended.

The Capacity Team highly recommends a complete analysis of all of the South Florida airspace. This analysis should include concepts of airspace restructuring that offer the potential for improving arrival and departure air route capacity in conjunction with airport improvements. New technology and operating concepts need to be reviewed in an effort to improve flow-control procedures and reduce or eliminate miles-in-trail restrictions that exceed optimal aircraft spacing. The goal would be to ensure sufficient airspace capacity to fully utilize airport surface capacity.

The analysis could include a study of modifications to air traffic procedures and instrument approaches to accommodate the capabilities of the Flight Management System (FMS). The FMS integrates the Global Positioning System (GPS), Very Low Frequency Navigation System (OMEGA), Long-Range Navigation System (LORAN), and Very High Frequency Omnidirectional Range/Distance Measuring Equipment (VOR/DME) systems to provide lateral flight path guidance to support instrument approaches and departures. Many aircraft use this equipment today, and its use is becoming more widespread.

FMS paths may be straight, curved, or segmented. In short, this transition to the final approach segment is limited only by aircraft performance, air traffic capabilities, and the length of final approach. The use of an FMS ILS approach or FMS non-precision instrument approach will allow air traffic to design the airspace to maximum efficiency. FMS departures will allow diverse departures to any point in the airway system.

Modifying the South Florida airway structure to allow for FMS arrivals and transitions would allow air traffic a free hand to design the airspace to its maximum potential. Aircraft would no longer be concentrated at focal points such as Bimini, Freeport, Miami, Biscayne, Fort Lauderdale, Pahokee, and Palm Beach. Transitioning aircraft could be kept clear of congested areas without radar vectors.

21. Increase/enhance general aviation (GA) reliever airports.

Recommended.

The percentage of general aviation activity is expected to decrease, from 29 percent of the annual operations for the Baseline demand level to 20 percent at Future 1 and 17 percent at Future 2. GA is an integral part of the aviation system and provides a vital service to businesses and the local community. Every effort should be made to accommodate these aircraft at enhanced "reliever airports" with equal or better access to the metropolitan area. These reliever airports would need to provide services similar to those available at FLL. "Similar services" would include runways of adequate length and width to accommodate the fleet of business aircraft, with associated lighting and increased pavement strength, all-weather approach capability, parallel taxiways, larger aprons, and such ancillary services as rental cars and easy access to public and private transportation.

The instrument systems needed to provide approach capability under IMC are limited in their availability. The FAA has reinstated the use of a localizer only/Outer Marker (LOC/OM) approach, including a light lane (formerly known as a partial ILS). This provides for approach minimums of a 400 foot ceiling and 3/4 mile visibility. These lower approach minimums would allow the existing facilities, without precision instrument approach procedures, to be available for a larger percent of the time in IMC.

Fort Lauderdale Executive Airport (FXE) is a reliever for FLL but is currently at about 80 percent of its capacity, and, therefore, its ability to relieve GA traffic is becoming increasingly more difficult. North Perry Airport (HWO) is also a reliever for FLL. Dense residential development adjacent to HWO has limited its operations to propeller-driven light aircraft (12,500 pounds and lighter), and HWO is not capable of relieving the type of GA traffic that would use FLL. Broward County is currently pursuing the option of developing a new general aviation airport in the south section of the County.

A 50 percent reduction in small-slow general aviation activity at FLL would result in annual savings at Future 2 activity levels of 1,877 hours or $2.94 million. Ninety three percent of the annual savings is under IFR 1, and 7 percent, under VFR.

The results of the analysis indicate that GA aircraft are not a significant cause of delay at the current activity level, but may become a factor at demand levels beyond Future 2.

22. Redistribute traffic more uniformly within the hour.

Not recommended.

A more uniform distribution of airline flights during peak periods would promote a more orderly flow of traffic, reduce arrival and departure delays, and reduce ground congestion near the terminal and on the taxiway system.

However, FLL is a part of hub-and-spoke operations, and uniform distribution of traffic is not consistent with such an operation. Hubbing creates efficiencies that cannot be measured in a delay study of this type. This system of operations provides frequent service between city-pairs that could not support frequent direct service. Frequent flights provide an economic benefit to consumers, in particular the business flyer. In order to properly evaluate the overall impact of hubbing and the redistribution of scheduled operations, the entire system must be studied, not any one individual airport.

Section 3 Summary of Technical Studies

Overview

The Fort Lauderdale-Hollywood International Airport Capacity Team evaluated the efficiency of the existing airfield and the proposed future configuration. Figure 7 illustrates annual distribution of traffic, Figure 8, airfield weather conditions, and Figures 9 and 10, runway utilization. The potential benefits of various improvements were determined by examining airfield capacity, airfield demand, and average aircraft delays.

The Capacity Team used the Runway Delay Simulation Model (RDSIM) to determine aircraft delays during peak periods. Delays were calculated for current and future conditions.

Daily operations corresponding to an average busy day in the year were used for each of the forecast periods. Daily delays were annualized to measure the potential economic benefits of the proposed improvements. The annualized delays provide a basis for comparing the benefits of the proposed changes. The benefits associated with various runway use strategies were also identified.

The fleet mix at Fort Lauderdale-Hollywood International Airport (FLL) has an average direct operating cost of $1,193 per hour, or $19.88 per minute, at the Baseline level; $1,406 per hour, or $23.43 per minute, at Future 1; and $1,564 per hour, or $26.07 per minute, at Future 2. These figures represent the costs for operating the aircraft and includes such items as fuel, maintenance, and crew costs, but they do not consider lost passenger time, disruption to airline schedules, or any other intangible factors.

The cost of a particular improvement can be compared to its annual delay savings. This comparison will indicate which improvements will be the most effective.

For expected increases in demand, a combination of improvements can be implemented to allow airfield capacity to increase while aircraft delays are minimized.

Figure 7. Annual Distribution of Traffic — Baseline Demand

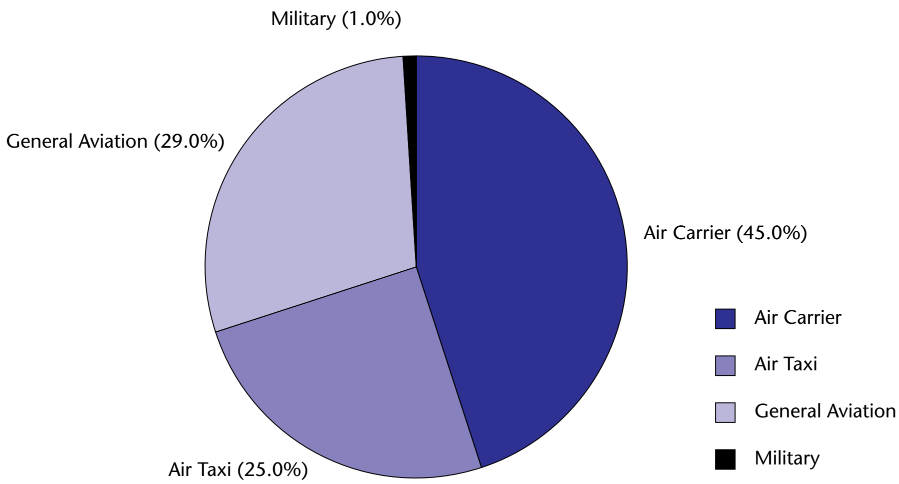


Figure 8. Airfield Weather

	Ceiling/Visibility	Occurrence (%)
VFR	1,000 feet and above / 3 mi and above	98.7
IFR 1	250 to 1,000 feet / 1 to 3 mi	1.3
	Total	100.0

VFR – visual flight rules
IFR – instrument flight rules
mi – miles

Note: The minimum ceiling and visibility for standard visual approaches are 2,500 ft. and 3 miles, respectively.

Figure 9. Runway Utilization (percentage use)

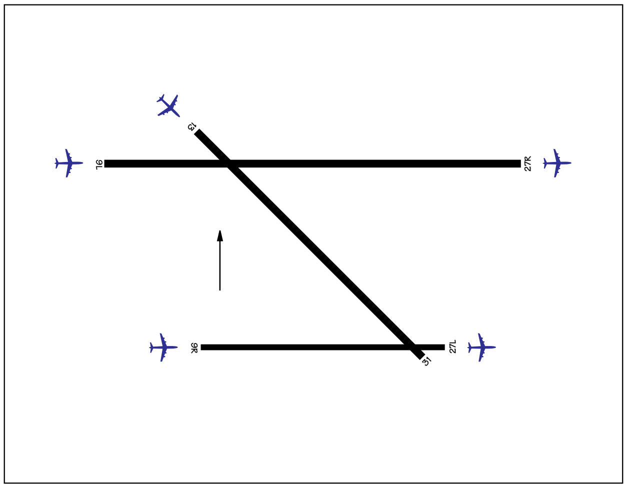
	VFR	IFR 1	Total
East Flow	82.5	0.4	82.9
West Flow	16.2	0.9	17.1
Total	98.7	1.3	100.0

Note: West flow predominates during winter IFR 1

Figure 10. Runway Utilization

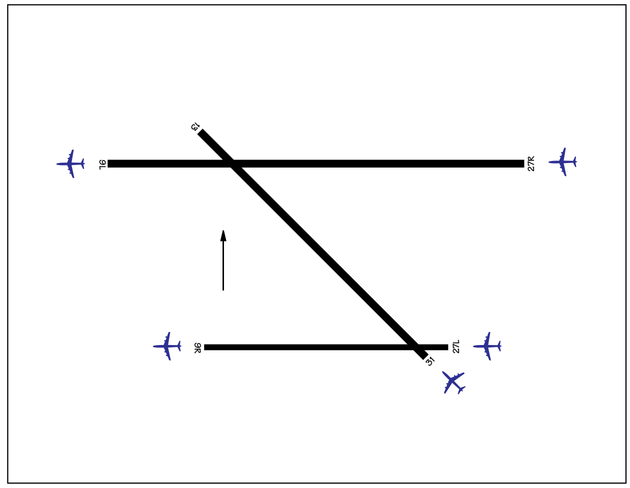
Configuration 1 — East Flow

VFR = 82.5%



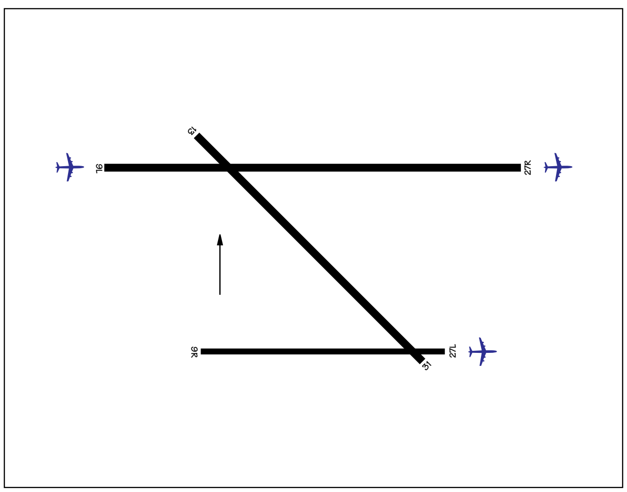
Configuration 2 — West Flow

VFR = 16.2%



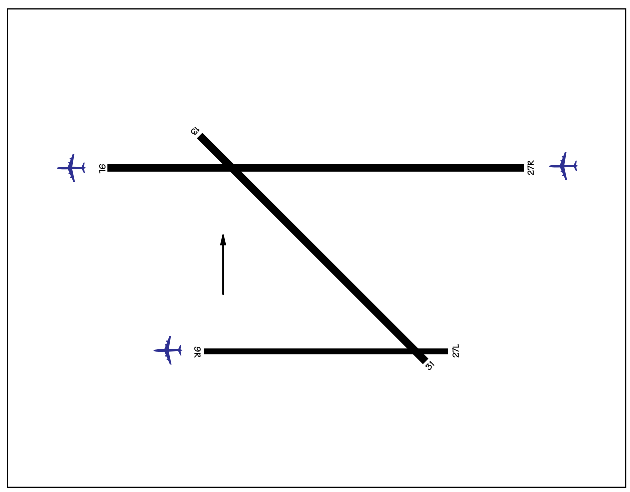
Configuration 1 — East Flow

IFR 1 = 0.4%



Configuration 2 — West Flow

IFR 1 = 0.9%



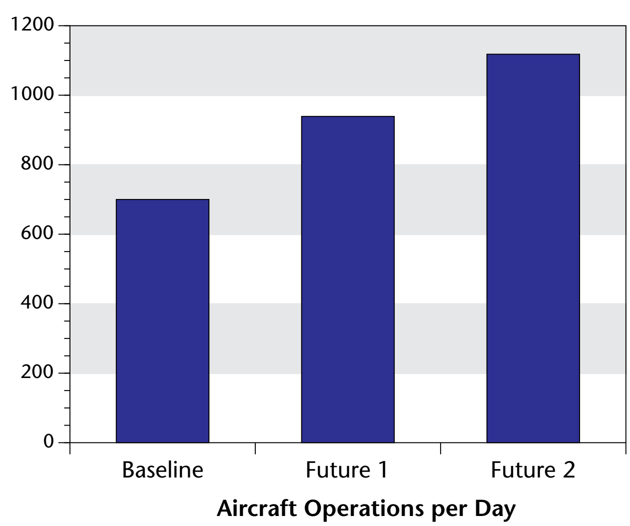
Airfield Capacity

The FLL Capacity Team defined airfield capacity to be the maximum number of aircraft operations (one takeoff or one landing equals one operation) that can take place during a given time under given conditions. They recognized that airfield capacity is a complex issue that cannot be represented by a single value, but rather changes as conditions change. The following conditions were considered:

- Level of delay
- Airspace constraints
- Ceiling and visibility conditions
- Runway layout and use
- Aircraft mix
- Percent arrival demand

Figure 11 illustrates the average busy day, peak month demand levels for FLL for each of the three annual activity levels used in the study, Baseline, Future 1, and Future 2.

Figure 11. Airfield Demand Levels



	Aircraft Operations		
	Annual	24-Hour Day*	Peak Hour
Baseline	219,000	700	75
Future 1	294,000	939	95
Future 2	350,000	1,118	116

* Average busy day, peak month.

Figure 12 presents the airport capacity curves for FLL. The curves were developed for various runway configurations, under instrument flight rules (IFR 1) and visual flight rules (VFR), with a 50/50 split of arrivals and departures and balanced flow rates. These curves are based on the assumption that arrival and departure demand is randomly distributed within the hour. Other patterns of demand can alter the demand/delay relationship.

The curves in Figure 12 illustrate the relationship between airfield capacity, stated in the number of operations per hour, and the average delay per aircraft. It shows that, as the number of aircraft operations per hour increases, the average delay per operation increases exponentially.

Figure 13 illustrates the hourly profile of daily demand for the Baseline activity level of 219,000 aircraft operations per year. It also includes a curve that depicts the profile of daily operations for the Future 2 activity level of 350,000 aircraft operations per year.

Comparing the information in Figures 12 and 13 shows that:

- Aircraft delays will begin to rapidly escalate as hourly demand exceeds 48 operations per hour under IFR 1, and,
- While hourly demand exceeds 48 operations during certain hours of the day at Baseline demand levels, 48 operations per hour is frequently exceeded at the demand levels forecast for Future 2.

Figure 12. Airport Capacity Curves — Flow Rate Versus Average Delay

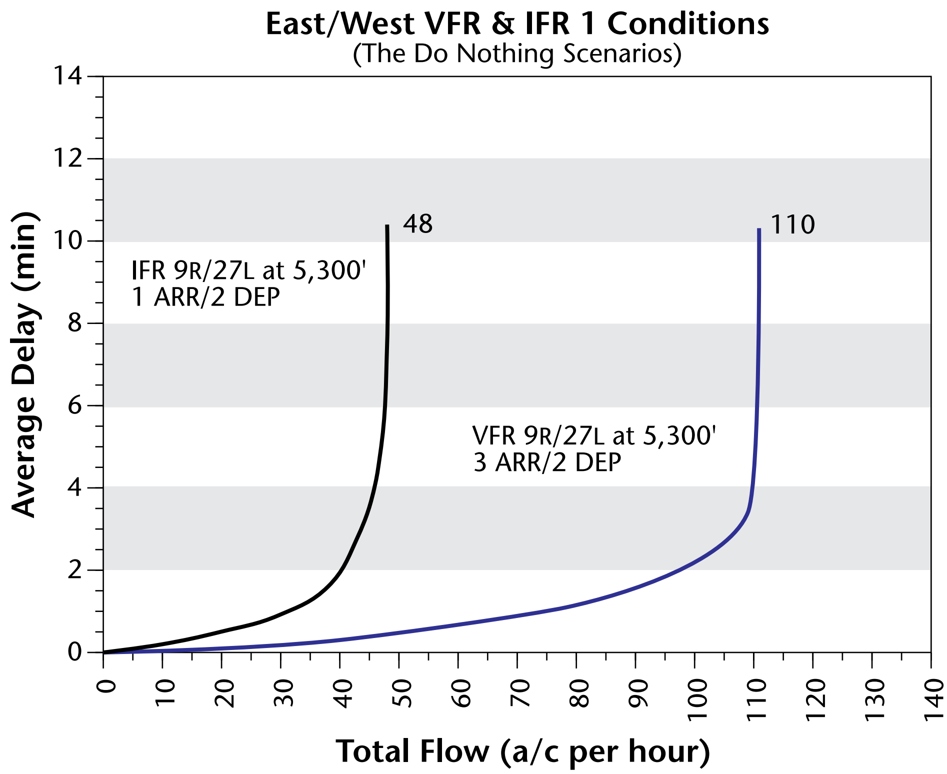
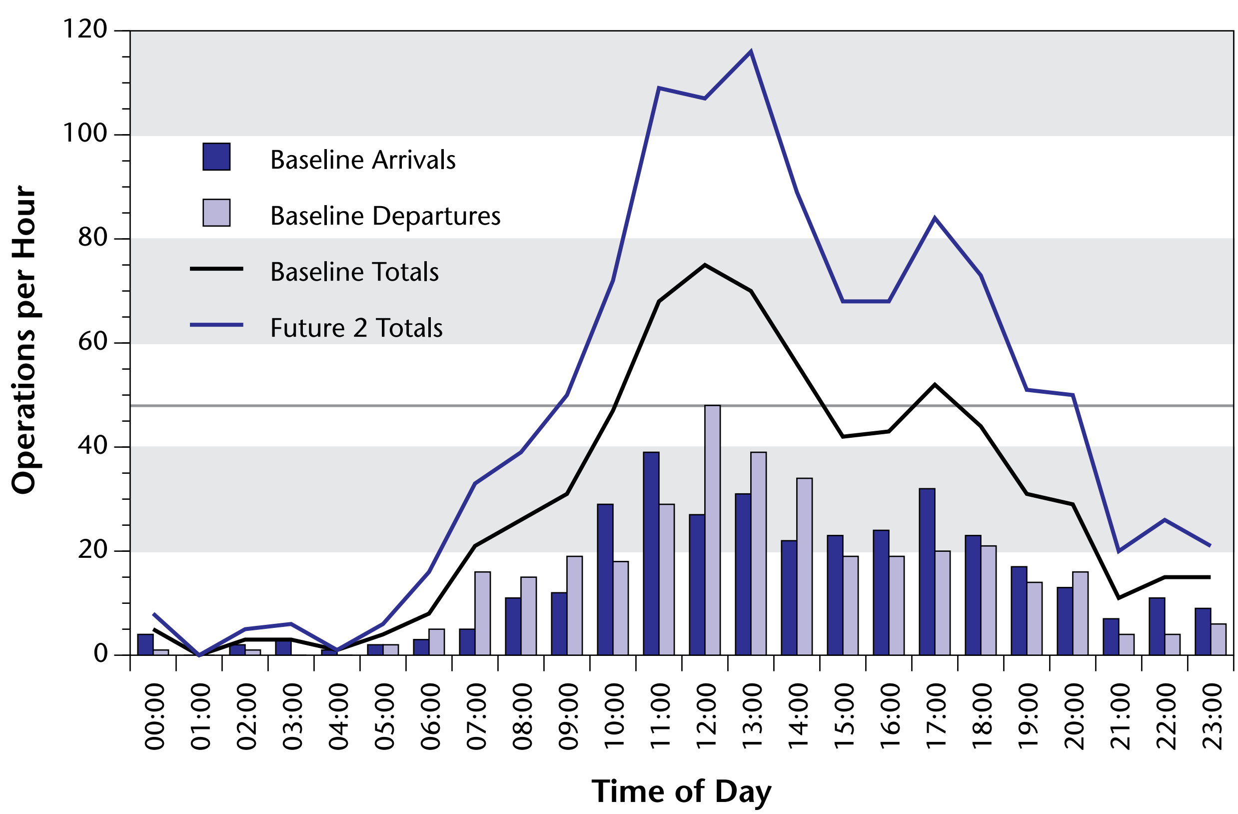


Figure 13. Profile of Daily Demand — Hourly Distribution



Aircraft Delays

Aircraft delay is defined as the time above the unimpeded travel time for an aircraft to move from its origin to its destination. Aircraft delay results from interference from other aircraft competing for the use of the same facilities.

The major factors influencing aircraft delays are:

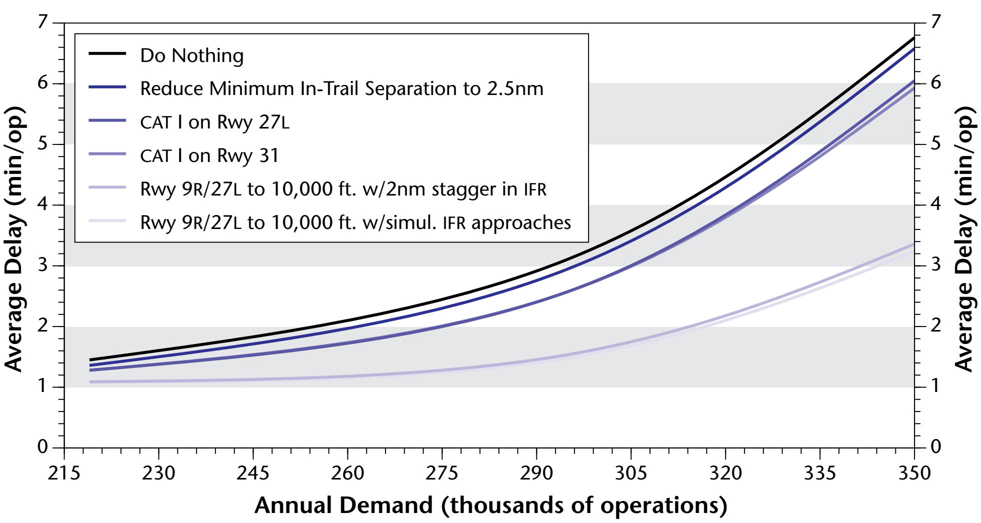
- Weather
- Airfield and ATC system demand
- Airfield physical characteristics
- Air traffic control procedures
- Aircraft operational characteristics

Average delay in minutes per operation was generated by the Runway Delay Simulation Model (RDSIM). A description of this model is included in Appendix B. If no improvements are made in airport capacity, the average delay per operation of 1.4 minutes in Baseline will increase to 6.8 minutes per operation by Future 2, as shown in Figure 14.

Under the Do Nothing situation, if there are no improvements in airfield capacity, the annual delay cost could increase as follows:

	Annual Delay Costs Hours	Millions of 1990 $
Baseline	5,275	$6.29
Future 1	15,054	$21.17
Future 2	39,454	$61.71

Figure 14. Average Delays — Capacity Enhancement Alternatives



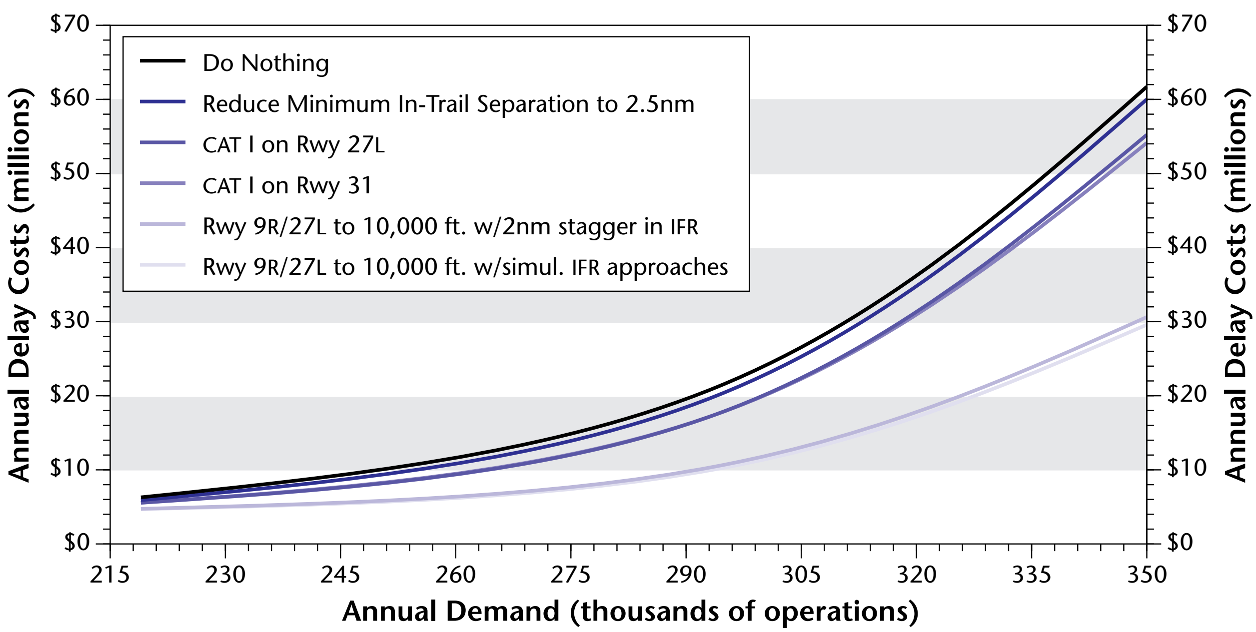
Conclusions

Figure 15 demonstrates the impact of delays at Fort Lauderdale-Hollywood International Airport. The chart shows how delay costs will continue to grow at a substantial rate as demand increases if there are no improvements made in airfield capacity, i.e., the Do Nothing scenario. The graph also shows the savings in delay costs that would be provided by the major recommendations:

- Extending Runway 9R/27L to 10,000 feet
  - with simultaneous IFR approaches (with PRM)
  - with 2 nm stagger in IFR
- CAT I ILS on Runway 31
- CAT I ILS on Runway 27L
- Reducing minimum in-trail separation to 2.5 nm

Note: The delay savings of these alternatives are not necessarily additive.

Figure 15. Annual Delay Costs — Capacity Enhancement Alternatives



Figures 16 and 17 present airport capacity curves for the major improvements and compare them to the capacity curves for the airport if there are no improvements made, i.e., the Do Nothing scenario. Both figures show airfield capacity with a 50/50 split of arrivals and departures and balanced flow rates, Figure 16 under VFR and Figure 17 under IFR.

Figure 16. Airport Capacity Curves — Major Improvements, Under VFR

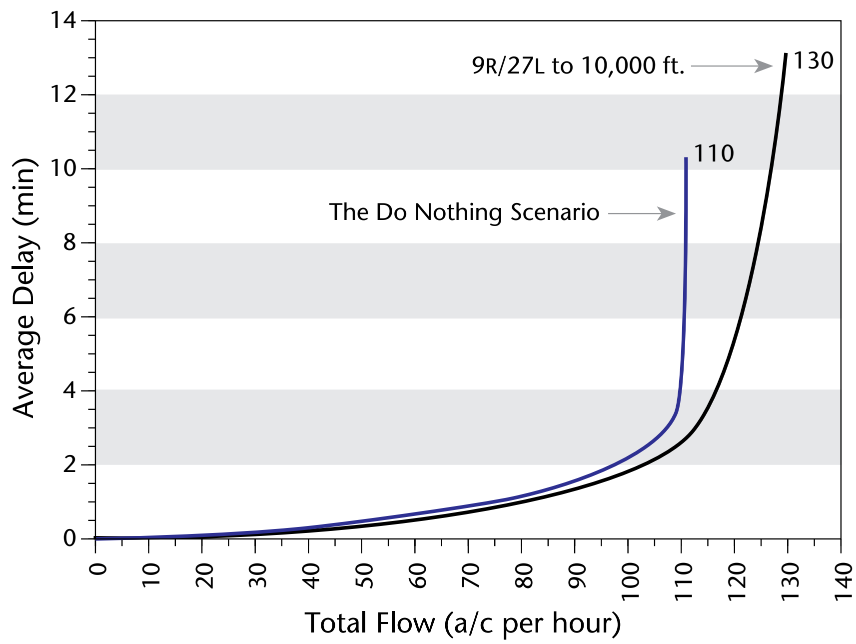
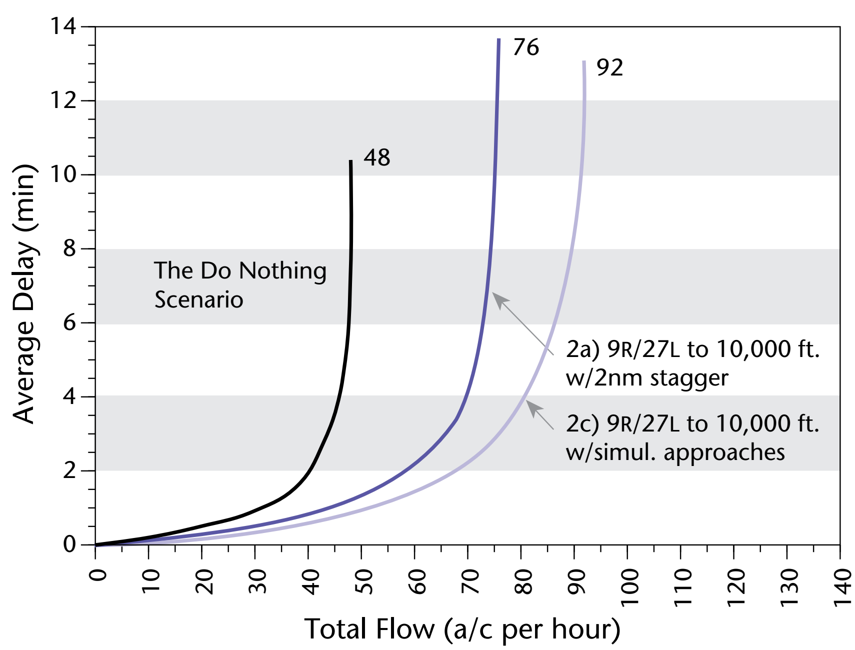


Figure 17. Airport Capacity Curves — Major Improvements, Under IFR 1



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Appendix B Computer Models and Methodology

The FLL Capacity Team studied the effects of various improvements proposed to reduce delay and enhance capacity. The options were evaluated considering the anticipated increase in demand. The analysis was performed using several computer modeling techniques. A brief description of the models and the methodology employed follows.

Computer Models

Airfield Delay Simulation Model (ADSIM)

ADSIM is a fast-time, discrete event model that employs stochastic processes and Monte Carlo sampling techniques. It describes significant movements of aircraft on the airport and the effects of delay in the adjacent airspace. The model was validated in 1978 at Chicago O'Hare International Airport against actual flow rates and delay data.

Inputs for the simulation model were derived from empirical field data. The model repeated each experiment 10 times using Monte Carlo sampling techniques to introduce system variability, which occurs on a daily basis in actual airport operations. The results were averaged to produce output statistics. Total and hourly aircraft delays, travel times, and flow rates for the airport and for the individual runways were calculated.

Runway Delay Simulation Model (RDSIM)

RDSIM is a short version of the ADSIM model that simulates only the runways and runway exits. There are two versions of the model. The first version ignores the taxiway and gate complexes for a user-specified daily traffic demand and is used to calculate daily demand statistics. In this mode, the model replicated each experiment forty times, using Monte Carlo sampling techniques to introduce daily variability of results, which were averaged to produce output statistics. The second version also simulates the runway and runway exits only, but it creates its own demand using randomly assigned arrival and departure times. The demand created is based upon user-specified parameters. This form of the model is suitable for capacity analysis.

RDSIM was calibrated for this study against field data collected at FLL to ensure that the model was site specific.

For a given demand, the model calculated the hourly flow rate and average delay per aircraft during the full period of airport operations. Using the same aircraft mix, computer specialists simulated different demand levels for each run to generate demand versus delay relationships.

Airport and Airspace Simulation Model (SIMMOD)

SIMMOD is a fast-time, event-step model that simulates the real-world process by which aircraft fly through air traffic controlled en route and terminal airspace and arrive and depart at airports. SIMMOD traces the movement of individual aircraft as they travel through the gate, taxiway, runway, and airspace system. It detects potential violations of separations and operation procedures. It simulates the air traffic control actions required to resolve potential conflicts to insure that aircraft operate within procedural rules. Aircraft travel time, delay, and traffic statistics are computed and provided as model outputs. The model was calibrated for this study against field data collected at FLL to ensure it was site specific. Inputs for the simulation model were also derived from empirical field data.

Methodology

Model simulations included present and future air traffic control procedures, various airfield improvements, and traffic demands for different times. To assess the benefits of proposed airfield improvements, the FAA used different airfield configurations derived from present and projected airport layouts. The projected implementation time for air traffic control procedures and system improvements determined the aircraft separations used for IFR and VFR weather simulations.

For the delay analysis, agency specialists developed traffic demands based on the *Official Airline Guide*, historical data, and various forecasts. Aircraft volume, mix and peaking characteristics were developed for three demand periods (Baseline, Future 1, and Future 2). The estimated annual delays for the proposed improvement options were calculated from the experimental results. These estimates took into account the yearly variations in runway configurations, weather, and demand based on historical data.

The potential delay reductions for each improvement were assessed by comparing the annual delay estimates with the Do Nothing case.

RDSIM was used to perform the capacity analysis and study the runway improvements, while SIMMOD was used to study the taxiway and exit improvements.

Appendix C List of Abbreviations

ADSIM	Airfield Delay Simulation Model
ASR	Airport Surveillance Radar
ATC	Air Traffic Control
CRDA	Converging Runway Display Aid
DME	Distance Measuring Equipment
FAA	Federal Aviation Administration
GA	General Aviation
GPS	Global Positioning System
FXE	Fort Lauderdale Executive Airport
FLL	Fort Lauderdale-Hollywood International Airport
FMS	Flight Management System
HWO	North Perry Airport
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
LLWAS	Low Level Wind Shear Alert System
LOC	Localizer
LORAN	Long-Range Navigation System
LVOR	Low Altitude En Route VOR
MI	Miles
MIA	Miami International Airport
NM	Nautical Miles
NOAA	National Oceanic and Atmospheric Administration
OM	Outer Marker
OMEGA	VLF Navigation System
PRM	Precision Runway Monitor
RDSIM	Runway Delay Simulation Model
RVR	Runway Visual Range
SIMMOD	Airport and Airspace Simulation Model
TCA	Terminal Control Area
TERPS	Terminal Instrument Procedures
TVOR	Terminal VOR
VAS	Vortex Advisory System
VFR	Visual Flight Rules
VHF	Very High Frequency
VLF	Very Low Frequency
VMC	Visual Meteorological Conditions
VOR	VHF Omnidirectional Range — course information only

Credits:

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