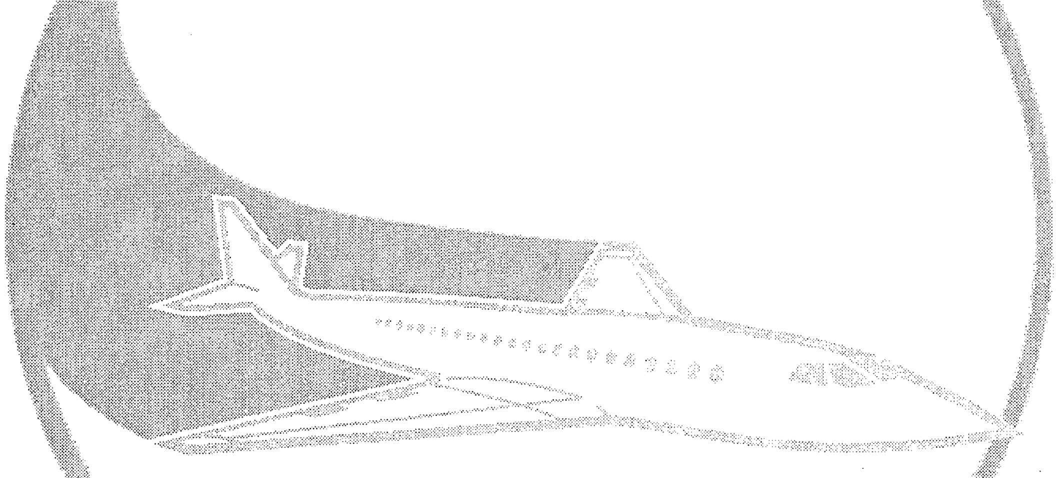
technical note

National Airspace System Performance Assessment for the Year 2010

Douglas Baart and Anny Cheung
ACT-520



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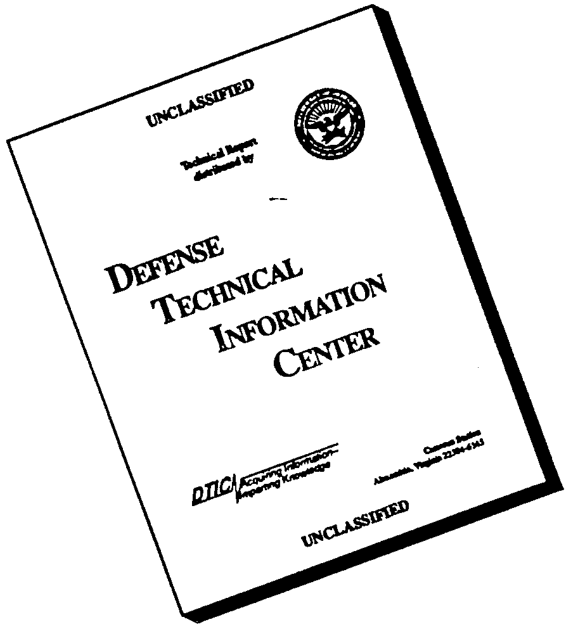

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16. Abstract
This report documents the assessment of the National Airspace System (NAS) for the year 2010. The NAS Performance Analysis Capability (NASPAC) simulation model was used to simulate the future air traffic control (ATC) system. Airport, airfield, and technological improvements expected to be completed by year 2010 were included in the analysis. These improvements are outlined in the 1994 Aviation System Capacity Plan. Future traffic growth for each of the airports modeled by NASPAC were derived from the 1993 Terminal Area Forecasts (TAF).

The study suggests that about 70 percent of the total system delay is attributed to ground operations for the year 2010. Ground delay consists of ground holds, pushback from gates, and taxi procedures from active runways. Airports that are the largest contributors of system delay include John Wayne Airport-Orange County Airport, Miami International Airport, Los Angeles International Airport, and Chicago O'Hare International Airport. Areas of highest airspace activity include parts of southern California, Florida, Salt Lake City, and Denver.

17. Key Words

NASPAC
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EXECUTIVE SUMMARY

This report documents the continuous effort of simulating the capacity-related improvements to the National Airspace System (NAS) for future years. It identifies system impacts of projected traffic growth in the NAS based on technological advances and airfield improvements planned to be completed by the year 2010. Measures of throughput and delay were used to assess the performance of the future air traffic control (ATC) system. The objective of this study is to determine where congestion in the future NAS is likely to be in order to guide future investment strategies. This study is one in a series of studies designed to evaluate future system performance and may be used as a planning tool for the development of future NAS architecture.

Measures of delay by phase of flight indicate that the future NAS architecture should focus on technologies designed to optimize ground operations at key airports in the NAS. In addition, delay attributed to taxi procedures is where most of the ground delay accumulates and should be the area of focus for future system acquisitions.

Results of the simulation project a 22 percent increase in air traffic growth by the year 2010. The study suggests that passenger delay will increase by 136 percent and operational delay by 157 percent over current figures. This translates into total delay cost increases for passenger delay and operational delay of 5.8 billion dollars and 3.3 billion dollars, respectively.

The analysis also indicates that about 70 percent of the total delay for the year 2010 is attributed to ground operations (taxi procedures, pushback, and airborne holdings resulting from occupied runways). Most of the delay occurs at airports that have no planned airfield improvements in future years. On the contrary, those airports that are scheduled to receive airfield improvements show substantial reductions in delay and delay costs. Reductions in operational delay were observed at those airports for the year 2010.

National Airspace System Performance Analysis Capability Simulation Modeling System was used to simulate the NAS for the years 1993 and 2010. Six days from 1990 were simulated and weighted according to yearly weather patterns to produce annual results. Air traffic growth for the year 2010 was generated at each of the 58 modeled airports using the 1993 Terminal Area Forecasts [1].

Airport capacity estimates were derived from the 1994 Aviation System Capacity Plan Report [2]. The plan outlined all proposed airport improvements expected to be completed by the year 2010. New technologies designed to increase system capacity by the year 2010 were also included in the analysis. These include Center-Terminal Radar Approach Control (TRACON) Automation System, Dependent Converging Instrument Approaches, Precision Runway Monitor, and Airport Surface Traffic Automation.

1. INTRODUCTION

The Federal Aviation Administration (FAA) Office of System Architecture and Program Evaluation (ASD) has identified a need to study the impact that advanced technologies and improvements to the National Airspace System (NAS) will have on system performance. The National Airspace System Performance Analysis Capability (NASPAC) Simulation Modeling System (SMS) was used as an analytical tool to evaluate the current and future NAS performance.

NASPAC SMS was designed to provide a system-wide assessment of any air traffic control (ATC) change to the NAS. Key metrics used in this assessment include measures of throughput and delay. Evaluations of the NAS are based on future traffic growth provided by the Terminal Area Forecasts (TAF) [1] and projected airport and airspace capacity parameters derived from future acquisition plans. The simulation is a macro model that traces individual aircraft through the NAS and records the ripple effect of delay as it propagates throughout the system.

The model may be used as a strategic system planning tool by providing a quantitative assessment of the future ATC system, which includes improvements to airports and airspace or advances in technology that influence NAS operations. This report presents the results of one in a series of analyses designed to evaluate the performance of the NAS based on improvements that are expected to be in place by the year 2010.

2. METHODOLOGY

A scenario was generated to simulate traffic flows as they are expected to exist in the year 2010 with airport and airspace improvements likely to be in place. A 1993 baseline scenario was also developed so that validation with actual data could be performed. Airport capacity estimates used in the 2010 scenario were based on airfield improvements that were outlined in the Aviation System Capacity Plan [2] and advances in technology expected to be completed by the year 2010. These technological improvements, designed to improve airport operations, are summarized in Section 4 of this report.

In reviewing the proposed expenditures contained in the Aviation System Capacity Plan [2], 24 airports modeled by NASPAC were identified to receive funding for either new runways or runway extensions. Funding for these airport enhancements is derived from local, state, and federal agencies. Table 1 lists all of the airport improvements that were modeled for the year 2010 scenario. See appendix A for location identifier expansions.

TABLE 1. AIRPORT IMPROVEMENTS MODELED

ID	Type of Improvement	Specifics
ATL	New commuter runway	3,000ft south (5th parallel).
BWI	New parallel runway	10R/28L.
CLT	New parallel runway	18W/36W, assume independent IFR.
DEN	New Denver Airport	(DIA)
DFW	Two new runways	GA rwy 16/34, rwy 18/36.
DTW	Two new runways	9R/27L and 4/22.
FLL	Runway extension	9R/27L.
IAD	New runway	1W/19W.
IAH	Two new runways	8L/26R and 9L/27R.
IND	New runway	5R/23L.
MCO	New runway	17L/35R.
MEM	New runway	18L/36R.
MKE	New runway and extension	7L/25R and 1L/19R.
MSP	New runway	11/29W.
MSY	New runway	1L/19R.
PHL	New runway	8/26.
PHX	New runway	8S/26S (3rd parallel).
PIT	New runway	10S/28S.
SDF	Two new runways	17L/35R and 17R/35L (parallels).
SEA	New runway	16W/34W.
SLC	New runway	16W/34W.
STL	New runway	12L/30R, 4,300ft from parallel.
SYR	New parallel runway	10L/28R.
TPA	New parallel runway	18/36.

The 1993 and 2010 scenarios were simulated with 6 days that reflect different weather conditions in the NAS, allowing annualization of findings. This analysis was based on averaging three stochastic runs for each weather day for the two scenarios.

The MITRE Corporation developed a method for computing annual results from days recorded from the year 1990 [3]. Six scenario days were selected as representative of varying levels of instrument meteorological conditions (IMC) and visual meteorological conditions (VMC) across the 58 NASPAC airports. To compute the annual results, weighting factors for each scenario day were applied according to the frequency of occurrence of similar days that were observed in the year 1990. Table 2 shows the weights applied to the six scenario days.

TABLE 2. WEIGHTING FACTORS FOR THE SIX WEATHER SCENARIOS

Percent (%) VMC	Scenario Day Chosen	Weighting Factor
95% - 100%	January 13, 1990	80.00
90% - 95%	September 27, 1990	127.50
85% - 90%	May 16, 1990	86.25
80% - 85%	March 10, 1990	23.75
70% - 80%	March 31, 1990	17.50
< 70%	December 22, 1990	30.00

As a means of identifying delay causes, ground and airborne delays were summarized and presented on a system level and for individual airports. Ground delay consists of pushback delay at a gate, taxi delay to and from active runways, and arrival delay caused by occupied runways. Airborne delay accumulates when flights compete for arrivals and departures at ATC resources such as flow control restrictions, arrival and departure fixes, and sectors.

3. OVERVIEW

The NASPAC SMS is a discrete-event simulation model that tracks aircraft as they progress through the NAS and compete for ATC resources. NASPAC evaluates system performance based on the demand placed on resources modeled in the NAS and records statistics at 50 of the busiest national airports plus 8 associated airports. NASPAC simulates system-wide performance and provides a quantitative basis for decision making related to system improvements and management. The model supports strategic planning by identifying air traffic flow congestion problems and examining solutions.

NASPAC analyzes the interactions between many components of the ATC system and the system reaction to projected demand and operational changes. The model was designed to study nation-wide system performance rather than localized airport changes in detail, therefore, airports are modeled at an aggregate level. The model shows how improvements to a single airport can impact other airports in the NAS by altering the arrival times. An aircraft itinerary may consist of many flight legs that an aircraft will traverse during the course of a day. If an aircraft is late on any of its flight legs, successive flight legs may be affected. This is the way the model captures the rippling effect of passenger delay.

NASPAC records two different types of delay, passenger and operational. Passenger delay is the difference between the scheduled arrival time contained in the Official Airline Guide (OAG) and the actual arrival time as simulated by NASPAC. Operational delay is the amount of time that an aircraft spends waiting to use an ATC system resource.

Traffic profiles consist of scheduled and unscheduled demand for each modeled airport. Scheduled demand is derived from the OAG and is used as the baseline from which future growth is projected. Unscheduled demand is calculated from daily and hourly demand distributions taken from real world data (Host-Z data and tower counts). Projected traffic growth for future years is provided by the TAF.

Key output metrics recorded in the model include delay and throughput at airports, departure fixes, arrival fixes, restrictions, and sectors. This reporting is done system-wide and at all modeled airports. Operational delay consists of airborne and ground delay. Airborne operational delay is the delay that a flight experiences from competing for airborne ATC resources. Ground operational delay accumulates when an aircraft is ready to depart but has to wait for a runway to taxi on or take off from or when airfield capacity limitations prohibit the aircraft from landing. Operational delay contributes to passenger delay and is assigned to the airport to which the flight is destined. Sector entry delay occurs when the instantaneous or hourly aircraft count parameters for that sector are exceeded. Monetary assessments are derived by translating delay into measures of cost to the user by using the Cost of Delay Module. The Cost of Delay Module was incorporated into the NASPAC SMS user interface in 1992.

The Cost of Delay Module was used to translate delay into measures of cost to the airlines and user community. The Origin and Destination Survey, Form 41, for the last quarter of 1993, acquired from the Office of Airline Statistics (K-25), was used to calculate operational and passenger delay cost estimates. Operational costs include crew salaries, maintenance, fuel, equipment, depreciation, and amortization and are reported by the airlines on a quarterly basis. The data are disseminated into airborne and ground delay costs by carrier and aircraft type. Passenger costs are derived from the expected number of passengers on a flight multiplied by the FAA-endorsed value of $40.50 per hour of delay, multiplied by delay hours. Form 41 was used to estimate aircraft occupancy values.

4. ASSUMPTIONS AND CAVEATS

All of the airport capacity estimates used in the analysis for the year 2010 were based on airport airfield improvements. These were projected in the Aviation System Capacity Plan and new technologies expected to be implemented by the year 2010. The 1994 TAF were used to project traffic growth for the year 2010. These forecasts depend on many factors that are subject to change, such as economic factors, airport improvements, and new technologies designed to increase airport capacity.

The annualization method used in the 2010 scenario is an approximation and is based on weather observations taken from the year 1990. The model does not include re-routing or other methods used to minimize the impacts of adverse weather. New technologies designed to increase airport capacity without adding or extending new runways include the following.

a. Precision Runway Monitor (PRM)

   This would allow simultaneous parallel Instrument Flight Rule (IFR) arrivals on runways spaced between 3,000 and 4,300 ft. Atlanta International Airport (ATL), Charlotte/Douglas International Airport (CLT), Minneapolis St. Paul International Airport (MSP), Raleigh Durham International Airport (RDU), Clevland-Hopkins International Airport (CLE), John F. Kennedy International Airport (JFK), and Philadelphia International Airport (PHL) are likely to be equipped with PRMs by the year 2010.

b. Final Monitor Aid

   Improved resolution would allow simultaneous parallel IFR approaches on dual runways spaced between 4,000 and 4,300 ft without full PRMs. Those airports that would take advantage of this technology are Fort Lauderdale/Hollywood International Airport (FLL) and Stapleton International Airport (DEN).

c. Airport Surface Traffic Automation

   This technology is designed to optimize surface operations through improved sequencing of departures and more tactical management of aircraft movement. All NASPAC-modeled airports will be affected by this improvement.

In addition to improvements in technology, procedural changes for the future system have been considered for this study. The following are procedural changes designed to increase airport capacity.

a. Center-Terminal Radar Approach Control (TRACON) Automation System (CTAS)

   NAS-wide implementation of this system would optimize final approach separations by more efficiently distributing en route delay.

b. Dependent Converging Instrument Approaches (DCIA)

   The reduction of terminal separation minima may be realized by monitoring aircraft approaching converging runways more accurately. Those airports affected include Logan International Airport (BOS), CLE, CLT, Cincinnati/Northern Kentucky International Airport (CVG), Memphis International Airport (MEM), General Mitchell International

Airport (MKE), PHL, San Francisco International Airport (SFO), and Lambert-St. Louis International Airport (STL).

c. Reduced Diagonal Separation for Parallel Approaches

The reduction of diagonal separation from 2 nmi to 1.5 nmi may be realized for parallel runways not eligible for independent parallel approaches and that are at least 2,500 ft apart. Affected airports include Dallas Love Field Airport (DAL), Phoenix Sky Harbor International Airport (PHX), PHL, Salt Lake City International Airport (SLC), San Jose International Airport (SJC), Seattle-Tacoma International Airport (SEA), MSP, STL, and DEN.

5. RESULTS

5.1 SYSTEM-WIDE

Model parameters project an increase of 5 millions flights (22 percent) by the year 2010 over 1993 levels. Simulations of the NAS indicate significant increases in operational and passenger delay. Passenger delay and operational delay are projected to increase by 3.4 million hours (136 percent) and 2.2 million hours (157 percent), respectively. Most of this delay is attributed to airports that show significant increases in demand with little or no added capacity to accommodate that demand for the year 2010. This delay translates into cost increases of 5.8 billion (1993 dollars) for passenger delay and 3.3 billion (1993 dollars) for operational delay, for a total of 9.1 billion (1993 dollars). Table 3 presents the system delay and cost of delay for years 1993 and 2010.[1]

5.2 AIRPORT LEVEL

Analyses were conducted on 10 specific airports because of their influence on the system as a whole. These airports were also chosen due to their strategic location in the NAS where airlines may increase hubbing operations. These airports include: ATL, DEN, Dallas/Fort Worth International Airport (DFW), McCarren International Airport (LAS), Los Angeles International Airport (LAX), Dougherty Field Airport (LGB), Miami International Airport (MIA), Chicago O'Hare International Airport (ORD), PHX, and John Wayne Airport-Orange County Airport (SNA). These airports are projected to see the greatest amount of air traffic for the year 2010. The results of the analyses are presented in the following sections.

[1]Readers should not compare the 1993 baseline scenario with the one used in the 1994 Updated National Airspace System Performance Assessment for Year 2005 report. [4] New input files and model improvements used in this study caused differences between the two baselines.

TABLE 3. ANNUAL DELAY AND COST OF DELAY FOR 1993 AND 2010

	Year 1993	Year 2010
Number of Flights	22.2 million	27.3 million
Average Delay/Aircraft	6.9 minutes	13.1 minutes
Passenger Delay	2.5 million hours	5.9 million hours
Operational Delay	1.4 million hours	3.6 million hours
Passenger Delay Cost	2.7 billion dollars	8.5 billion dollars
Operational Delay Cost	2 billion dollars	5.3 billion dollars

5.2.1 Annual Operations

The 10 airports, with the exception of LGB, show increases in operations for the year 2010 over current operations. LGB has a large number of general aviation operations. Model parameters project that this airport will experience a 5 percent decrease in the total number of operations, with general aviation operations experiencing the largest decline. DFW shows a 51 percent increase in operations, to about 1,300,000 for the year 2010. The projections are based on the assumption that DFW will have completed the addition of two new runways by 2010. ATL and DEN also show considerable growth, with about 30 percent increase in operations for both airports. Again, this growth can be explained by the addition of a commuter runway at ATL and the new Denver airport (DIA) that will be completed in 1995. LAX and SNA show considerable growth with no airfield improvements planned. Annual operations of the 10 airports are shown in Figure 1.

5.2.2 Increase or Decrease on Delay and Cost of Delay

Figures 2 and 3 show the percentage of delay increase or decrease and the cost of delay increase or decrease between the two scenarios for passenger and operational delay. Six of the 10 airports show substantial increases in delay and delay costs. As shown in the figures, SNA and MIA are projected to have the highest delay and cost of delay increase between the two years. The results also show that ATL, DFW, PHX, and DEN are much better in terms of delay. This is due to the added capacity of these airports from the new runways expected to be completed by the year 2010 for ATL, DFW, and PHX and the construction of DIA. LGB shows a small reduction in operational delay but a slight increase in operational cost. This is due to the slight change in fleet

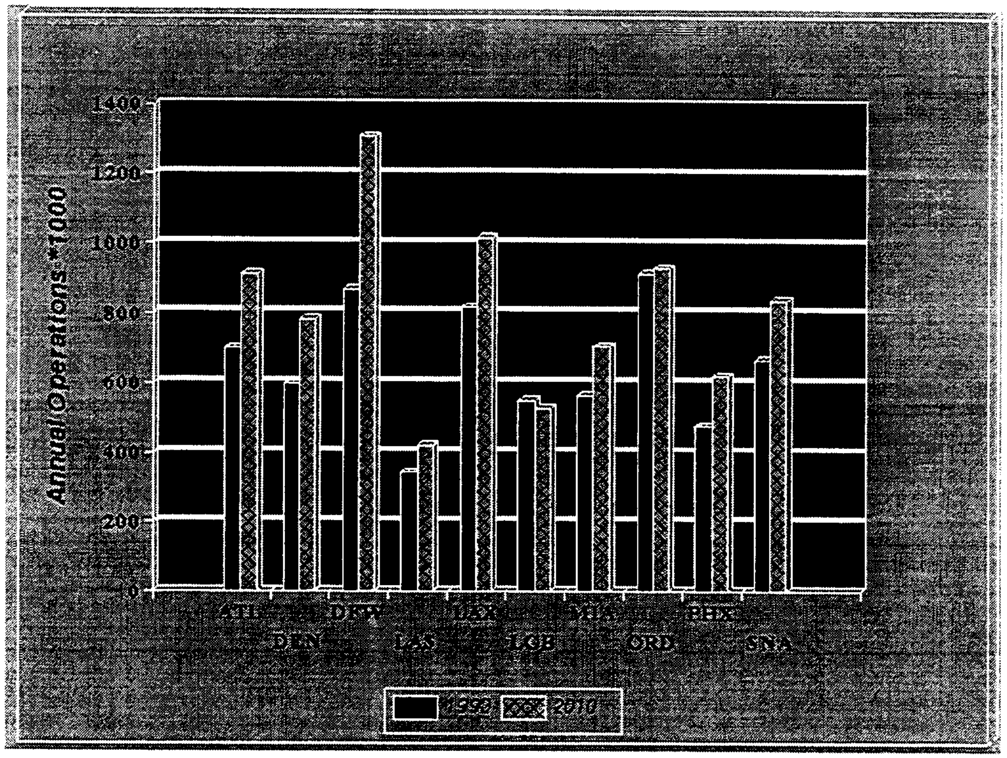

FIGURE 1. ANNUAL OPERATIONS

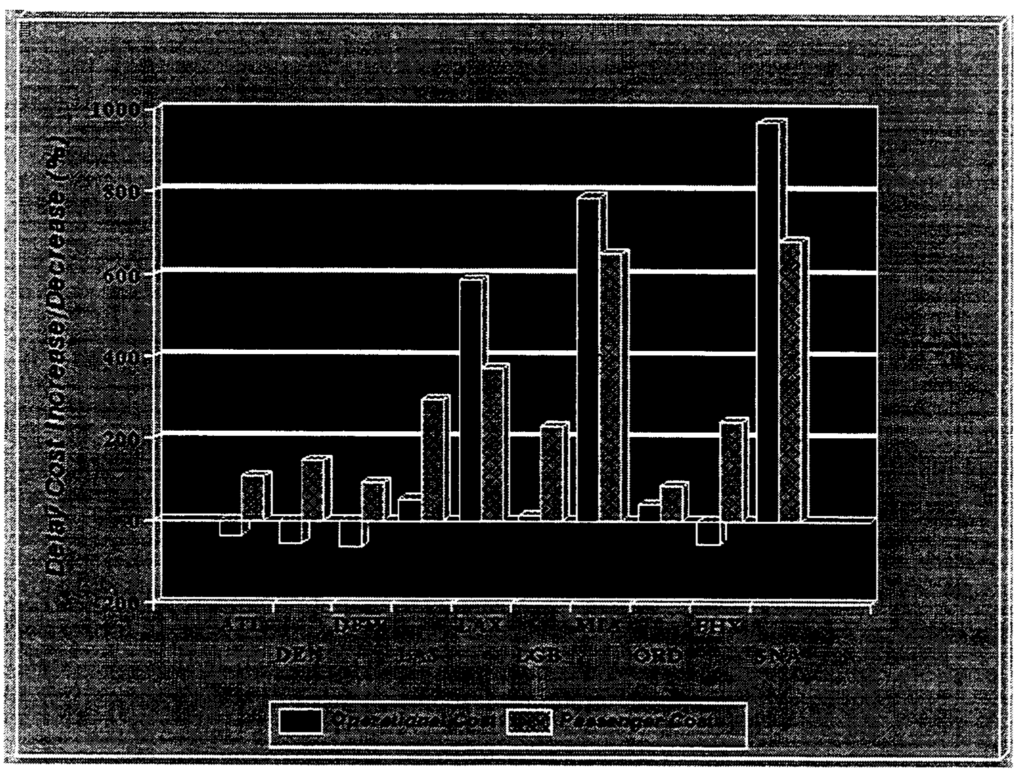

FIGURE 2. PERCENT OF DELAY INCREASE OR DECREASE

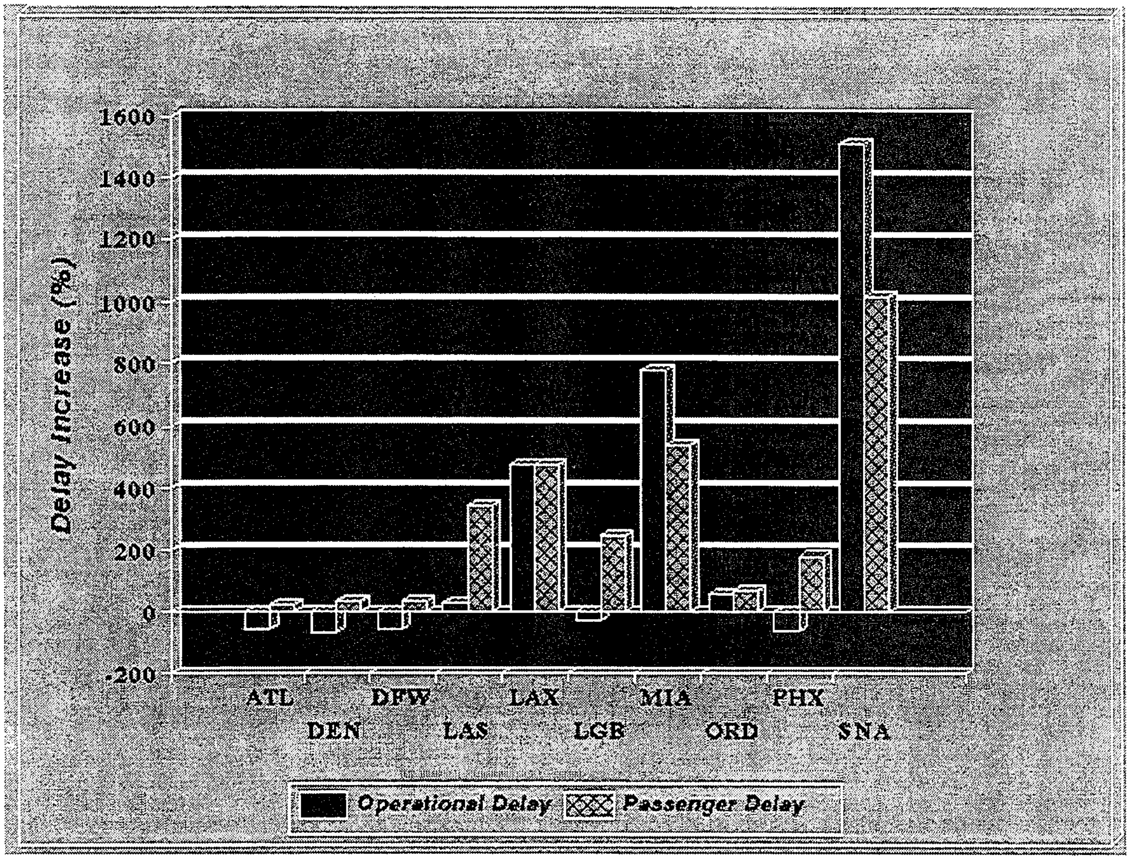

FIGURE 3. PERCENT OF DELAY COST INCREASE OR DECREASE

mix that is projected to arrive in the year 2010. The number of air carriers at LGB is expected to slightly increase, while general aviation operations are expected to decrease. Air carriers are considerably more expensive to operate than general aviation flights. Operational delay costs are a function of air carrier, aircraft type, type of delay (ground or airborne), and the magnitude of the delay.

5.2.3 Throughtput and Capacity

Metrics defining the ratio of throughput over capacity indicate that MIA, LAX, ORD, and SNA will lack the capacity needed to meet demand by the year 2010. This is evidenced by the ratio exceeding the value of one in Figure 4. None of these airports were scheduled to receive improvements that would increase capacity. All of the airports listed in Figure 4 show increases for this metric over current operations with the exception of LGB and ORD. The slight reduction in traffic growth at LGB accounts for the reduction in this ratio, while ORD is expected to experience very little traffic growth. Although ORD shows a reduction in the throughput/capacity ratio from current levels, the ratio still exceeds one for the year 2010.

5.2.4 En Route Times Between City Pairs

Figure 5 describes the differences in en route time between key city pairs for the two time frames. The comparisons indicate that although there are differences in transit times between 1993 and

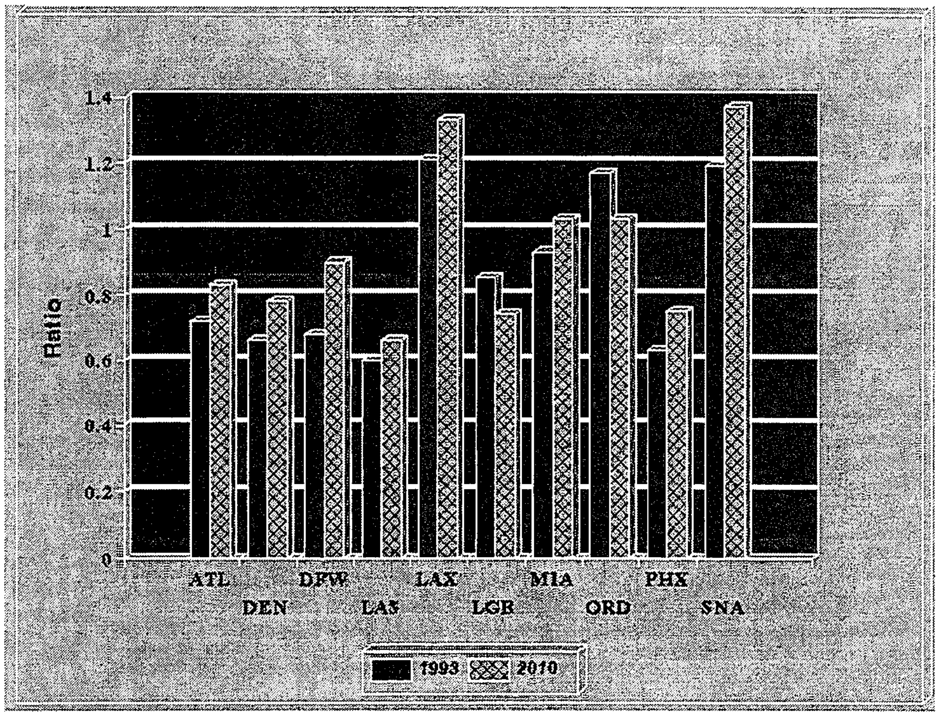

FIGURE 4. THROUGHPUT/CAPACITY

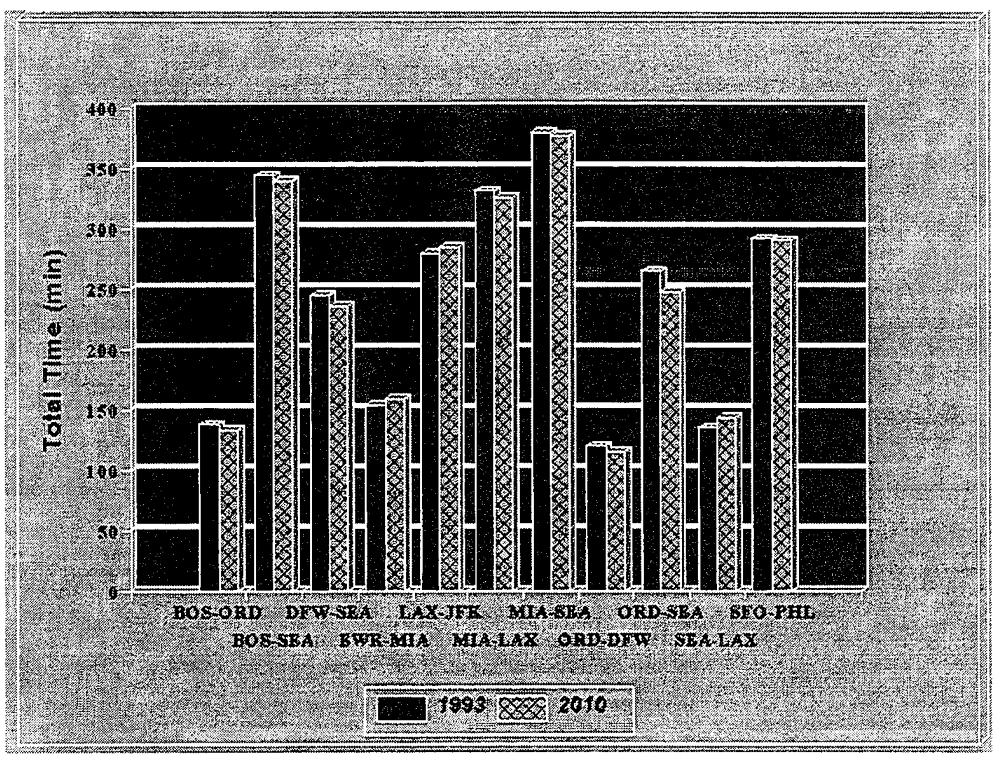

FIGURE 5. EN ROUTE TIMES BETWEEN CITY PAIRS

2010, these differences are not significant. However, north-south flights (Newark-Miami, Seattle-Los Angeles) show the largest amount of change in transit time (about 10 minutes). This is probably a result of airspace congestion that was observed in the MIA and SNA areas for the year 2010.

5.2.5 On-Time Performance

On-time performance measures the percent of undelayed operations at an airport. Undelayed operations refer to passenger delays reported that are not in excess of 15 minutes. Figures 6 and 7 describe on-time performance for those key airports. Drastic reductions of this metric were recorded at LAX, MIA and SNA. Again, future growth at these airports is expected with little or no increase in airport capacity. The on-time departure percentages show the same pattern of lateness, except for LAX where the on-time departures are expected to improve in the year 2010.

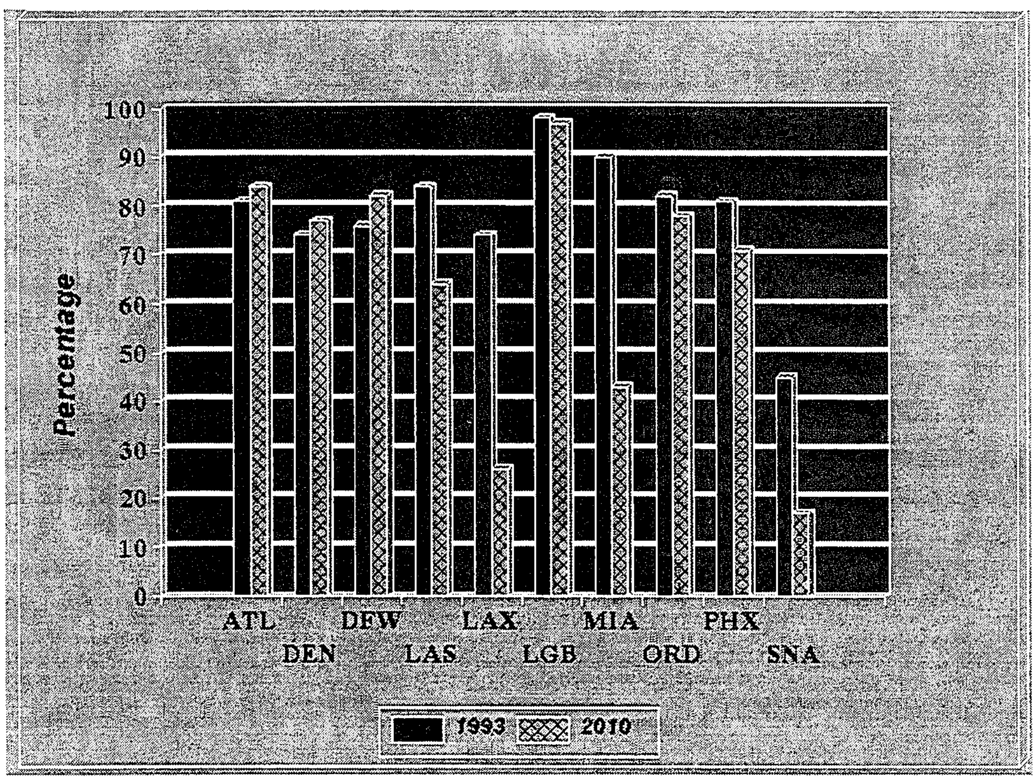

FIGURE 6. ARRIVAL ON-TIME PERFORMANCE

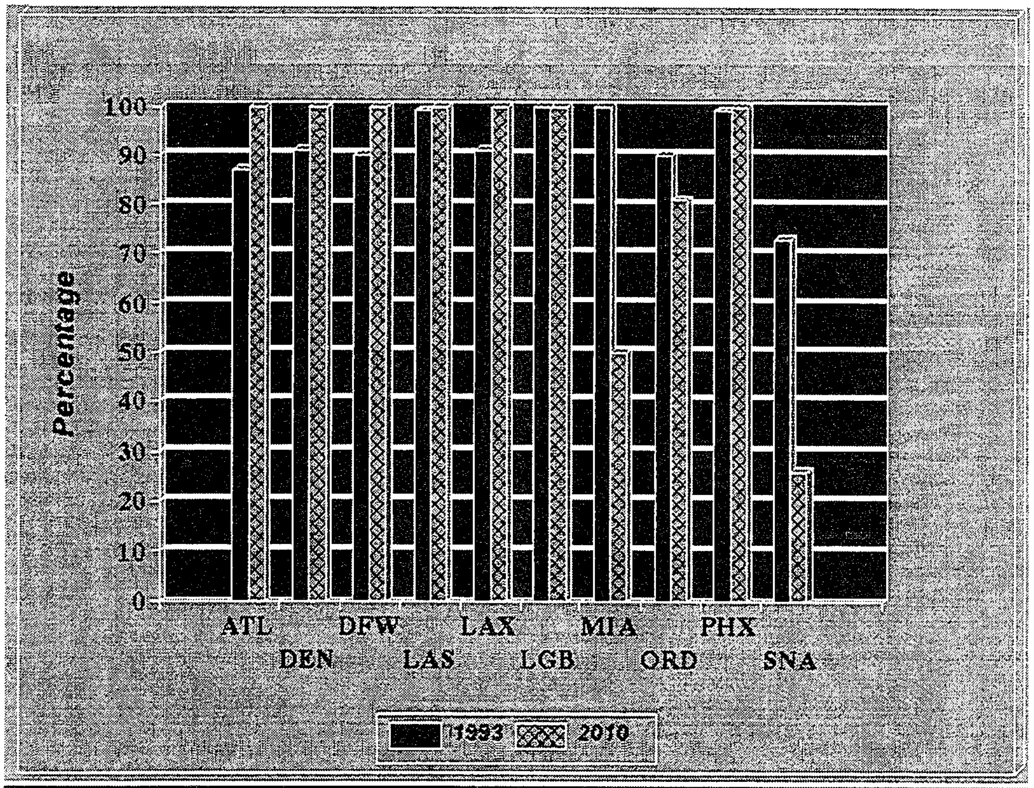

FIGURE 7. DEPARTURE ON-TIME PERFORMANCE

5.2.6 Propagation of Passenger Delay

Figure 8 plots the propagation of passenger delay recorded at the key airports for the years 1993 and 2010. Those airports slated for new runways (ATL, DEN, DFW, PHX) show a decrease in the total passenger delay attributed to that airport. This indicates that more delay is passed to those airports from in-bound flights originating from other airports. On the contrary, airports such as MIA, SNA, LGB, and ORD show that most of the passenger delay culminates from the airport itself, which would indicate that these airports lack the capacity to accommodate the projected demand.

5.2.7 Total Delay - Ground and Airborne Operations

Figures 9 and 10 show delay attributed to ground and airborne operations for the years 1993 and 2010. Ground delay, which is made up of pushback delay and delay attributed to taxi procedures, contributes about 70 percent of the total delay for both time frames. LAX, MIA, and SNA ground delays are expected to increase more than 500 percent over current levels. Figure 9 illustrates total ground delay accumulated for the 2 years. As illustrated in Figure 10, delay related to airborne operations have less impact on total system delay. PHX and SNA show the largest airborne delay increases (about 800 percent).

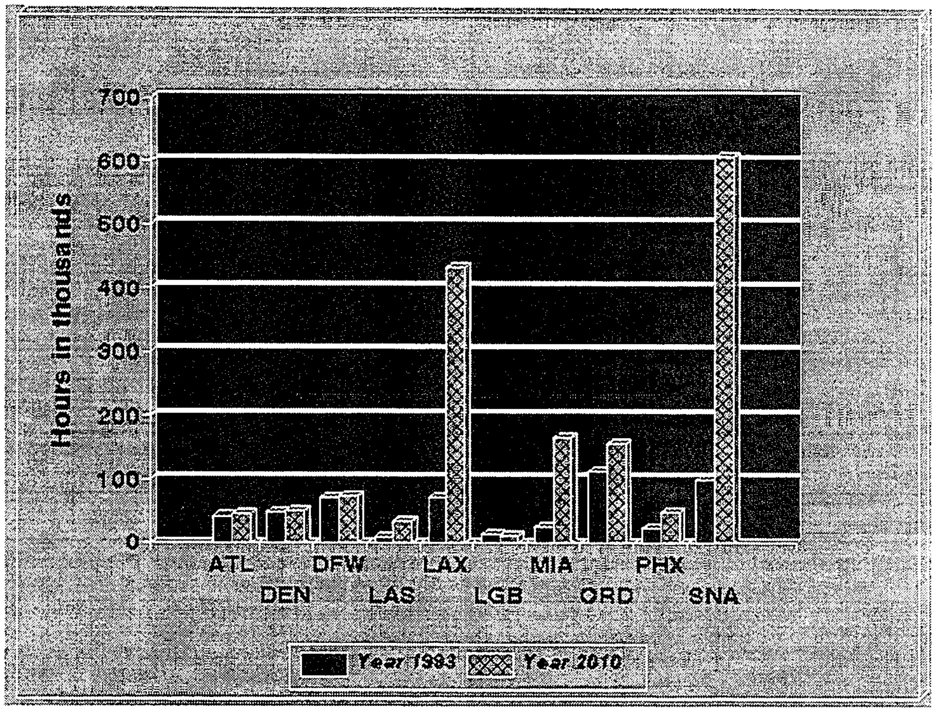

FIGURE 8. PROPAGATION OF PASSENGER DELAY

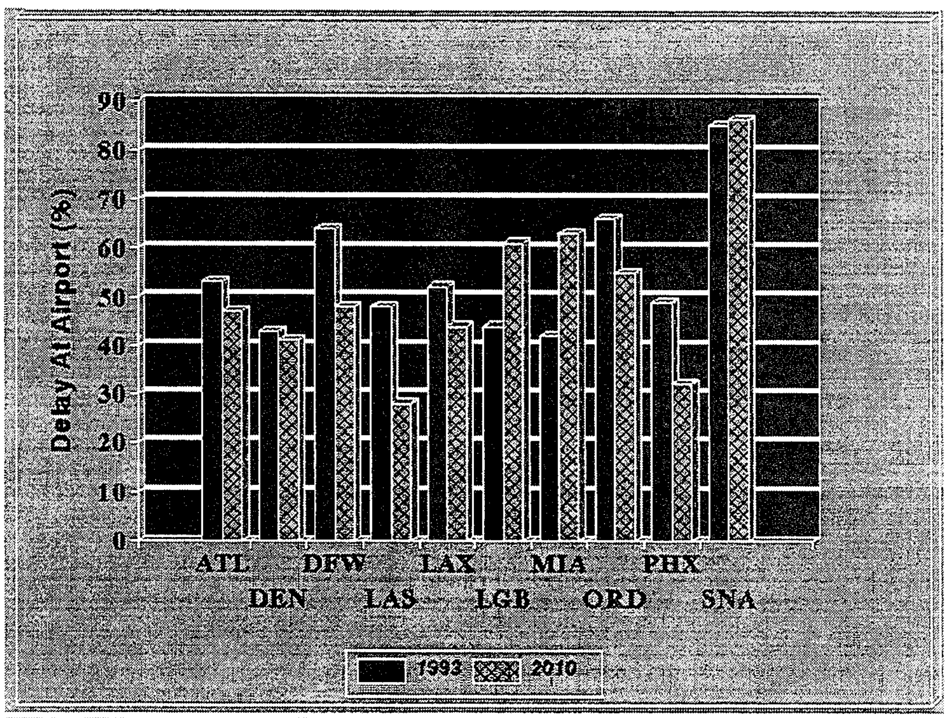

FIGURE 9. TOTAL DELAY- GROUND OPERATIONS

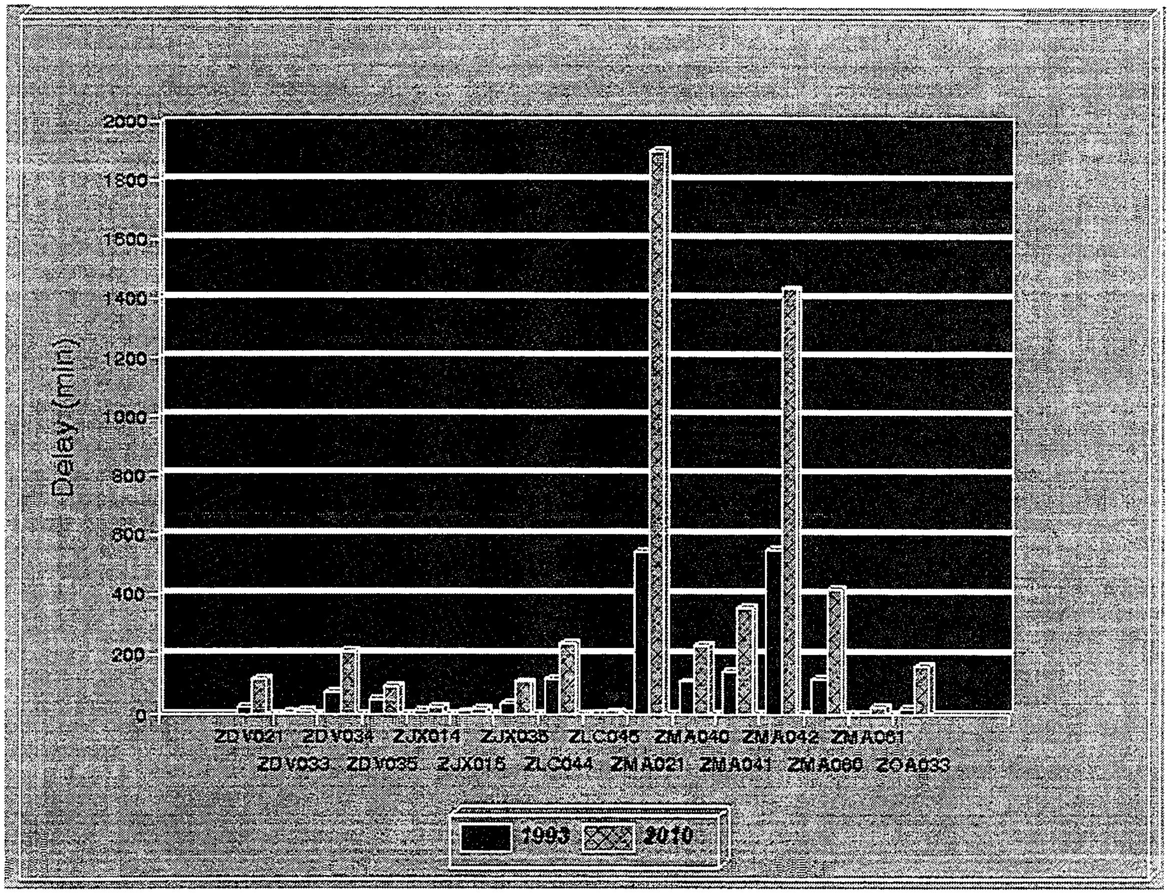

FIGURE 10. TOTAL DELAY - AIRBORNE OPERATIONS

5.2.8 Airspace Congestion

Future airspace congestion in the NAS is described in Figure 11. Sectors found under the control of Miami center account for the highest percent of congestion. This airspace delay contributes to the total passenger and airborne delay observed at MIA airport. Sectors located in DEN, SLC, Jacksonville International Airport (JAX), and Metropolitan Oakland International Airport (OAK) also were observed to have increases in delay over current operations.

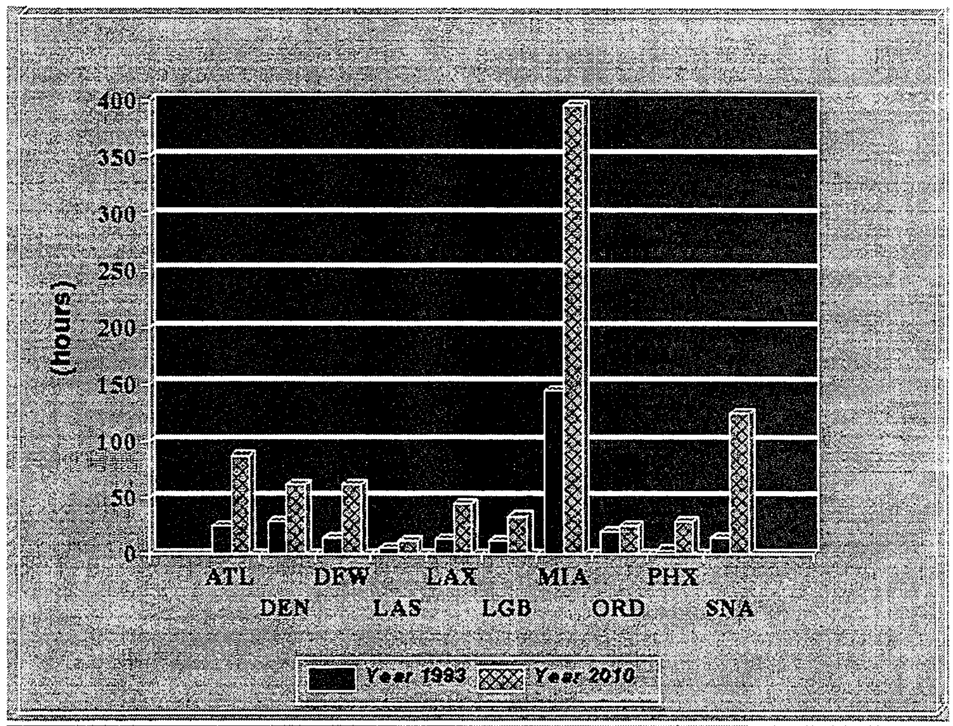

FIGURE 11. SECTOR DELAY

5.3 VALIDITY ISSUES

Airline Service Quality Performance (ASQP), Host-Z data, and information obtained from the Administrators Fact Book of 1993 were used to validate the 1993 baseline scenario. ASQP delay values reported by several major carriers, and throughput from 1993 Host-Z data were compared to simulation results for March 10, 1993. Center throughput recorded in the Administrators fact book was compared to the annualized NASPAC results of 1993. March 10, 1993 was chosen because most of the largest national airports were under IMC during some part of the day, and this day was one of the days used to predict annual results. Figure 12 compares the mean delay for the 1993 baseline with ASQP data for March 10, 1993. Most of the recorded delay from the ASQP compare favorably with model results for those airports that are listed. There were some variations between the two data sets, however, for most of the airports, and on a system level, this variation was slight.

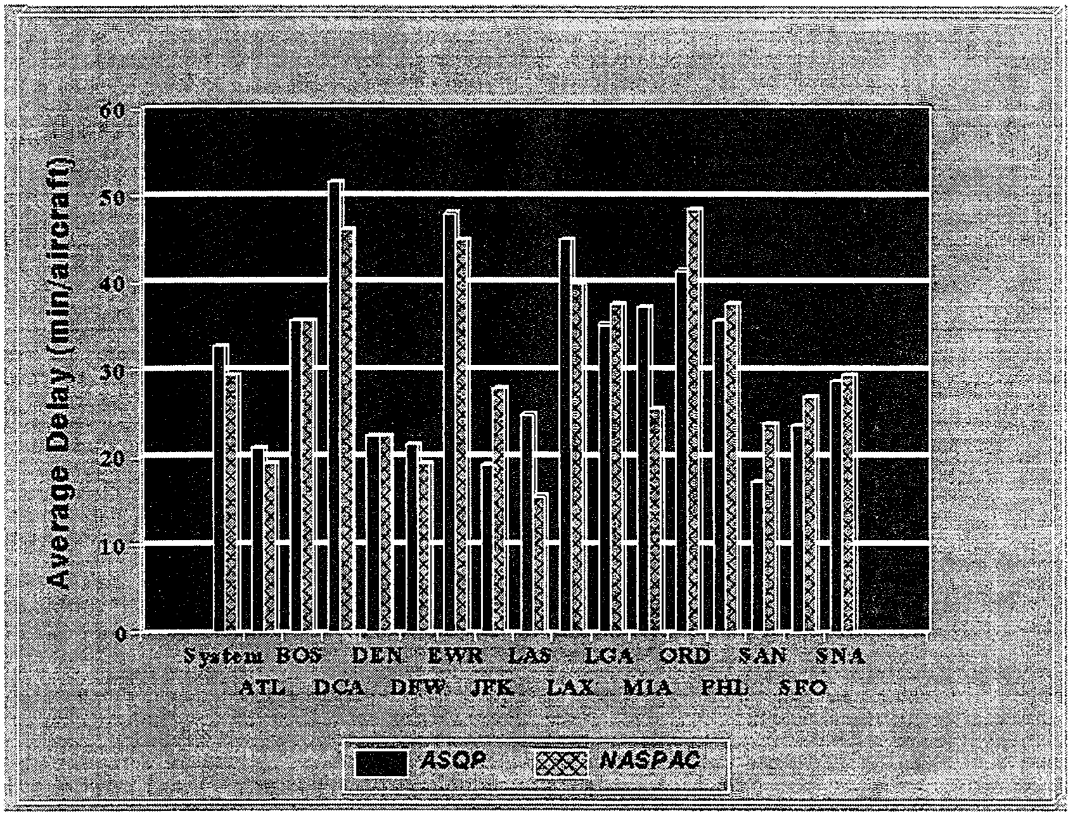

FIGURE 12. AIRLINE SERVICE QUALITY PERFORMANCE (ASQP) VERSUS NATIONAL AIRSPACE SYSTEM PERFORMANCE ANALYSIS CAPABILITY (NASPAC) FOR MARCH 10, 1993

Statistical tests were performed on the distribution of delay at several airports for March 10, 1993. A nonparametric procedure (Kolmogorov-Smirnov two-sample test) was conducted to determine whether the two distributions (ASQP vs. NASPAC) of delay have similar properties. Six major carriers that recorded delay in the ASQP file and NASPAC results were compared for several key airports. A two-tailed probability value was used to determine whether the two distributions had significant differences.

The carriers are listed as numbers in order to preserve their identity. Two-tail probability estimates are recorded in Table 4. Since small probability values result in significant differences in distributional properties, the test indicates that the distributional properties between the two data sets compare favorably for the airports and air carriers listed. The results of the test suggest that the distributional properties of actual delay obtained from ASQP and NASPAC results are not significantly different.

TABLE 4. TWO-TAIL PROBABILITY VALUE FOR KOLMOGOROV-SMIRNOV TWO SAMPLE TEST

Airport	Carrier 1	Carrier 2	Carrier 3	Carrier 4	Carrier 5	Carrier 6
BOS	0.776	0.783	0.761	0.637	0.609	0.568
LAX	0.563	0.524	0.612	0.561	0.671	0.523
SFO	0.673	0.682	0.712	0.715	0.691	0.531
SNA	0.769	0.714	0.813	0.831	0.792	0.629

Host-Z data from March 10, 1993 was used to compare throughput with simulation results. Scheduled and unscheduled IFR flights were summarized for each of the 58 airports on which the model records statistics and compared to the Host-Z data. Since most of the demand placed at the modeled airports are derived from Host-Z data, it is not surprising that these figures are quite similar. Figures 13 and 14 depict the comparisons. In addition, center throughput was tabulated from the annual results of the model and compared to the Administrators Fact Book (December 1993). As shown in Figure 15, the bar graph of simulated versus actual counts for 20 Air Route Traffic Control Centers (ARTCCs) also compare favorably.

6. CONCLUSIONS

The study suggests that investment strategies for the future NAS should focus on technologies designed to alleviate ground congestion. Ground delay consist of aircraft pushbacks, ground holds, and taxi procedures to and from active runways. These delay estimates are expected to increase by about 200 percent system-wide over current levels and account for about 70 percent of the total delay for the year 2010. The largest contributors to this delay are those delays that culminate from taxi-out procedures.

Airports that are major contributors of system-wide delay include SNA, MIA, LAX, and ORD. With the exception of ORD, these airports project significant traffic growth from current levels with no additional capacity to accommodate that growth. ORD will experience a slight growth rate over current levels and sustain considerable delay. Although delay attributable to airspace congestion played less of a role than ground delay, there were areas that showed high congestion. These areas include parts of Southern California, Florida, Salt Lake City, and Denver.

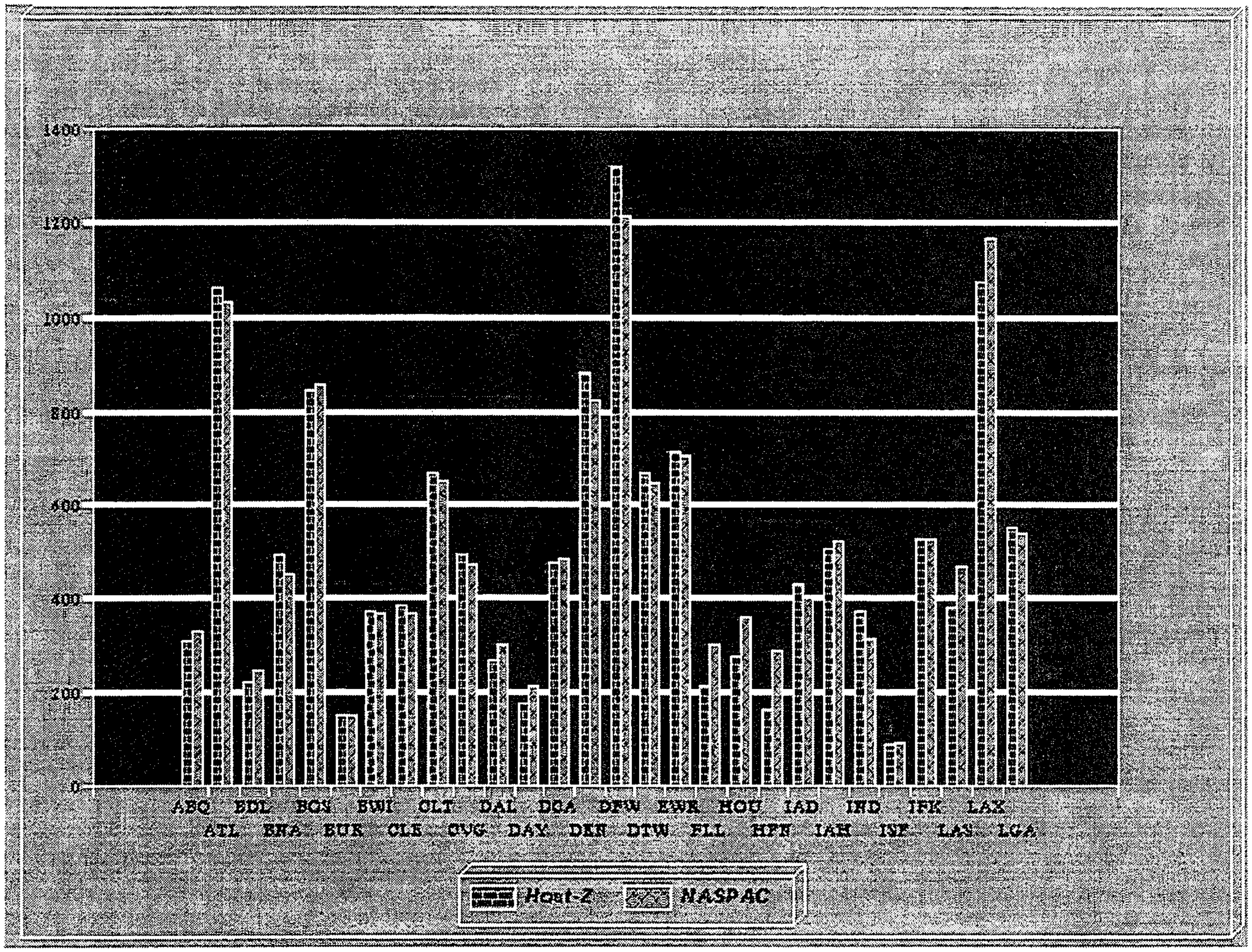

FIGURE 13. TRAFFIC COUNTS - HOST-Z DATA VERSUS NASPAC (1)

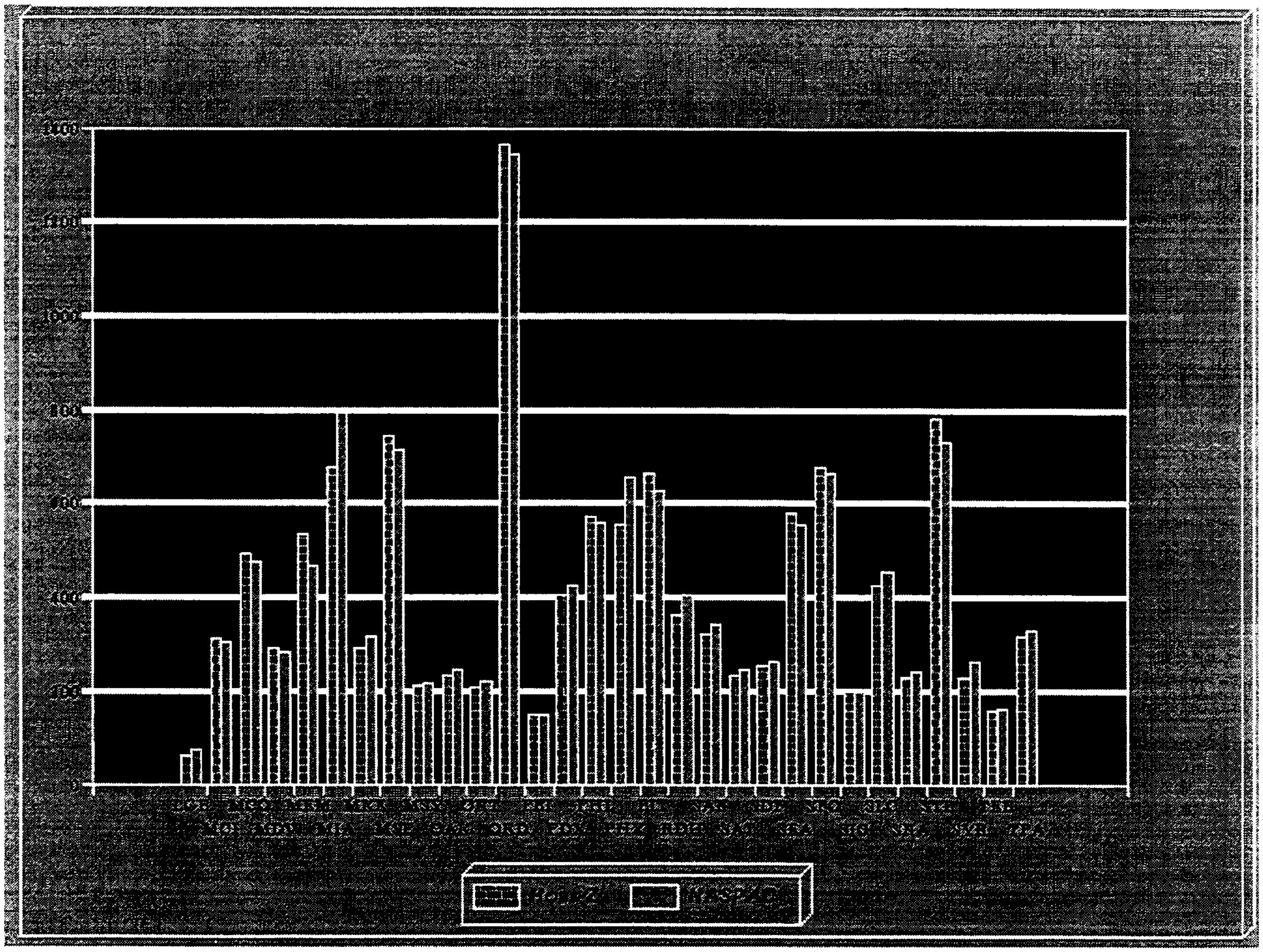

FIGURE 14. TRAFFIC COUNTS - HOST-Z DATA VERSUS NASPAC (2)

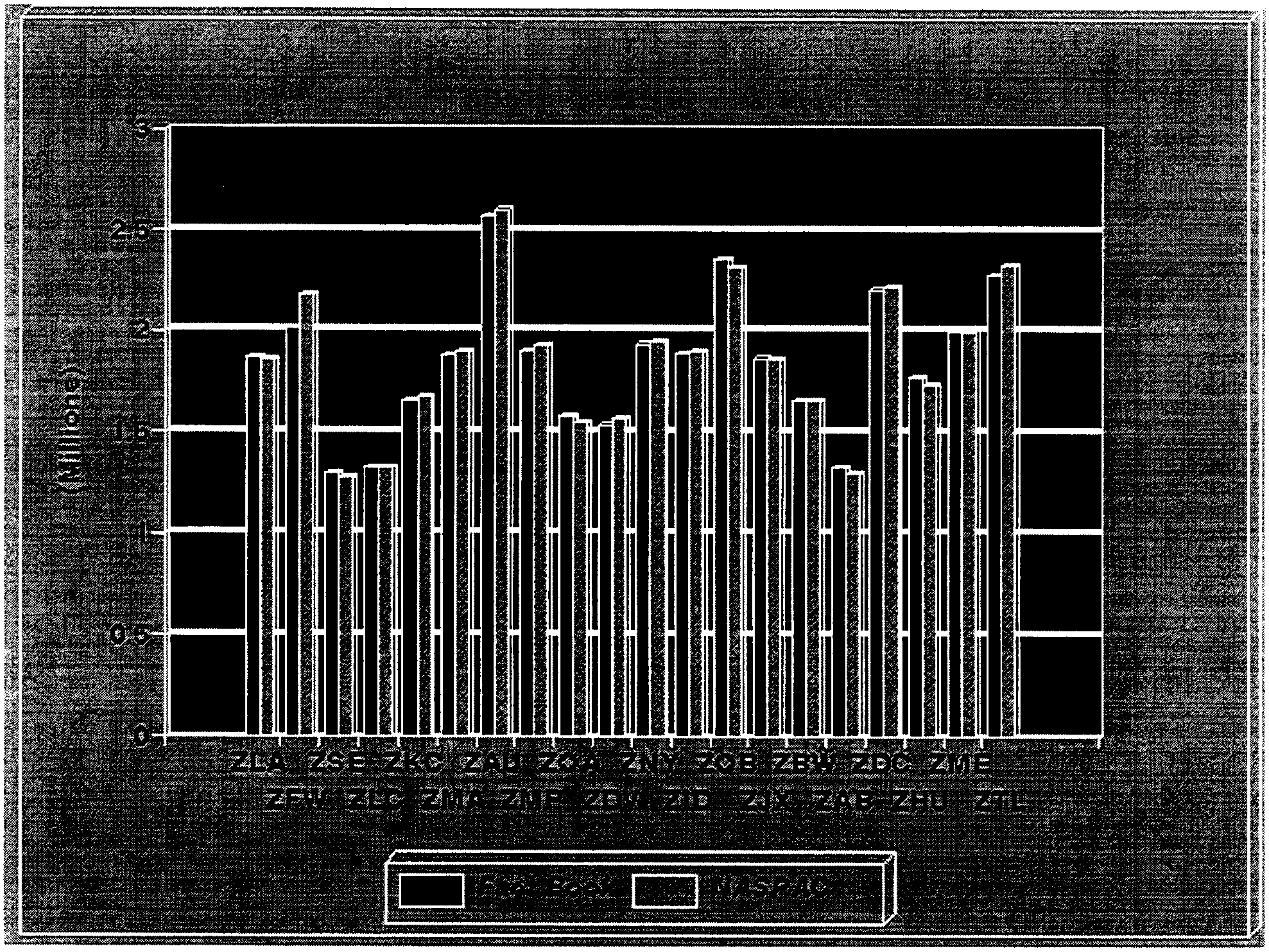

FIGURE 15. CENTERS TRAFFIC COUNT - ADMINISTRATOR'S FACT BOOK VERSUS NASPAC

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APPENDIX A

AIRPORTS MODELED BY NASPAC

LOCATION IDENTIFIER:	AIRPORT NAME:
ATL	The William B. Hartsfield Atlanta International Airport
BOS	General Edward Lawrence Logan International Airport
BWI	Baltimore/Washington International Airport
CLE	Clevland-Hopkins International Airport
CLT	Charlotte/Douglas International Airport
CVG	Cincinnati/Northern Kentucky International Airport
DAL	Dallas Love Field Airport
DEN	Stapleton International Airport
DFW	Dallas/Fort Worth International Airport
DTW	Detroit Metropolitan Wayne County Airport
FLL	Fort Lauderdale/Hollywood International Airport
IAD	Washington Dulles International Airport
IAH	Houston Intercontinental Airport
IND	Indianapolis International Airport
JAX	Jacksonville International Airport
JFK	John F. Kennedy International Airport
LAS	McCarren International Airport
LAX	Los Angeles International Airport
LGB	Long Beach/Dougherty Field Airport
MCO	Orlando International Airport
MEM	Memphis International Airport

MIA	Miami International Airport
MKE	General Mitchell International Airport
MSP	Minneapolis St. Paul International/Wold-Chamberlain Airport
MSY	New Orleans International/Moisant Field Airport
OAK	Metropolitan Oakland International Airport
ORD	Chicago O'Hare International Airport
PHL	Philadelphia International Airport
PHX	Phoenix Sky Harbor International Airport
PIT	Greater Pittsburgh International Airport
RDU	Raleigh Durham International Airport
SDF	Standiford Field Airport
SEA	Seattle-Tacoma International Airport
SFO	San Francisco International Airport
SJC	San Jose International Airport
SLC	Salt Lake City International Airport
SNA	John Wayne Airport-Orange County Airport
STL	Lambert-St. Louis International Airport
SYR	Syracuse Hancock International Airport
TPA	Tampa International Airport