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AIRPORT QUOTAS AND PEAK HOUR PRICING: ANALYSIS OF AIRPORT NETWO--ETC(U)

JUN 76 W R FROMME, W M SWAN

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# AIRPORT QUOTAS AND PEAK HOUR PRICING: ANALYSIS OF AIRPORT NETWORK IMPACTS



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This report provides an evaluation of the impacts of airport quotas and peak-hour pricing on air traffic congestion and airport system delay.

This analysis addresses two issues. First, would a schedule of peak-load pricing and quotas reduce airport system delays? Second, would a schedule of peak-pricing and quotas complement the system improvements provided by the technological features of the UG3RD? It is concluded, as a result of this analysis, that, in theory, peak-hour pricing and quota alternatives would effectively complement the technological features of the UG3RD by relieving aircraft congestion and delay and improving the flow of air traffic between the 25 largest air carrier airports.

While there are theoretical advantages to pricing and quota alternatives, there are economic and institutional constraints limiting their implementation on a widespread scale. Included among these constraints are the unresolved issues which might confront the FAA, airport sponsors, and the airlines.



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## 1.0 Executive Summary

This report provides an evaluation of the impacts of airport quotas and peak-hour pricing on air traffic congestion and airport system delay. It is the second of two analyses of quotas and peak-pricing undertaken by the Federal Aviation Administration (FAA) in response to a 1974 request by the Office of the Secretary of Transportation for a review of specific policy alternatives to the Upgraded Third Generation Air Traffic Control System (UG3RD). The first report, Airport Quotas and Peak-Hour Pricing: Theory and Practice, FAA AVP-77-5, examined the leading theoretical studies of peak-hour pricing and airport quotas, comparing and contrasting theory with the real-world situation. The potential problems of implementation were identified and discussed.

This report computes and compares air traffic delays anticipated at the 25 largest air carrier airports under alternative airport development strategy assumptions. Airport delays anticipated under a schedule of quotas and peak-hour pricing, for example, are compared to projected delays, assuming airports were equipped with UG3RD technological improvements and also compared to delays associated with a peak-pricing system implemented in concert with the UG3RD.

This analysis addresses two issues. First, would a schedule of peak-load pricing and quotas reduce airport system delays? Second, would a schedule of peak-pricing and quotas complement the system improvements provided by the technological features of the UG3RD? It is concluded, as a result of this analysis, that, in theory, peak-hour pricing and quota alternatives would effectively complement the technological features of the UG3RD by relieving aircraft congestion and delay and improving the flow of air traffic between the 25 largest air carrier airports.

While there are theoretical advantages to pricing and quota alternatives, there are economic and institutional constraints limiting their implementation on a widespread scale. For example, the optimum fare schedule necessary to shift air carrier traffic away from peak demand periods is not presently known. Nor have all the possible issues which might confront the FAA, airport sponsors, and the airlines been satisfactorily resolved. Perhaps, more importantly, a peak-pricing strategy would represent a departure from the traditional concept of free access to the nation's airspace system and services. The realities of peak-pricing and quota alternatives limit their practical value at this time.

## 2.0 Introduction

The FAA is engaged in major Engineering and Development (E&D) programs to provide new and improved air traffic control capabilities for the 1980's and 1990's. When these developments are completed, implemented, and integrated with existing facilities, the result will be the "Upgraded Third Generation Air Traffic Control System (UG3RD)."

The Under Secretary of Transportation, by memorandum of March 13, 1974, to the Assistant Secretary for Systems Development and Technology, requested a comprehensive technical review of the entire UG3RD program. As a result of the Under Secretary's request, the FAA has been asked to undertake economic evaluations of technical and operational features of the UG3RD.

Technical features of the UG3RD include Aerosat, Flight Service Station Automation, Wake Vortex Avoidance (WVAS), Airport Surface Traffic Control, Area Navigation (RNAV), Microwave Instrument Landing System (MLS), Discrete Address Beacon System/Intermittent Positive Control (DABS/IPC), and automation. 1/ In addition to these technical features, there are numerous noncapital, or relatively low-capital, program alternatives that might be introduced. The question has been raised whether or not two of these noncapital alternatives--peak-load landing fees and airport quotas--would complement technical features of the UG3RD and improve the flow of air traffic. The purpose of this research is to evaluate quotas and peak-pricing, and determine the impact these alternatives might have on congestion and delay at major air carrier airports.

The basic concept of peak-load pricing is the use of higher charges on aircraft (and/or passengers) during periods of high demand to control airport congestion. Theoretically, users confronted with a peak-time pricing schedule will redistribute their demand more uniformly throughout the day, with only the highest valued users receiving service during the peak-demand period.

1/ Each of these systems is described in The National Aviation System, Challenges of the Decade Ahead, 1977-1986 DOT, FAA, 1976.

There are at least two well documented examples in which airports have imposed peak-hour charges to alleviate congestion. One of these is at Heathrow Airport, where the British Airport Authority (BAA) in 1971 imposed a peak-period surcharge on aircraft operations in an attempt to alleviate congestion in the airport terminals and access roads.

Although there is some data indicating the peak-period surcharge has shifted demand slightly, it has not resulted in any major redistribution of traffic. It is noted, however, that the Heathrow peak-time charge (approximately $100) is imposed upon air carriers, which, as a group, are less sensitive to changes in operating expenses than are other sectors of the aviation community. This may account for the negligible impact of peak charges at Heathrow.

Results of the peak-pricing experiment at New York City airports, the second of the two examples, are more pronounced. In 1968, in order to alleviate congestion and make more capacity available for air carrier operations, the Port Authority of New York imposed a $25 fee for all landing and take-offs during peak hours by aircraft with less than 25 seats. The normal landing fee was $5. The impact of the surcharge was immediate. For the three major New York airports--Kennedy, LaGuardia, and Newark--general aviation activity during high-activity hours dropped over 30 percent from pre surcharge levels, indicating that peak-time landing fees can result in significant redistribution of particular user demands (general aviation) at a given airport and time of day.

Quotas and other administrative alternatives typically involve some form of fiat rationing to restrict air traffic access to congested airports. These restrictions may be applied selectively on specific categories of aviation; they may be in force only for certain periods of a day; and/or apply to some, but not all, runways of an airport. Banning of general aviation flights from an airport, or from some part of an airport, is an example of an administrative option. Establishment of a quota system for all users is perhaps the most familiar of these alternatives.

Quotas are easy to describe and comprehend. Their first-order and short-term effects are also straightforward and predictable: as the number of flights at an airport is reduced (due to quota limits on the number of flights that can be scheduled or to a ban on specific types of operations), congestion at an airport also decreases. In fact, since the relationship between airport demand and airport delay is nonlinear, a carefully chosen limit on the number of operations at a severely congested airport may lead to a significant reduction in the cost of delays, with a less than proportionate decrease in the number of flights allowed.

This phenomenon is illustrated in Figure 2.1, for year 2000 air carrier forecasts at Chicago O'Hare (ORD). The two demand curves shown in this figure represent projected air carrier traffic levels before and after the imposition of hypothetical quotas on operations. As explained later, these forecasts were developed for this analysis to test the impact of airport capacity constraints on air traffic delay. Figure 2.1 shows that a daily quota of 1,875 aircraft movements represents a 15 percent reduction in the number of ORD operations which might otherwise be anticipated in the year 2000. Delay, however, is more than proportionately reduced 53 percent, from the pre quota level of over 44,000 minutes each day to less than 21,000 minutes. Furthermore, the forecast indicates that more extensive use of wide-body aircraft under quota conditions would provide for equivalent numbers of passengers carried in either case.

It is little wonder that quotas have been particularly attractive to the various responsible bodies as a means of dealing swiftly and effectively with airside congestion. In 1969, for example, the FAA imposed hourly quotas on the scheduling of operations at the three New York City airports, O'Hare International in Chicago, and Washington National. These quotas have been generally credited for relieving traffic congestion at these airports. Developments since 1969 have made it possible to eliminate the quota at J. F. Kennedy and Newark. However, the system continues to be in effect at the other three airports.

The theory of these noncapital alternatives has been adequately reviewed in the economic literature. 2/ Previous efforts have shown convincingly that peak-time landing fees and/or quotas at an air carrier airport can reduce air traffic delays at that station. This was shown in Figure 2.1.

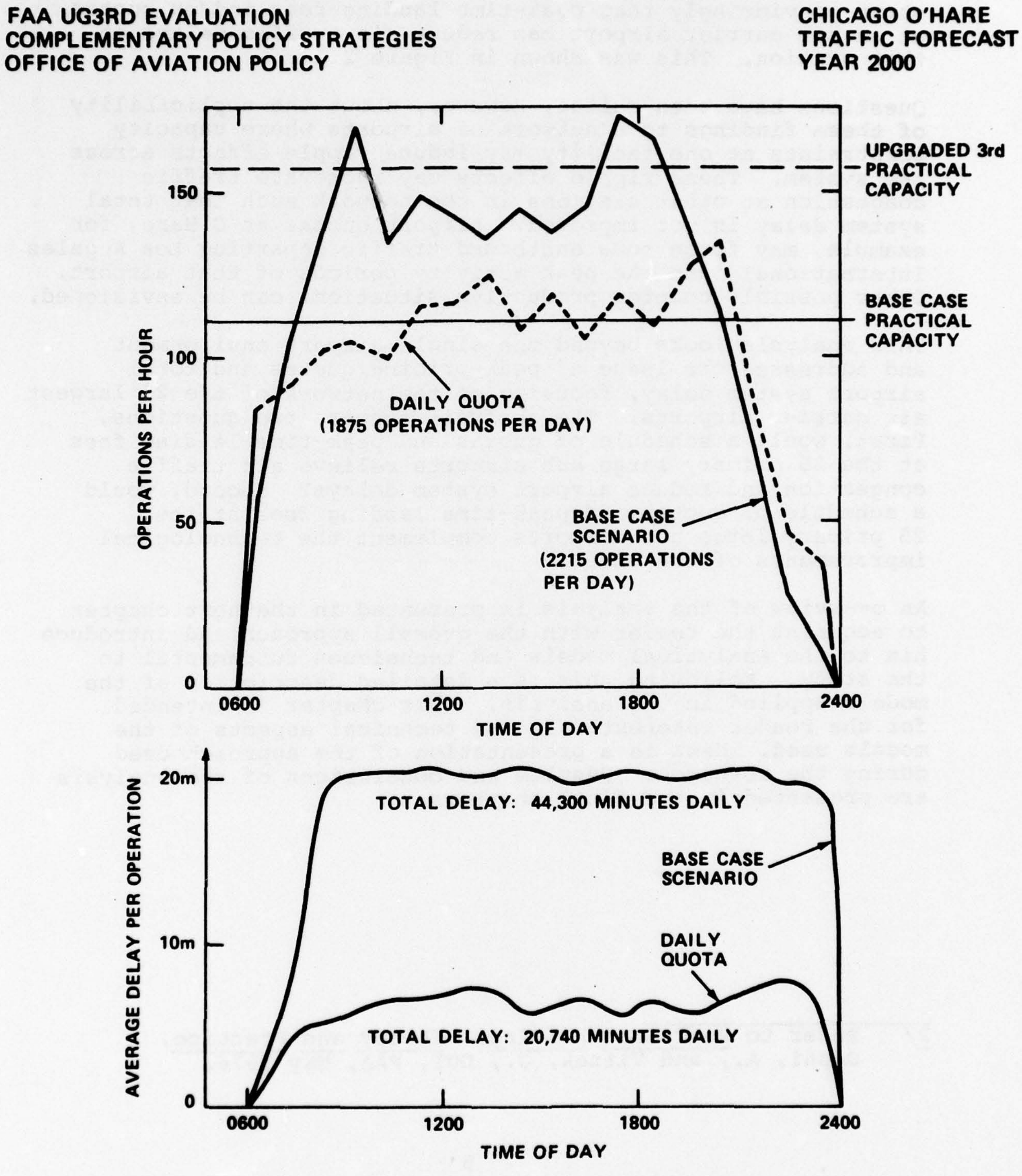
Questions have been raised, however, about the applicability of these findings to a network of airports where capacity constraints at one facility may induce ripple effects across the system. These ripple effects may aggrevate traffic congestion at other stations in the network such that total system delay is not improved. Airport quotas at O'Hare, for example, may force some eastbound traffic departing Los Angeles International into the peak activity periods of that airport. Other possibly counter productive situations can be envisioned.

This analysis looks beyond the single airport environment and addresses the issue of peak-pricing/quotas and total airport system delay, focusing on the network of the 25 largest air carrier airports. The analysis answers two questions. First, would a schedule of quotas and peak-time landing fees at the 25 primary large hub airports relieve air traffic congestion and reduce airport system delays? Second, would a schedule of quotas and peak-time landing fees at the 25 primary large hub airports complement the technological improvements of the UG3RD?

An overview of the analysis is presented in the next chapter to acquaint the reader with the overall approach and introduce him to the analytical models and techniques fundamental to the study. Following this is a detailed description of the models applied in the analysis. This chapter is intended for the reader interested in the technical aspects of the models used. Next is a presentation of the approach used during the research. Results and conclusions of the analysis are presented in the final chapters.

2/ Refer to Peak-Load Pricing: Theory and Practice, Odoni, A., and Vittek, J., DOT, FAA, May 1976.

## FIGURE 2.1
## IMPACT OF QUOTAS ON AIRPORT DELAY



## 3.0 Overview

In order to examine the impact of peak-time pricing and quotas on congestion and delay at major air carrier airports, an experiment with four operational scenarios or situations was designed, each scenario representing a different development strategy for the national airport system. Two of the scenarios employed peak pricing and quotas to relieve congestion, the others did not. Airport system delays associated with each scenario were computed and compared, and differences observed were attributed to the unique features of each scenario.

To test the impact of these scenarios on airport system delay, a mathematical programming model was developed at the Massachusetts Institute of Technology (MIT) Flight Transportation Laboratory to represent the network of the 23 largest metropolitan air carrier centers or hubs. The analysis of airport delays focused on the primary airport in each large hub. As a group, these airports--listed in Appendix A--account for approximately 70 percent of all national passenger enplanements and almost 40 percent of all air carrier operations. 1/ They also account for almost 75 percent of all air carrier airport delays. 2/

Simulating the planning and routing activities of the United States domestic airline industry, the MIT fleet assignment model routed aircraft through the system of 243 city pairs or markets to provide either direct or multistop aircraft services to the primary large hub airports in accordance with a set of optimization criteria. For this analysis an airline strategy to maximize profits was adopted in order to provide a realistic air carrier environment. That is, it was assumed the airlines would behave rationally to maximize net revenues on the routes they were flying.

1/ Terminal Area Forecast, 1976-1986, DOT, FAA, September 1974, Table II.

2/ Airline Delay Data, 1970-1974, DOT, FAA, February 1975, page 22.

The fleet assignment model applied in this analysis takes into account a wide choice of different routing possibilities for market development by combining several route segments into nonstop flights as warranted by the volume of passenger demand and the economics of airline operations. The model is sensitive to practical limitations on load factors, aircraft capacity, and/or other constraints, such as the availability or price of fuel.

Once the routing of aircraft among the 23 major cities was developed, a second program was used to generate schedules of aircraft departures between network city pairs. Using empirically derived time of day demand preferences, a set of departure "windows" was established for each domestic market, forcing departures at preferred or peak times, but allowing broader variation in departure time during off-peak hours if necessary. Assigning departures within permissible "windows" to minimize the aircraft fleet size, the scheduling model produces an "Official Airline Guide" (OAG) type schedule for any planning period, using the fleet assignment model frequencies, time of day traffic demand preferences, and its own scheduling logic.

The sequential routing and scheduling process described above was used to produce a series of OAG type time of day traffic profiles for each of the 25 primary air carrier airports in the 23 large hubs through the year 2000.

For all the airports in the 23 hub network, different 25-year traffic histories were developed, one representing the average time of day traffic profile associated with each of the four scenarios noted earlier. Approximately equal numbers of passengers were carried on respective markets in each scenario. The unique provisions of each scenario, however, resulted in different traffic patterns for each airport and time period.

Overall airport system delays under the four scenarios were computed and compared, and differences were attributed to the features of each scenario. This was the fundamental step in the analysis. The impact of the UG3RD on airport congestion, for example, was contrasted with peak-time pricing and quotas by comparing total system delays accumulated under the scenario most closely resembling each of these alternatives. Findings and conclusions of the report were based upon these comparisons.

Several analytical models have been introduced in this section, including a fleet assignment model, a scheduling model, and airport delay model. Each of these will be fully described in the following chapter. While a careful review of these models is recommended, the discussion which follows, as explained earlier, is presented primarily for the reader seeking a better technical understanding of the analysis. Other readers may wish to skim over Chapter 4 and continue with the following chapter, the Approach.

## 4.0 Description of Modeling

The process of predicting delays throughout a network of airports can be divided into three distinct steps: (1) the aircraft routing exercise, (2) the scheduling exercise, and (3) delay calculations. This chapter reviews each of these steps in detail.

### 4.1 Aircraft Routing

Aircraft routing is accomplished with a fleet assignment model, FA-4, which assigns aircraft over the network of cities in the manner of the U.S. domestic airline industry, that is, in such a way as to maximize profits for the airlines. In so doing, it takes into account a wide choice of different routings, the possibility for load building by combining several markets into multicity flights, and the opportunities for stimulating demand by improving service levels.

The FA-4 model was originally developed to assist in the fleet allocation decisions of commercial airlines, and, in fact, has been used in the scheduling process by several carriers. Because of its "real world" characteristic response, FA-4 has proven useful for exploring the behavior of air transportation companies in the face of widely varying regulatory and operational constraints. FA-4 addresses the following problem: Given passenger demand in designated markets, and given the costs of certain input factors such as fuel, vehicles, and labor, find the profit maximizing behavior of the firm. FA-4 solves the optimum airline strategy in terms of markets and capacity, making trade-offs with respect to cost, vehicle size, frequency, and routing.

#### 4.1.1 Demand Modeling

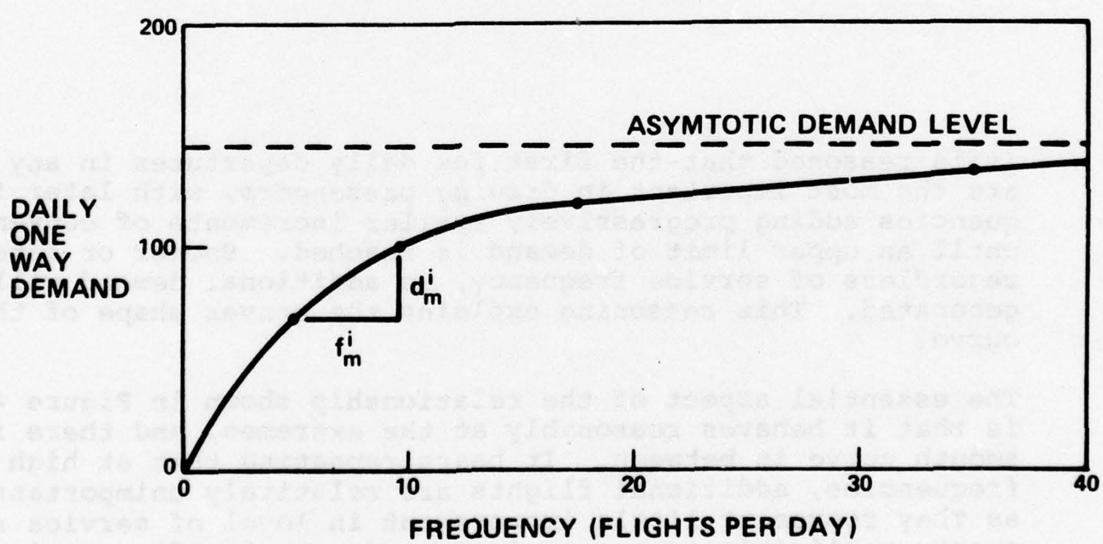
The FA-4 model is best introduced by discussing the process of air travel demand modeling. Each city pair market has a demand for travel which may be expressed as a curve relating passengers to the daily inter-city frequency of service. The shape and magnitude of this function determine the FA-4 solution of aircraft types, frequency, and routings. The discussion in this section explores the means by which the demand/frequency curve is generated.

## Description of the Demand Curve

A typical traffic frequency curve is illustrated in Figure 4.1. This relationship assumes there is an upper limit on passenger demand in any city market; that is, there is an upper bound on demand, regardless of service frequency provided by the airlines. This is shown as an asymtotic demand level. At the other extreme, it is clear that a daily frequency of zero flights is equivalent to zero demand. No one flies when no aircraft are scheduled.

**FIGURE 4.1**

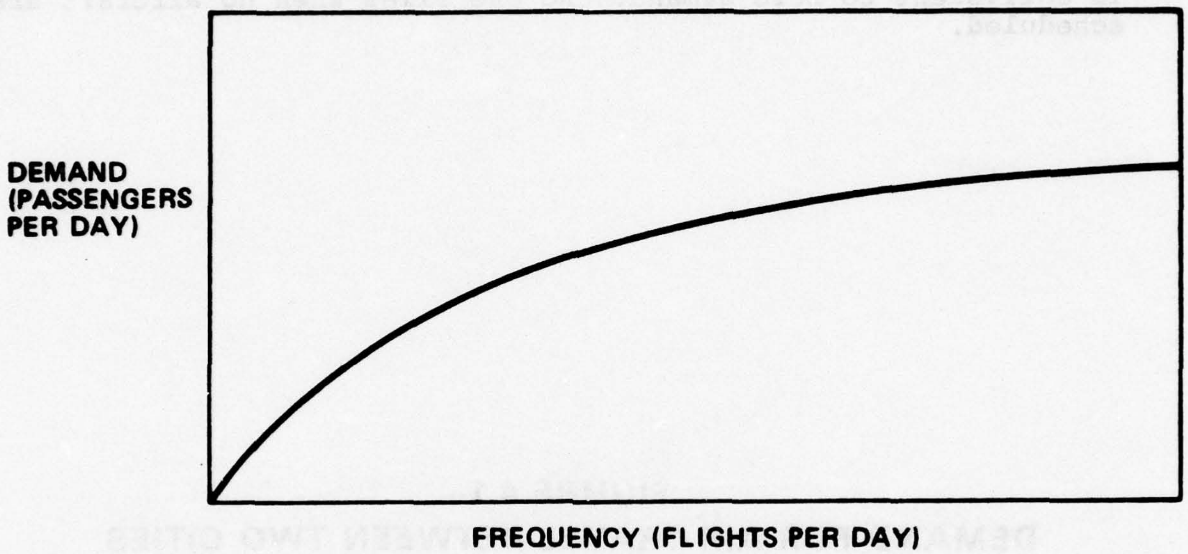
**DEMAND FOR AIR TRAVEL BETWEEN TWO CITIES**



The Treatment of Frequency

Passenger demand for air travel for this analysis can be represented by the typical demand curve illustrated in Figure 4.2. Here, demand = f (frequency).

FIGURE 4.2
A TYPICAL DEMAND CURVE




It is reasoned that the first few daily departures in any market are the most important in drawing passengers, with later frequencies adding progressively smaller increments of convenience until an upper limit of demand is reached. Sooner or later, regardless of service frequency, no additional demand will be generated. This reasoning explains the convex shape of the curve.

The essential aspect of the relationship shown in Figure 4.2 is that it behaves reasonably at the extremes, and there is a smooth curve in between. It bears repeating that at high frequencies, additional flights are relatively unimportant as they represent little improvement in level of service and create negligible increases in demand. At low frequencies, however, additional flights are very important as they generate more than a proportional increase in passengers.

## The Impact of Flight Distance on Demand

Range or distance also has bearing on the demand frequency relationship. This can be expressed mathematically by the following equation:

$$\text{(4.1)} \quad \text{DEMAND} = K\,(t_o + W_o/\text{frequency})^{\alpha}$$

$K$ is a constant of proportionality

$t_o$ is fixed-travel time, and includes the sum of block time, boarding time, access, and egress time.

$W_o$ is a constant representing 1/2 the period of service provided.

$W_o$/frequency represents the average headway between service flights.

$\alpha$ is a constant value representing the elasticity of demand.

Equation 4.1 shows demand as function of total travel time, the sum of fixed travel time, $t_o$, and an additional shcedule delay, $W_o$/frequency. Schedule delay is defined as the inconvenience of waiting for the next departure. It is equal to half the average headway, or $W_o$/frequency. As frequencies increase, inconvenience waiting for a departure is minimized.

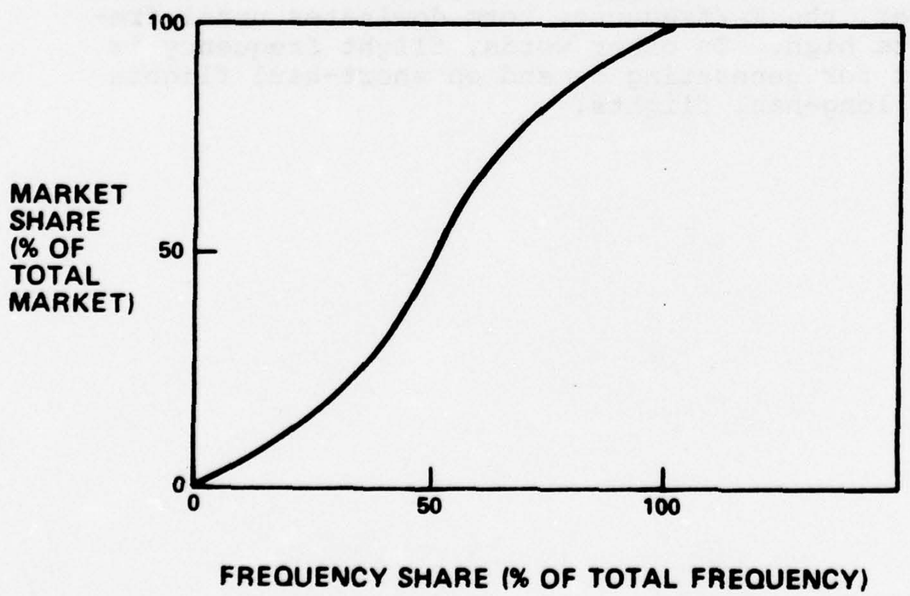
At long flight distances, $t_o$ is a relatively large number, and the frequency term is comparatively small. At shorter ranges, however, the $W_o$/frequency term dominates until frequency is quite high. In other words, flight frequency is more important for generating demand on short-haul flights than it is on long-haul flights.

## Competition

When two or more airlines compete over the same route, the effective frequency of service used to generate a passenger demand curve may differ from a simple count of the number of flights. In the generation of demand curves, frequency is defined as the number of departure options available to passengers in a given market. If airlines compete by scheduling nearly simultaneous departures, the number of departure options available to passengers is less than the sum of daily departure. In most cases, however, carriers share a market by scheduling alternating flights, in which case the frequency is equal to the number of total departures.

In competitive markets, passenger demand must be shared by two or more air carriers. Both practice and theory suggest that the market split follows the "S" shaped dependence on frequency share displayed in Figure 4.3. That is, a carrier's market share is less than proportional to his share of flight frequencies until he accounts for at least 50 percent of total flights. As his flights increase beyond that point, market share becomes more than proportional to his frequency share.

**FIGURE 4.3**
**MARKET SHARE VS. FREQUENCY SHARE**



## Calibration from Existing Conditions

The demand model discussed in this chapter is expressed by the equation:

$$(4.2) \quad \text{DEMAND} = K\,(t_O + W_O/\text{frequency})^{\alpha}$$

This equation results in the geometrical shape displayed by the curve in Figure 4.2. Of the variables in this equation, only the existing frequency and number of passengers carried are generally known. The fixed time $t_O$ is a characteristic of the aircraft and city pair. The term $W_O$ is the length of the travel day, and is halved so that $W_O$/frequency is the scheduled delay. The elasticity is determined empirically from regression analysis of existing markets. The two known parameters, frequency and passengers carried provide the one point necessary for calibrating the demand curve. The demand model formulation fixes the shape of the curve, and the existing data point determines its size.

## Treatment of Multiple Stops

The demand frequency relationship developed assumes that the expected level of service in FA-4 and the actual service used to calibrate the demand model are the same. If nonstop jet service was used in calibration, then nonstop jet service is the dimension of the frequency axis measure. However, FA-4 permits multistop routings and also allows the use of slower, or less appealing aircraft. What is needed is a conversion factor between different levels of service.

The market model permits this conversion to be made. In summarizing total frequencies, multistop flights were given a value of less than one.

## Data Sources

Three pieces of data are needed to generate the single data point for each demand curve for a single airline:

1. Competition either as a frequency share or as a market share.

2. Existing total passenger travel on all airlines.

3. Existing single airline daily frequency, number of stops, and aircraft type.

Frequency share competition is available from examining the city pair in the OAG. Market share data is available from CAB Origin-Destination Surveys of airline passenger traffic. Total (or airline) passenger traffic is also available from the CAB references. Existing (or total) frequency is available from the OAG. Finally, fares are listed in the OAG, and distances in CAB Traffic statistics.

These data sources are used as inputs to a program which generates demand curve data points suitable for input to FA-4.

4.1.2 Mathematical Formulation

FA-4 is a linear program. Thus, the rules of the market place and of practicality are expressed as a series of constraints that airlines must obey. The solution procedure of FA-4 may be thought of as trying out every imaginable combination of aircraft, routes, and frequencies. Revenues and costs associated with each combination are added up, and that combination with the greatest excess of income over cost is selected as best.

The rules the solution must obey are the following:

1. The total cost of a system of airplane flights is the sum of the direct operating costs for each aircraft-route employed and the indirect operating costs proportional to passengers and passenger miles. Landing fees are included. However, administrative overheads do not affect the solution or routing decision. Overhead is taken out of the profits, if any.

2. The total income of the system is the sum of all the passengers carried times the fares paid.

3. No passenger is carried unless there are sufficient seats for him on each link of his flight. A maximum load factor establishes effective average aircraft capacities.

4. No more passengers are carried than the demand indicates. The demand, as discussed in Section 4.1.1, is limited by the level of service. Upper bound on the passengers is the upper bound on gross revenues in each market.

5. Finally, there may be a maximum number of departures allowed at any specific airport, due either to a physical or operational constraint.

Output from the aircraft routing exercise is a set of aircraft routes that are flown and the frequencies at which they are flown. The solution represents a predicted average over the year, and is, therefore, noninteger. That is, a route can be flown 4.7 or 11.3 times a day, for example. For planning purposes, all outputs can be rounded to integer values.

## TABLE 4.1

## DEFINITION OF TERMS AND VARIABLES USED IN THE MATHEMATICAL FORMULATION OF FA-4

| | |
|---|---|
| $\pi$ | Total airline profit |
| $F_{rv}$ | Frequency of service on route r by aircraft v |
| $COST_{rv}$ | Cost of service $F_{rv}$ |
| $D_m$ | Total passenger traffic in city pair market m |
| $FARE_m$ | Fare for passengers in market m |
| $f^i_m$ | Subsegment i of total frequency of service in market m |
| $d^i_m$ | Slope of demand curve segment corresponding to $f^i_m$ |
| K | Demand curve calibration constant |
| $t_o$ | Travel time in a market |
| Freq | Total frequency of service in a market |
| $W_{rm}$ | Weighting factor for frequency on route r with respect to frequency of service in market m |
| $D_{mr}$ | Subcomponent of passenger traffic in market m. This part of traffic uses route r. |
| $S_v$ | Seating capacity (with correction for load factor = 53 percent) for vehicle v |
| $DEP_c$ | Total permissible departures from airport c |
| $IOC^m_r$ | Indirect operating costs for passengers in market m by route r |
| $P^m_r$ | Passengers in markets m by routes r |
| $DOC^v_r$ | Direct operating costs for aircraft v on route r |

The driving function for FA-4 solutions is profit maximization. Profit is defined here as excess of revenues over expenses, as shown in expression (4.3).

$$(4.3) \qquad \pi = \sum_m D_m \cdot FARE_m - \sum_r \sum_v F_{rv} \cdot COST_{rv}$$

A description of the terms used above is presented in Table 4.1. The equation says that profit, $\pi$, is airline revenues less costs. Revenues are the demand in each market $D_m$ times the fare in that market $FARE_m$. The fare is reduced by indirect operating costs associated with ticket sales, boarding, cabin service, and baggage handling. The costs are a sum of the frequencies with which each vehicle flies each route, $F_{rv}$, times the cost for that vehicle to fly that route. $COST_{rv}$ is composed of total block hour direct operating costs for a given vehicle on a given route plus indirect operating costs associated with landing and gate operations plus landing fees.

Another way to visualize total costs, $COST_T$, is shown in equation (4.4).

$$(4.4) \qquad COST_T = \sum_m \sum_r P_r^m \cdot (IOC_r^m) + \sum_v \sum_r F_{rv} \cdot (DOC_r^v)$$

That is, total cost in the sum of indirect operating costs for passengers in markets m by routes r, $(IOC_r^m)$, with direct operating costs for aircraft v on route r, $(DOC_r^v)$.

The FA-4 model is sensitive to the rise in passenger demand triggered by an increase in service in a market, equation 4.5.

$$(4.5) \qquad D_m = \sum_i f_m^i \cdot d_m^i$$

This equation states that the demand in market m, $D_m$, is a factor of $f_m^i$, a bounded component of the demand frequency curve for market m (shown in Figure 4.0), and $d_m^i$, the slope of the corresponding segment of the demand curve. This curve, as noted previously, is calibrated from historical demand and frequency combinations.

Equation (4.6) establishes the shape of the demand frequency curve.

$$(4.6) \quad D_m = K(t_o + 6/\text{frequency})^{-1.3}$$

Here, K is the calibration constant and $t_o$ is the sum of the flight time, access, boarding, and egress time. The term 6/frequency is the schedule inconvenience and is expressed as the average wait time.

Two definitional equations are necessary to complete the mathematical description of the model. The first merely establishes the total frequency in a market:

$$(4.7) \quad \sum_i f^i_m = \sum_r \sum_v F_{rv} \cdot W_{rm}$$

This equation says that the total frequencies for the purpose of calculating the demand equals the sum of the frequencies of all the vehicles over all the routes,

$$\sum_r \sum_v F_{rv}.$$

Each route frequency is weighted by a factor $W_{rm}$, for each market. If the route serves the market nonstop, $W_{rm}$ is unity. If it serves the market with intermediate stops, the value of $W_{rm}$ is less than one. The weighting function is complex and depends on the absence of historical nonstop service. If the route does not serve the market at all, $W_{rm}$ is set equal to zero.

The second definitional equation expresses the total demand in each market, $D_m$, as a sum of passengers using one or the other market routes:

$$(4.8) \quad D_m = \sum_r D_{mr}$$

This identification is necessary so that the load factor constraint can be written. The load factor constraint sums the seats available on each link of each route r:

$$(4.9) \quad \sum_v F_{rv} \cdot S_v \geq D_{mr}$$

The capacity of each vehicle $S_v$ times the frequency of that vehicle on the route $F_{rv}$ must exceed the sum of the demands using that link.

Lastly, the activity at each airport is summed by summing the route vehicle frequencies which use the airport. This sum may be subject to a limit $DEP_c$:

(4.10) $$\sum_r \sum_v F_{rvc} \leq DEP_c$$

It is this airport activity provision which allows FA-4 to test the system impacts of quotas, peak-pricing, and/or other airport capacity constraints.

This completes the description of the mathematics of FA-4.

### 4.1.3 Data Requirements

FA-4 has a wide number of options for inputting data and greater or lesser degrees of internal preprocessing are available. The following information must be provided in the minimum case:

1. IOC's: cost per aircraft departure, aircraft miles, passenger boarding, and passenger miles.

2. Fare structure: a zero distance cost, plus a cost per intercity mile.

3. Generalized equivalent nonstop frequency values for one-stop and two-stop services.

4. Station data: each airport name, the maximum daily departures, if there is a limit, and the landing fees, if any.

5. For each aircraft type: zero distance block time, cruise speed, seating capacity, cost per hour, maximum daily utilization, number of aircraft available.

6. For each route: the cities on the routes in the order served and the aircraft forbidden on each route (aircraft costs and times can be computed if not input here).

7. For each city pair market: the intercity distance, the demand curve as a series of straight line segments input as break points and slopes, and the maximum load factor. (Specific equivalent frequency coefficients may be input. Fares will be computed if not input here.)

The 23 city network evaluated by FA-4 for this analysis was first run for the year 1975. Demand, fare, and cost data for the year 1974 were used for calibration. The only changes for runs simulating later years were the demands. The 1974 dollars were used for both costs and fares throughout.

Table 4.2 lists the aircraft costs for the two vehicles postulated in this analysis. It was possible to introduce intermediate vehicle sizes. However, FA-4 can artificially create middle size aircraft by mixing service with the two extremes. Service with one wide aircraft and two small aircraft was the equivalent of three services with a 153 seat aircraft. This approximation reduces the size of the problem without sacrificing accuracy.

## TABLE 4.2

## AIRCRAFT COSTS 1/

| NAME | SMALL | WIDE |
|---|---|---|
| Seats | 80 | 300 |
| Load Factor Maximum | 53% | 53% |
| Cost Per Hour | $775 | $2,214 |
| Speed | 510 mph | 510 mph |
| Take-off and Climb Time | 15 min. | 15 min. |
| Landing Fee and IOC | $156 | $328 |

1/ These costs are above 1974 reported costs because depreciation has been replaced by a dry lease cost, which includes a return on investment. Costs for the 80-seat vehicle exceed B-737 and DC-9 costs because these two aircraft are short range while the 23 city network operated long-range flights. Sources: CAB Aircraft Performance Data, 1974, and "Flight International," January 3, 1974.

Indirect operating costs were estimated from empirical data to be $0.025 per revenue passenger mile and $8.00 per passenger boarding. 1/ These figures represented long-run marginal costs, which include a certain amount of lower management and sales overheads as well as the direct handling costs. Fares were approximated by the formula $16.80 + $0.0692/mile. This was 5 percent over 1974 fares. 2/

1/ A Multi Regression Analysis of 10C's," Simpson, R., and Taneja, N., Massachusetts Institute of Technology, Flight Transportation Laboratory, FTL-R-67-2.

2/ Derived from May 1, 1974 OAG.

## 4.2 Aircraft Scheduling

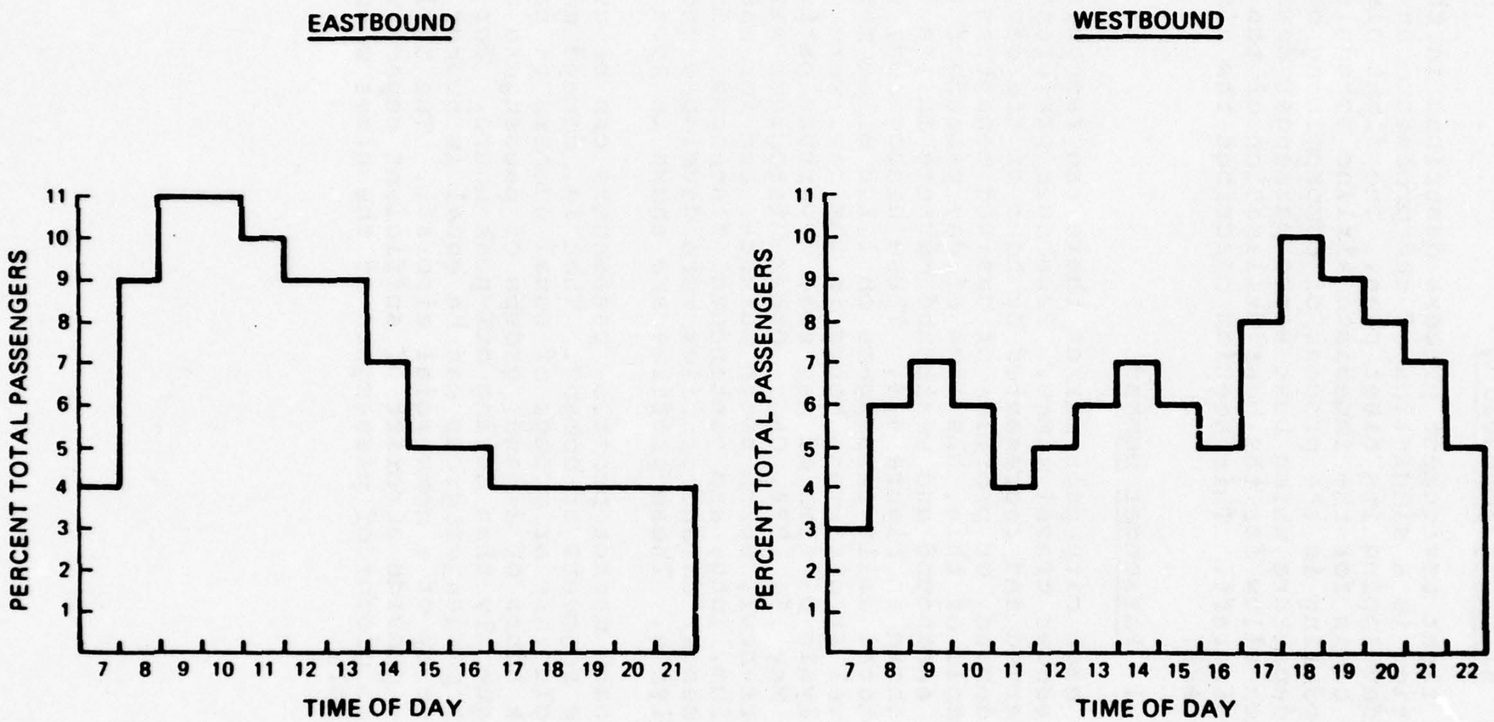
The fleet assignment process described in the preceeding section is a simulation of the procedure an airline follows in developing its fleet plan. The fleet plan then becomes the basis for the immediate airline schedule. Airline scheduling is the process of compromising between the times of departure which best serve passenger demand and the times which allow for the best utilization of the available fleet of aircraft. This section describes the aircraft scheduling process.

### 4.2.1 Passenger Demand

For each city-pair market there are recognized preferred passenger travel times. Passenger preferences can be observed and represented by hour of the day, distribution of demand, or profiles of desired departure times. As an example of this, the time of day passenger travel preference for eastbound and westbound markets in the 1,200 mile range is shown in Figure 4.4. These histograms, showing the percent of total daily passengers on 1,200 miles markets preferring to travel at different hours in the day, were developed from an analysis of time of day seat departure patterns scheduled in the May 15, 1974, OAG. Other histograms were developed for short-haul, north-south markets, and for east and westbound medium, long, and continental distances. In all, eight passenger demand profiles were developed and used for this analysis. These profiles are shown in Appendix C.

In each market profile, passengers can be grouped into equal size segments of demand. That is, demand can be represented by clusters or groups of equal numbers of passengers. At peak hours of demand, groups of passengers occur more frequently than during off-peak hours. For convenience, each passenger group can be equal in number to the seating capacity of a commercial aircraft. The airline schedule must provide aircraft of sufficient capacity to service these groups of passengers at the times when they prefer to travel.

FIGURE 4.4
TIME OF DAY PASSENGER TRAVEL PREFERENCES
1200 MILE MARKETS



### 4.2.2 Fleet Scheduling

In the absence of any constraints on number of airplanes available, an airline scheduler would assign aircraft departures to the mid-point in time of each group of passengers, or segment of passenger demand. At peak hour of demand, the time between aircraft departures would be short, while in off-peak hours, time between departures would be longer.

The scheduler has a limited number of aircraft to use, however, and must service passenger demand with the aircraft available. To do this, he must move some flights away from the "ideal" schedule. For example, he must move some flights to an earlier departure, allowing them to connect at their destination with outbound flights. Or he may delay departures to connect with arriving aircraft.

The same scheduling strategy was used in this analysis. A scheduling model, SKEDGEN, began with a list of nonstop routes and associated frequencies of service. These were provided by the fleet assignment model, FA-4. Multistop routes were separated into their component nonstops and added to the nonstop listing. Then, an "ideal" schedule was developed to satisfy the demand. Aircraft were assigned departures at the mid-point in time of each group of passengers desiring air transportation. Then, in the manner of an airline scheduler, SKEDGEN adjusted departure times from ideal to minimize the number of aircraft required.

For the schedule adjustment operation, all the arrivals and departures at one airport were considered. Aircraft arrivals were advanced and/or departures delayed in order to allow single aircraft to serve on a connecting flight where two had been required for independent operations. This was continued so long as it did not interfere with aircraft schedules at another facility. Once the schedule at the first airport was adjusted, SKEDGEN considered the arrival/departure schedule at the next airport, and so on. The result of this fleet minimizing heuristic was an "Official Airline Guide" (OAG) type timetable of arrivals and departures for the entire system. As an example, the OAG generated for Chicago, O'Hare, year 2000, is shown in Figure 4.5.

Another key output provided by SKEDGEN, the one important for delay calculations, was the time of day history of aircraft activities at each airport. These histories, derived from the arrival and departure timetables, give the amount of peaking at an airport, a fundamental characteristic in the delay computations. The time of day aircraft movements forecast at Boston for the year 2000 are shown as an example in Figure 4.6.

## FIGURE 4.5
## FORECAST SCHEDULE OF FLIGHT ARRIVALS AT CHICAGO OHARE

**FAA UG3RD EVALUATION**
**COMPLEMENTARY POLICY STRATEGIES**
**OFFICE OF AVIATION POLICY**

**FORECAST YEAR 2000**
**BASE CASE SCENARIO**
**SCHEDULED OAG**

**To CHICAGO, ILL. CST**
**ORD (O'HARE)**

**From ATLANTA, GA** — EST ALT

| Leave | Arrive |
|---|---|
| 6 40 | 7 10 |
| 7 45 | 8 15 |
| 8 30 | 9 00 |
| 10 10 | 10 40 |
| 10 50 | 11 20 |
| 11 50 | 12 20 |
| 13 00 | 13 30 |
| 14 20 | 14 50 |
| 15 25 | 15 55 |
| 16 20 | 16 50 |
| 17 10 | 17 40 |
| 17 55 | 18 25 |
| 18 35 | 19 05 |
| 19 25 | 19 55 |
| 20 20 | 20 50 |
| 22 00 | 22 30 |

**BOSTON, MASS** — EST ALT

| Leave | Arrive |
|---|---|
| 6 50 | 7 50 |
| 8 00 | 9 00 |
| 8 55 | 9 55 |
| 10 05 | 11 05 |
| 11 15 | 12 15 |
| 12 30 | 13 30 |
| 13 25 | 14 25 |
| 14 25 | 15 25 |
| 15 35 | 16 35 |
| 16 30 | 17 30 |
| 17 15 | 18 15 |
| 17 50 | 18 50 |
| 18 30 | 19 30 |
| 19 15 | 20 15 |
| 20 00 | 21 00 |
| 21 00 | 22 00 |

**CLEVELAND, OH** — EST CLE

| Leave | Arrive |
|---|---|
| 6 35 | 6 35 |
| 7 30 | 7 30 |
| 8 15 | 8 15 |
| 8 55 | 8 55 |
| 9 30 | 9 30 |
| 10 10 | 10 10 |
| 11 00 | 11 00 |
| 11 40 | 11 40 |
| 12 40 | 12 40 |
| 13 45 | 13 45 |
| 14 50 | 14 50 |
| 15 40 | 15 40 |
| 16 25 | 16 25 |
| 17 10 | 17 10 |
| 17 45 | 17 45 |
| 18 25 | 18 25 |
| 19 00 | 19 00 |
| 19 45 | 19 45 |
| 20 40 | 20 40 |
| 22 05 | 22 05 |

**DALLAS FT. WORTH, TEX** — CST DFW

| Leave | Arrive |
|---|---|
| 6 35 | 8 30 |
| 7 20 | 9 15 |
| 7 55 | 9 50 |
| 8 25 | 10 20 |
| 8 55 | 10 50 |
| 9 20 | 11 15 |
| 9 50 | 11 45 |
| 10 20 | 12 15 |
| 10 55 | 12 50 |
| 11 30 | 13 25 |
| 12 05 | 14 00 |
| 12 40 | 14 35 |
| 13 20 | 15 15 |
| 14 10 | 16 05 |
| 15 10 | 17 05 |
| 16 20 | 18 15 |
| 17 40 | 19 35 |
| 19 00 | 20 55 |
| 20 20 | 22 15 |

**DENVER, COL.** — MST DEN

| Leave | Arrive |
|---|---|
| 6 25 | 9 30 |
| 7 10 | 10 15 |
| 7 35 | 10 40 |
| 8 00 | 11 05 |
| 8 20 | 11 25 |
| 8 40 | 11 45 |
| 9 05 | 12 10 |
| 9 20 | 12 25 |
| 9 45 | 12 50 |
| 10 05 | 13 10 |
| 10 30 | 13 35 |
| 10 50 | 13 55 |
| 11 15 | 14 20 |
| 11 50 | 14 55 |
| 12 10 | 15 15 |
| 12 35 | 15 40 |
| 13 00 | 16 05 |
| 13 35 | 16 40 |
| 14 10 | 17 15 |
| 14 55 | 18 00 |
| 15 40 | 18 55 |
| 16 35 | 19 40 |
| 17 35 | 20 40 |
| 18 35 | 21 40 |
| 19 30 | 22 35 |
| 20 20 | 23 25 |

CONT NEXT COLUMN

**To CHICAGO, ILL. CST CHI**

**From DETROIT, MICH.** — EST DET

| Leave | Arrive |
|---|---|
| 6 20 | 6 10 |
| 7 10 | 7 00 |
| 7 40 | 7 30 |
| 8 10 | 8 00 |
| 8 35 | 8 25 |
| 9 05 | 8 55 |
| 9 30 | 9 20 |
| 9 55 | 9 45 |
| 10 30 | 10 20 |
| 11 00 | 10 50 |
| 11 30 | 11 20 |
| 12 05 | 11 55 |
| 12 45 | 12 35 |
| 13 35 | 13 25 |
| 14 20 | 14 10 |
| 15 00 | 14 50 |
| 15 35 | 15 25 |
| 16 05 | 15 55 |
| 16 35 | 16 25 |
| 17 30 | 17 20 |
| 17 55 | 17 45 |
| 18 25 | 18 15 |
| 18 50 | 18 40 |
| 19 15 | 19 05 |
| 19 45 | 19 35 |
| 20 25 | 20 15 |
| 21 10 | 21 00 |
| 22 20 | 22 10 |

**HOUSTON, TEX.** — CST HOU

| Leave | Arrive |
|---|---|
| 6 40 | 8 50 |
| 7 30 | 9 40 |
| 8 05 | 10 15 |
| 8 35 | 10 45 |
| 9 10 | 11 20 |
| 9 40 | 11 50 |
| 10 15 | 12 25 |
| 11 00 | 13 10 |
| 11 35 | 13 45 |
| 12 20 | 14 30 |
| 12 50 | 15 00 |
| 13 35 | 15 45 |
| 14 35 | 16 45 |
| 15 50 | 18 00 |
| 17 15 | 19 25 |
| 18 45 | 20 55 |
| 20 10 | 22 20 |

**KANSAS CITY, MO** — CST MKI

| Leave | Arrive |
|---|---|
| 6 40 | 7 45 |
| 7 45 | 8 50 |
| 8 30 | 9 35 |
| 9 15 | 10 20 |
| 10 00 | 11 05 |
| 10 50 | 11 55 |
| 12 05 | 13 10 |
| 13 00 | 14 05 |
| 14 20 | 15 25 |
| 15 25 | 16 30 |
| 16 20 | 17 25 |
| 17 10 | 18 15 |
| 17 55 | 19 00 |
| 18 35 | 19 40 |
| 19 25 | 20 30 |
| 20 20 | 21 25 |
| 22 00 | 23 05 |

**LAS VEGAS, NEV** — PST LAS

| Leave | Arrive |
|---|---|
| 6 20 | 11 30 |
| 7 00 | 12 10 |
| 7 35 | 12 45 |
| 8 05 | 13 15 |
| 8 35 | 13 45 |
| 9 05 | 14 15 |
| 9 40 | 14 50 |
| 10 10 | 15 20 |
| 10 45 | 15 55 |
| 11 20 | 16 30 |
| 12 00 | 17 10 |
| 12 30 | 17 40 |
| 13 10 | 18 20 |
| 13 55 | 19 05 |
| 14 45 | 19 55 |
| 16 00 | 21 10 |

**LOS ANGELES, CAL** — PST LAX

| Leave | Arrive |
|---|---|
| 6 10 | 11 50 |
| 6 30 | 12 50 |
| 7 00 | 12 40 |
| 7 15 | 12 55 |
| 7 30 | 13 10 |
| 7 45 | 13 25 |
| 8 00 | 13 40 |
| 8 15 | 13 55 |
| 8 30 | 14 10 |
| 8 45 | 14 25 |
| 9 00 | 14 40 |
| 9 15 | 14 55 |
| 9 30 | 15 10 |
| 9 45 | 15 25 |
| 10 05 | 15 45 |
| 10 20 | 16 00 |
| 10 40 | 16 20 |
| 10 55 | 16 35 |
| 11 10 | 16 50 |
| 11 30 | 17 10 |
| 11 45 | 17 25 |
| 12 05 | 17 45 |
| 12 25 | 18 05 |
| 12 40 | 18 20 |

CONT NEXT COLUMN

**To CHICAGO, ILL. CST CHI**

**From LOS ANGELES, CAL -CONT** — PST LAX

| Leave | Arrive |
|---|---|
| 13 00 | 18 40 |
| 13 20 | 19 00 |
| 13 45 | 19 25 |
| 14 05 | 19 45 |
| 14 30 | 20 10 |
| 15 00 | 20 40 |
| 15 35 | 21 15 |
| 16 25 | 22 05 |

**MIAMI, FLA.** — EST MIA

| Leave | Arrive |
|---|---|
| 6 50 | 8 30 |
| 8 00 | 9 40 |
| 8 55 | 10 35 |
| 9 55 | 11 35 |
| 11 20 | 13 00 |
| 12 35 | 14 15 |
| 13 30 | 15 10 |
| 14 25 | 16 05 |
| 15 35 | 17 15 |
| 16 30 | 18 10 |
| 17 15 | 18 55 |
| 17 50 | 19 30 |
| 18 30 | 20 10 |
| 19 15 | 20 55 |
| 20 00 | 21 40 |
| 21 00 | 22 40 |

**MINNEAPOLIS, MINN** — CST MSP

| Leave | Arrive |
|---|---|
| 6 30 | 7 30 |
| 7 15 | 8 15 |
| 7 55 | 8 55 |
| 8 25 | 9 25 |
| 8 55 | 9 55 |
| 9 25 | 10 25 |
| 9 55 | 10 55 |
| 10 30 | 11 30 |
| 11 05 | 12 05 |
| 11 50 | 12 50 |
| 12 30 | 13 30 |
| 13 30 | 14 30 |
| 14 20 | 15 20 |
| 15 05 | 16 05 |
| 15 45 | 16 45 |
| 16 20 | 17 20 |
| 16 55 | 18 55 |
| 17 25 | 18 25 |
| 17 55 | 18 55 |
| 18 25 | 19 25 |
| 18 55 | 19 55 |
| 19 30 | 20 30 |
| 20 10 | 21 10 |
| 21 00 | 22 00 |
| 22 15 | 23 15 |

**NEW ORLEANS, LA** — CST MSY

| Leave | Arrive |
|---|---|
| 7 15 | 9 15 |
| 8 45 | 10 45 |
| 10 00 | 12 00 |
| 11 30 | 13 30 |
| 13 25 | 15 25 |
| 15 40 | 17 40 |
| 19 10 | 21 10 |

**NEW YORK, N. Y.** — EST NYC

| Leave | Arrive |
|---|---|
| 6 10 | 6 35 |
| 6 40 | 7 05 |
| 7 05 | 7 30 |
| 7 20 | 7 45 |
| 7 30 | 7 55 |
| 7 45 | 8 10 |
| 8 00 | 8 25 |
| 8 15 | 8 40 |
| 8 25 | 8 50 |
| 8 40 | 9 05 |
| 8 50 | 9 15 |
| 9 05 | 9 30 |
| 9 20 | 9 45 |
| 9 35 | 10 00 |
| 9 50 | 10 15 |
| 10 10 | 10 35 |
| 10 30 | 10 55 |
| 10 55 | 11 20 |
| 11 10 | 11 35 |
| 11 30 | 11 55 |
| 11 45 | 12 10 |
| 12 00 | 12 25 |
| 12 15 | 12 40 |
| 12 30 | 12 55 |
| 12 45 | 13 10 |
| 13 00 | 13 25 |
| 13 15 | 13 40 |
| 13 25 | 13 50 |
| 13 40 | 14 05 |
| 13 50 | 14 15 |
| 14 05 | 14 30 |
| 14 20 | 14 45 |
| 14 35 | 15 00 |
| 14 50 | 15 15 |
| 15 05 | 15 30 |
| 15 25 | 15 50 |
| 15 40 | 16 05 |
| 15 55 | 16 20 |
| 16 05 | 16 30 |
| 16 20 | 16 45 |
| 16 30 | 16 55 |
| 16 40 | 17 05 |
| 16 50 | 17 15 |
| 17 00 | 17 25 |
| 17 10 | 17 35 |

CONT NEXT COLUMN

**To CHICAGO, ILL. CST CHI**

**From NEW YORK, N. Y.-CONT.** — EST NYC

| Leave | Arrive |
|---|---|
| 17 20 | 17 45 |
| 17 30 | 17 55 |
| 17 35 | 18 00 |
| 17 45 | 18 10 |
| 17 55 | 18 20 |
| 18 05 | 18 30 |
| 18 15 | 18 40 |
| 18 25 | 18 50 |
| 18 35 | 19 00 |
| 18 45 | 19 10 |
| 18 50 | 19 15 |
| 19 05 | 19 30 |
| 19 15 | 19 40 |
| 19 25 | 19 50 |
| 19 35 | 20 00 |
| 19 50 | 20 15 |
| 20 00 | 20 25 |
| 20 10 | 20 35 |
| 20 25 | 20 50 |
| 20 35 | 21 00 |
| 20 50 | 21 15 |
| 21 05 | 21 30 |
| 21 25 | 21 50 |

**PHILADELPHIA, PA** — EST PHL

| Leave | Arrive |
|---|---|
| 6 40 | 7 20 |
| 7 35 | 8 15 |
| 8 20 | 9 00 |
| 9 05 | 9 45 |
| 9 50 | 10 30 |
| 10 55 | 11 35 |
| 11 55 | 12 35 |
| 12 45 | 13 25 |
| 13 25 | 14 05 |
| 14 10 | 14 50 |
| 14 55 | 15 35 |
| 15 50 | 16 30 |
| 16 30 | 17 10 |
| 17 05 | 17 45 |
| 17 30 | 18 10 |
| 18 00 | 18 40 |
| 18 35 | 19 15 |
| 19 05 | 19 45 |
| 19 40 | 20 20 |
| 20 20 | 21 00 |
| 21 05 | 21 45 |

**PITTSBURG, PA.** — EST PIT

| Leave | Arrive |
|---|---|
| 6 30 | 6 35 |
| 7 25 | 7 30 |
| 8 05 | 8 10 |
| 8 40 | 8 45 |
| 9 15 | 9 20 |
| 9 50 | 9 55 |
| 10 30 | 10 35 |
| 11 05 | 11 10 |
| 11 45 | 11 50 |
| 12 45 | 12 35 |
| 13 50 | 13 55 |
| 14 45 | 14 50 |
| 15 35 | 15 40 |
| 16 15 | 16 20 |
| 16 55 | 17 00 |
| 17 30 | 17 35 |
| 18 05 | 18 10 |
| 18 40 | 18 45 |
| 19 25 | 19 30 |
| 19 55 | 20 00 |
| 20 50 | 20 55 |
| 22 10 | 22 15 |

**SAN FRANCISCO, CAL** — PST SFO

| Leave | Arrive |
|---|---|
| 6 30 | 12 20 |
| 7 15 | 13 05 |
| 7 40 | 13 30 |
| 8 05 | 13 55 |
| 8 20 | 14 10 |
| 8 40 | 14 30 |
| 9 00 | 14 50 |
| 9 20 | 15 10 |
| 9 35 | 15 25 |
| 9 55 | 15 45 |
| 10 15 | 16 05 |
| 10 40 | 16 30 |
| 11 00 | 16 50 |
| 11 20 | 17 10 |
| 11 45 | 17 35 |
| 12 10 | 18 00 |
| 12 50 | 18 40 |
| 13 30 | 19 20 |
| 14 30 | 20 20 |
| 15 35 | 21 25 |

**SEATTLE, WASH** — PST SEA

| Leave | Arrive |
|---|---|
| 6 25 | 12 00 |
| 7 15 | 12 50 |
| 7 45 | 13 20 |
| 8 20 | 13 55 |
| 8 55 | 14 30 |
| 9 35 | 15 10 |
| 10 10 | 15 45 |
| 10 50 | 16 25 |
| 11 30 | 17 05 |
| 12 10 | 17 45 |
| 12 50 | 18 25 |
| 13 35 | 19 10 |
| 14 35 | 20 10 |
| 15 55 | 21 30 |

**FIGURE 4.6**
**TIME-OF-DAY AIRCRAFT MOVEMENTS AT BOSTON, YEAR 2000**

| TIME OF DAY | NUMBER OF ARRIVALS AND DEPARTURES 10 | 20 | 30 | 40 | 50 |
|---|---|---|---|---|---|
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |
| 6 | | | | | |
| 7 | DDDDDDADD | | | | |
| 8 | DDDDAAADDD | DADDDA | | | |
| 9 | DDDDAADAAD | DAADDADADD | DAADDDDA | | |
| 10 | DDDAADADDD | AAADAADADD | DADAAAADDD | A | |
| 11 | DDAAADDDAD | DAAADDAAAD | DDDAADDDAD | | |
| 12 | DAAAADDAAD | AAADADDAAA | ADDAADAADA | A | |
| 13 | DDADADADAD | AAADDAAAAD | DDAAADA | | |
| 14 | DADAAADDAA | DADDDAAADA | AADDDDD | | |
| 15 | DAAADDDDAD | DADDADDAAA | AAADDAADD | | |
| 16 | AAADAADDAA | ADDDAAAAAA | DDDDA | | |
| 17 | DDDAADAADD | AADDDDAADD | DAAADDAAAD | A | |
| 18 | DDAADDDDAA | ADDDAAAAAA | DDDADDADDA | DAA | |
| 19 | DDAADDDDAA | DDDAAAAAAD | DADAADDDAD | DADAAADDDA | |
| 20 | DAADDDDDAA | DDDDAAAAAD | DAADDDADDA | A | |
| 21 | AADDAADAAD | AADDAAAAAD | DDDA | | |
| 22 | ADDDAADAAA | AAA | | | |
| 23 | DDAADAADAA | A | | | |
| 24 | AAAA | | | | |

28 OVERNIGHTING AIRCRAFT

A: ARRIVAL
D: DEPARTURE

## 4.3 Delay Calculations

The estimation of average and total airside delays at major airports is usually based either on queuing theory or on computer supported simulation. Alternatively, an extensive data collection program on delays at the airport of interest can be initiated. The work described here uses a simple and practical tool, A Handbook of Airport Delays, from which airport delays can be estimated using the knowledge of a few basic variables associated with any given airport. 3/

The basic quantity with which the handbook deals is that of average total daily delays (TDDEL's), i.e., the total delays experienced in the course of a typical day by aircraft attempting to use the runways of an airport. The delays referred to here are solely those due to normal runway congestion and do not reflect problems that may be due, for instance, to exceptional weather conditions or to other causes. No distinction is made between delays suffered by landing aircraft which have to queue in the air and those suffered by departing aircraft on the ground.

### 4.3.1 The Handbook of Airport Delays

The Handbook of Airport Delays is a collection of data statistics for a set of demand profiles specifically chosen to represent observed current demand patterns at air carrier airports. These profiles are used by computing airport delays by matching the demand profile under observation with that profile it most closely resembles in the Handbook of Airport Delays.

Standard profiles in the handbook were developed from traffic patterns at the top 100 U.S. airports. 4/ Two basic descriptions of demand characterize the profiles developed.

1. The number of daily peak periods. This identifies the general shape of the demand profile.

3/ A Handbook for the Estimation of Airside Delays at Major Airports, Amedeo Odoni and Peeter Kivestu, NASA Contractor Report NASA CR-2644, June 1976.

4/ Profiles of Scheduled Air Carrier Airport Operations - Top 100 U.S. Airports, Department of Transportation, Federal Aviation Administration, November 1973, and August 1974.

2. The "peak-hour operations as a percent of total daily operations." This is a rough indicator of the sharpness of the peaks and valleys in the demand profile. 5/

Ten profiles developed were representative of the traffic patterns observed at the top 100 airports. These profiles are identified below.

| | | |
|---|---|---|
| NP 7 - no peak 7% | OP 7 - one peak 7% | TP 7 - two peak 7% |
| NP 8 - no peak 8% | OP 8 - one peak 8% | TP 8 - two peak 8% |
| | OP 9 - one peak 9% | TP 9 - two peak 9% |
| | OP10 - one peak 10% | TP10 - two peak 10% |

The graphs of TDDEL, for each of the ten profiles plotted against an average "hourly" capacity, are provided in the handbook with the computational techniques described in this section. These ten TDDEL graphs are the core of the handbook. The user selects one of the ten profiles most closely matching the observed airport profile. Knowledge of the airport capacity then allows straightforward graphical lookup from the appropriate TDDEL graph. For example, Figure 4.7 illustrates the "two peak; 8 percent" (TP8) standard traffic profile. For this profile, total daily delay values (TDDEL's) were developed using the delay programs discussed in Section 4.3.2. These are shown as a series of nomographs in Figure 4.8. Given an airport with a TP8 profile, 86 operations/hour capacity, and 92 operations in the peak hour, daily delay is approximately 5,400 minutes.

### 4.3.2. Delay Programs

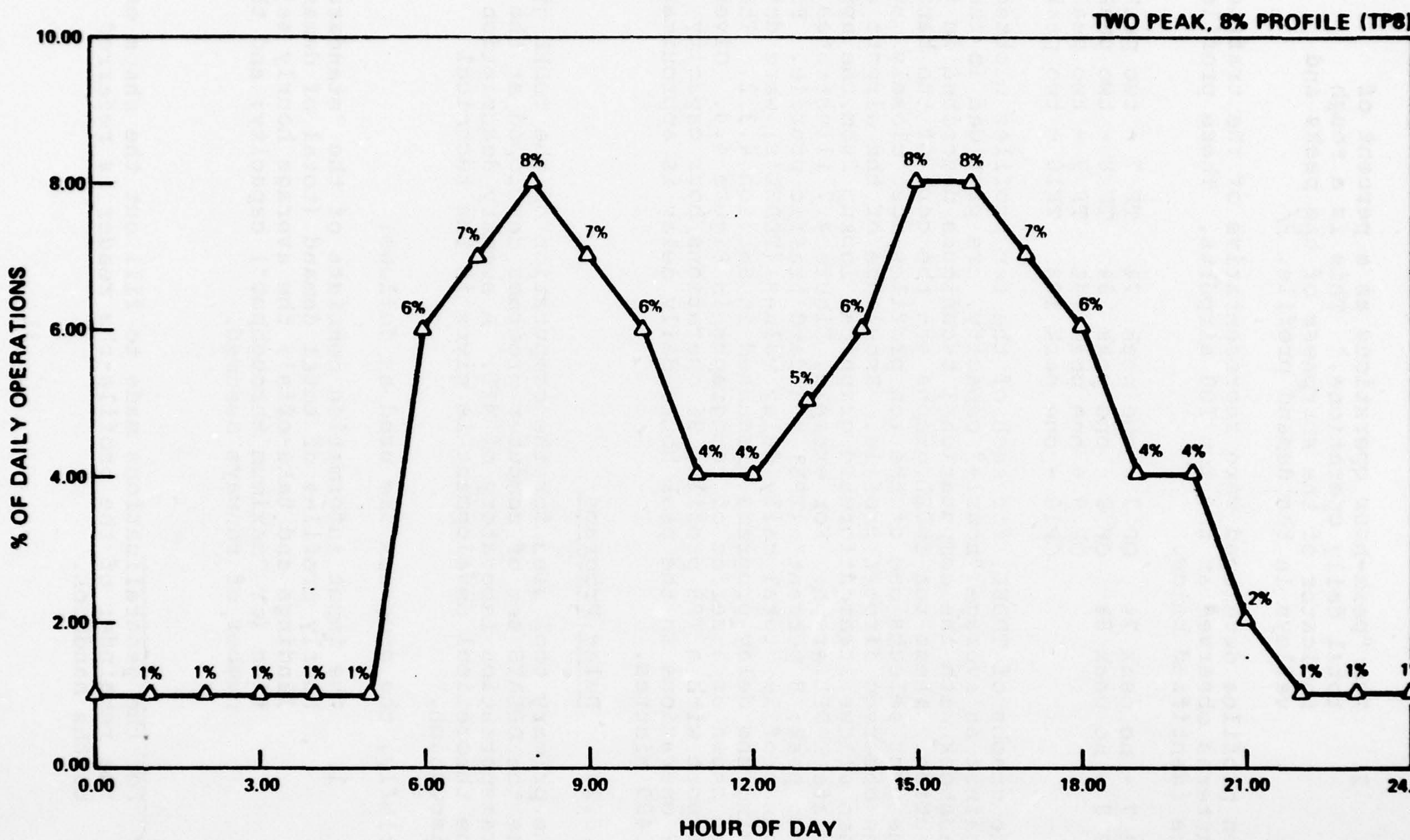
The primary tool used for the computation of the TDDEL graphs was the DELAYS set of computer programs developed at the Flight Transportation Laboratory of MIT. A summary description of the theoretical development is given in the technical discussion.

Briefly, the programs are used as follows:

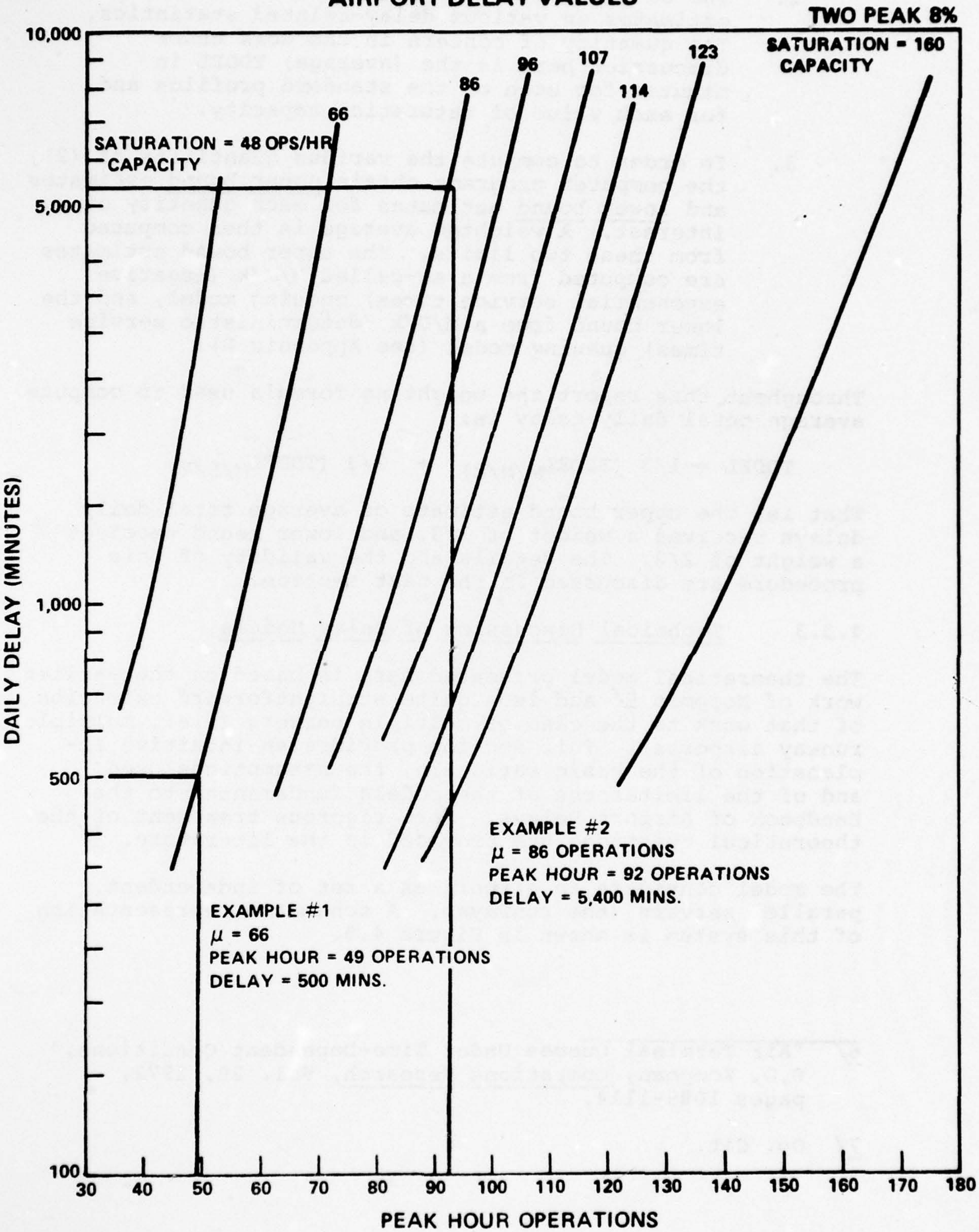
1. The input information consists of the "standard" hourly profiles of total demand (total of demanded landings and take-offs); the average hourly saturation (or "maximum throughput") capacity; and the number of runways assumed.

5/ For the generalizations made to fill out the shape of the remainder of the profile the reader is referred to the handbook.

## FIGURE 4.7
## AIRPORT TRAFFIC DISTRIBUTION



## FIGURE 4.8
## AIRPORT DELAY VALUES



2. The output of the computer programs provides estimates on various delay-related statistics. The quantity of concern in the work under discussion here is the (average) TDDEL in minutes for each of the standard profiles and for each value of saturation capacity.

3. In order to compute the various quantities of (2), the computer programs obtain upper bound estimates and lower bound estimates for each quantity of interest. A weighted average is then computed from these two limits. The upper bound estimates are computed from a so-called M/M/k (negative exponential service times) queuing model, and the lower bound from a M/D/k (deterministic service times) queuing model (see Appendix D).

Throughout this report the weighting formula used to compute average total daily delay is:

$$TDDEL = 1/3\ (TDDEL_{M/M/k}) + 2/3\ (TDDEL_{M/D/k})$$

That is, the upper bound estimate of average total daily delays receives a weight of 1/3, and lower bound receives a weight of 2/3. The details and the validity of this procedure are discussed in the next section.

### 4.3.3 Technical Discussion of Delay Models

The theoretical model presented here is based on the earlier work of Koopman 6/ and is a quite straightforward extension of that work to the case of multiple servers (i.e., multiple runway airports). This section provides an intuitive explanation of the basic rationale, the assumptions used, and of the limitations of the models fundamental to the Handbook of Airport Delays. More rigorous treatment of the theoretical questions are provided in the literature. 7/

The model considers an airport as a set of independent, parallel servers (the runways). A schematic representation of this system is shown in Figure 4.9.

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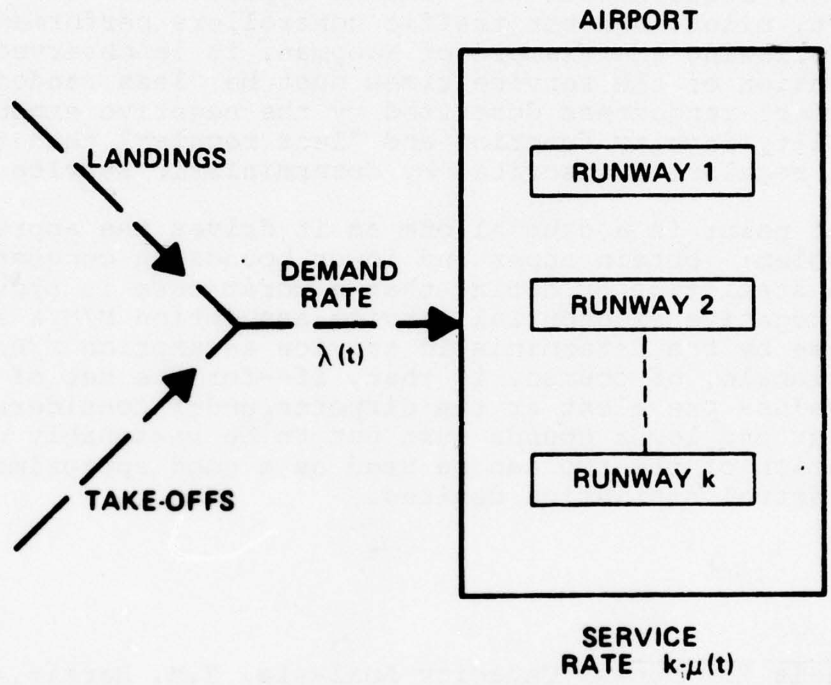
6/ "Air Terminal Queues Under Time-Dependent Conditions," B.O. Koopman, Operations Research, Vol. 20, 1972, pages 1089-1114.

7/ Op. Cit.

**FIGURE 4.9**

**SCHEMATIC REPRESENTATION OF THE QUEUING MODEL**



It is assumed that the total demand at the airport--that is, the sum of the demands for landing and for take-offs--is a Poisson process with a time-dependent average demand rate, given by $\lambda(t)$. The Poisson assumption for airport demand is consistent with actual observations at several major airports and has been used extensively in the literature. 8/

By contrast, the form of the probability law describing the duration of a service at the runways is still a matter for speculation. 9/ The duration of the period, during which a runway is busy with an aircraft, depends on such diverse factors as type of operation being conducted, weather, aircraft mix, runway configuration in use, runway surface conditions, location of runway exits, air traffic control equipment, requirements for minimum separations between aircraft, pilot, and air traffic controllers performance, etc. Following the example of Koopman, it is observed that the duration of the service times must be "less random" than the perfect randomness described by the negative exponential probability density function and "less regular" than the perfect regularity described by deterministic service times.

The last point is a crucial one as it drives the approach to the problem: obtain upper and lower bounds on congestion-related statistics by noting that a worst case is provided by the negative exponential service assumption M/M/k and a best case by the deterministic service assumption M/D/k. The rationale, of course, is that, if--for the set of parameter values prevalent at the airports under consideration--the upper and lower bounds turn out to be reasonably weighted combination of the two can be used as a good approximation of the actual statistics desired.

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8/ Models for Runway Capacity Analysis, R.M. Harris, Report MITRE, the MITRE Corporation, McLean, Virginia, December 1972. Also, Analysis of a Capacity Concept for Runway and Final Approach Path Airspace, U.S. National Bureau of Standards, Report No. NBS-10111, AD-698-521, November 1969.

9/ An Analytic Investigation of Air Traffic in the Vicinity of Terminal Areas, A.R. Odoni, Operations Research Center, Massachusetts Institute of Technology, Cambridge, 1969.

Here, then, is the strategy to be followed: Given an airport with k independent runways, each of which has a time-dependent average service rate $\lambda(t)$, solve iteratively, and for the desired period of time, two systems of equations, one describing an M/M/k queuing system and the other an M/D/k queuing system. [10/] The actual values of interest will then be bounded from above and below by the values obtained from these two queuing models. This whole approach is dictated by the fact that the differential equations describing an M/G/k (arbitrary) queuing system--a more realistic model for the case of interest--are unwieldy even for the purpose of obtaining numerical solutions.

## Assumptions in the Model

To complete the description of queuing models which are fundamental to the airport delay calculations, the assumptions which were made are identified here. The most important of these, from a practical viewpoint, is the assumption of the existence of a single queue of aircraft awaiting use of the runways on a strictly first-come, first-served basis. Thus, there is no distinction between landing and departing aircraft. While, in practice, the average service times (and the probability distributions) for landings and take-offs are different, a single weighted average service time for both kinds of operations is used.

Another assumption is that all active runways (or, all the parallel servers in Figure 4.9) operate independently and are identical. In practice, runways often cannot be operated independently, since operations at one may affect those on another, due to airport geometry. Again, from the practical viewpoint, this assumption is not too restrictive since dependencies among the servers, if they exist, can be accounted for by adjusting the service rates accordingly. As an example, consider an airport with a single runway which can handle, say, 50 aircraft movements per hour, i.e., the average service time in 72 seconds. Suppose, now, that operations are begun at a second runway which intersects the first one. Then, the overall airport capacity might increase to, say, 80 operations per hour, and not to 100 as it would if the two runways were independent. To account for this in our model, we would then assume the existence of a single independent server, with an average service time of 45 seconds, for an overall airport capacity of 80 movements per hour.

10/ The M/M/k and M/D/k queuing systems are described in Appendix D.

Obviously, the number of state-transition equations, describing the queuing models and being iteratively solved by the computer, must be finite. Since the number of such equations is equal to the number of states in the queuing model, it must be assumed that the queuing system of Figure 4.8 can accommodate up to a maximum of *m aircraft* (including the ones in service at the k servers). The variable m can be selected large enough to make it highly unlikely that the number of aircraft in the terminal area, at any given instant, will be equal to m.

Finally, it is assumed that successive service times are statistically independent. This is substantially true in reality, as little attempt is made under today's air traffic control regime to sequence operations in anything but a first-come, first-served way. Successive service times are, therefore, randomly mixed according to the mix of aircraft with little or no interdependence among them.

## 5.0 Analytical Approach

Peak-pricing and quotas were evaluated in this analysis on the basis of potential reductions offered in congestion and air carrier delays at the 25 largest air carrier airports. Delays were computed assuming a system of: (1) conventional airport improvements, (2) peak pricing and quotas, (3) UG3RD improvements, and (4) peak-pricing and UG3RD. Different scenarios were developed to represent these situations.

Airline passenger enplanements through the year 2000 were forecast, and the airport network model, introduced in Chapter 4, was developed to translate these anticipated enplanements into projected air carrier aircraft operations. Delays at each airport were computed on the basis of air carrier traffic projections.

Total airport system delays were assessed for each scenario. The alternatives under review, peak-pricing, quotas, and the UG3RD, were evaluated by comparing system delays in each scenario.

The work program undertaken to accomplish this analysis can be divided into four major elements:

1. Development of Scenarios
2. Passenger Demand Forecast
3. Air Traffic Forecast
4. Delay Computation

Each of these elements is discussed in the following sections.

## 5.1 Development of Scenarios

In order to test the impact of quotas and peak-load pricing on airport system delays, a series of four operational scenarios or situations was developed. Each scenario defined a unique air transportation system in terms of airport capacities and air traffic demand. Two of the scenarios employed peak-pricing and quotas, two did not. Each scenario, however, provided for equivalent numbers of air passengers carried.

The four scenarios included:

- Base Case Scenario

  The airport system enhanced only by conventional capacity improvements

- Peak Pricing and Quota Scenario

  Pricing and administrative options provided in addition to conventional airport improvements

- UG3RD Scenario

  Airport capacities were enhanced with UG3RD hardware features 1/

- Peak-Pricing and UG3RD Scenario

  Peak-pricing schedules supplementing UG3RD hardware improvements

In the Base Case scenario, airport capacities were generally defined by the present system. Time phased capacity enhancements provided by conventional hardware improvements (parallel runways, extended runways, extra taxiways, etc.) over the period 1975-2000 were identified by the MITRE Corporation. 2/ Typically, a schedule of capacities, or throughput rates, were identified for each airport in the network at 5-year intervals through the planning period.

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1/ UG3RD components are described in The National Aviation System: Challenges of the Decade Ahead, 1977 - 1986, DOT, FAA, 1976.

2/ Airport capacities and improvement schedules under each scenario are defined in the MITRE Corporation memorandum W 43-127.7, July 31, 1975.

Discussions of the subject of airport capacity often assume a single value. Actually, airports may have numerous capacities, each operating at different times.

In the Base Case scenario, airports were identified by up to four capacities. At most airports, Visual Flight Rules (VFR) capacity exceeded the capacity under Instrument Flight Rules (IFR) conditions. This is explained by the fact that aircraft operating in visual conditions are able to maintain closer separation, which means that more aircraft can use the facilities in a given period of time. Similarly, at most airports there is a difference in capacity when aircraft are using the normal duty runways and the capacity which prevails during cross-wind conditions when an alternative runway is required. Airports are generally configured to provide maximum capacity during normal wind conditions.

The case of Boston's Logan Airport can be used as an example. The four current Base Case capacities at Logan are shown below:

| Runway Strategy | IFR | VFR |
|---|---|---|
| Normal | 53.9 | 111.3 |
| Cross-Winds | 50.3 | 89.8 |

The relative percentage of times in each condition are as follows:

| Runway Strategy | IFR | VFR | All Conditions |
|---|---|---|---|
| Normal | 8% | 63% | 71% |
| Cross-Winds | 8% | 21% | 29% |
| All Conditions | 16% | 84% | 100% |

For each time period, each of the capacity measures shown above and the percentage of time in that capacity condition is figured in the analysis.

## 5.2 Passenger Demand Forecast

The scenarios described in Section 5.1 were compared by examining the capacity of each to accommodate air passenger forecasts through the year 2000. These passenger forecasts, developed by the FAA's Aviation Forecast Branch, are shown in Table 5.1. For a quantitative discussion of the forecasting methodology, the reader is referred to Appendix A in *Aviation Forecasts--Fiscal Years 1975 to 1986*.

Projected air carrier passenger enplanements are derived from econometric forecasting models. The fundamental assumptions underlying these models are that various measures of aviation activity are related to the level of economic activity and that the various activity measures are dependent on one another in a predictable way. The model for air carrier enplanements is based upon economic data from the years 1964 through 1973. The model relates level of air carrier activity to the total consumption of services, the number of civilians employed, investment expenditure in the aircraft industry, the price of air travel relative to that of other modes of transportation, and purchases of automobiles. Tests of the model show that an increase in automobile purchases or air fares can be expected to result in a decrease in revenue passenger enplanements, whereas increasing the portion of the population that uses air carrier services, improving the level of service, or increasing the consumption of services can be expected to increase enplanements.

## TABLE 5.1

## UNITED STATES CERTIFICATED ROUTE AIR CARRIER DOMESTIC SCHEDULED PASSENGER TRAFFIC 1/

| Fiscal Year | Revenue Passenger Enplanements (Millions) |
|---|---|
| 1975 | 200.7 |
| 1976 | 215.3 |
| 1977 | 231.0 |
| 1978 | 247.8 |
| 1979 | 262.3 |
| 1980 | 276.1 |
| 1981 | 288.5 |
| 1982 | 301.7 |
| 1983 | 315.0 |
| 1984 | 328.9 |
| 1985 | 346.0 |
| 1986 | 355.0 |
| 1987 | 369.1 |
| 1988 | 383.9 |
| 1989 | 399.1 |
| 1990 | 415.1 |
| 1991 | 431.8 |
| 1992 | 448.4 |
| 1993 | 466.3 |
| 1994 | 483.7 |
| 1995 | 502.1 |
| 1996 | 520.7 |
| 1997 | 540.7 |
| 1998 | 561.5 |
| 1999 | 588.2 |
| 2000 | 604.5 |

1/ UG3RD Baseline and Implementation Scenario. National Baseline Forecast. FAA Policy Development Division, November 20, 1975.

It was assumed for the Base Case scenario that aircraft were serviced, or allowed runway access on a first come, first served basis. With no priority system, therefore, the probability that any one type of aircraft was first in the queue for runway use was equal to the relative percentage of use by that type (air carrier, air taxi, military, etc.). At each airport, it was assumed that military, commuter, air taxi, other general aviation, and nonscheduled operations accounted for 20 percent of the runway demand throughout the day. 3/ This was accomplished in the analysis by assigning 20 percent of available airport capacity to these users.

Airport capacities in the Peak-Pricing and Quota Scenario were the same as described in the Base Case throughout the planning period. However, airports were assumed to price non-air carrier traffic (defined here as military, air taxi, commuter, other general aviation, and non-scheduled operators) out of the system whenever delays were encountered. At most airports, this still allowed a variable amount of unscheduled use during VFR or off-peak conditions.

In the Peak-Pricing and Quota Scenario, airport which experienced significant annual average delays imposed peak-pricing schedules to smooth air carrier demands. A 6-minute rule was used to identify significant annual airport delay. At 6 minutes of annual delay, an airport experiences noticeable delays in all operating conditions. During VFR operations, which typically occur approximately 85 percent of the time, delays amount to slightly less than 4 minutes on the average. In IFR conditions, average delay can approach 20 minutes per aircraft movement, or 40 minutes per flight, and airlines may begin to cancel operations. For this analysis, peak-pricing schedules were implemented by smoothing passenger demands on flights which arrive and depart congested airports. This had the effect of smoothing aircraft demand. Finally, absolute daily quotas were imposed whenever peak-time pricing was inadequate to limit average annual delay to 6 minutes or less.

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3/ This assumption was made in order to facilitate the analysis. Latest figures show that general aviation, air taxi (commuter), and military aircraft traffic ranges from 13 percent of all operations (in Atlanta) to 65 percent (in Las Vegas). This traffic averages 20 percent of total at the top seven commercial airports, and for this reason, the 20 percent estimate was chosen. The reader is referred to FAA Air Traffic Activity, CY-1974, DOT, FAA, March 1974, page 34. Also, The National Aviation System: Challenges of the Decade Ahead, 1977-1986, DOT, FAA, 1976, page 5.

Airport capacities in the UG3RD Scenario, the third of four scenarios developed, were enhanced by time-phased implementation of conventional improvements, as well as the technical features of the UG3RD. One of these features, the Wake Vortex Avoidance System (WVAS), is programmed to detect wake vortex dissipation, and will allow terminal aircraft operation at lower separation standards and higher frequencies. This adds a third dimension to the airport capacity matrix, as shown below for Logan Airport.

LOGAN AIRPORT CAPACITY, YEAR 2000

| Wake Turbulence / No Wake Turbulence | IFR | VFR |
|---|---|---|
| Normal Winds (Wake Turbulence) | 66.8 | 129.6 |
| Normal Winds (No Wake Turbulence) | 82.1 | 135.9 |
| Cross Winds (Wake Turbulence) | 58.3 | 97.0 |
| Cross Winds (No Wake Turbulence) | 58.9 | 107.0 |

The percentage of time in each condition is as follows:

| Wake Turbulence / No Wake Turbulence | IFR | VFR |
|---|---|---|
| Normal Winds (Wake Turbulence) | 2% | 40% |
| Normal Winds (No Wake Turbulence) | 6% | 13% |
| Cross Winds (Wake Turbulence) | 2% | 8% |
| Cross Winds (No Wake Turbulence) | 6% | 5% |

In other words, each of the airports in this scenario can be described by up to eight capacities, each one operating at different times. The capacity estimates for all airports evaluated are presented in Appendix E.

The fourth, and final, case is the Peak-Pricing, UG3RD Scenario, which incorporates UG3RD improvements, as well as the peak-time pricing strategy already described. Because of the increase in airport capacities provided by the UG3RD, and the smoothed demand under a peak-pricing schedule, no quotas were required in this scenario.

Numerous assumptions were made regarding the general economic climate for the planning period of this report. These assumptions and the forecast economic variables for the air carrier enplanement models relate to those variables used by the Council of Economic Advisors. The factors discussed here include forecasts of several of these key economic indicators. 4/

First, the Nation's gross national product (GNP) in constant 1958 dollars is forecast to increase from $748 billion (est) in 1975 to $1,169 billion in 1985, an average growth rate of 4.0 percent per year. GNP is estimated to reach $1,870 billion by the year 2000 at an average growth rate of 3.2 percent per year. See Figure 5.1. Population is expected to grow at the rate of 1 percent per year.

Total personal consumption expenditures are expected to increase from $533 billion (est) in constant 1958 dollars in 1975 to $770 billion in 1985, and $1,201 billion in 2000. See Figure 5.2.

It is anticipated that the inflation rate will decrease from 10.1 percent (est) in 1975 to an average of 7.1 percent per year until 1980, then 5.5 percent per year from 1980 to 1985, and then 5 percent per year from 1985 until 2000.

Finally, real personal disposale income (RDI) is expected to grow at an annual average rate of 4.5 percent for the period 1975 through 1986, the rate of growth (about 5.2 percent) increasing for the 1987 through 1990 period and slowing (about 3.4 percent) for 1991 through 2000. The assumed increase in RDI's rate of growth for 1987 through 1990 is based upon the expectation of continued strong expansionary fiscal policies and large catch-up wage gains after a prolonged drop in real wages. The relatively slower rate of growth over the 1990 through 2000 period is attributed to expected moderation in wage demands, constraints placed upon Government expansionary policy due to increased tax burden, rekindled inflationary pressures stemming partly from earlier wage gains, and partly from energy shortages and expected capacity bottlenecks impacting on employment.

4/ Provided by UG3RD Baseline and Implementation Scenario, FAA Policy Development Division, November 20, 1975.

FIGURE 5.1
PROJECTED GROSS NATIONAL PRODUCT
(1958 DOLLARS)

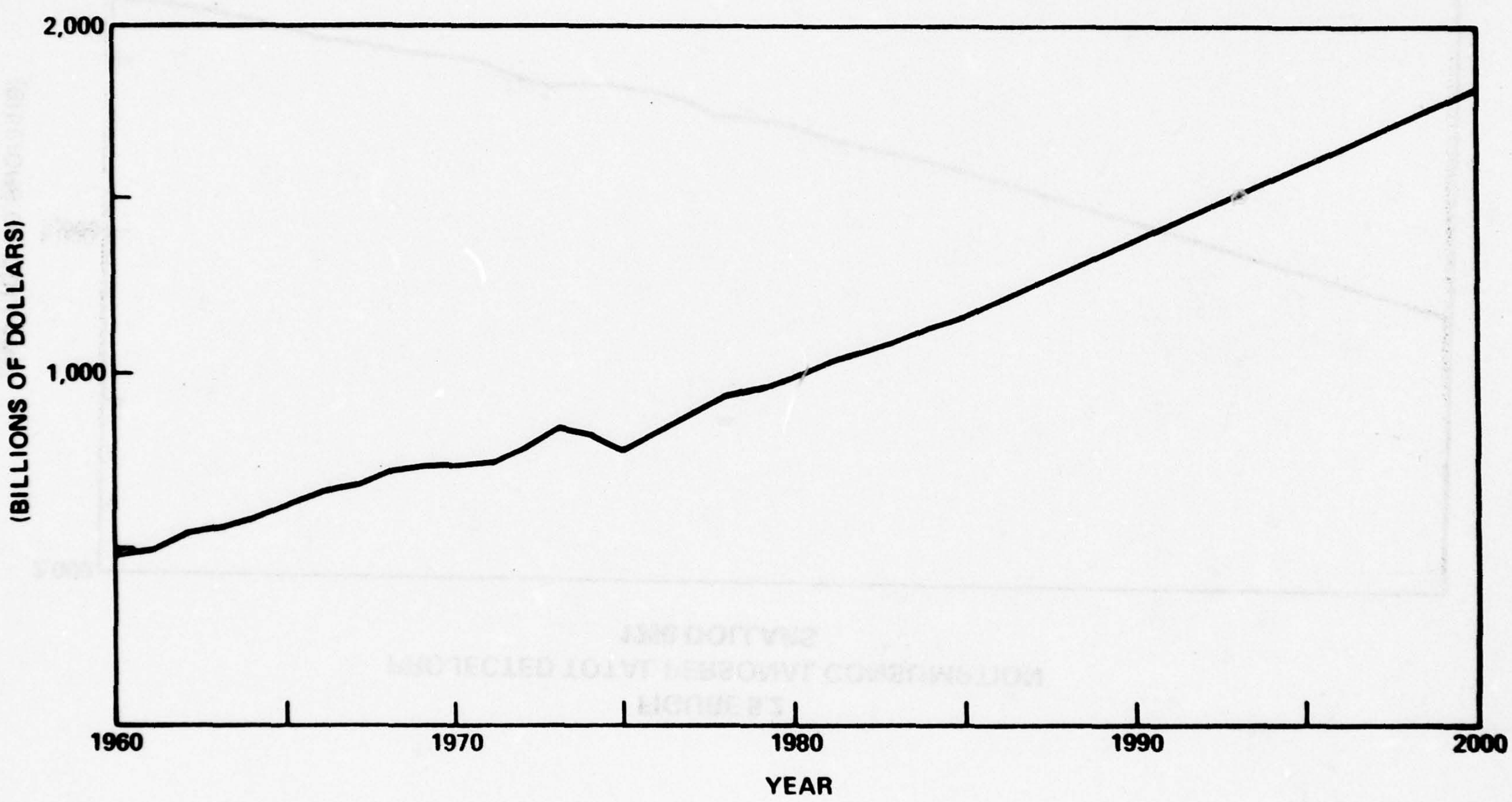
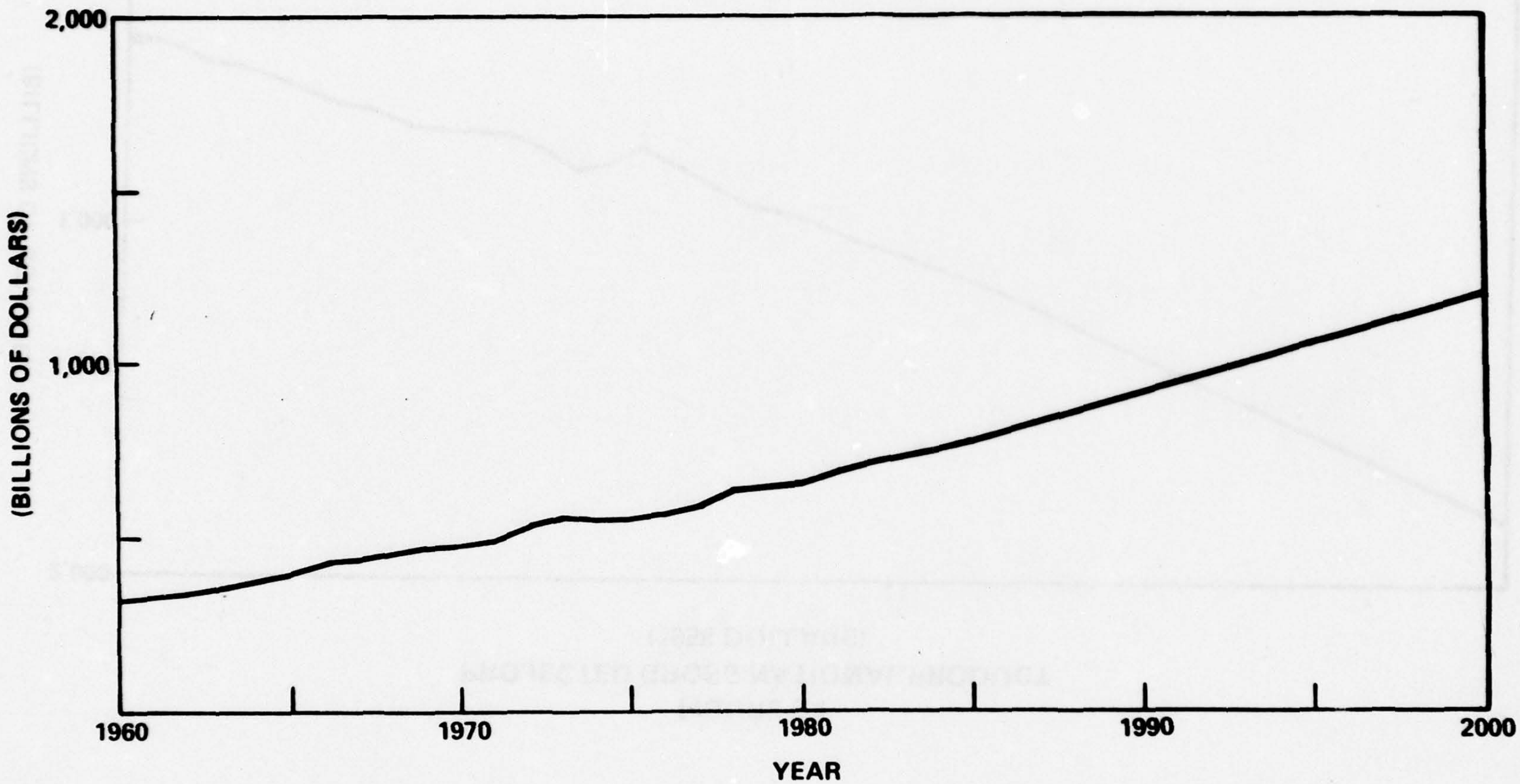


FIGURE 5.2
PROJECTED TOTAL PERSONAL CONSUMPTION
1958 DOLLARS



Passenger enplanement forecasts, once developed, were used to derive projected passenger demands on each city pair market. Using 1974 as a base, the growth rate of passenger enplanements was computed at 5 year intervals through the year 2000. This growth schedule, roughly averaging 4.5 percent annual increase, is shown in Table 5.2.

To establish the level of activity in 1974, current (1974) passenger demand on each city pair market was compiled from Civil Aeronautics Board (CAB) publications. 5/ This passenger demand is presented in Appendix F. Passenger forecasts were then derived by multiplying the number of passengers on each 1974 market (Appendix F) by the growth factors shown in Table 5.2. This provided an estimate of the passenger demand on each city pair market for each forecast year through the planning period.

### 5.3. Air Traffic Projections

Aircraft traffic projections were derived from passenger enplanement forecasts using the airport network model described in Chapter 4.0. Delays at each airport, then, were computed from these air traffic projections.

Several features of the network model that should be mentioned here. First, while there are 25 airports in the model, a consolidation of airport in the New York Hub, JFK, LaGuardia, and Newark, reduced the number of network cities to 23. Although New York was treated as a single travel destination for modeling purposes, air traffic was manually divided among the three airports so that delay levels were equalized. In Washington, D.C., National Airport remained the destination of all Washington traffic now serving the airport. No new nonstop authority was assumed. Therefore, direct flights from DEN, DFW, HNL, IAH, LAS, LAX, MCI, SEA, and SFO did not serve National Airport.

Nonstop and multistop markets or flights were developed to link the 23 network cities and provide alternative routes for meeting passenger demands. With such a large network, a formidable number of nonstop and multistop city pair flights could be hypothesized. A strategy was developed to limit the alternatives to the most likely city pair combinations.

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5/ This was compiled from the May 15, 1974, OAG and from Tables 8 and 10 of the 1974 annual Civil Aeronautics Board Origin and Destination Tables.

## TABLE 5.2

## SCHEDULE OF PASSENGER ENPLANEMENT GROWTH

**1974 Base**

| Year | Growth Factor |
|---|---|
| 1975 | 1.00 |
| 1980 | 1.30 |
| 1985 | 1.74 |
| 1990 | 2.07 |
| 1995 | 2.51 |
| 2000 | 3.02 |

First, all markets currently receiving nonstop service continued to receive service throughout the planning period. This amounted to 243 direct city pair routings. Those markets served exclusively nonstop were generally not offered other possibilities, i.e., one stop or two stop service.

Multistop flights were added next. All one and two stop markets now being serviced were offered several alternatives in both routing and number of stops. All flights through Chicago, for example, were provided alternative routings. When complete, the model included 445 nonstop, one stop, and two stop route options. These are listed in Appendix G.

With all possible city pair routings fully defined, the airport network model was exercised to derive air carrier flight activity from the passenger enplanement forecasts presented in Section 5.2. Activity was described in terms of hourly operations throughout the average day at each of the 25 airports in the network. Forecasts were developed for 1985, 1990, 1995, and the year 2000. A summarization of this daily airport activity is shown in Table 5.3.

It is noted that the 1995 and year 2000 forecasts show two estimates of average daily airport activity levels. Numbers in parentheses represent projected operations for the peak pricing and quota scenario, which are different from the other three scenarios. Not only are the total number of operations different in this scenario, but the profiles of flight activity are different as well. Appendix H compares the projected year 2000 activity profiles for each airport in the network under Base Case and peak pricing/quota assumptions. The profiles show a noticeable difference in the peaking characteristics of airport traffic in each scenario.

## 5.4 Delay Computation

As noted in the previous sections, implementation of the scenarios described in Chapter 4 resulted in airport traffic levels which were unique in terms of numbers of overall operations, and/or the pattern of traffic activity throughout the day, and/or the capacity available for air carrier operations at each airport. Consequently, each scenario established a different level of airport system delay. The computation of anticipated delay was accomplished with the model described in Section 4.3. The procedure adopted in this analysis for applying the model and computing airport delays is explained in the following paragraphs.

# TABLE 5.3
# FORECAST AIR CARRIER DAILY OPERATIONS 1/

**FAA UG3RD EVALUATION**
**COMPLEMENTARY POLICY STRATEGIES**
**OFFICE OF AVIATION POLICY**

| AIRPORT | 1985 | 1990 | 1995[2/] | 2000[2/] |
|---|---|---|---|---|
| ORD | 1842 | 1875 | 2030 (1875) | 2215 (1875) |
| BOS | 815 | 900 | 1000 (1000) | 1150 (1150) |
| SFO | 843 | 915 | 995 (965) | 1095 (1098) |
| STL | 576 | 708 | 830 (825) | 909 (904) |
| DEN | 738 | 933 | 970 (975) | 1065 (1035) |
| LAX | 1133 | 1253 | 1502 (1502) | 1725 (1715) |
| SEA | 573 | 580 | 610 (600) | 695 (710) |
| PHL | 481 | 519 | 565 (565) | 750 (685) |
| CLE | 452 | 470 | 530 (555) | 585 (610) |
| NYC[3/] | 1665 | 1745 | 1885 (1885) | 2200 (2160) |
| ATL | 1100 | 1200 | 1220 (1240) | 1315 (1310) |
| MSY | 438 | 475 | 500 (505) | 570 (560) |
| MSP | 518 | 550 | 625 (625) | 665 (665) |
| DTW | 596 | 650 | 690 (665) | 785 (665) |
| MCI | 503 | 555 | 665 (680) | 810 (785) |
| DFW | 952 | 962 | 1010 (1014) | 1190 (1195) |
| PIT | 682 | 700 | 755 (750) | 786 (759) |
| MIA | 705 | 750 | 960 (960) | 1075 (1070) |
| HOU | 515 | 600 | 681 (647) | 723 (694) |
| LAS | 396 | 443 | 526 (491) | 709 (557) |
| HLU[4/] | 470 | 530 | 643 (661) | 800 (826) |
| TPA | 559 | 581 | 633 (626) | 674 (656) |

1/ DERIVED FROM FAA PASSENGER ENPLANEMENT FORECASTS

2/ ACTIVITY LEVELS IN PARENTHESES INDICATE AIR CARRIER OPERATIONS FOR PEAK PRICING AND QUOTA SCENARIO (#2).

3/ INCLUDES JFK, LGA, EWK

4/ HONOLULU FORECASTS ARE INVALID–LOW CORRELATION WITH OBSERVED ACTIVITY LEVELS

First, the airport departure and arrivals activity profiles developed by the network model were examined (see Section 4.2). As explained earlier, these traffic profiles represented only the services provided among the 23 cities. To reflect the rest of the air carrier demand, the ratio of scheduled traffic among the 23 cities compared to all scheduled operations was computed for each airport. These ratios are listed in Appendix I. 6/ The ratios were then used to expand the predicted schedules to reflect total air carrier operations at each respective airport. The assumption was made that for any airport in the network markets to the top 23 cities would grow at the same rate as other commercial traffic, and, therefore, traffic expansion factors shown in Appendix I remained constant throughout the planning period of the analysis.

Next, each airport activity profile was categorized by number of traffic peaks, and the percentage of total daily traffic operating in the peak hour. This categorization allowed the computation of airport delays in the manner explained in Section 4.3.

Air carrier delays were computed for each of the two to eight hourly capacities applicable to each airport (see Section 5.1). Within each hourly capacity, cancellations were assumed to occur whenever the average daily delay per operation reached 20 minutes, equivalent to 40 minutes average delay per scheduled departure. Sufficient cancellations were enforced to maintain the 20 minute maximum, on the assumption that air carriers would not allow delays to exceed this limit.

Finally, aircraft delays and flight cancellation rates were weighted by the relative percentage of occurrence of each capacity condition, and aggregated by airport. The overall result was annual average delay and cancellation rates. These delays are listed by airport in Appendix J. Different annual air carrier delays are recorded for each of the four scenarios under evaluation.

6/ Derived from OAG, June 1, 1975, schedules.

The costs of air traffic delay to the airlines and airline passengers were computed at each airport in the network through the year 2000. The direct operating costs (DOC) of the airlines were derived for each aircraft type from 1975 CAB statistics. The assumption was made that passenger time was valued at $12.50 per hour. The results, by airport and scenario, are shown in Appendix K.

## 6.0 Results

The preceding chapters described the models applied, as well as the approach for the analysis of the impact of peak-pricing and quotas on airport system delay. This chapter presents the results of the analysis. Conclusions drawn from these findings are presented in the final chapter of the report.

### 6.1 Air Carrier Airport Delay

Airport delays resulting from each traffic distribution (i.e., scenario) were computed for 1975, 1985, and at 5-year intervals thereafter through the year 2000. These delays were aggregated over all airports in the 23 city network. Airport system totals are shown for each scenario in Figure 6.1. Delay tables for individual airports, as well as annual system totals throughout the planning period, are presented in Appendix J.

Figure 6.1 provides the means for evaluating the comparative advantages of airport policy alternatives. The impact of the UG3RD on airport delay, for example, may be contrasted with delays under a system of peak pricing and quotas by comparing the respective curves shown in the Figure.

The costs of air traffic delays anticipated in each of the four scenarios (see Appendix K) were aggregated for all airports in the network and discounted to 1975 dollar values. 1/ These anticipated delay costs are shown in Table 6.1. It is noted, for example, that a peak-load pricing schedule implemented in concert with UG3RD technological improvements could eliminate almost 80 percent of the cost of air traffic delays anticipated at the 25 largest airports through the year 2000.

Another measure of system capacity and/or service quality is the rate of flight cancellations at an airport. As explained earlier, under certain heavy traffic conditions flights were cancelled in order to avoid situations of unrealistically large delays. These cancellations may inconvenience air

1/ A 10 percent discount rate was used.

## FIGURE 6.1

## TOTAL ANNUAL AIR CARRIER DELAY 25 AIRPORT SYSTEM

FAA UG3RD EVALUATION
COMPLEMENTARY POLICY STRATEGIES
OFFICE OF AVIATION POLICY

SYSTEM DELAYS UNDER
ALTERNATIVE SCENARIOS

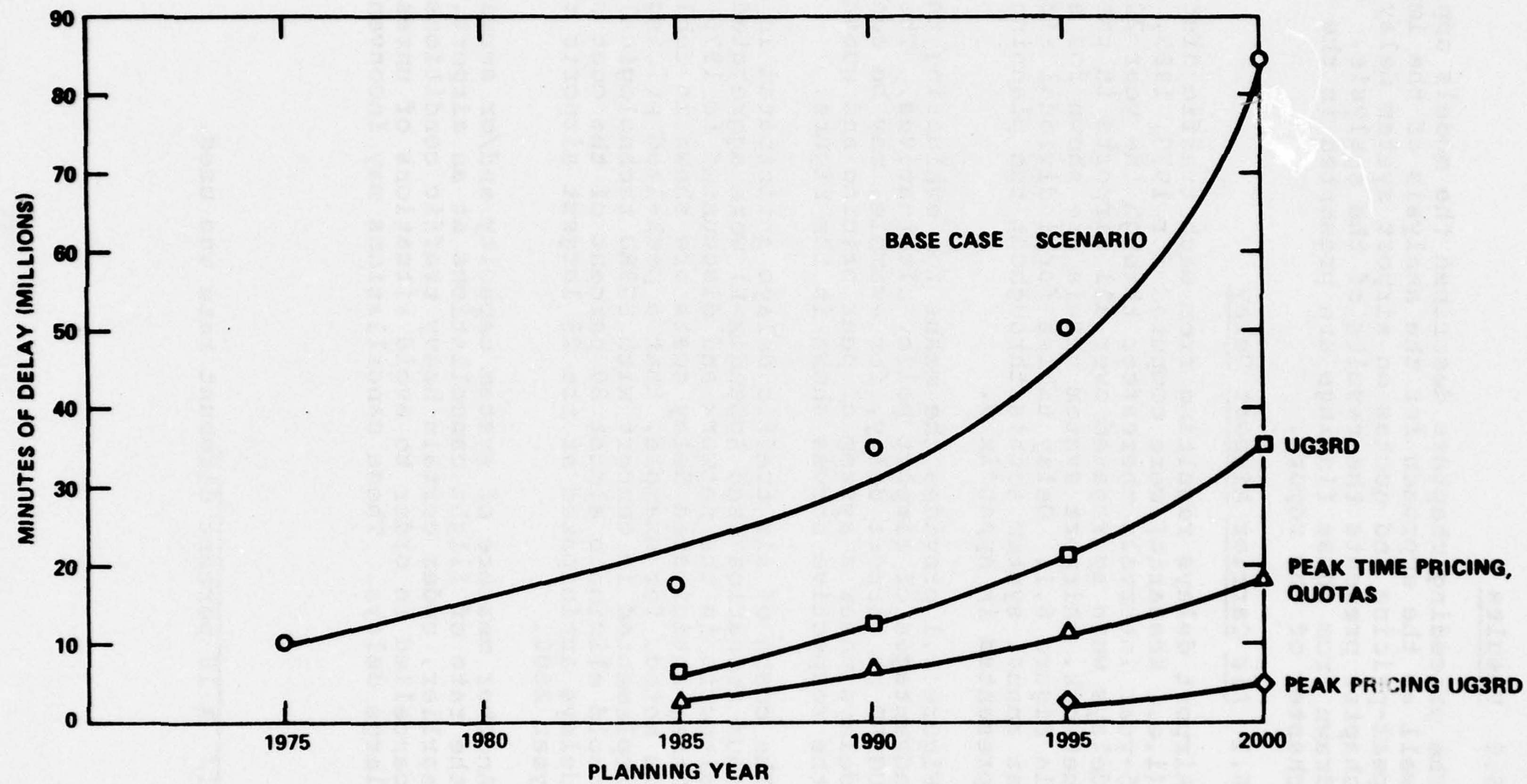

TABLE 6.1

DISCOUNTED COST OF AIR CARRIER DELAY IN THE 25 AIRPORT SYSTEM THROUGH THE YEAR 2000

FAA UG3RD EVALUATION
COMPLEMENTARY POLICY STRATEGIES
OFFICE OF AVIATION POLICY

| SCENARIO | DELAY COSTS 1/ ($ MILLIONS) |
|---|---|
| BASE CASE | $7,107 |
| PEAK PRICING & QUOTAS | 2,489 |
| UG3RD | 3,540 |
| PEAK PRICING & UG3RD | 1,504 |

1/ Aircraft and Passenger Delay Discounted at 10% to 1975 Dollars travellers and/or airline operators, and may be viewed as a disbenefit. 2/ Each scenario has its own unique traffic distribution and, consequently, its unique flight cancellation rate. The projected occurrence of flight cancellations under the UG3RD may be contrasted with those under peak-pricing and quotas by comparing projected cancellation rates shown in Figure 6.2.

## 6.2 Traffic Forecasts

Traffic forecasts derived by the airport network model described in this report are presented in Table 5.2. As noted, these forecasts are based upon the passenger enplanement forecasts shown in Table 5.1. Equivalent numbers of passengers were carried in each scenario developed for the analysis.

It is observed that the threefold growth in air passenger demand anticipated by the year 2000 results in a less than proportional increase in aircraft operations. At some of the busiest airports, for example, annual growth rates for passengers and aircraft operations are 4 percent and 1 percent, respectively. An explanation for this is that many of the larger markets are already receiving frequent service, and much of the predicted passenger growth is accommodated with larger aircraft instead of increased flight frequency. In addition, there is a tendency towards more point-to-point or direct service, eliminating some of the multistop routes. This report finds that a shift towards wide-body aircraft utilization and direct routing of flights results in less airport activity in future years than would be anticipated from simple assessments.

In addition to accelerating the shift towards larger aircraft and direct routing, the peak-pricing and quota strategy implemented in this analysis resulted in the rescheduling of some (less than 20 percent) air carrier traffic. Most commercial operations were unaffected. The non-air carrier operators, however, were essentially "priced" out of congested periods of operation at the primary air carrier airports. Most of the reduction in peak-hour operations, as a result of marginal cost pricing, came from the non-air carrier users.

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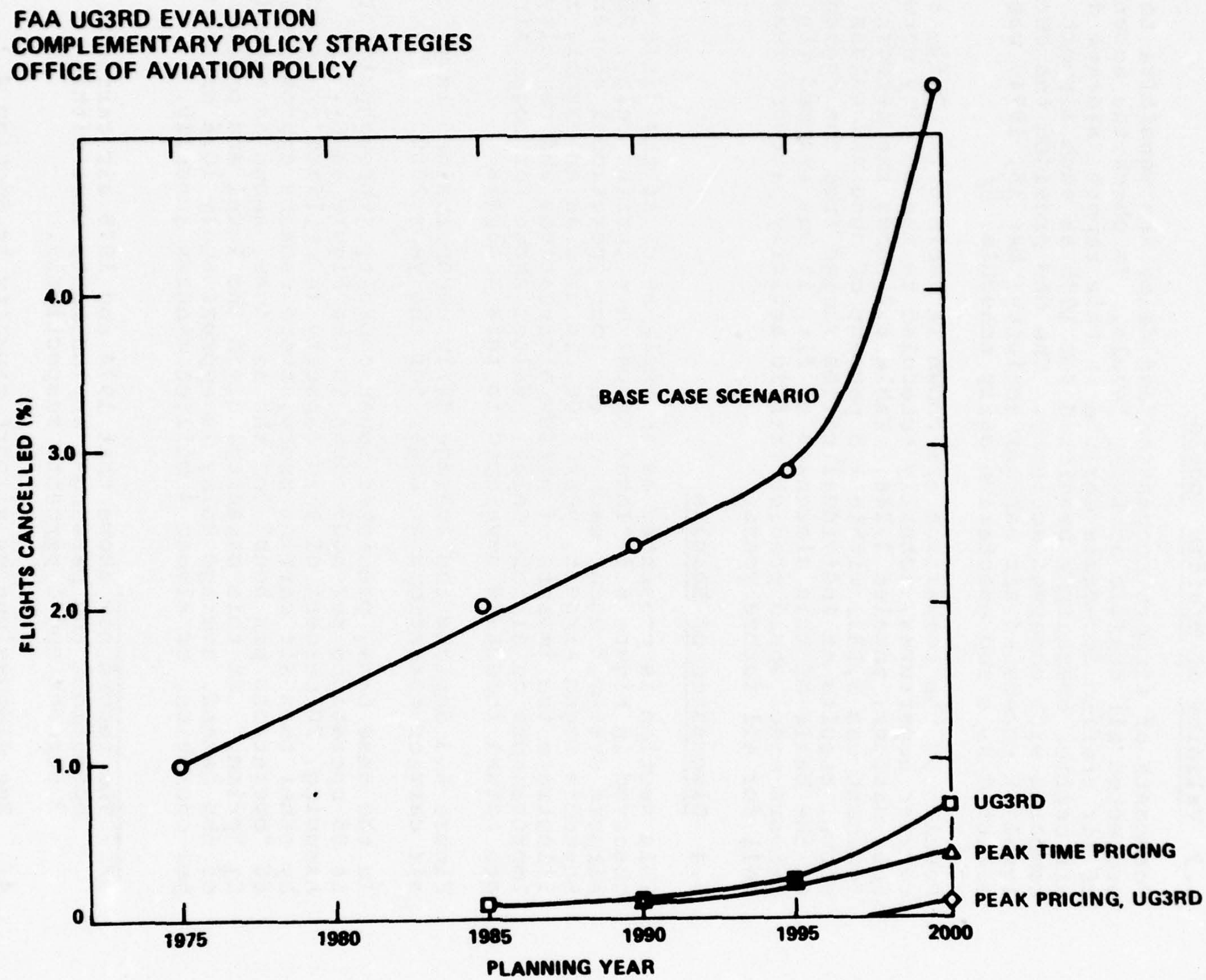
2/ It is estimated that no more than 20 percent of all airline passengers in any forecast year were subjected to flight cancellations. In every case, seats were made available to these displaced travellers on an earlier or later departure. In the worst case, passengers were displaced a maximum of 2 hours from their desired departure times.

## FIGURE 6.2

## PROJECTED FLIGHT CANCELLATION RATES AT THE 25 MAJOR AIR CARRIER AIRPORTS



## 6.3 Validity of Traffic Models

Forecasts of airport congestion and delay are sensitive to projected air traffic activity levels. To check the accuracy of air traffic forecasts derived in this report, average daily air carrier operations predicted for 1975 at each airport were compared with observed activity. The OAG provided the current level of scheduled air carrier activity; May 15, 1974, was selected as a representative daily schedule. 3/

Results of the comparison are shown in Table 6.2. Daily air carrier departures, actually scheduled to the 23 city network destinations, totaled 3,244. Table 6.2 shows the network model forecast was 3,082, within ± 5 percent of observed values. As shown, results at individual cities varied from the aggregate. On the basis of this closeness of fit, it was assumed the airport network model would predict traffic activity patterns reasonably well for all future years.

## 6.4 Discussion of Results

This section is presented as an explanation of the differences observed in Figure 6.1 "Total Annual Air Carrier Delay, 25 Airport System," under each of the four operational scenarios. Boston's Logan Airport, year 2000, is used as an example to illustrate the impacts of policy alternatives and capacity improvements on airport delay. Values shown for Logan Airport are actual forecasts developed in this analysis.

Figure 6.3 depicts the average daily unconstrained level of air carrier operations at Logan for the year 2000.

In the Base Case, predicted Logan capacity (throughput rate) is 85 operations per hour shown in the Figure as $C_1$. 4/ Assuming, 20 percent of this capacity is utilized or consumed by other than air carrier users, there remains approximately 68 "operations per hour" for the airlines, shown as capacity $C_1$ "prime." At this capacity, given the level and profile of the demand, average delay is approximately 10.6 minutes per operation, or almost 4 million minutes annually.

---

3/ The record now shows that 1974 and 1975 air carrier operations and passenger enplanements were within 3 percent and 1 percent, respectively.

4/ See discussions on airport capacity in Section 4.1. The concept of average capacity is used here for purposes of discussion only. In reality, there are up to eight different capacities for Logan Airport.

## TABLE 6.2

## FLEET ASSIGNMENT MODEL VALIDITY CHECK

FAA UG3RD EVALUATION
COMPLEMENTARY POLICY STRATEGIES
OFFICE OF AVIATION POLICY

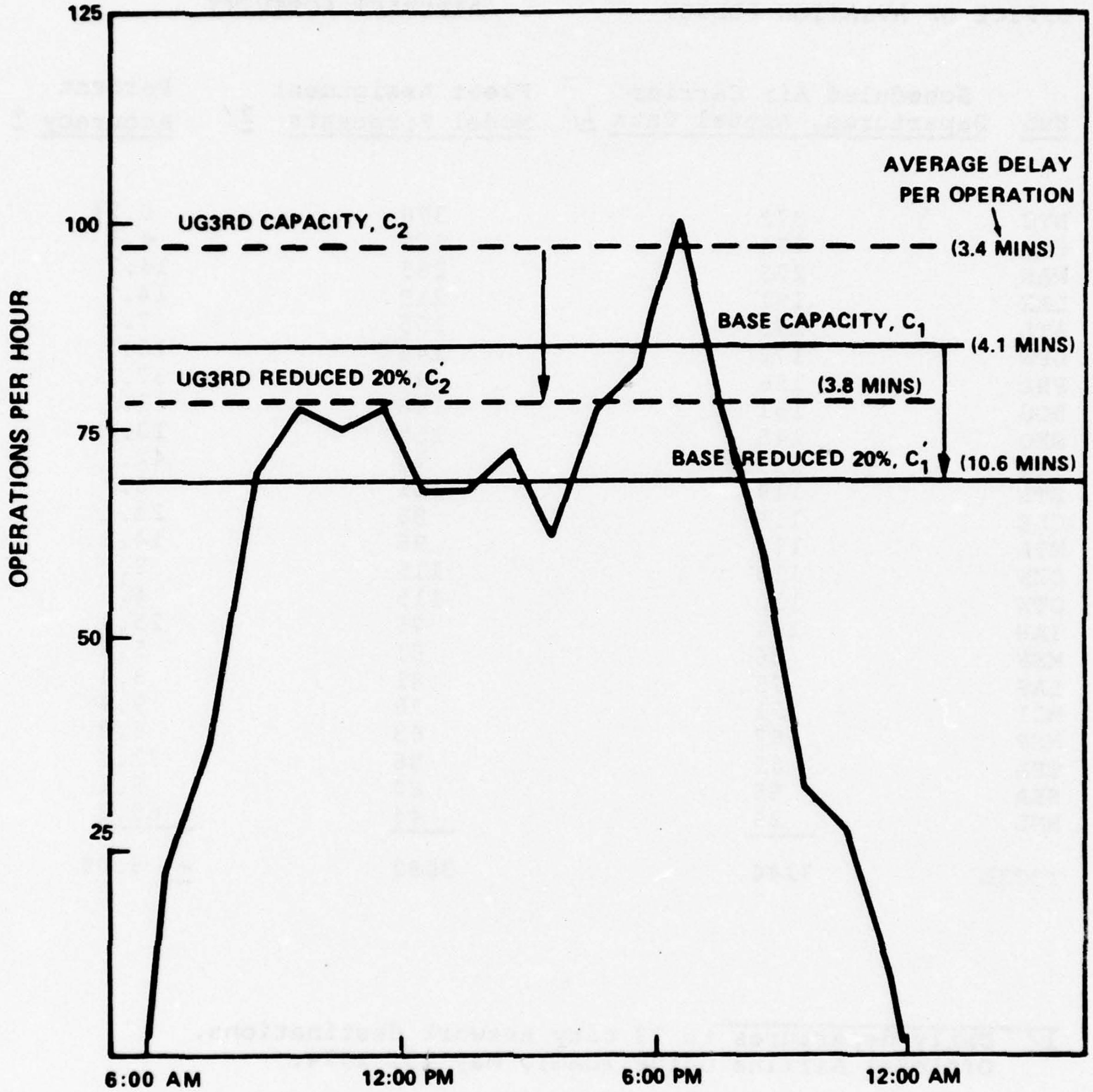
COMPARISON OF INTRA NETWORK
TRAFFIC FORECASTS WITH ACTUAL
AIRCRAFT ACTIVITY

| Hub | Scheduled Air Carrier Departures, Actual Data 1/ | Fleet Assignment Model Forecasts 2/ | Percent Accuracy ± |
|---|---|---|---|
| NYC | 373 | 370 | 0.2% |
| ORD | 353 | 369 | 4.5 |
| WAS | 273 | 233 | 14.7 |
| LAX | 191 | 219 | 14.7 |
| ATL | 178 | 165 | 7.3 |
| DFW | 172 | 144 | 16.3 |
| PHL | 156 | 98 | 37.2 |
| BOS | 151 | 146 | 3.3 |
| SFO | 145 | 165 | 13.8 |
| PIT | 133 | 77 | 42.1 |
| STL | 119 | 111 | 6.7 |
| CLE | 116 | 88 | 24.1 |
| MIA | 115 | 98 | 14.8 |
| DEN | 113 | 116 | 2.7 |
| DTW | 110 | 115 | 4.5 |
| IAH | 101 | 75 | 25.4 |
| MSP | 86 | 81 | 5.8 |
| LAS | 75 | 81 | 8.0 |
| MCI | 71 | 78 | 9.9 |
| MSP | 67 | 63 | 6.0 |
| TPA | 65 | 86 | 32.3 |
| SEA | 55 | 60 | 9.1 |
| HNL | 26 | 44 | 69.2 |
| TOTAL | 3244 | 3082 | ± 5.0% |

1/ Daily departures to 23 city network destinations. Official Airline Guide (OAG), May 15, 1974.

2/ Daily departures to 23 city network destinations.

## FIGURE 6.3
## FORECAST DAILY AIR CARRIER DEMAND, YEAR 2000 [1]
## BOSTON, LOGAN AIRPORT




[1] AIR CARRIER OPERATIONS DERIVED FROM FAA PASSENGER ENPLANEMENT FORECASTS

If, however, all other users were priced out, or otherwise denied airport access during congested periods, air carriers would have the full capacity ($C_1$), or 85 operations per hour, at their disposal. Airline delay under these conditions would decrease to 6.1 million minutes a year, an average of 3.8 minutes per operation, and a savings of 2.3 million minutes of annual air carrier delay over the Base Case.

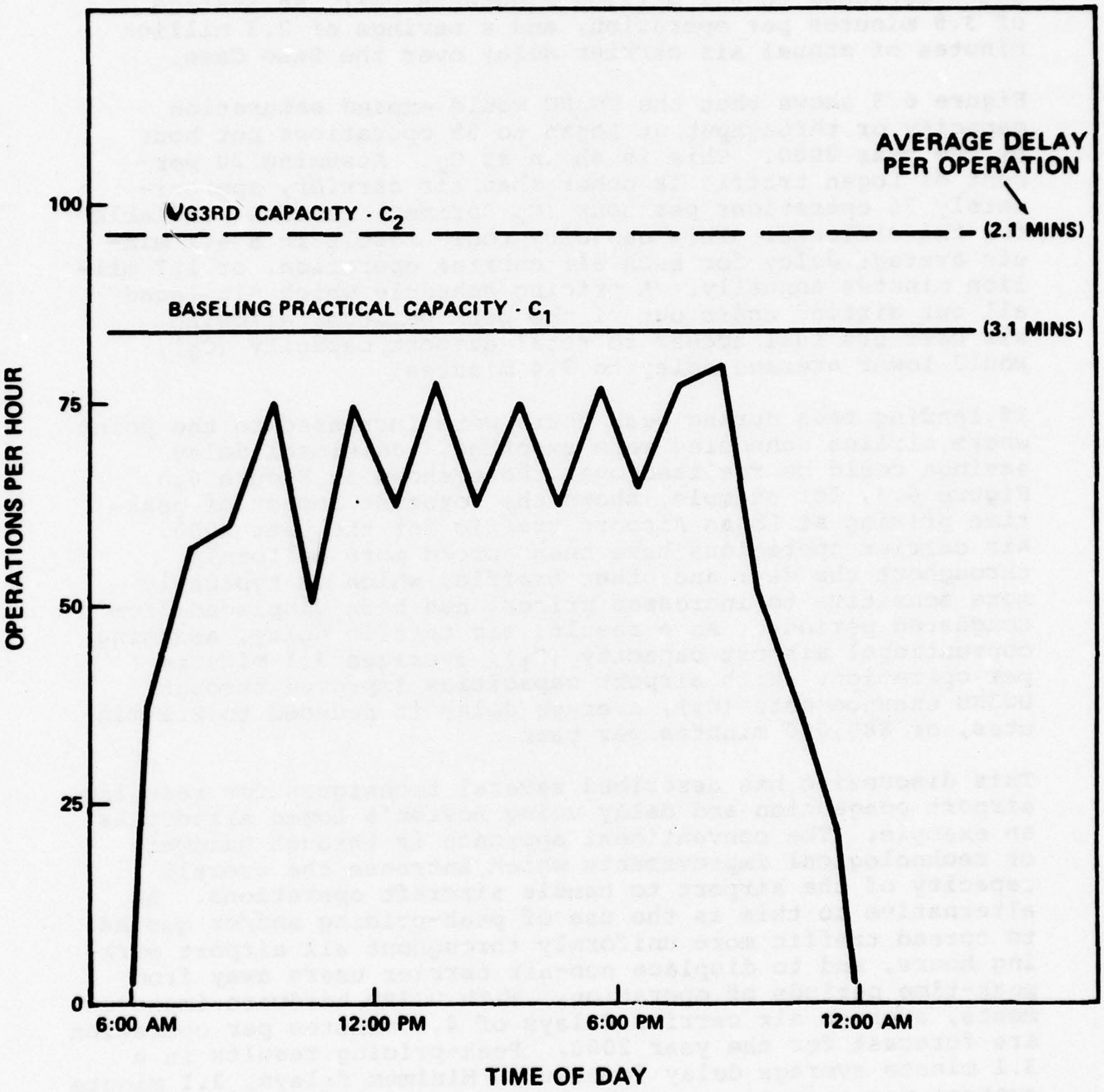
Figure 6.3 shows that the UG3RD would expand saturation capacity or throughput at Logan to 95 operations per hour by the year 2000. This is shown as $C_2$. Assuming 20 percent of Logan traffic is other than air carrier, approximately 76 operations per hour ($C_2$ "prime") remains available for the airlines. This capacity would result in a 4.1 minute average delay for each air carrier operation, or 1.7 million minutes annually. A pricing schedule which displaced all but airline users out of the peak periods, allowing air carriers full access to total airport capacity ($C_2$), would lower average delay to 3.4 minutes.

If landing fees during peak hours were increased to the point where airline schedules were smoothed, additional delay savings could be realized over those shown in Figure 6.3. Figure 6.4, for example, shows the forecast impact of peak-time pricing at Logan Airport traffic for the year 2000. Air carrier operations have been spread more uniformly throughout the day; and other traffic, which is typically more sensitive to increased prices, has been displaced from congested periods. As a result, air traffic delay, assuming conventional airport capacity ($C_1$), averages 3.1 minutes per operation. With airport capacities improved through UG3RD enhancements ($C_2$), average delay is reduced to 2.1 minutes, or 880,000 minutes per year.

This discussion has described several techniques for reducing airport congestion and delay using Boston's Logan Airport as an example. The conventional approach is through hardware or technological improvements which increase the overall capacity of the airport to handle aircraft operations. An alternative to this is the use of peak-pricing and/or quotas to spread traffic more uniformly throughout all airport working hours, and to displace non-air carrier users away from peak-time periods of operation. With UG3RD hardware improvements, average air carrier delays of 4.1 minutes per operation are forecast for the year 2000. Peak-pricing results in a 3.1 minute average delay forecast. Minimum delays, 2.1 minute average per operation, result from a combination of UG3RD technological enhancements and a peak-time pricing schedule.

FIGURE 6.4

FORECAST DAILY AIR CARRIER DEMAND, YEAR 2000 – BOSTON, LOGAN AIRPORT PEAK HOUR PRICING



Comparable results were observed at the remaining airports in the network. This is shown in the delay and cost of delay estimates presented in Appendices J and K. In each case, a schedule of peak-pricing and quotas reduced air carrier airport delays appreciably. Furthermore, this report found no evidence of adverse network or ripple effect induced by airport pricing or quota limitations. That is, at no time did the imposition of pricing or quota limitations at an airport resulted in increased traffic congestion at other facilities such that total system delay was not reduced.

The purpose of this analysis was to answer two basic questions about peak-time pricing and airport quotas. First, could they relieve air traffic congestion and reduce delays at the 25 primary air carrier airports? Second, would peak-pricing and quotas complement the technological improvements provided by the UG3RD? These two questions are addressed in the concluding chapter of the report.

## 7.0 Conclusions

Figures 6.1 and 6.2 represent summary results of the analysis of pricing and administrative alternatives to the UG3RD. Conclusions from the analysis are presented below.

First, peak-pricing and quotas were found, in theory, to be effective as a method of reducing air carrier congestion and delay. In fact, there were fewer delays at primary large hub airports under a system of pricing and administrative alternatives than there were as a result of UG3RD airport capacity improvements. This is shown in Figure 6.1, where, at any time in the 25-year period--1975-2000--annual system delays under a peak-pricing and quota scenario were less than delays which would be anticipated if UG3RD improvements were implemented. Moreover, Figure 6.2 shows that congestion experienced in a peak-pricing and quota scenario forced fewer cancellations of air carrier flights than there were when airport capacities were improved with UG3RD technological features.

Of all cases examined, minimum airport congestion and delay was observed when UG3RD improvements were combined with a schedule of peak-pricing and quotas. This was shown at a single airport, as well as throughout the airport network. It is concluded, therefore, that, in theory, peak-hour pricing and quota alternatives would effectively complement the technological features of the UG3RD and improve the flow of air traffic between the primary large hub airports.

While peak-pricing and quotas may offer theoretical advantages, they have limiting characteristics that must be reviewed. For example, airport quotas and other purely administrative measures, while found effective in dealing with congestion problems, tend to be biased toward maintaining the status quo when used over a protracted period of time. Because economic value is not fully taken into consideration in the implementation of a quota system, an environment can be created which: (1) protects those with rights to time slots from being displaced by others who may derive a higher economic value from the same time slots; and (2) prevents the airport from obtaining through economic mechanisms the information required to determine the need for capacity expansion or for an improved quality of service.

Administrative limitations on the use of an airport by keeping demand within acceptable bounds assures the relatively smooth operation of the facility. In effect, severe congestion can be disallowed. This state of affairs can be maintained indefinitely.

However, with access to the airport restricted and with potential users unable to indicate the true value to them of airport capacity expansion, a false sense of wellbeing can be conveyed. In effect, by arbitrarily constraining demand, artificial equilibrium conditions can be created which, in the long run, may have distorting effects on the nature, quality, and cost of the transportation service provided. These limitations are discussed further in Airport Quotas and Peak-Hour Pricing: Theory and Practice, FAA-AVP-77-5.

Similarly, the realities of a peak-load pricing system must be closely examined. The theory of peak-pricing is very persuasive. Moreover, experience has shown that a peak-pricing schedule can shift some airport user demand patterns at a given airport and time of day.

While the basic arguments which support peak-time pricing have been thoroughly reviewed in the technical literature, in practice, there are significant problems relating to implementation of peak-pricing schedules. For example, there is no accurate method for determining the optimal pricing structures, due primarily to the formidable problem of estimating elasticities and cross elasticities of airport demand to usage charges.

Furthermore, while peak-load landing charges were uniformly assessed on all airport users during congested periods, it is noted that the relative burden was not evenly distributed. When considered as a percentage of each flight's value to the aircraft operator, peak-pricing had the greatest impact on general aviation, air taxi, commuter, and all other than air carrier operators, many of which would find a peak-load pricing schedule difficult or impossible to bear.

There are some institutional issues, as well, that must be resolved before a peak-time pricing system could be widely adopted. For example, should peak-load charges be imposed by the FAA or the local sponsor? Could a peak-time pricing shedule be integrated with airport pricing agreements now in effect? Typically, airlines and airport sponsors negotiate landing fee schedules often on a long-term basis. If neither party favored a peak-pricing strategy, it is not clear how it would be instituted. Perhaps, more importantly, would the large charges needed to shift demand be politically acceptable?

By design, peak-pricing does not consider ability to pay. This is consistent with desired effects of a peak-pricing policy, of course. Those continuing to use the airport will be the ones who derive the highest benefit. However, such a pricing policy represents a radical departure from the traditional practice of free access to national aviation facilities and services. Not all sectors of the aviation community are likely to agree with such a change.

Peak-pricing and quota alternatives offer significant potential advantages. The realities of these options, however, limit their practical value at this time.

# APPENDIX A

## NETWORK MODEL AIRPORTS

### 25 PRIMARY LARGE HUB AIRPORTS

| AIRPORT NAME | MODEL DESIGNATION |
|---|---|
| Chicago O'Hare | ORD |
| Boston Logan | BOS |
| San Francisco International | SFO |
| St. Louis | STL |
| Denver Stapleton | DEN |
| Los Angeles International | LAX |
| Seattle | SEA |
| Philadelphia | PHL |
| Cleveland | CLE |
| Atlanta | ALT |
| New Orleans | MSY |
| Minneapolis-Saint Paul | MSP |
| Detroit Metro | DET |
| Kansas City International | MKI |
| Dallas-Fort Worth | DFW |
| Honolulu | HLU |
| Houston | HOU |
| Miami | MIA |
| Pittsburg | PIT |
| Tampa | TPA |
| Las Vegas | LAS |
| Newark | NYC |
| Kennedy | NYC |
| LaGuardia | NYC |
| National | WAS |

## APPENDIX B

APPENDIX B INTENTIONALLY LEFT BLANK

## APPENDIX C

## TIME OF DAY PASSENGER TRAVEL PREFERENCES

**FIGURE C-1**
**TIME OF DAY PASSENGER TRAVEL PREFERENCES**
**TRANSCONTINENTAL MARKETS**

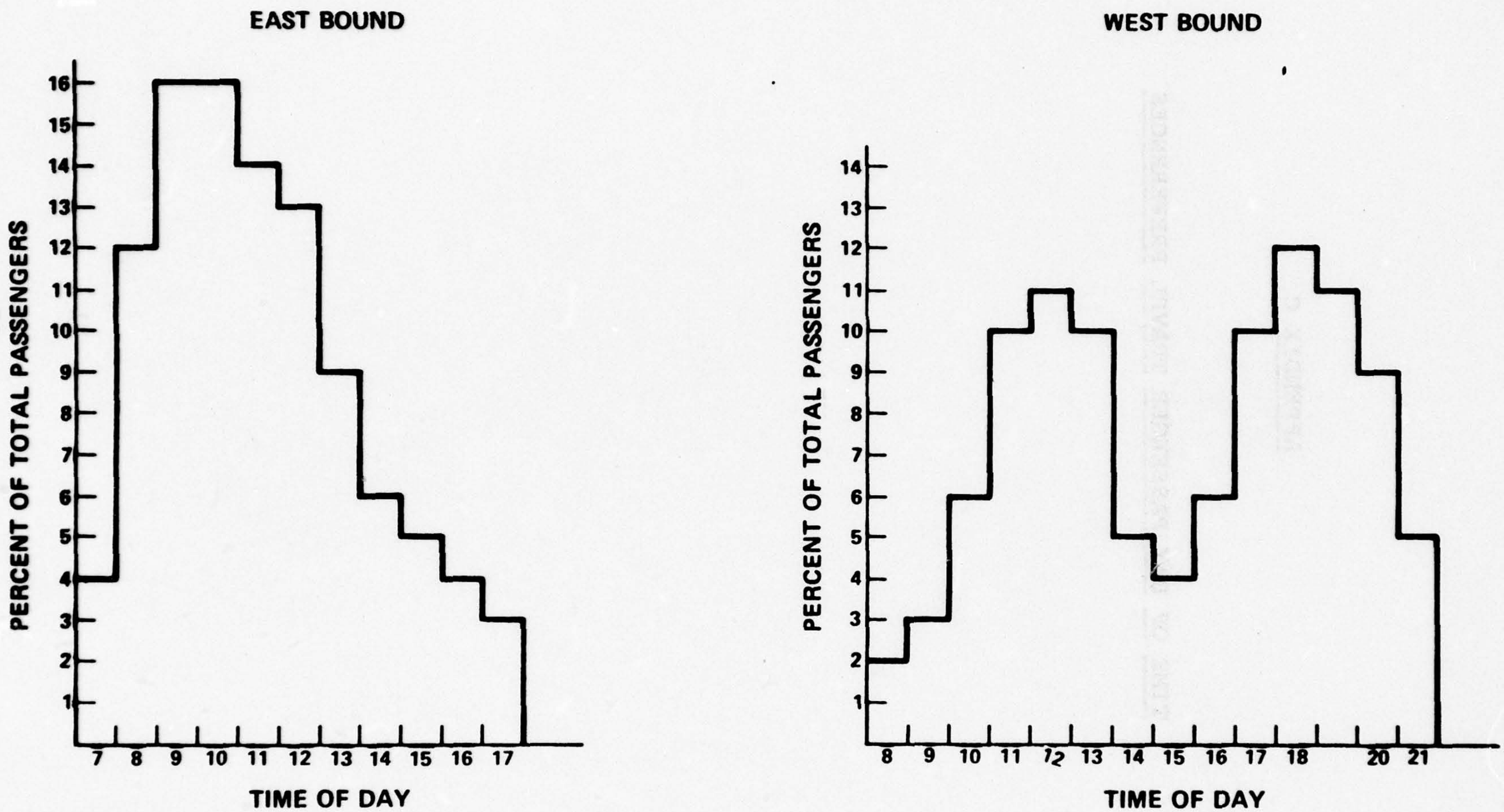
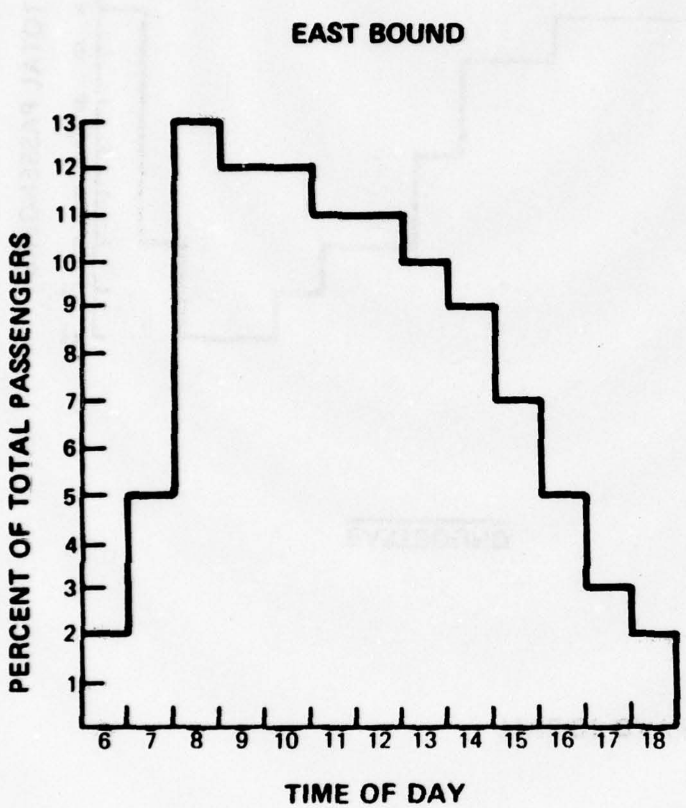


FIGURE C-2
TIME OF DAY PASSENGER TRAVEL PREFERENCES
1800 MILE MARKETS



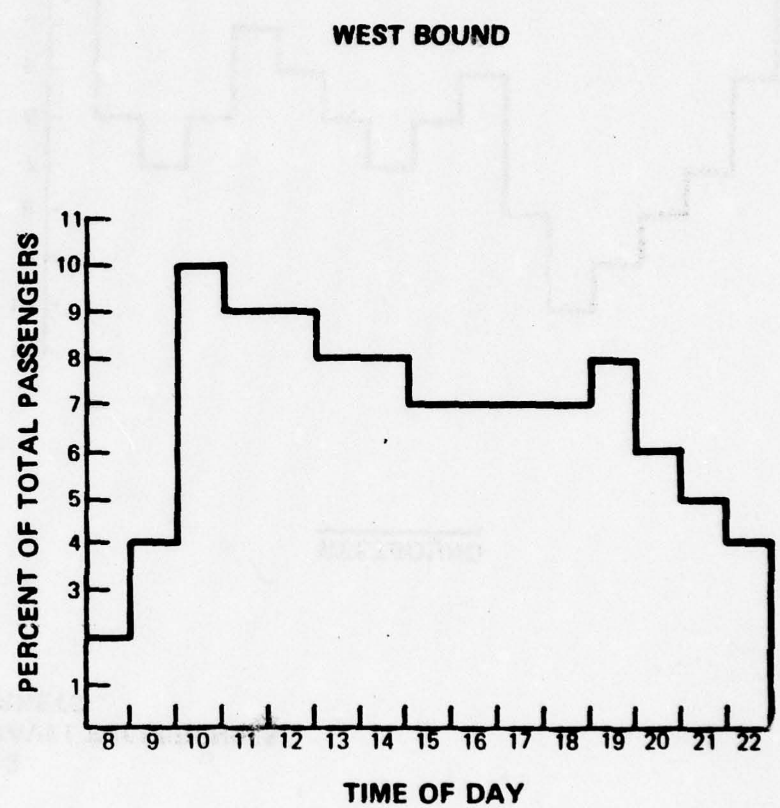



FIGURE C-3
TIME OF DAY PASSENGER TRAVEL PREFERENCES
1200 MILE MARKETS

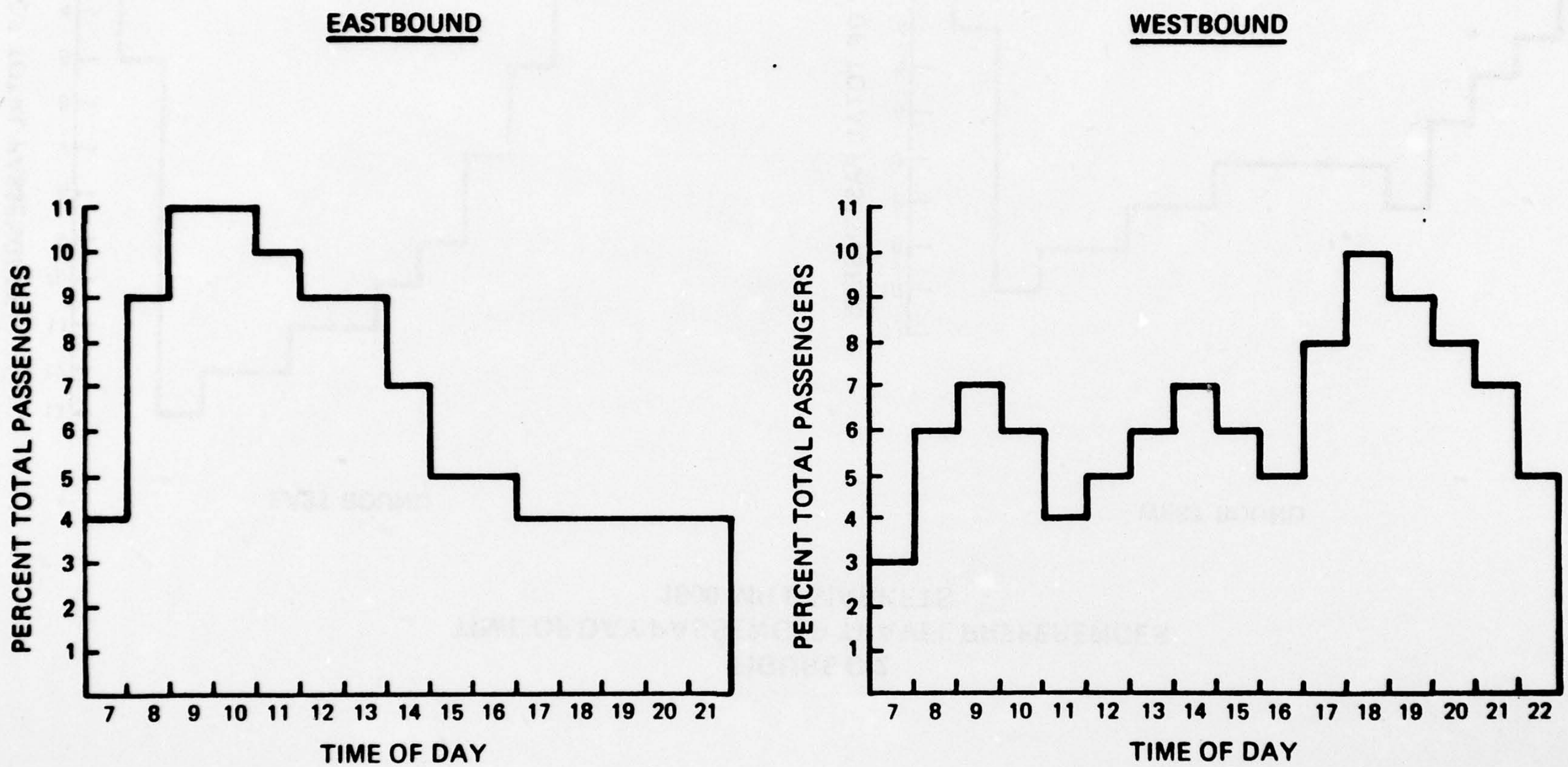
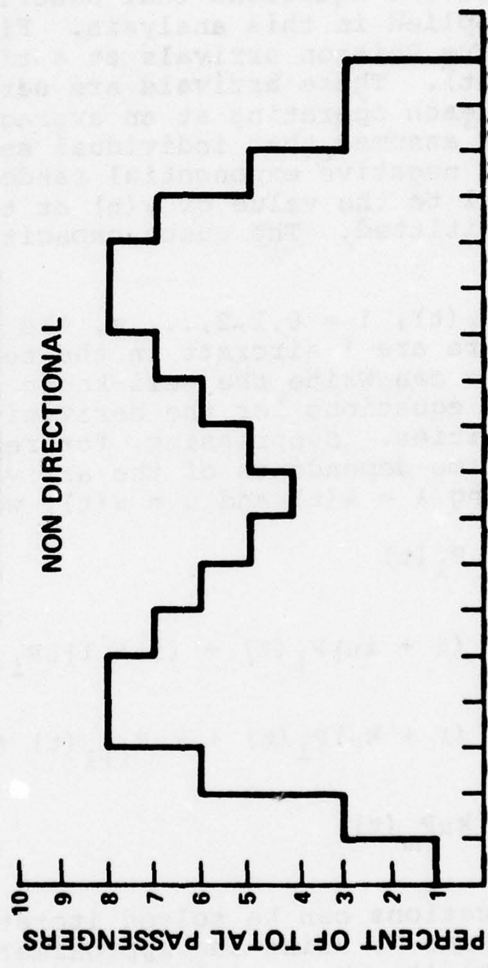


FIGURE C-4
TIME OF DAY PASSENGER TRAVEL PREFERENCES
SHORT HAUL MARKETS
NON DIRECTIONAL



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Massachusetts Institute of Technology
Cambrdige, Massachusetts

## APPENDIX D

### The Queuing System Equations

This appendix lists the equations that describe the two queuing systems applied in this analysis. First, for the M/M/k model, we have Poisson arrivals at a time-dependent average rate of $\lambda(t)$. These arrivals are served by k parallel servers, each operating at an average service rate, $\mu(t)$. It is assumed that individual service times are distributed as negative exponential random variables with exponent equal to the value of $\mu(t)$ at the instant t when service is initiated. The queue capacity is equal to m.

Let us define by $P_i(t)$, $i = 0,1,2,\ldots,m$, the probability that at time t there are i aircraft in the terminal area. Then, for any t, we can write the well-known set of Chapman-Kolmogorov equations for the derivatives $P_i'(t)$ of the state probabilities. Suppressing, for reasons of conciseness, the time-dependence of the arrival and service rates, i.e., writing $\lambda = \lambda(t)$ and $\mu = \mu(t)$, we have:

$$P_0'(t) = -\lambda P_0(t) + \mu P_1(t)$$

$$P_i'(t) = \lambda P_{i-1}(t) - (\lambda + i\mu)P_i(t) + (i + 1)\mu P_{i+1}(t) \quad \text{for } 1 \leq i \leq k-1$$

$$P_i'(t) = \lambda P_{i-1}(t) - (\lambda + k\mu)P_i(t) + k\mu P_{i+1}(t) \quad \text{for } k \leq i \leq m-1$$

$$P_m'(t) = \lambda P_{m-1}(t) - k\mu P_m(t)$$

The above m + 1 equations can be solved iteratively for any desired period of time T, using the approximation $P_i(t+\Delta t) = P_i(t) + P_i'(t) \cdot \Delta t$, where $\Delta t$ is a time interval chosen sufficiently small to be consitent with the Poisson assumptions regarding the arrival and service processes. A boundary set of values $P_i(0)$, $i = 0,1,2,\ldots,m$, and the functions $\lambda(t)$ and $\mu(t)$ for $0 \leq t \leq T$ must be provided.

### The M/D/k System Equations

Turning to the corresponding system of equations for the model in which service is assumed to be deterministic, we define the increment of time as equal to the duration of a single service time. We assume further that all k parallel servers begin and end service simultaneously. It is then possible to write equations relating the sets of state probabilities $P_i(t)$ and $P_i(t+1)$ - remember that t is now being increased at discrete intervals equal to the average service time. (Since time intervals are normalized to $1/\mu$, the demand rate must also be normalized to $\rho = \lambda/\mu$, the demand per unit of service.) These equations are based on the fact that the probability that exactly n aircraft will attempt to join the system between t and t+1 is equal to $\rho^n \cdot \exp(-\rho)/n!$ due to the Poisson law for the demand pattern.

We then have:

$$P_0(t+1) = \exp(-\rho) q_k(t) \quad (2.1)$$

$$P_i(t+1) = \exp(-\rho)\left[q_k(t)\frac{\rho^i}{i!} + P_{k+1}(t)\frac{\rho^{i-1}}{(i-1)!} + P_{k+i}(t)\right]$$

$$\text{for } 1 \leq i \leq m-k \quad (2.2)$$

$$P_i(t+1) = \exp(-\rho)\left[q_k(t)\frac{\rho^i}{i!} + P_{k+1}(t)\frac{\rho^{i-1}}{(i-1)!} + \dots\dots\right.$$

$$\left.\dots + P_m(t)\frac{\rho^{i+k-m}}{(i+k-m)!}\right] \quad \text{for } m-k+1 \leq i \leq m-1 \quad (2.3)$$

$$P_m(t+1) = q_k(t)b_m + P_{k+1}(t)\cdot b_{m-1} + \dots + P_m(t)\cdot b_k \quad (2.4)$$

where $q_k(t) = \sum_{i=0}^{k} P_i(t)$ and $b_j = \exp(-\rho)\sum_{i=j}^{\infty}\frac{\rho^i}{i!}$.

Strictly speaking, (2) assumes that the new arrivals during a unit of time join the queue at the end of the service unit at which time the capacity limit, m, applies.

Again, beginning with a set of initial conditions $P_i(0)$, $i = 0, 1, 2, \ldots, m$, the above set of equations can be solved iteratively to obtain numerical answers for demand and service rate profiles, $\lambda(t)$ and $\mu(t)$ (we have, for conciseness, suppressed the time variable in the equations

Related Quantities

Koopman has shown that for "relatively slow varying" $\lambda(t)$ and $\mu(t)$ the sets of equations for the M/M/k and M/D/k systems possess unique periodic solutions with period T whenever the demand and service rates are both periodic with period T. 1/ In the case of airports, demand and service rates can indeed be considered to be periodic quantities with period T=24 hours. It remains, therefore, to solve the two sets of equations numerically to obtain estimates of the state probilities, $P_i(t)$, for all $0 \leq t \leq T$. The state probabilities, in turn, can be used to compute other quantities of interest. Of those, we shall specifically refer to:

i) The probability that all runways are busy and, therefore, that a newly- arriving aircraft will experience positive delay,

$$B(t) = 1 - \sum_{i=0}^{k} P_i(t) \qquad (3)$$

ii) The expected number of aircraft in the queue at time t,

$$Q(t) = \sum_{i=k+1}^{m} (i-k) P_i(t) \qquad (4)$$

1/ Koopman #2

iii) The average waiting time in the queue for aircraft that arrive at time t

$$W(t) = \frac{1}{k \cdot \mu(t)} \sum_{i=k}^{m} (i-k+1)P_i(t) \qquad (5)$$

This last quantity is only an approximation in the case when $\mu(t)$ is a function of time. The reason is that the $\mu(t)$, may change in the future if the waiting time is long.

In all cases, two estimates of these parameters of interest are obtained, one based on the M/M/k and the other based on the M/D/k model.

## APPENDIX E

## AIRPORT CAPACITY ESTIMATES 1/
## FAA UG3RD EVALUATION

Throughput Rates
Airport: Atlanta (ATL)

| Year | System Package | WVAS 2/ Use | IFR Capacity 16% IFR Standard | IFR Capacity 16% IFR Crosswind | VFR Capacity 84% VFR Standard | VFR Capacity 84% VFR Crosswind |
|---|---|---|---|---|---|---|
| 1975 | Base Case | - | 107.8 | 107.8 | 129.8 | 129.8 |
| 1980 | Base Case | | 107.3 | 107.3 | 129.0 | 129.0 |
| | UG3RD | 75% | 127.4 | 127.4 | 139.4 | 139.4 |
| | UG3RD | 25% | 117.1 | 117.1 | 137.6 | 137.6 |
| 1985 | Base Case | | 112.8 | 112.8 | 142.6 | 142.6 |
| | UG3RD | 75% | 153.3 | 153.3 | 162.1 | 162.1 |
| | UG3RD | 25% | 127.5 | 127.5 | 154.7 | 154.7 |
| 1990 | Base Case | | 111.4 | 111.4 | 140.7 | 140.7 |
| | UG3RD | 75% | 152.9 | 152.9 | 161.5 | 161.5 |
| | UG3RD | 25% | 127.1 | 127.1 | 153.3 | 153.3 |
| 1995 | Base Case | | 109.4 | 109.4 | 137.7 | 137.7 |
| | UG3RD | 75% | 152.4 | 152.4 | 160.7 | 160.7 |
| | UG3RD | 25% | 126.5 | 126.5 | 151.3 | 151.3 |
| 2000 | Base Case | | 107.5 | 107.5 | 134.5 | 134.5 |
| | UG3RD | 75% | 152.0 | 152.0 | 160.0 | 160.0 |
| | UG3RD | 25% | 126.1 | 126.1 | 149.3 | 149.3 |

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

## APPENDIX E

## AIRPORT CAPACITY ESTIMATES 1/
## FAA UG3RD EVALUATION

Throughput Rates
Airport: Boston (BOS)

| Year | System Package | WVAS 2/ Use | IFR Capacity 15% IFR Standard | Crosswind | VFR Capacity 85% VFR Standard | Crosswind |
|---|---|---|---|---|---|---|
| 1975 | Base Case | - | 51.8 | 56.8 | 91.8 | 117.7 |
| 1980 | Base Case | | 51.2 | 55.9 | 89.6 | 115.6 |
| | UG3RD | 75% | 55.8 | 73.1 | 101.9 | 125.9 |
| | UG3RD | 25% | 55.3 | 63.0 | 96.3 | 123.5 |
| 1985 | Base Case | | 51.1 | 55.9 | 89.4 | 115.1 |
| | UG3RD | 75% | 55.7 | 76.2 | 103.4 | 127.5 |
| | UG3RD | 25% | 55.3 | 63.3 | 96.3 | 123.3 |
| 1990 | Base Case | | 50.8 | 55.5 | 88.4 | 113.9 |
| | UG3RD | 75% | 55.7 | 76.4 | 103.6 | 127.2 |
| | UG3RD | 25% | 55.2 | 63.5 | 95.8 | 122.7 |
| 1995 | Base Case | | 50.7 | 55.1 | 87.5 | 113.3 |
| | UG3RD | 75% | 55.7 | 76.3 | 103.4 | 127.0 |
| | UG3RD | 25% | 55.2 | 63.4 | 95.3 | 122.3 |
| 2000 | Base Case | | 50.3 | 53.9 | 84.8 | 111.3 |
| | UG3RD | 75% | 55.7 | 76.0 | 103.1 | 126.5 |
| | UG3RD | 25% | 55.1 | 63.1 | 93.7 | 121.0 |

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

## APPENDIX E

## AIRPORT CAPACITY ESTIMATES 1/
## FAA UG3RD EVALUATION

Throughput Rates
Airport: Chicago (ORD)

| Year | System Package | WVAS Use 2/ | IFR Capacity 15% IFR Standard | Crosswind | VFR Capacity 85% VFR Standard | Crosswind |
|---|---|---|---|---|---|---|
| 1975 | Base Case | - | 102.0 | 134.5 | 136.9 | 136.9 |
| 1980 | Base Case | | 101.5 | 133.1 | 135.0 | 135.0 |
| | UG3RD | 75% | 111.4 | 170.4 | 152.2 | 152.2 |
| | UG3RD | 25% | 110.4 | 149.7 | 147.6 | 147.6 |
| 1985 | Base Case | | 101.1 | 131.7 | 133.3 | 133.3 |
| | UG3RD | 75% | 111.3 | 177.5 | 156.3 | 156.3 |
| | UG3RD | 25% | 110.3 | 149.5 | 146.7 | 146.7 |
| 1990 | Base Case | | 100.4 | 128.8 | 130.1 | 130.1 |
| | UG3RD | 75% | 111.4 | 177.0 | 155.7 | 155.7 |
| | UG3RD | 25% | 110.3 | 148.7 | 144.6 | 144.6 |
| 1995 | Base Case | | 100.0 | 126.7 | 127.5 | 127.5 |
| | UG3RD | 75% | 111.4 | 176.7 | 155.3 | 155.3 |
| | UG3RD | 25% | 110.2 | 148.2 | 143.1 | 143.1 |
| 2000 | Base Case | | 99.8 | 125.0 | 125.2 | 125.2 |
| | UG3RD | 75% | 111.5 | 176.6 | 155.1 | 155.1 |
| | UG3RD | 25% | 110.2 | 148.1 | 141.7 | 141.7 |

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

## APPENDIX E

## AIRPORT CAPACITY ESTIMATES 1/
## FAA UG3RD EVALUATION

Throughput Rates
Airport: Cleveland (CLE)

| Year | System Package | WVAS 2/ Use | IFR Capacity 15% IFR Standard | IFR Capacity 15% IFR Crosswind | VFR Capacity 85% VFR Standard | VFR Capacity 85% VFR Crosswind |
|---|---|---|---|---|---|---|
| 1975 | Base Case | - | 51.8 | 51.8 | 73.3 | 73.3 |
| 1980 | Base Case | | 51.5 | 51.5 | 72.6 | 72.6 |
| | UG3RD | 75% | 55.7 | 55.7 | 79.7 | 79.7 |
| | UG3RD | 25% | 55.3 | 55.3 | 78.2 | 78.2 |
| 1985 | Base Case | | 51.2 | 51.2 | 71.6 | 71.6 |
| | UG3RD | 75% | 55.6 | 55.6 | 81.2 | 81.2 |
| | UG3RD | 25% | 55.2 | 55.2 | 77.6 | 77.6 |
| 1990 | Base Case | | 50.9 | 50.9 | 70.3 | 70.3 |
| | UG3RD | 75% | 55.6 | 55.6 | 80.8 | 80.8 |
| | UG3RD | 25% | 55.2 | 55.2 | 76.7 | 76.7 |
| 1995 | Base Case | | 50.6 | 50.6 | 69.1 | 69.1 |
| | UG3RD | 75% | 55.7 | 55.7 | 80.4 | 80.4 |
| | UG3RD | 25% | 55.2 | 55.2 | 75.8 | 75.8 |
| 2000 | Base Case | | 50.3 | 50.3 | 67.5 | 67.5 |
| | UG3RD | 75% | 55.7 | 55.7 | 80.0 | 80.0 |
| | UG3RD | 25% | 55.1 | 55.1 | 74.8 | 74.8 |

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

## APPENDIX E

## AIRPORT CAPACITY ESTIMATES 1/
## FAA UG3RD EVALUATION

Throughput Rates
Airport: Dallas/Ft. Worth (DFW)

| Year | System Package | WVAS 2/ Use | IFR Capacity 9% IFR Standard | Crosswind | VFR Capacity 91% VFR Standard | Crosswind |
|---|---|---|---|---|---|---|
| 1975 | Base Case | - | 103.8 | 156.9 | 118.4 | 171.5 |
| 1980 | Base Case | | 103.7 | 156.8 | 118.1 | 171.1 |
| | UG3RD | 75% | 111.3 | 171.3 | 125.7 | 185.7 |
| | UG3RD | 25% | 110.7 | 167.3 | 124.3 | 180.9 |
| 1985 | Base Case | | 103.3 | 155.6 | 117.5 | 169.8 |
| | UG3RD | 75% | 111.2 | 171.2 | 125.5 | 185.5 |
| | UG3RD | 25% | 110.6 | 166.8 | 124.0 | 180.2 |
| 1990 | Base Case | | 102.5 | 153.3 | 116.7 | 167.5 |
| | UG3RD | 75% | 111.3 | 171.3 | 125.4 | 185.4 |
| | UG3RD | 25% | 110.5 | 166.0 | 123.5 | 179.1 |
| 1995 | Base Case | | 101.8 | 151.3 | 115.9 | 165.5 |
| | UG3RD | 75% | 111.3 | 171.3 | 125.3 | 185.3 |
| | UG3RD | 25% | 110.4 | 165.4 | 123.1 | 178.1 |
| 2000 | Base Case | | 101.1 | 149.2 | 115.2 | 163.3 |
| | UG3RD | 75% | 111.3 | 171.3 | 125.1 | 185.1 |
| | UG3RD | 25% | 110.3 | 164.7 | 122.7 | 177.1 |

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

## APPENDIX E

## AIRPORT CAPACITY ESTIMATES 1/
## FAA UG3RD EVALUATION

Throughput Rates
Airport: Denver (DEN)

| Year | System Package | WVAS 2/ Use | IFR Capacity 5% IFR Standard | IFR Capacity 5% IFR Crosswind | VFR Capacity 95% VFR Standard | VFR Capacity 95% VFR Crosswind |
|---|---|---|---|---|---|---|
| 1975 | Base Case | - | 52.0 | 59.6 | 59.6 | 106.2 |
| 1980 | Base Case | | 58.2 | 60.1 | 94.0 | 107.2 |
| | UG3RD | 75% | 73.9 | 74.0 | 103.2 | 119.7 |
| | UG3RD | 25% | 63.9 | 64.1 | 99.3 | 113.2 |
| 1985 | Base Case | | 57.4 | 59.8 | 92.2 | 103.3 |
| | UG3RD | 75% | 77.0 | 84.7 | 104.2 | 120.9 |
| | UG3RD | 25% | 64.1 | 64.4 | 98.3 | 112.1 |
| 1990 | Base Case | | 56.1 | 58.9 | 89.7 | 100.5 |
| | UG3RD | 75% | 76.6 | 83.8 | 103.8 | 120.4 |
| | UG3RD | 25% | 63.7 | 64.0 | 96.7 | 110.2 |
| 1995 | Base Case | | 55.3 | 68.2 | 87.9 | 98.4 |
| | UG3RD | 75% | 76.3 | 83.1 | 103.5 | 120.1 |
| | UG3RD | 25% | 63.4 | 63.8 | 95.5 | 108.9 |
| 2000 | Base Case | | 54.2 | 57.3 | 85.6 | 94.2 |
| | UG3RD | 75% | 76.1 | 82.4 | 103.2 | 119.7 |
| | UG3RD | 25% | 63.1 | 63.6 | 94.1 | 107.3 |

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

## APPENDIX E

## AIRPORT CAPACITY ESTIMATES 1/
## FAA UG3RD EVALUATION

Throughput Rates
Airport: Detroit (DTW)

| Year | System Package | WVAS 2/ Use | IFR Capacity 14% IFR Standard | IFR Capacity 14% IFR Crosswind | VFR Capacity 86% VFR Standard | VFR Capacity 86% VFR Crosswind |
|---|---|---|---|---|---|---|
| 1975 | Base Case | - | 78.9 | 78.9 | 117.2 | 117.2 |
| 1980 | Base Case | | 105.9 | 105.9 | 127.6 | 127.6 |
| | UG3RD | 75% | 129.3 | 129.3 | 140.9 | 140.9 |
| | UG3RD | 25% | 118.4 | 118.4 | 137.6 | 137.6 |
| 1985 | Base Case | | 105.0 | 105.0 | 126.1 | 126.1 |
| | UG3RD | 75% | 131.8 | 131.8 | 142.8 | 142.8 |
| | UG3RD | 25% | 118.4 | 118.4 | 136.8 | 136.8 |
| 1990 | Base Case | | 104.4 | 104.4 | 125.1 | 125.1 |
| | UG3RD | 75% | 131.7 | 131.7 | 142.6 | 142.6 |
| | UG3RD | 25% | 118.2 | 118.2 | 136.2 | 136.2 |
| 1995 | Base Case | | 103.4 | 103.4 | 123.6 | 123.6 |
| | UG3RD | 75% | 131.6 | 131.6 | 142.2 | 142.2 |
| | UG3RD | 25% | 118.1 | 118.1 | 135.3 | 135.3 |
| 2000 | Base Case | | 102.5 | 102.5 | 121.9 | 121.9 |
| | UG3RD | 75% | 131.7 | 131.7 | 141.9 | 141.9 |
| | UG3RD | 25% | 118.1 | 118.1 | 134.3 | 134.3 |

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

## APPENDIX E

## AIRPORT CAPACITY ESTIMATES 1/
## FAA UG3RD EVALUATION

Throughput Rates
Airport: Honolulu (HNL)

| Year | System Package | WVAS Use 2/ | IFR Capacity 1% IFR Standard | IFR Capacity 1% IFR Crosswind | VFR Capacity 99% VFR Standard | VFR Capacity 99% VFR Crosswind |
|---|---|---|---|---|---|---|
| 1975 | Base Case | - | 52.0 | 52.0 | 57.0 | 57.0 |
| 1980 | Base Case | | 52.6 | 52.6 | 65.1 | 65.1 |
| | UG3RD | 75% | 73.4 | 73.4 | 76.9 | 76.9 |
| | UG3RD | 25% | 62.9 | 62.9 | 73.4 | 73.4 |
| 1985 | Base Case | | 52.3 | 52.3 | 64.3 | 64.3 |
| | UG3RD | 75% | 77.6 | 77.6 | 79.6 | 79.6 |
| | UG3RD | 25% | 63.0 | 63.0 | 73.1 | 73.1 |
| 1990 | Base Case | | 52.1 | 52.1 | 63.8 | 63.8 |
| | UG3RD | 75% | 77.6 | 77.6 | 79.6 | 79.6 |
| | UG3RD | 25% | 63.1 | 63.1 | 72.9 | 72.9 |
| 1995 | Base Case | | 51.9 | 51.9 | 63.4 | 63.4 |
| | UG3RD | 75% | 77.6 | 77.6 | 79.6 | 79.6 |
| | UG3RD | 25% | 63.2 | 63.2 | 72.7 | 72.7 |
| 2000 | Base Case | | 51.7 | 51.7 | 62.8 | 62.8 |
| | UG3RD | 75% | 77.7 | 77.7 | 79.7 | 79.7 |
| | UG3RD | 25% | 63.4 | 63.4 | 72.6 | 72.6 |

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

## APPENDIX E

## AIRPORT CAPACITY ESTIMATES 1/
## FAA UG3RD EVALUATION

Throughput Rates
Airport: Houston (IAH)

| Year | System Package | WVAS Use 2/ | IFR Capacity 15% IFR Standard | IFR Capacity 15% IFR Crosswind | VFR Capacity 85% VFR Standard | VFR Capacity 85% VFR Crosswind |
|---|---|---|---|---|---|---|
| 1975 | Base Case | - | 83.2 | 83.2 | 93.7 | 99.7 |
| 1980 | Base Case | | 82.3 | 82.3 | 92.7 | 99.2 |
| | UG3RD | 75% | 97.2 | 97.2 | 103.1 | 105.9 |
| | UG3RD | 25% | 88.4 | 88.4 | 98.5 | 104.3 |
| 1985 | Base Case | | 80.5 | 80.5 | 90.7 | 98.2 |
| | UG3RD | 75% | 102.1 | 102.1 | 103.9 | 106.6 |
| | UG3RD | 25% | 87.6 | 87.6 | 97.3 | 103.5 |
| 1990 | Base Case | | 79.6 | 79.6 | 89.7 | 97.7 |
| | UG3RD | 75% | 101.9 | 101.9 | 103.8 | 106.4 |
| | UG3RD | 25% | 87.3 | 87.3 | 96.7 | 103.1 |
| 1995 | Base Case | | 77.3 | 77.3 | 87.1 | 96.4 |
| | UG3RD | 75% | 101.4 | 101.4 | 103.4 | 106.0 |
| | UG3RD | 25% | 86.4 | 86.4 | 95.0 | 101.9 |
| 2000 | Base Case | | 76.0 | 76.0 | 85.8 | 95.7 |
| | UG3RD | 75% | 101.2 | 101.2 | 103.2 | 105.7 |
| | UG3RD | 25% | 85.9 | 85.9 | 94.1 | 101.3 |

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

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## APPENDIX E

## AIRPORT CAPACITY ESTIMATES 1/
## FAA UG3RD EVALUATION

Throughput Rates
Airport: Kansas City (MCI)

| Year | System Package | WVAS 2/ Use | IFR Capacity 10% IFR Standard | IFR Capacity 10% IFR Crosswind | VFR Capacity 90% VFR Standard | VFR Capacity 90% VFR Crosswind |
|---|---|---|---|---|---|---|
| 1975 | Base Case | - | 88.6 | 88.6 | 99.6 | 102.9 |
| 1980 | Base Case | | 88.2 | 88.2 | 99.3 | 102.6 |
| | UG3RD | 75% | 97.3 | 97.3 | 104.5 | 107.8 |
| | UG3RD | 25% | 91.1 | 91.1 | 102.8 | 107.2 |
| 1985 | Base Case | | 87.8 | 87.8 | 99.1 | 102.3 |
| | UG3RD | 75% | 103.6 | 103.6 | 105.3 | 108.2 |
| | UG3RD | 25% | 91.1 | 91.1 | 102.9 | 107.1 |
| 1990 | Base Case | | 86.0 | 86.0 | 97.0 | 101.3 |
| | UG3RD | 75% | 103.2 | 103.2 | 104.9 | 107.8 |
| | UG3RD | 25% | 90.2 | 90.2 | 101.5 | 106.2 |
| 1995 | Base Case | | 84.9 | 84.9 | 95.7 | 100.7 |
| | UG3RD | 75% | 103.0 | 103.0 | 104.7 | 107.6 |
| | UG3RD | 25% | 89.6 | 89.6 | 100.6 | 105.7 |
| 2000 | Base Case | | 83.3 | 83.3 | 93.9 | 99.8 |
| | UG3RD | 75% | 102.6 | 102.6 | 104.4 | 107.2 |
| | UG3RD | 25% | 88.9 | 88.9 | 99.4 | 104.9 |

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

## APPENDIX E

### AIRPORT CAPACITY ESTIMATES 1/
### FAA UG3RD EVALUATION

Throughput Rates
Airport: Kennedy (JFK)

| Year | System Package | WVAS 2/ Use | IFR Capacity 15% IFR Standard | IFR Capacity 15% IFR Crosswind | VFR Capacity 85% VFR Standard | VFR Capacity 85% VFR Crosswind |
|---|---|---|---|---|---|---|
| 1975 | Base Case | - | 59.3 | 72.2 | 81.3 | 81.3 |
| 1980 | Base Case | | 59.0 | 71.9 | 81.1 | 81.1 |
| | UG3RD | 75% | 73.3 | 96.7 | 100.6 | 100.6 |
| | UG3RD | 25% | 68.3 | 85.1 | 91.9 | 91.9 |
| 1985 | Base Case | | 58.4 | 71.3 | 80.4 | 80.4 |
| | UG3RD | 75% | 76.0 | 100.5 | 102.7 | 102.7 |
| | UG3RD | 25% | 68.1 | 85.1 | 91.6 | 91.6 |
| 1990 | Base Case | | 57.4 | 70.2 | 79.1 | 79.1 |
| | UG3RD | 75% | 76.3 | 100.4 | 102.7 | 102.7 |
| | UG3RD | 25% | 68.3 | 85.4 | 91.4 | 91.4 |
| 1995 | Base Case | | 57.0 | 69.9 | 78.8 | 78.8 |
| | UG3RD | 75% | 76.4 | 100.4 | 102.7 | 102.7 |
| | UG3RD | 25% | 68.6 | 85.5 | 91.3 | 91.3 |
| 2000 | Base Case | | 55.8 | 68.8 | 77.6 | 77.6 |
| | UG3RD | 75% | 77.0 | 100.5 | 102.9 | 102.9 |
| | UG3RD | 25% | 69.5 | 86.2 | 91.5 | 91.5 |

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1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

## APPENDIX E

## AIRPORT CAPACITY ESTIMATES 1/
## FAA UG3RD EVALUATION

Throughput Rates
Airport: Las Vegas (LAS)

| Year | System Package | WVAS Use 2/ | IFR Capacity 2% IFR Standard | IFR Capacity 2% IFR Crosswind | VFR Capacity 98% VFR Standard | VFR Capacity 98% VFR Crosswind |
|---|---|---|---|---|---|---|
| 1975 | Base Case | - | 80.9 | 80.9 | 91.2 | 91.2 |
| 1980 | BAse Case | | 80.5 | 80.5 | 90.7 | 90.7 |
| | UG3RD | 75% | 97.1 | 97.1 | 102.7 | 102.7 |
| | UG3RD | 25% | 87.6 | 87.6 | 97.3 | 97.3 |
| 1985 | Base Case | | 79.6 | 79.6 | 89.7 | 89.7 |
| | UG3RD | 75% | 101.9 | 101.9 | 103.8 | 103.8 |
| | UG3RD | 25% | 87.3 | 87.3 | 96.7 | 96.7 |
| 1990 | Base Case | | 78.4 | 78.4 | 88.4 | 88.4 |
| | UG3RD | 75% | 101.6 | 101.6 | 103.6 | 103.6 |
| | UG3RD | 25% | 86.8 | 86.8 | 95.8 | 95.8 |
| 1995 | Base Case | | 76.3 | 76.3 | 85.9 | 85.9 |
| | UG3RD | 75% | 101.2 | 101.2 | 103.2 | 103.2 |
| | UG3RD | 25% | 86.0 | 86.0 | 94.3 | 94.3 |
| 2000 | Base Case | | 74.4 | 74.4 | 83.9 | 83.9 |
| | UG3RD | 75% | 100.9 | 100.9 | 103.0 | 103.0 |
| | UG3RD | 25% | 85.5 | 85.5 | 93.2 | 93.2 |

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

## APPENDIX E

## AIRPORT CAPACITY ESTIMATES 1/
## FAA UG3RD EVALUATION

Throughput Rates
Airport: La Guardia (LGA)

| Year | System Package | WVAS 2/ Use | IFR Capacity 15% IFR Standard | IFR Capacity 15% IFR Crosswind | VFR Capacity 85% VFR Standard | VFR Capacity 85% VFR Crosswind |
|---|---|---|---|---|---|---|
| 1975 | Base Case | - | 59.3 | 61.5 | 73.1 | 78.0 |
| 1980 | Base Case | | 57.9 | 59.8 | 71.3 | 75.8 |
| | UG3RD | 75% | 62.0 | 74.0 | 75.8 | 81.5 |
| | UG3RD | 25% | 62.0 | 64.8 | 75.4 | 80.6 |
| 1985 | Base Case | | 56.5 | 58.3 | 69.7 | 73.8 |
| | UG3RD | 75% | 61.4 | 73.9 | 74.6 | 81.9 |
| | UG3RD | 25% | 61.3 | 64.4 | 74.1 | 79.2 |
| 1990 | Base Case | | 55.3 | 56.9 | 68.2 | 72.0 |
| | UG3RD | 75% | 60.7 | 73.6 | 73.5 | 81.3 |
| | UG3RD | 25% | 60.6 | 63.9 | 72.8 | 77.8 |
| 1995 | Base Case | | 54.6 | 56.1 | 67.3 | 71.0 |
| | UG3RD | 75% | 60.3 | 73.5 | 72.8 | 80.9 |
| | UG3RD | 25% | 60.2 | 63.7 | 72.1 | 77.1 |
| 2000 | Base Case | | 53.9 | 55.3 | 66.3 | 69.7 |
| | UG3RD | 75% | 59.8 | 73.3 | 71.9 | 80.6 |
| | UG3RD | 25% | 59.7 | 63.4 | 71.1 | 76.2 |

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

APPENDIX E

AIRPORT CAPACITY ESTIMATES 1/
FAA UG3RD EVALUATION

Throughput Rates
Airport: Los Angeles (LAX)

| Year | System Package | WVAS Use 2/ | IFR Capacity 25% IFR Standard | IFR Capacity 25% IFR Crosswind | VFR Capacity 75% VFR Standard | VFR Capacity 75% VFR Crosswind |
|---|---|---|---|---|---|---|
| 1975 | Base Case | - | 106.6 | 106.6 | 167.0 | 167.0 |
| 1980 | Base Case | | 106.5 | 106.5 | 166.5 | 166.5 |
| | UG3RD | 75% | 146.9 | 146.9 | 202.0 | 202.0 |
| | UG3RD | 25% | 125.9 | 125.9 | 185.7 | 185.7 |
| 1985 | Base Case | | 105.6 | 105.6 | 164.2 | 164.2 |
| | UG3RD | 75% | 151.8 | 151.8 | 205.6 | 205.6 |
| | UG3RD | 25% | 125.9 | 125.9 | 184.6 | 184.6 |
| 1990 | Base Case | | 104.7 | 104.7 | 161.6 | 161.6 |
| | UG3RD | 75% | 152.0 | 152.0 | 205.4 | 205.4 |
| | UG3RD | 25% | 126.0 | 126.0 | 183.6 | 183.6 |
| 1995 | Base Case | | 104.0 | 104.0 | 159.4 | 159.4 |
| | UG3RD | 75% | 152.3 | 152.3 | 205.4 | 205.4 |
| | UG3RD | 25% | 126.2 | 126.2 | 182.9 | 182.9 |
| 2000 | Base Case | | 84.4 | 84.4 | 131.0 | 131.0 |
| | UG3RD | 75% | 124.8 | 124.8 | 168.9 | 168.9 |
| | UG3RD | 25% | 103.3 | 103.3 | 150.5 | 150.5 |

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

## APPENDIX E

## AIRPORT CAPACITY ESTIMATES 1/
## FAA UG3RD EVALUATION

Throughput Rates
Airport: Miami (MIA)

| Year | System Package | WVAS 2/ Use | IFR Capacity 1% IFR Standard | IFR Capacity 1% IFR Crosswind | VFR Capacity 99% VFR Standard | VFR Capacity 99% VFR Crosswind |
|---|---|---|---|---|---|---|
| 1975 | Base Case | - | 101.4 | 101.4 | 115.8 | 115.8 |
| 1980 | Base Case | | 100.8 | 100.8 | 115.1 | 115.1 |
| | UG3RD | 75% | 111.4 | 111.4 | 125.0 | 125.0 |
| | UG3RD | 25% | 110.3 | 110.3 | 122.7 | 122.7 |
| 1985 | Base Case | | 100.5 | 100.5 | 114.6 | 114.6 |
| | UG3RD | 75% | 111.4 | 111.4 | 124.9 | 124.9 |
| | UG3RD | 25% | 110.3 | 110.3 | 122.4 | 122.4 |
| 1990 | Base Case | | 100.2 | 100.2 | 114.3 | 114.3 |
| | UG3RD | 75% | 111.4 | 111.4 | 124.8 | 124.8 |
| | UG3RD | 25% | 110.3 | 110.3 | 122.2 | 122.2 |
| 1995 | Base Case | | 100.0 | 100.0 | 113.9 | 113.9 |
| | UG3RD | 75% | 111.4 | 111.4 | 124.7 | 124.7 |
| | UG3RD | 25% | 110.2 | 110.2 | 121.9 | 121.9 |
| 2000 | Base Case | | 99.7 | 99.7 | 113.6 | 113.6 |
| | UG3RD | 75% | 111.5 | 111.5 | 124.5 | 124.5 |
| | UG3RD | 25% | 110.3 | 110.3 | 121.7 | 121.7 |

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

## APPENDIX E

## AIRPORT CAPACITY ESTIMATES 1/
## FAA UG3RD EVALUATION

Throughput Rates
Airport: Minneapolis/St. Paul (MSP)

| Year | System Package | WVAS 2/ Use | IFR Capacity 12% IFR Standard | IFR Capacity 12% IFR Crosswind | VFR Capacity 88% VFR Standard | VFR Capacity 88% VFR Crosswind |
|---|---|---|---|---|---|---|
| 1975 | Base Case | - | 57.8 | 57.8 | 59.3 | 118.7 |
| 1980 | Base Case | | 56.7 | 56.7 | 58.6 | 117.2 |
| | UG3RD | 75% | 73.9 | 73.9 | 62.8 | 125.7 |
| | UG3RD | 25% | 63.6 | 63.6 | 62.0 | 123.9 |
| 1985 | Base Case | | 55.9 | 55.9 | 58.1 | 116.1 |
| | UG3RD | 75% | 76.5 | 76.5 | 62.7 | 125.3 |
| | UG3RD | 25% | 63.6 | 63.6 | 61.6 | 123.2 |
| 1990 | Base Case | | 55.1 | 55.1 | 57.7 | 115.5 |
| | UG3RD | 75% | 76.3 | 76.3 | 62.6 | 125.2 |
| | UG3RD | 25% | 63.4 | 63.4 | 61.4 | 122.9 |
| 1995 | Base Case | | 54.4 | 54.4 | 57.5 | 114.9 |
| | UG3RD | 75% | 76.1 | 76.1 | 62.5 | 125.0 |
| | UG3RD | 25% | 63.2 | 63.2 | 61.3 | 122.6 |
| 2000 | Base Case | | 53.8 | 53.8 | 57.2 | 114.5 |
| | UG3RD | 75% | 76.0 | 76.0 | 62.5 | 124.9 |
| | UG3RD | 25% | 63.0 | 63.0 | 61.1 | 122.3 |

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

## APPENDIX E

## AIRPORT CAPACITY ESTIMATES 1/
## FAA UG3RD EVALUATION

Throughput Rates
Airport: Newark (EWR)

| Year | System Package | WVAS 2/ Use | IFR Capacity 15% IFR Standard | IFR Capacity 15% IFR Crosswind | VFR Capacity 85% VFR Standard | VFR Capacity 85% VFR Crosswind |
|---|---|---|---|---|---|---|
| 1975 | Base Case | - | 51.3 | 56.2 | 58.7 | 78.7 |
| 1980 | Base Case | 51.3 | 56.8 | 58.5 | 79.8 | |
| | UG3RD | 75% | 55.7 | 74.1 | 62.7 | 85.5 |
| | UG3RD | 25% | 55.3 | 63.8 | 61.9 | 83.6 |
| 1985 | Base Case | 50.9 | 55.7 | 58.0 | 78.5 | |
| | UG3RD | 75% | 55.6 | 76.4 | 62.6 | 87.3 |
| | UG3RD | 25% | 55.2 | 63.5 | 61.6 | 82.2 |
| 1990 | Base Case | 50.7 | 55.1 | 57.7 | 77.7 | |
| | UG3RD | 75% | 55.7 | 76.3 | 62.6 | 86.9 |
| | UG3RD | 25% | 55.2 | 63.4 | 61.4 | 81.3 |
| 1995 | Base Case | 50.2 | 51.6 | 56.9 | 71.9 | |
| | UG3RD | 75% | 55.8 | 77.1 | 61.9 | 85.8 |
| | UG3RD | 25% | 55.3 | 64.1 | 60.7 | 75.0 |
| 2000 | Base Case | 50.1 | 53.5 | 57.1 | 75.5 | |
| | UG3RD | 75% | 55.7 | 75.9 | 62.4 | 85.9 |
| | UG3RD | 25% | 55.1 | 63.0 | 61.1 | 78.9 |

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

## APPENDIX E

### AIRPORT CAPACITY ESTIMATES [1]
### FAA UG3RD EVALUATION

Throughput Rates
Airport: New Orleans (MSY)

| Year | System Package | WVAS Use [2] | IFR Capacity 11% IFR Standard | IFR Capacity 11% IFR Crosswind | VFR Capacity 89% VFR Standard | VFR Capacity 89% VFR Crosswind |
|---|---|---|---|---|---|---|
| 1975 | Base Case | - | 55.5 | 57.2 | 58.8 | 70.7 |
| 1980 | Base Case | | 55.5 | 57.3 | 58.7 | 70.6 |
| | UG3RD | 75% | 62.8 | 69.8 | 62.8 | 77.1 |
| | UG3RD | 25% | 61.1 | 64.0 | 62.0 | 75.9 |
| 1985 | Base Case | | 55.3 | 57.1 | 58.5 | 70.3 |
| | UG3RD | 75% | 62.7 | 69.7 | 62.7 | 78.6 |
| | UG3RD | 25% | 61.0 | 64.0 | 61.9 | 75.7 |
| 1990 | Base Case | | 54.5 | 56.1 | 58.1 | 69.1 |
| | UG3RD | 75% | 62.7 | 69.6 | 62.7 | 78.2 |
| | UG3RD | 25% | 60.7 | 63.7 | 61.7 | 74.9 |
| 1995 | Base Case | | 53.6 | 55.1 | 57.7 | 67.7 |
| | UG3RD | 75% | 62.6 | 69.4 | 62.6 | 77.8 |
| | UG3RD | 25% | 60.3 | 63.4 | 61.4 | 74.0 |
| 2000 | Base Case | | 52.9 | 54.2 | 57.4 | 66.5 |
| | UG3RD | 75% | 62.5 | 69.3 | 62.5 | 77.5 |
| | UG3RD | 25% | 60.0 | 63.1 | 61.2 | 72.3 |

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

## APPENDIX E

## AIRPORT CAPACITY ESTIMATES 1/
## FAA UG3RD EVALUATION

Throughput Rates
Airport: Philadelphia (PHL)

| Year | System Package | WVAS Use 2/ | IFR Capacity 15% IFR Standard | IFR Capacity 15% IFR Crosswind | VFR Capacity 85% VFR Standard | VFR Capacity 85% VFR Crosswind |
|---|---|---|---|---|---|---|
| 1975 | Base Case | - | 57.3 | 57.3 | 73.4 | 73.4 |
| 1980 | Base Case | | 57.8 | 57.8 | 73.6 | 73.6 |
| | UG3RD | 75% | 73.7 | 73.7 | 80.0 | 80.0 |
| | UG3RD | 25% | 63.7 | 63.7 | 78.7 | 78.7 |
| 1985 | Base Case | | 57.4 | 57.4 | 72.7 | 72.7 |
| | UG3RD | 75% | 77.0 | 77.0 | 81.5 | 81.5 |
| | UG3RD | 25% | 64.1 | 64.1 | 78.4 | 78.4 |
| 1990 | Base Case | | 56.9 | 56.9 | 72.0 | 72.0 |
| | UG3RD | 75% | 76.8 | 76.8 | 81.3 | 81.3 |
| | UG3RD | 25% | 63.9 | 63.9 | 77.8 | 77.8 |
| 1995 | Base Case | | 56.1 | 56.1 | 71.0 | 71.0 |
| | UG3RD | 75% | 76.6 | 76.6 | 80.9 | 80.9 |
| | UG3RD | 25% | 63.7 | 63.7 | 77.1 | 77.1 |
| 2000 | Base Case | | 55.3 | 55.3 | 69.7 | 69.7 |
| | UG3RD | 75% | 76.3 | 76.3 | 80.6 | 80.6 |
| | UG3RD | 25% | 63.4 | 63.4 | 76.2 | 76.2 |

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

## APPENDIX E

## AIRPORT CAPACITY ESTIMATES 1/
## FAA UG3RD EVALUATION

Throughput Rates
Airport: Pittsburgh (PIT)

| Year | System Package | WVAS 2/ Use | IFR Capacity 17% IFR Standard | IFR Capacity 17% IFR Crosswind | VFR Capacity 83% VFR Standard | VFR Capacity 83% VFR Crosswind |
|---|---|---|---|---|---|---|
| 1975 | Base Case | - | 87.9 | 87.9 | 101.4 | 101.4 |
| 1980 | Base Case | | 87.5 | 89.0 | 100.8 | 100.8 |
| | UG3RD | 75% | 97.2 | 92.4 | 104.7 | 104.7 |
| | UG3RD | 25% | 90.7 | 92.3 | 104.4 | 104.4 |
| 1985 | Base Case | | 84.9 | 87.6 | 99.8 | 99.8 |
| | UG3RD | 75% | 103.0 | 91.7 | 104.2 | 104.2 |
| | UG3RD | 25% | 89.6 | 91.5 | 103.7 | 103.7 |
| 1990 | Base Case | | 82.8 | 87.1 | 99.3 | 99.3 |
| | UG3RD | 75% | 102.5 | 91.7 | 104.2 | 104.2 |
| | UG3RD | 25% | 88.7 | 91.4 | 103.4 | 103.4 |
| 1995 | Base Case | | 80.9 | 86.7 | 98.9 | 98.9 |
| | UG3RD | 75% | 102.1 | 91.7 | 104.1 | 104.1 |
| | UG3RD | 25% | 87.8 | 91.4 | 103.2 | 103.2 |
| 2000 | Base Case | | 79.2 | 86.4 | 98.5 | 98.5 |
| | UG3RD | 75% | 101.8 | 91.8 | 104.0 | 104.0 |
| | UG3RD | 25% | 87.1 | 91.3 | 103.0 | 103.0 |

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

## APPENDIX E

### AIRPORT CAPACITY ESTIMATES 1/
### FAA UG3RD EVALUATION

Throughput Rates
Airport: St. Louis (STL)

| Year | System Package | WVAS Use 2/ | IFR Capacity 12% IFR Standard | IFR Capacity 12% IFR Crosswind | VFR Capacity 88% VFR Standard | VFR Capacity 88% VFR Crosswind |
|---|---|---|---|---|---|---|
| 1975 | Base Case | - | 59.4 | 59.4 | 75.6 | 75.6 |
| 1980 | Base Case | | 59.0 | 59.0 | 74.9 | 74.9 |
| | UG3RD | 75% | 74.5 | 74.5 | 80.9 | 80.9 |
| | UG3RD | 25% | 64.5 | 64.5 | 79.9 | 79.9 |
| 1985 | Base Case | | 58.0 | 58.0 | 73.5 | 73.5 |
| | UG3RD | 75% | 77.1 | 77.1 | 81.7 | 81.7 |
| | UG3RD | 25% | 64.3 | 64.3 | 78.9 | 78.9 |
| 1990 | Base Case | | 56.9 | 56.9 | 72.0 | 72.0 |
| | UG3RD | 75% | 76.8 | 76.8 | 81.3 | 81.3 |
| | UG3RD | 25% | 63.9 | 63.9 | 77.8 | 77.8 |
| 1995 | Base Case | | 55.7 | 55.7 | 70.3 | 70.3 |
| | UG3RD | 75% | 76.4 | 76.4 | 80.8 | 80.8 |
| | UG3RD | 25% | 63.5 | 63.5 | 76.7 | 76.7 |
| 2000 | Base Case | | 54.5 | 54.5 | 68.6 | 68.6 |
| | UG3RD | 75% | 76.1 | 76.1 | 80.3 | 80.3 |
| | UG3RD | 25% | 63.2 | 63.2 | 75.5 | 75.5 |

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

## APPENDIX E

### AIRPORT CAPACITY ESTIMATES 1/
### FAA UG3RD EVALUATION

Throughput Rates
Airport: San Francisco (SFO)

| Year | System Package | WVAS 2/ Use | IFR Capacity 10% IFR Standard | IFR Capacity 10% IFR Crosswind | VFR Capacity 90% VFR Standard | VFR Capacity 90% VFR Crosswind |
|---|---|---|---|---|---|---|
| 1975 | Base Case | - | 52.4 | 54.3 | 76.7 | 76.7 |
| 1980 | Base Case | | 52.2 | 54.1 | 76.3 | 76.3 |
| | UG3RD | 75% | 61.2 | 73.6 | 82.9 | 82.9 |
| | UG3RD | 25% | 59.0 | 63.1 | 79.8 | 79.8 |
| 1985 | Base Case | | 51.9 | 53.6 | 75.7 | 75.7 |
| | UG3RD | 75% | 61.3 | 78.0 | 86.0 | 86.0 |
| | UG3RD | 25% | 58.9 | 63.0 | 79.1 | 79.1 |
| 1990 | Base Case | | 51.6 | 53.1 | 74.9 | 74.9 |
| | UG3RD | 75% | 61.3 | 77.8 | 85.7 | 85.7 |
| | UG3RD | 25% | 58.9 | 62.9 | 78.3 | 78.3 |
| 1995 | Base Case | | 51.2 | 52.6 | 74.1 | 74.1 |
| | UG3RD | 75% | 61.4 | 77.6 | 85.5 | 85.5 |
| | UG3RD | 25% | 58.8 | 62.9 | 77.4 | 77.4 |
| 2000 | Base Case | | 51.0 | 52.1 | 73.3 | 73.3 |
| | UG3RD | 75% | 61.4 | 77.6 | 85.4 | 85.4 |
| | UG3RD | 25% | 58.9 | 63.1 | 76.5 | 76.5 |

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

## APPENDIX E

## AIRPORT CAPACITY ESTIMATES 1/
## FAA UG3RD EVALUATION

Throughput Rates
Airport: Seattle (SEA)

| Year | System Package | WVAS 2/ Use | IFR Capacity 16% IFR Standard | IFR Capacity 16% IFR Crosswind | VFR Capacity 84% VFR Standard | VFR Capacity 84% VFR Crosswind |
|---|---|---|---|---|---|---|
| 1975 | Base Case | - | 53.8 | 53.8 | 67.5 | 67.5 |
| 1980 | Base Case | | 53.6 | 53.6 | 67.0 | 67.0 |
| | UG3RD | 75% | 73.5 | 73.5 | 77.4 | 77.4 |
| | UG3RD | 25% | 63.0 | 63.0 | 74.5 | 74.5 |
| 1985 | Base Case | | 53.6 | 53.6 | 67.0 | 67.0 |
| | UG3RD | 75% | 76.0 | 76.0 | 79.9 | 79.9 |
| | UG3RD | 25% | 63.0 | 63.0 | 74.5 | 74.5 |
| 1990 | Base Case | | 53.1 | 53.1 | 66.1 | 66.1 |
| | UG3RD | 75% | 75.9 | 75.9 | 79.8 | 79.8 |
| | UG3RD | 25% | 62.9 | 62.9 | 74.0 | 74.0 |
| 1995 | Base Case | | 52.7 | 52.7 | 65.3 | 65.3 |
| | UG3RD | 75% | 75.9 | 75.9 | 79.7 | 79.7 |
| | UG3RD | 25% | 62.9 | 62.9 | 73.5 | 73.5 |
| 2000 | Base Case | | 52.2 | 52.2 | 64.2 | 64.2 |
| | UG3RD | 75% | 76.0 | 76.0 | 79.6 | 79.6 |
| | UG3RD | 25% | 63.0 | 63.0 | 73.0 | 73.0 |

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

## APPENDIX E

## AIRPORT CAPACITY ESTIMATES 1/ FAA UG3RD EVALUATION

Throughput Rates
Airport: Tampa (TPA)

| Year | System Package | WVAS Use 2/ | IFR Capacity 7% IFR Standard | IFR Capacity 7% IFR Crosswind | VFR Capacity 93% VFR Standard | VFR Capacity 93% VFR Crosswind |
|---|---|---|---|---|---|---|
| 1975 | Base Case | - | 82.3 | 82.3 | 117.6 | 117.6 |
| 1980 | Base Case | | 80.5 | 80.5 | 116.7 | 116.7 |
| | UG3RD | 75% | 97.1 | 97.1 | 125.3 | 125.3 |
| | UG3RD | 25% | 87.6 | 87.6 | 123.5 | 123.5 |
| 1985 | Base Case | | 78.8 | 78.8 | 115.9 | 115.9 |
| | UG3RD | 75% | 101.7 | 101.7 | 125.3 | 125.3 |
| | UG3RD | 25% | 86.9 | 86.9 | 123.1 | 123.1 |
| 1990 | Base Case | | 77.3 | 77.3 | 115.3 | 115.3 |
| | UG3RD | 75% | 101.4 | 101.4 | 125.1 | 125.1 |
| | UG3RD | 25% | 86.4 | 86.4 | 122.8 | 122.8 |
| 1995 | Base Case | | 76.3 | 76.3 | 114.9 | 114.9 |
| | UG3RD | 75% | 101.2 | 101.2 | 125.0 | 125.0 |
| | UG3RD | 25% | 86.0 | 86.0 | 122.6 | 122.6 |
| 2000 | Base Case | | 75.0 | 75.0 | 114.5 | 114.5 |
| | UG3RD | 75% | 101.0 | 101.0 | 124.9 | 124.9 |
| | UG3RD | 25% | 85.6 | 85.6 | 122.3 | 122.3 |

1/ Source: The MITRE Corporation

2/ Percentage of time in alternative capacity conditions. Wake Vortex Avoidance System (WVAS) allows reduced, longitudinal separation of aircraft and increased airport capacity.

## APPENDIX F

## NETWORK PASSENGER TRAFFIC FOR 1974 1/

**Table Description**

P - City name

Q - City name

PAX - Passenger in the 10 percent sample of one way on line 090 passengers. In the case of mostly connecting services total O-D passengers was used, this being the larger number due to interline-line connections.

CN - The number of competitors having at least 10% of the largest market share.

CI - The reciprocal of the largest market share (rounded up) if different from CN.

DIST- Intercity distance in miles

0 Nonstop services, including night coach

1 One stop services

2 Two stop services

C Connecting services

FQ Number of distinguishable departure times

HR Number of hours from earliest to latest departure times (excluding night coach) rounded up (usually to an even hour)

NC
- 0 Night coach nonstops
- 1 Night coach one stop
- 2 Night coach two stop

1/ Data comes from inspection of OAG May 15, 1974, schudule for June 1, and from Table 10 and Table 8 of the 1974 Annual CAB O-D (Origin-Destination) Tables.

## APPENDIX F

| P | Q | PAX | CN | CI | DIST | O | 1 | 2 | C | FQ | HR | NCO | NCI | NC2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NYC | ALT | 70996 | 3 | 2.0 | 755 | 23 | | | | 11 | 16 | | | |
| NYC | BOS | 201398 | 2 | 1.2 | 191 | 43 | | | | 32 | 16 | 3 | 2 | |
| NYC | ORD | 194282 | 3 | | 721 | 51 | | | | 32 | 14 | | | |
| NYC | CLE | 61338 | 2 | 1.3 | 410 | 19 | | | | 8 | 12 | | | |
| NYC | DFW | 41497 | 2 | | 1363 | 13 | | | | 9 | 12 | | | |
| NYC | DEN | 32268 | 2 | | 1627 | 6 | 2 | 1 | | 5 | 8 | | | |
| NYC | DET | 85138 | 2 | 1.5 | 489 | 19 | | | | 14 | 16 | | | |
| NYC | HLU | 11786 | 1 | | 4971 | 1 | 1 | 15 | | 5 | 7 | | | |
| NYC | HOU | 35841 | 2 | | 1416 | 7 | 7 | | | 9 | 10 | | | |
| NYC | LAX | 113742 | 3 | | 2453 | 13 | 3 | 3 | | 9 | 12 | | | |
| NYC | MEM | 13363 | 3 | 1.4 | 956 | 2 | 5 | | | 7 | 10 | | | |
| NYC | MIA | 159094 | 3 | | 1092 | 30 | 4 | 3 | | 15 | 10 | | | |
| NYC | MSP | 27758 | 2 | 1.8 | 1016 | 7 | 2 | | | 6 | 11 | | | |
| NYC | PHL | 9141 | 6 | | 84 | 11 | | | | 9 | 12 | | | |
| NYC | PIT | 68838 | 2 | | 329 | 27 | 5 | | | 17 | 14 | | | |
| NYC | WAS | 186968 | 2 | 1.3 | 215 | 61 | 3 | | | 34 | 17 | | | |
| NYC | STL | 35118 | 2 | 1.5 | 882 | 9 | 5 | | | 10 | 10 | | | |
| NYC | SFO | 81151 | 3 | | 2574 | 9 | 7 | 3 | | 8 | 12 | | | |
| ALT | BOS | 14388 | 2 | 1.3 | 946 | 5 | 8 | 4 | | 11 | 11 | | | |
| ALT | ORD | 42503 | 3 | 2.0 | 597 | 15 | 7 | 8 | | 18 | 14 | | | |
| ALT | CLE | 17838 | 1 | | 559 | 6 | 1 | 1 | | 7 | 10 | | | |
| ALT | DAL | 36215 | 2 | 1.3 | 707 | 13 | 5 | 5 | | 12 | 14 | | | |
| ALT | DEN | 3887 | 5 | | 1208 | | 1 | 1 | 15 | 7 | 12 | | | |
| ALT | DET | 22210 | 1 | | 602 | 3 | 3 | 7 | | 8 | 10 | | | |
| ALT | HOU | 20931 | 2 | 1.5 | 692 | 10 | | | | 8 | 14 | | | |
| ALT | LAX | 20811 | 2 | 1.5 | 1934 | 7 | 2 | 1 | | 7 | 9 | | | |
| ALT | MEM | 23276 | 2 | 1.5 | 332 | 11 | 2 | 3 | | 13 | 12 | | | |

## APPENDIX F CONT.

| P | Q | PAX | CN | CI | DIST | O | 1 | 2 | C | FQ | HR | NCO | NC1 | NC2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALT | MIA | 36819 | 2 | 1.5 | 595 | 15 | 8 | 4 | | 11 | 13 | | | |
| ALT | MSP | 10624 | 2 | 1.5 | 906 | 6 | 1 | 1 | | 6 | 10 | | | |
| ALT | PHL | 22663 | 2 | | 672 | 11 | | | | 8 | 12 | | | |
| ALT | PIT | 16301 | 2 | | 526 | 7 | 3 | | | 10 | 12 | | | |
| ALT | WAS | 35748 | 3 | 2.0 | 540 | 9 | | | | 17 | 12 | 3 | | |
| ALT | STL | 17481 | 2 | 1.5 | 434 | 9 | 1 | | | 8 | 12 | | | |
| ALT | SFO | 14435 | 1 | | 2141 | 2 | 2 | 1 | | 3 | 6 | 2 | | |
| BOS | ORD | 50711 | 3 | | 860 | 16 | 3 | 2 | | 16 | 14 | | | |
| BOS | CLE | 15228 | 2 | 1.1 | 588 | 5 | 1 | 3 | | 8 | 12 | | | |
| BOS | DFW | 9654 | 1 | | 1543 | | 6 | 2 | | 5 | 12 | | | |
| BOS | DEN | 9372 | 2 | 1.5 | 1766 | 3 | 2 | | | 5 | 10 | | | |
| BOS | DET | 21925 | 1 | | 623 | 4 | | | | 5 | 11 | | | |
| BOS | HLU | 3112 | 1 | | 5095 | | | 19 | | 7 | 12 | | | |
| BOS | HOU | 5241 | 2 | 1.2 | 1603 | | 2 | 2 | | 4 | 9 | | | |
| BOS | LAX | 27505 | 2 | | 2600 | 2 | 4 | | | 5 | 14 | | | |
| BOS | MEM | 2706 | 3 | 2.0 | 1139 | | 2 | 3 | | 3 | 12 | | | |
| BOS | MIA | 25264 | 2 | | 1258 | 4 | 2 | 2 | | 5 | 12 | | | |
| BOS | MSP | 8848 | 2 | | 1124 | 2 | 3 | | | 5 | 10 | | | |
| BOS | PHL | 48283 | 2 | 1.5 | 274 | 20 | | | | 16 | 14 | | | |
| BOS | PIT | 16904 | 2 | | 496 | 6 | 10 | 2 | | 10 | 14 | | | |
| BOS | STL | 8132 | 2 | 1.1 | 1046 | 2 | | 3 | | 5 | 9 | | | |
| BOS | SFO | 20404 | 3 | | 2703 | 2 | 5 | 3 | | 9 | 15 | | | |
| BOS | WAS | 71637 | 3 | 2.5 | 406 | 32 | | | | 20 | 16 | | | |
| ORD | CLE | 49128 | 2 | 1.5 | 312 | 20 | 7 | | | 16 | 15 | | | |
| ORD | DFW | 41069 | 2 | | 790 | 18 | 6 | 3 | | 20 | 13 | | | |
| ORD | DEN | 55949 | 3 | | 907 | 17 | 1 | 2 | | 15 | 14 | | | |
| ORD | DET | 78413 | 3 | 2.0 | 238 | 16 | 1 | 4 | 4 | 17 | 15 | | | |
| ORD | HLU | 19282 | 3 | 1.5 | 4251 | 1 | 2 | 2 | | 4 | 11 | | | |
| ORD | HOU | 33003 | 2 | | 932 | 9 | 1 | | | 5 | 11 | | | |
| ORD | LAX | 86701 | 4 | | 1740 | 22 | 8 | 6 | | 18 | 16 | 3 | 2 | |
| ORD | MEM | 24901 | 2 | 1.2 | 485 | 8 | 5 | | | 11 | 15 | 1 | 1 | |
| ORD | MIA | 46392 | 3 | 2.0 | 1188 | 8 | 4 | 5 | | 9 | 9 | 1 | | |
| ORD | MSP | 86524 | 2 | 1.2 | 344 | 26 | 2 | 3 | | 19 | 13 | | | |

## APPENDIX F CONT.

| P | Q | PAX | CN | CI | DIST | 0 | 1 | 2 | C | FQ | HR | NC0 | NC1 | NC2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ORD | PHL | 47415 | 2 | | 675 | 12 | 3 | | | 12 | 13 | | | |
| ORD | PIT | 39231 | 3 | | 404 | 21 | 3 | | | 16 | 14 | | | |
| ORD | STL | 63498 | 3 | 2.0 | 256 | 23 | 2 | 6 | | 22 | 16 | 1 | | |
| ORD | SFO | 53480 | 3 | | 1853 | 18 | 5 | | | 13 | 16 | | | |
| ORD | WAS | 68361 | 3 | 2.0 | 591 | 31 | 12 | 7 | | 23 | 14 | | | |
| CLE | DFW | 7879 | 1 | | 1010 | 2 | | | | 2 | 7 | | | |
| CLE | DEN | 5221 | 1 | | 1217 | 2 | | | | 2 | 7 | | | |
| CLE | DET | 21647 | 2 | 1.5 | 94 | 16 | | | | 14 | 13 | | | |
| CLE | HOU | 4623 | 1 | | 1104 | 1 | | 1 | 10 | 10 | 12 | | | |
| CLE | LAX | 14376 | 2 | | 2046 | 4 | | 2 | | 4 | 16 | | | |
| CLE | MEM | 2408 | 1 | | 628 | | | | 7 | 7 | 11 | | | |
| CLE | MIA | 12982 | 2 | 1.5 | 1083 | 3 | | | | 2 | 5 | | | |
| CLE | MSP | 6421 | 2 | 1.5 | 624 | 2 | 6 | | | 7 | 10 | | | |
| CLE | PHL | 17543 | 2 | 1.5 | 365 | 7 | | | | 6 | 12 | | | |
| CLE | PIT | 10003 | 4 | 3.5 | 105 | 9 | | | | 7 | 10 | | | |
| CLE | STL | 9579 | 2 | | 492 | 4 | 2 | | | 5 | 11 | | | |
| CLE | SFO | 7683 | 2 | 1.2 | 2164 | 1 | 2 | | | 3 | 5 | | | |
| CLE | WAS | 20074 | 2 | | 297 | 11 | 2 | | | 10 | 14 | | | |
| DFW | DEN | 29198 | 2 | 1.3 | 664 | 14 | 1 | | | 12 | 11 | 1 | | |
| DFW | DET | 10191 | 2 | 1.3 | 983 | 3 | 6 | 1 | | 10 | 13 | | | |
| DFW | HLU | 5407 | 1 | | 3810 | 1 | | | 2 | 1 | 4 | | | |
| DFW | HOU | 46156 | 2 | 1.2 | 222 | 33 | | | | 8 | 12 | | | |
| DFW | LAX | 40441 | 2 | 1.5 | 1248 | 14 | 1 | 1 | | 9 | 14 | 5 | | |
| DFW | MEM | 14118 | 2 | 1.5 | 410 | 9 | 3 | | | 9 | 12 | | | |
| DFW | MIA | 14404 | 2 | 1.5 | 1096 | 6 | 1 | | | 5 | 11 | | | |
| DFW | MSP | 9316 | 1 | | 850 | 3 | 3 | 2 | | 71 | 2 | | | |
| DFW | PHL | 10406 | 1 | | 1289 | 3 | 3 | 1 | | 6 | 12 | | | |
| DFW | PIT | 7548 | 1 | | 1049 | 2 | 2 | | | 4 | 10 | | | |
| DFW | STL | 16670 | 2 | | 537 | 9 | | 1 | | 7 | 10 | 1 | | |
| DFW | SFO | 24912 | 2 | | 1493 | 9 | 3 | | | 6 | 10 | 3 | 1 | |
| DFW | WAS | 18995 | 2 | | 1161 | 8 | 5 | 4 | | 13 | 10 | 1 | | |

## APPENDIX F CONT.

| P | Q | PAX | CN | CI | DIST | 0 | 1 | 2 | C | FQ | HR | NC0 | NC1 | NC2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DEN | DET | 8590 | 1 | | 1144 | 2 | | | | 2 | 10 | | | |
| DEN | HLU | 4374 | 3 | 2.3 | 3353 | | 2 | | | 2 | 5 | | | |
| DEN | HOU | 18205 | 3 | 2.0 | 875 | 4 | 4 | 5 | | 11 | 12 | | | |
| DEN | LAX | 44487 | 2 | 1.5 | 839 | 14 | 3 | 2 | | 11 | 12 | 2 | | |
| DEN | MEM | 8475 | 1 | | 880 | 1 | 1 | 1 | | 3 | 10 | | | |
| DEN | MIA | 5913 | 1 | 1.1 | 1716 | | 3 | | | 3 | 6 | | | |
| DEN | MSP | 20962 | 2 | 1.5 | 693 | 8 | 2 | | | 8 | 11 | | | |
| DEN | PHL | 7930 | 2 | 1.5 | 1575 | 2 | 4 | | | 5 | 10 | | | |
| DEN | PIT | 4825 | 2 | | 1302 | | 2 | | | 2 | 12 | | | |
| DEN | STL | 14780 | 2 | | 781 | 7 | 2 | | | 7 | 14 | | | |
| DEN | SFO | 28821 | 3 | 1.5 | 956 | 10 | 5 | 2 | | 13 | 12 | | | |
| DEN | WAS | 15007 | 2 | 1.5 | 1476 | 5 | 2 | | | 5 | 10 | | | |
| DET | HLU | 2691 | 3 | 1.2 | 4483 | | 1 | | | 1 | 14 | | | |
| DET | HOU | 5066 | 2 | 1.5 | 1095 | | 3 | 1 | | 4 | 12 | | | |
| DET | LAX | 25893 | 2 | 1.5 | 1977 | 2 | 4 | | | 5 | 6 | | 1 | |
| DET | MEM | 7645 | 1 | | 621 | 2 | 3 | | | 4 | 10 | | 1 | |
| DET | MIA | 21222 | 2 | 1.5 | 1151 | 3 | 1 | 2 | | 6 | 14 | | | |
| DET | MSP | 12383 | 2 | 1.1 | 534 | 1 | 5 | | | 6 | 12 | | 1 | |
| DET | PHL | 21588 | 2 | | 452 | 6 | | | | 4 | 12 | | | |
| DET | PIT | 17750 | 3 | 2.3 | 198 | 8 | 3 | 1 | | 11 | 14 | | | |
| DET | STL | 13171 | 1 | | 451 | 4 | | | | 4 | 10 | | | |
| DET | SFO | 15464 | 2 | 1.5 | 2086 | 5 | 1 | | | 2 | 16 | | | |
| DET | WAS | 30713 | 2 | 1.5 | 391 | 12 | 3 | 1 | | 12 | 16 | | | |
| HLU | LAX | 88196 | 6 | 4.0 | 2568 | 12 | 1 | | | 10 | 12 | | | |
| HLU | MSP | 7236 | 2 | | 3972 | | 2 | 1 | 9 | 3 | 4 | | | |
| HLU | PIT | 2057 | 1 | | 4652 | | 1 | | 8 | 2 | 12 | | | |
| HLU | SFO | 49452 | 4 | 2.2 | 2399 | 9 | 2 | | | 9 | 12 | | | |
| HOU | LAX | 27947 | 2 | 1.2 | 1372 | 6 | | 3 | | 5 | 12 | 1 | | 1 |
| HOU | MEM | 7028 | 2 | 1.1 | 477 | 1 | 6 | 2 | | 8 | 12 | | 1 | |
| HOU | MIA | 15668 | 4 | 2.2 | 959 | 4 | 3 | 1 | | 8 | 12 | | | |
| HOU | MSP | 4468 | 1 | | 1046 | | 1 | | 16 | 2 | 6 | | | |
| HOU | PHL | 9150 | 2 | 1.5 | 1336 | 1 | 3 | | | 4 | 10 | | | |
| HOU | PIT | 5325 | 1 | | 1124 | 1 | | | | 1 | 12 | | | |
| HOU | WAS | 10391 | 3 | 1.5 | 1204 | 2 | 6 | 1 | | 5 | 10 | | | |
| HOU | STL | 13069 | 2 | 1.5 | 677 | 3 | | 1 | | 3 | 8 | | | |
| HOU | SFO | 13300 | 2 | 1.5 | 1647 | 2 | 3 | 1 | | 7 | 8 | | 1 | |

## APPENDIX F CONT.

| P | Q | PAX | CN | CI | DIST | 0 | 1 | 2 | C | FQ | HR | NC0 | NC1 | NC2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LAX | MEM | 7856 | 2 | 1.5 | 1606 | 4 | | | | 3 | 8 | | | |
| LAX | MIA | 18777 | 4 | 1.5 | 2330 | 2 | 1 | 2 | | 5 | 10 | 1 | | |
| LAX | MSP | 26988 | 2 | 1.5 | 1526 | 6 | 2 | 1 | | 10 | 14 | | | |
| LAX | PHL | 22357 | 3 | | 2396 | 3 | 3 | 2 | | 7 | 10 | | | 1 |
| LAX | PIT | 12357 | 2 | 1.3 | 2125 | 1 | 4 | 1 | | 5 | 10 | | | |
| LAX | STL | 21902 | 2 | 1.3 | 1581 | 5 | 3 | 2 | | 8 | 12 | 1 | | |
| LAX | SFO | 111202 | 3 | 2.3 | 355 | 40 | 5 | | | 29 | 24 | | | |
| LAX | WAS | 34924 | 3 | | 2288 | 6 | 4 | | | 8 | 10 | | 2 | |
| MEM | MIA | 5462 | 2 | 1.2 | 861 | 2 | 1 | | 17 | 6 | 10 | | | |
| MEM | MSP | 1411 | 3 | 1.2 | 699 | | | | 28 | 14 | 12 | | | |
| MEM | PHL | 4620 | 1 | 1.1 | 881 | 1 | 2 | 1 | 15 | 4 | 11 | | | |
| MEM | PIT | 2474 | 1 | | 652 | | 3 | | 10 | 3 | 11 | | | |
| MEM | WAS | 9022 | 2 | | 754 | 5 | 2 | 1 | | 8 | 12 | | | |
| MEM | STL | 15718 | 2 | | 255 | 12 | | | | 7 | 12 | | | |
| MIA | MSP | 6356 | 2 | 1.1 | 1501 | | 2 | 2 | 7 | 4 | 10 | | | |
| MIA | PHL | 2826 | 2 | 1.5 | 1017 | 7 | | | | 5 | 11 | | | |
| MIA | PIT | 13289 | 2 | 1.5 | 1013 | 4 | 1 | | 16 | 3 | 10 | | | |
| MIA | WAS | 26463 | 2 | 1.5 | 920 | 11 | | 2 | | 8 | 10 | | | |
| MIA | STL | 10255 | 2 | | 1068 | 3 | 2 | | 12 | 5 | 10 | | | |
| MIA | SFO | 9310 | 2 | 1.5 | 2589 | 1 | 1 | 1 | 5 | 3 | 14 | | | |
| MSP | PHL | 8309 | 2 | 1.5 | 985 | 2 | 3 | 1 | | 6 | 10 | | | |
| MSP | PIT | 3196 | 2 | 1.5 | 726 | | 1 | 1 | | 2 | 6 | | | |
| MSP | STL | 13733 | 2 | | 448 | 4 | 3 | 2 | | 8 | 14 | | | |
| MSP | SFO | 18919 | 2 | 1.5 | 1587 | 5 | 1 | 1 | | 5 | 12 | 1 | | |
| MSP | WAS | 17594 | 2 | 1.5 | 919 | 6 | | 6 | | 6 | 12 | | | |
| PHL | PIT | 37196 | 2 | 1.3 | 273 | 21 | | | | 15 | 16 | | | |
| PHL | STL | 9205 | 1 | | 820 | 2 | 1 | 3 | | 6 | 12 | | | |
| PHL | SFO | 14572 | 3 | 2.2 | 2526 | 2 | 1 | 2 | | 3 | 12 | | | |
| PHL | WAS | 20292 | 2 | 1.0 | 133 | 36 | 2 | 1 | | 25 | 14 | | | |
| PIT | STL | 8356 | 2 | | 554 | 7 | 4 | | | 10 | 14 | | | |
| PIT | SFO | 8284 | 2 | 1.3 | 2253 | 1 | 3 | | | 2 | 8 | | 1 | |
| PIT | WAS | 21988 | 3 | 1.8 | 193 | 13 | 2 | 2 | | 14 | 16 | | | |

## APPENDIX F CONT.

| P | Q | PAX | CN | CI | DIST | 0 | 1 | 2 | C | FQ | HR | NC0 | NC1 | NC2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STL | SFO | 12293 | 2 | 1.2 | 1736 | 3 | 2 | 3 | | 5 | 8 | 1 | | 1 |
| STL | WAS | 18557 | 2 | 1.3 | 707 | 6 | 2 | | | 7 | 12 | | | |
| SFO | WAS | 26517 | 3 | 2.2 | 2430 | 5 | 3 | 3 | | 8 | 10 | | | |
| MSY | ALT | 20983 | 2 | 1.4 | 425 | 13 | 4 | 1 | | 8 | 14 | 3 | 1 | |
| MSY | BOS | 4748 | 2 | 1.6 | 1367 | 1 | 3 | 2 | | 4 | 12 | | | 1 |
| MSY | ORD | 21859 | 1 | | 831 | 3 | 4 | 2 | | 7 | 10 | | 1 | |
| MSY | CLE | 2723 | 1 | | 922 | | 2 | | 6 | 6 | 14 | | | |
| MSY | DFW | 27736 | 2 | 1.3 | 423 | 10 | 2 | | | 9 | 12 | | | |
| MSY | DEN | 5676 | 2 | 1.1 | 1067 | 1 | 1 | 1 | | 3 | 10 | | | |
| MSY | DET | 4626 | 1 | | 936 | | | 3 | | 3 | 10 | | | |
| MSY | HOU | 35180 | 4 | 3.0 | 303 | 17 | | 3 | | 14 | 16 | 2 | | |
| MSY | LAX | 12229 | 2 | 1.6 | 1658 | 2 | 5 | | | 3 | 12 | | 3 | |
| MSY | MIA | 13719 | 3 | 2.3 | 675 | 7 | | 3 | | 8 | 12 | 1 | | |
| MSY | MSP | 2793 | 2 | 1.2 | 1040 | | 2 | 2 | | 4 | 14 | | | |
| MSY | PHL | 6764 | 2 | 1.6 | 1094 | 2 | 2 | 1 | | 4 | 10 | | | |
| MSY | PIT | 4300 | 1 | | 918 | 2 | | | | 6 | 12 | | | |
| MSY | WAS | 7433 | 2 | 1.4 | 962 | 2 | 2 | | | 4 | 10 | | | |
| MSY | STL | 8445 | 2 | 1.2 | 604 | 2 | 3 | 2 | | 6 | 12 | | | |
| MSY | SFO | 8010 | 2 | 1.6 | 1915 | 1 | 4 | 2 | | 3 | 10 | | | 1 |
| MSY | MKI | 3942 | 1 | 1.1 | 676 | 1 | 2 | 2 | | 4 | 10 | | | |
| MSY | NYC | 26643 | 2 | 2.0 | 1177 | 6 | 1 | 1 | | 5 | 10 | 1 | | |

## APPENDIX F CONT.

| P | Q | PAX | CN | CI | DIST | O | 1 | 2 | C | FQ | HR | NCO | NC1 | NC2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MKI | ALT | 9954 | 2 | 1.4 | 681 | 3 | 2 | | 1 | 4 | 10 | | 1 | |
| MKI | BOS | 3511 | 1 | | 1254 | | 1 | | 7 | 7 | 12 | | | |
| MKI | ORD | 47454 | 2 | 1.6 | 407 | 16 | | 1 | | 14 | 18 | | | |
| MKI | CLE | 3102 | 1 | | 696 | | 1 | | 8 | 8 | 16 | | | |
| MKI | DFW | 16895 | 1 | | 448 | 9 | 4 | 4 | | 13 | 16 | | | |
| MKI | DEN | 19032 | 2 | 1.4 | 552 | 9 | | | | 6 | 12 | 1 | | |
| MKI | DET | 5689 | 2 | 1.8 | 638 | 3 | 1 | | | 4 | 12 | | | |
| MKI | HLU | 1684 | 4 | 1.7 | 3900 | | | | 8 | 8 | 16 | | | |
| MKI | HOU | 6846 | 1 | | 643 | 1 | 4 | | | 5 | 10 | | | |
| MKI | LAX | 19147 | 2 | 1.5 | 1357 | 6 | | | 1 | 4 | 12 | 2 | | |
| MKI | MIA | 4796 | 3 | 2.4 | 1239 | | 3 | 4 | | 6 | 10 | | | |
| MKI | MSP | 11290 | 1 | | 404 | 3 | 6 | 1 | | 8 | 16 | | | |
| MKI | PHL | 4593 | 2 | 1.8 | 1040 | 1 | 2 | | 1 | 4 | 10 | | | |
| MKI | PIT | 2118 | 1 | | 769 | | | | 10 | 10 | 14 | | | |
| MKI | WAS | 9647 | 2 | 1.3 | 932 | 2 | 4 | | | 5 | 14 | | | |
| MKI | STL | 24073 | 1 | | 229 | 15 | 1 | | | 14 | 14 | 1 | | |
| MKI | SFO | 9366 | 2 | 1.3 | 1507 | 3 | 1 | 1 | | 3 | 10 | | 1 | |
| MKI | NYC | 15896 | 1 | 1.0 | 1098 | 2 | 6 | 3 | | 8 | 12 | | | |
| TPA | ALT | 30282 | 2 | 1.7 | 409 | 18 | 2 | | | 10 | 14 | 4 | | |
| TPA | BOS | 13629 | 2 | 1.6 | 1182 | 3 | 3 | | | 5 | 10 | 1 | 1 | |
| TPA | ORD | 33180 | 2 | 1.9 | 1006 | | 2 | 1 | | 4 | 10 | 2 | | |
| TPA | CLE | 10332 | 2 | 1.2 | 932 | 3 | 1 | | | 3 | 10 | | | |
| TPA | DFW | 9077 | 2 | 1.6 | 911 | 6 | | | | 6 | 10 | | | |
| TPA | DEN | 3045 | 1 | | 1520 | | 2 | 1 | | 3 | 10 | | | |
| TPA | DET | 22400 | 2 | 1.1 | 991 | 3 | | 1 | | 3 | 12 | 1 | | |
| TPA | HLU | 727 | 2 | 1.2 | 4699 | | | | 5 | 5 | 12 | | | |
| TPA | HOU | 3945 | 2 | 1.5 | 791 | | 3 | | 1 | 4 | 10 | | | |
| TPA | LAX | 5828 | 2 | 1.5 | 2153 | 1 | 1 | | 13 | 13 | 12 | 1 | | |
| TPA | MIA | 24698 | 4 | 3.0 | 199 | 10 | 12 | 2 | | 11 | 12 | | | |

## APPENDIX F CONT.

| P | O | PAX | CN | CI | DIST | 0 | 1 | 2 | C | FQ | HR | NC0 | NC1 | NC2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TPA | MSP | 5949 | 1 | | 1311 | | 5 | | | 4 | 10 | | | |
| TPA | PHL | 12079 | 2 | 1.9 | 922 | 4 | 1 | 1 | | 6 | 12 | | | |
| TPA | PIT | 11273 | 2 | 1.4 | 873 | 3 | | | | 2 | 10 | | | |
| TPA | WAS | 10540 | 2 | 1.7 | 810 | 3 | 3 | 2 | | 6 | 12 | | | |
| TPA | STL | 8066 | 2 | 1.6 | 873 | 3 | 1 | | | 4 | 10 | | | |
| TPA | SFO | 3315 | 2 | 1.9 | 2403 | | | | 9 | 9 | 12 | | | |
| TPA | MSY | 6142 | 2 | 1.2 | 495 | 4 | | | 1 | 4 | 12 | | | |
| TPA | MKI | 2816 | 2 | 1.3 | 1040 | | 2 | | 8 | 8 | 12 | | | |
| TPA | NYC | 215599 | 3 | 2.0 | 1003 | 11 | 4 | 2 | | 12 | 14 | | | |
| SEA | ALT | 3751 | 2 | 1.5 | 2182 | | 1 | 1 | 8 | 7 | 12 | | | |
| SEA | BOS | 3765 | 1 | | 2495 | 2 | | | 8 | 8 | 12 | | | |
| SEA | ORD | 21897 | 2 | 1.5 | 1730 | 7 | 2 | 3 | | 8 | 14 | | | |
| SEA | CLE | 1770 | 2 | 1.5 | 2023 | | 1 | | 9 | 9 | 12 | | | |
| SEA | DFW | 7556 | 2 | 1.4 | 1681 | 3 | 2 | | | 5 | 12 | | | |
| SEA | DEN | 14679 | 2 | 1.6 | 1020 | 6 | 3 | | | 8 | 12 | | | |
| SEA | DET | 2785 | 2 | 1.4 | 1932 | | 2 | | 10 | 10 | 10 | | | |
| SEA | HLU | 20071 | 2 | 1.8 | 2678 | 2 | 2 | | | 4 | 12 | | | |
| SEA | HOU | 4077 | 2 | 1.1 | 1885 | | 4 | | | 4 | 12 | | | |
| SEA | LAX | 43065 | 2 | 1.5 | 959 | 9 | 9 | 3 | | 14 | 14 | | | |
| SEA | MSP | 9029 | 2 | 1.2 | 1398 | 4 | 2 | | | 6 | 12 | | | |
| SEA | PHL | 3354 | 2 | 1.2 | 2383 | | 1 | 1 | | 9 | 12 | | | |
| SEA | PIT | 1362 | 1 | | 2124 | | | | 9 | 9 | 14 | | | |
| SEA | WAS | 8324 | 2 | 1.5 | 2317 | 1 | 2 | | 12 | 12 | 12 | | | |
| SEA | STL | 4830 | 1 | | 1710 | 2 | 2 | 1 | | 4 | 10 | | | 1 |
| SEA | SFO | 43624 | 2 | 1.5 | 671 | 15 | 8 | 1 | 12 | 12 | 14 | | | |
| SEA | TPA | 887 | 3 | 1.5 | 2527 | | | 2 | 6 | 6 | 12 | | | |
| SEA | MSY | 9029 | 2 | 1.2 | 1398 | | | | 7 | 7 | 4 | | | |
| SEA | MKI | 2714 | 2 | 1.4 | 1501 | 1 | | | 10 | 10 | 12 | | | |
| SEA | NYC | 12531 | 2 | 1.5 | 2408 | 3 | 1 | | 4 | 4 | 10 | | | |

## APPENDIX F CONT.

| P | Q | PAX | CN | CI | DIST | 0 | 1 | 2 | C | FQ | HR | NC0 | NC1 | NC2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LAS | ALT | 4255 | 1 | | 1747 | 1 | 2 | | 5 | 3 | 11 | | | |
| LAS | BOS | 3659 | 2 | 1.5 | 2381 | | 2 | | 8 | 5 | 12 | | | |
| LAS | ORD | 34671 | 2 | 1.7 | 1521 | 8 | 1 | 1 | | 7 | 10 | | | |
| LAS | CLE | 4873 | 1 | | 1829 | 1 | | | 14 | 3 | 12 | | | |
| LAS | DFW | 16631 | 1 | | 1081 | 4 | | | | 4 | 12 | | | |
| LAS | DEN | 17969 | 2 | 1.9 | 616 | 7 | 1 | | | 7 | 12 | | | |
| LAS | DET | 7170 | 1 | | 1758 | 1 | 2 | | 9 | 4 | 12 | | | |
| LAS | HLU | 3656 | 2 | 1.4 | 2762 | | 2 | | 7 | 7 | 12 | | | |
| LAS | HOU | 3969 | 1 | | 1229 | 3 | | | 2 | 4 | 12 | | | |
| LAS | LAX | 77383 | 1 | | 227 | 30 | | | | 17 | 24 | | | |
| LAS | MIA | 2308 | 2 | 1.4 | 2175 | | | 2 | 2 | 3 | 12 | | | |
| LAS | MSP | 14242 | 1 | | 1300 | 2 | | 1 | 3 | 2 | 10 | | | |
| LAS | PHL | 4097 | 2 | 1.6 | 2183 | 3 | | 2 | | 3 | 10 | | | |
| LAS | PIT | 3155 | 2 | 1.5 | 1910 | | 1 | 1 | 6 | 6 | 12 | | | |
| LAS | WAS | 2401 | 2 | 1.5 | 2077 | 1 | 2 | | 10 | 10 | 12 | | | |
| LAS | STL | 7899 | 2 | 1.1 | 1372 | 2 | 1 | 2 | | 3 | 10 | | | |
| LAS | SFO | 23756 | 2 | 1.5 | 419 | 11 | 2 | 1 | | 12 | 14 | 2 | | |
| LAS | SEA | 3208 | 2 | 1.1 | 869 | | 1 | 1 | 3 | 4 | 12 | | | |
| LAS | TPA | 1381 | 2 | 1.4 | 1991 | | | 1 | 5 | 6 | 10 | | | |
| LAS | MSY | 3015 | 2 | 1.9 | 1500 | | 4 | | | 4 | 10 | | | |
| LAS | MKI | 5854 | 2 | 1.2 | 1145 | | 4 | | | 4 | 10 | | | |
| LAS | NYC | 18853 | 2 | 1.9 | 2237 | 3 | 1 | 2 | | 4 | 10 | | | |

APPENDIX G

AIRPORT NETWORK ROUTING OPTIONS

ALT WAS BOS
ALT PHL BOS
ALT NYC BOS
ALT PIT BOS
ALT STL ORD
ALT MSY DFW
ALT HOU DFW
ALT MKI DEN
ALT DFW DEN
ALT STL DEN
ALT STL MKI DEN
ALT DFW LAX
ALT TPA MIA
ALT ORD MSP
ALT STL MSP
ALT WAS PIT
ALT LAS SFO
ALT DEN SFO
ALT BOS
ALT ORD
ALT CLE
ALT DFW
ALT DEN
ALT DET
ALT HOU
ALT LAX

ALT MIA
ALT MSP
ALT PHL
ALT PIT
ALT WAS
ALT STL
ALT SFO

BOS PIT DFW
BOS NYG DFW
BOS PHL DFW
BOS WAS DFW
BOS CLE DFW
BOS STL DFW
BOS CLE DFN
BOS DET DEN
BOS ORD DEN
BOS STL DEN
BOS MKI DEN
BOS LAX HLU
BOS DEN LAX HLU
BOS SFO HLU
BOS ORD LAX
BOS MKI LAX
BOS PHL MIA
BOS WAS MIA
BOS DET MSP
BOS NYC PIT
BOS PIT STL
BOS ORD
BOS CLE
BOS DEW
BOS DEN
BOS DET
BOS HLU
BOS HOU
BOS LAX

BOS MIA
BOS MSP
BOS PHL
BOS PIT
BOS STL
BOS SFO
BOS WAS

CLE DET MSP
CLE ORD MSP
CLE ORD STL
CLE ORD SFO
CLE STL SFO
CLE MKI SFO
CLE DFW
CLE DEN
CLE DET
CLE HOU
CLE LAX

CLE MIA
CLE MSP
CLE PHL
CLE PIT
CLE STL
CLE SFO
CLE WAS

DEN LAX HLU
DEN SFO HLU
DEN MKI PHL
DEN STL PHL
DEN PIT PHL
DEN MKI STL PIT
DEN MKI PIT
DEN MKI PIT
DEN MKI STL
DEN LAS SFO
DEN STL WAS
DEN MKI WAS
DEN DET
DEN HLU
DEN HOU
DEN LAX

DEN MIA
DEN MSP
DEN PHL
DEN PIT
DEN STL
DEN SFO
DEN WAS

DET SFO HLU
DET LAX HLU
DET DFW HOU
DET STL HOU
DET LAS LAX
DET ORD LAX
DET DEN LAX
DET ORD MSP
DET CLE PIT
DET HLU
DET HOU

## APPENDIX G (Cont'd.)

DET LAX

DET MIA
DET MSP
DET PHL
DET PIT
DET STL
DET SFO
DET WAS

DFW STL DET
DFW ORD DET
DFW MKI MSP
DFW WAS PHL
DFW PIT PHL
DFW STL PIT
DFW LAS SFO
DFW DEN SFO
DFW ALT WAS
DFW DEN
DFW DET
DFW HLU
DFW HOU

DFW MIA
DFW MSP
DFW PHL
DFW PIT
DFW STL
DFW SFO
DFW WAS

HLU SFO MSP
HLU SFO PIT
HLU LAX
HLU MSP
HLU PIT
HLU SFO

HOU TPA MIA
HOU ALT PHL
HOU WAS PHL
HOU MSY WAS
HOU ALT WAS
HOU LAS SFO
HOU DFW SFO
HOU LAX

HOU MIA
HOU MSP

HOU PHL
HOU PIT
HOU WAS
HOU STL
HOU SFO

LAS DFW ALT
LAS NYC BOS
LAS CLE BOS
LAS STL BOS
LAS ORD DET
LAS LAX HLU
LAS STL PIT
LAS DEN PIT
LAS STL WAS
LAS MKI STL
LAS SFO SEA
LAS DFW TPA
LAS DEW MSY TPA
LAS DFW MSY
LAS DEN MKI
LAS ALT

LAS ORD
LAS CLE
LAS DFW
LAS DEN
LAS DET
LAS HLU
LAS HOU
LAS LAX
LAS MIA
LAS MSP
LAS PHL
LAS PIT
LAS WAS
LAS STL
LAS SFO
LAS SEA
LAS TPA
LAS MSY
LAS MKI
LAS NYC

LAX DFW PHL
LAX MKI PHL
LAX STL PHL
LAX DEN PHL
LAX DEN PIT
LAX ORD PIT

LAX STL PIT
LAX DEN STL
LAX LAS STL
LAX MKI STL

LAX MIA
LAX MSP
LAX PHL
LAX PIT
LAX STL
LAX SFO
LAX WAS

MIA ORD MSP
MIA STL MSP
MIA TPA MSP
MIA TPA STL
MIA ALT STL
MIA TPA SFO
MIA MSY SFO
MIA DFW SFO
MIA MSP
MIA PHL
MIA PIT
MIA WAS
MIA STL
MIA SFO

MKI STL ALT
MKI PIT BOS
MKI CLE BOS
MKI STL CLE
MKI ORD CLE
MKI ORD DET
MKI DFW HOU
MKI ALT MIA
MKI TPA MIA
MKI WAS PHL
MKI PIT PHL
MKI STL PIT
MKI ORD PIT
MKI STL WAS
MKI PHL NYC
MKI ALT
MKI BOS
MKI ORD
MKI CLE
MKI DFW
MKI DEN

APPENDIX G (Cont'd.)

MKI DET
MKI HLU
MKI HOU
MKI LAX
MKI MIA
MKI MSP
MKI PHL
MKI PIT
MKI WAS
MKI STL
MKI SFO
MKI NYC
MSP DET PHL
MSP CLE PHL
MSP ORD STL
MSP CLE PIT
MSP DET PIT
MSP DET CLE PIT
MSP PHL
MSP PIT
MSP STL
MSP SFO
MSP WAS

MSY PHL BOS
MSY PIT BOS
MSY WAS BOS
MSY STL ORD
MSY ALT CLE
MSY DFW DEN
MSY ALT CLE DET
MSY STL ORD DET
MSY STL DET
MSY DFW LAX
MSY STL MSP
MSY ORD MSP
MSY LAS SFO
MSY DFW SFO
MSY STL MKI
MSY ALT
MSY BOS
MSY ORD
MSY CLE
MSY DFW
MSY DEN
MSY DET

MSY PHL
MSY PIT
MSY WAS
MSY STL
MSY SFO
MSY MKI
MSY NYC

NYC ORD DEN
NYC STL ORD
NYC MKI ORD
NYC SFO HLU
NYC LAX HLU
NYC STL HOU
NYC ALT HOU
NYC PIT HOU
NYC MKI LAX
NYC DEN LAX
NYC ORD MSP
NYC DET MSP
NYC PIT STL
NYC ORD STL
NYC CLE STL
NYC DEN SFO
NYC ORD SFO
NYC ALT
NYC BOS
NYC ORD
NYC CLE
NYC DFW
NYC DEN
NYC DET
NYC HLU
NYC HOU
NYC LAX

NYC MIA
NYC MSP
NYC PHL
NYC PIT
NYC WAS
NYC STL
NYC SFO

ORD LAX HLU
ORD ALT MIA

ORD CLE
ORD DFW
ORD DEN
ORD DET
ORD HLU
ORD HOU
ORD LAX
ORD MEM
ORD MIA
ORD MSP
ORD PHL
ORD PIT
ORD STL
ORD SFO
ORD WAS

PHL PIT
PHL STL
PHL SFO
PHL WAS

PIT CLE STL
PIT ORD SFO
PIT STL SFO
PIT STL
PIT SFO
PIT WAS
SEA MKL ALT
SEA STL ALT
SEA ORD CLE
SEA DEN DFW
SEA DEN DFW
SEA ORD DET CLE
SEA ORD DET
SEA DEN HOU
SEA DFW HOU
SEA ORD PHL
SEA ORD PIT PHL
SEA ORD WAS
SEA MKI STL
SEA ALT
SEA BOS
SEA ORD
SEA CLE
SEA DFW
SEA DEN

APPENDIX G (Cont'd.)

MSY HOU
MSY LAX
MSY MIA
MSY MSP
SEA PHL
SEA PIT
SEA WAS
SEA STL
SEA SFO
SEA TPA
SEA MSY
SEA MKI
SEA NYC
SFO WAS
STL MKI SFO
STL DEN SFO
STL SFO
STL WAS
TPA PHL BOS
TPA STL ORD
TPA ALT ORD
TPA MSY DEN
TPA DFW DEN
TPA MSY HOU
TPA DFW LAX
TPA ORD MSP
TPA STL MSP
TPA ALT WAS
TPA ALT
TPA BOS
TPA ORD
TPA CLE
TPA DFW
TPA DEN
TPA DET
TPA HLU
TPA HOU
TPA LAX
TPA MIA
TPA MSP
TPA PHL
TPA PIT
TPA WAS
TPA STL
TPA SFO
TPA MSY
TPA MKI
TPA NYC

ORD STL MIA

ORD SFO HLU
ORD TPA MIA

SEA DET
SEA HLU
SEA HOU
SEA MSP

**TABLE H-1**
**TIME OF DAY PROFILE OF AIRPORT ACTIVITY**
**TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS**
**YEAR 2000 FORECAST**

**ATLANTA**

NUMBER OF ARRIVALS AND DEPARTURES

BASE CASE SCENARIO

| TIME OF DAY | | 10 | 20 | 30 |
|---|---|---|---|---|
| 6 | | | | |
| 7 | DDDDDDDDDD | D | | |
| 8 | DDDDDDDDDD | DADAD | | |
| 9 | DDDADDDADA | DDADDADAAD | A | |
| 10 | DDDDAAADDD | DDDAAADADA | ADDDAADDDD | DAAA |
| 11 | AAAAADADDA | DADDDAADAD | DAAADDAAAD | DA |
| 12 | DDDADDADAA | DAAAADDDAD | DAAADAADAA | |
| 13 | DAADDAADAA | ADDDADDAAD | ADDA | |
| 14 | DAADDDADAA | ADADDADDAA | DAAD | |
| 15 | AAADDDAADD | ADAAAAADAD | ADDDDDDAAD | DDA |
| 16 | ADAAADAAAA | DADAAADDDD | AA | |
| 17 | DADADADAAA | DDADDAADDD | DADDDA | |
| 18 | ADDDAAAAAA | DDDADAADDD | AAADDDAAA | |
| 19 | DDDDDDADDA | ADAAADDDAD | DAAAADADDA | AA |
| 20 | DAAADDDADD | DADDDAADAA | AAADADDAAD | DA |
| 21 | AADADDDDAA | DADAAAAADD | DAAA | |
| 22 | AAADDAAAAA | AADAAADADD | | |
| 23 | DAAAAAAAAA | AA | | |
| 24 | AAAAA | | | |

PEAK PRICING & QUOTAS SCENARIO

| TIME OF DAY | | 10 | 20 | 30 |
|---|---|---|---|---|
| 6 | | | | |
| 7 | DDDDDDDDDD | DD | | |
| 8 | DDDDDDDDDD | AADDDD | | |
| 9 | DDDDADAAAD | ADDDDDAADA | DA | |
| 10 | DDDAAAADDD | DDDAAAADDD | DAADAAADDD | A |
| 11 | AADAAADDDA | ADADDDDDAD | DAAADADAA | |
| 12 | ADDADADAAD | ADAADADADA | AAAADDA | |
| 13 | DDADDDAAAA | ADDADDAAAD | ADDDADDDA | |
| 14 | AAADDDDDAD | ADAAAAAAAA | DDADDA | |
| 15 | DDDAADAADD | DDAAAAAAAD | ADDDDDDAAA | |
| 16 | AADDDAAAAD | ADADADAADD | DDDADA | |
| 17 | DAAAAAAADD | DAAADDADDD | DDD | |
| 18 | DDDAAADAAD | DDDAAAAAAD | DAADAADDDA | A |
| 19 | DDADDDADAA | ADAADDDAAD | ADDDAA | |
| 20 | ADDAADDAAA | DDDAADAADA | DADDADDAAA | |
| 21 | DADAADAADD | DDDAADDDAA | ADDDAAAA | |
| 22 | AAADADDADD | AADAAAADDA | | |
| 23 | AAAAAAAAAA | AAAA | | |
| 24 | AAAA | | | |

A: ARRIVAL
B: DEPARTURE

## TABLE H-2
## TIME OF DAY PROFILE OF AIRPORT ACTIVITY
## TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
## YEAR 2000 FORECAST

BOSTON

NUMBER OF ARRIVALS AND DEPARTURES

BASE CASE SCENARIO

| TIME OF DAY | 10 | 20 | 30 | 40 | 50 | 60 |
|---|---|---|---|---|---|---|
| 6 | | | | | | |
| 7 | DDDDDDDADD | | | | | |
| 8 | DDDDAAADDD | DADDDA | | | | |
| 9 | DDDDAADAAD | DAADDADADD | DAADDDDA | | | |
| 10 | DDDAADADDD | AAADAADADD | DADAAAADDD | A | | |
| 11 | DDAAADDDAD | DAAADDAAAD | DDDAADDDAD | | | |
| 12 | DAAAADDAAD | AAADADDAAA | ADDAADAADA | A | | |
| 13 | DDADADADAD | AAADDAAAAD | DDAAADA | | | |
| 14 | DADAAADDAA | DADDDAAADA | AADDDDD | | | |
| 15 | DAAADDDDAD | DADDADDAAA | AAADDAADD | | | |
| 16 | AAADAADDAA | ADDDAAAAAA | DDDDA | | | |
| 17 | DDDAADAADD | AADDDDAADD | DAAADDAAAD | A | | |
| 18 | DDAADDDDAA | ADDDAAAAAA | DDDADDADDA | DAA | | |
| 19 | DDAADDDDAA | DDDAAAAAAD | DADAADDDAD | DADAAADDDA | | |
| 20 | DAADDDDDAA | DDDDAAAAAD | DAADDDADDA | A | | |
| 21 | AADDAADAAD | AADDAAAAAD | DDDA | | | |
| 22 | ADDDAADAAA | AAA | | | | |
| 23 | DDAADAADAA | A | | | | |
| 24 | AAAA | | | | | |

PEAK PRICING & QUOTAS SCENARIO

| TIME OF DAY | 10 | 20 | 30 | 40 | 50 | 60 |
|---|---|---|---|---|---|---|
| 6 | | | | | | |
| 7 | DDDDDDDDDD | DDADD | | | | |
| 8 | DADADADDAD | DDDADDAAAD | DDD | | | |
| 9 | ADAADDADDA | DDDDDDAADD | ADAA | | | |
| 10 | DDAAADDADD | DAAADDDAAA | DAADDDDDDA | | | |
| 11 | ADDAADDAAD | DAAADDDAAD | | | | |
| 12 | DAADADDAAD | DADDDAADAD | DAADDADDAA | | | |
| 13 | DADADDAADA | ADDDDAAADA | ADAAD | | | |
| 14 | AADDDDAADD | AADAAAAADD | DDDDDDADDD | A | | |
| 15 | AAADADDAAD | AADAAADDAD | DAAAA | | | |
| 16 | DDDDDAAADD | DAAAAAADDA | ADDDDADDAA | | | |
| 17 | DDADADDAAD | DDAAAAADDA | DDAAA | | | |
| 18 | DDAADDDDAA | DDAAAAAAAA | DADDDDDAAD | D | | |
| 19 | DAAADADAAD | AADDDAAAAA | DDAAA | | | |
| 20 | DDAAADDDDD | ADDAADDDDD | AAAAAAADDD | D | | |
| 21 | DDADDAAADD | AADDADDDDA | AAADAADADD | AA | | |
| 22 | DDAADAADDA | DAADDAAADA | A | | | |
| 23 | AAAAAAAAAA | AAAAA | | | | |
| 24 | AAAAAAAA | | | | | |

A: ARRIVAL
B: DEPARTURE

## TABLE H-3
## TIME OF DAY PROFILE OF AIRPORT ACTIVITY
## TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
## YEAR 2000 FORECAST

CHICAGO

| TIME OF DAY | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 |
|---|---|---|---|---|---|---|---|---|
| | **BASE CASE SCENARIO** (NUMBER OF ARRIVALS AND DEPARTURES) | | | | | | | |
| 6 | | | | | | | | |
| 7 | DADDDDDDDD | DDDAAADDDD | DADA | | | | | |
| 8 | DADDDADDAD | DADDDDDDDA | AAAADDDDDD | ADDAA DDADD | ADDDA | | | |
| 9 | DDDDADDDDA | AADDAAAADD | DDDAADDDAA | DDDDDDDDAA | ADDADDAAAD | DDDAAAAAAA | | |
| 10 | DDDAAADDDD | DADDDDDAAD | DDDDDDAADD | DADDDDAAAD | DAAAAADDDD | AAAADDADDD | DDDAAADDDD | DAA |
| 11 | DDDDAAAAAD | DDAAADDDDA | DDDDDDDAAD | DAAADDDAAA | DDAADAADDD | DDDAAADA | | |
| 12 | DDDDAAADDD | DAADADAAAA | DDDAADDDDD | AADDAAADAA | DDAADDDDDD | DAAADAAADD | AAAA | |
| 13 | DDDDADDDAA | AADAAADAAD | DAAADDDDDD | DDDAAADAAA | DDDDDADDAA | AAAAADDDDD | A | |
| 14 | DDAADAAAAA | DDAADDDADD | AAAAADDDAA | AAADDADAAD | DAAADDAADD | AAAAADDA | | |
| 15 | DDAAAADAAA | DAAADDDDDD | DADAADDAAA | AADADDADDA | ADDAAAAAAA | ADAAADDDDD | AA | |
| 16 | DDDDAAAADA | AADAADDDDA | AAAAADDDDA | ADDDDAADDA | AADAAAAADD | AAADDDDDA | | |
| 17 | DDAAAAAAAD | DADDDDDAAA | DAAADDDDAA | AAADDAAADA | DDDDAAADAA | AADAADDDDD | DA | |
| 18 | DDDDDAAAAD | DDAAAAADAA | AAADDDDDAA | AADDDDADAA | AAAAAADDDD | AAAAAADDDD | DDDDDAAADA | AAAA |
| 19 | DDADDDAAAA | DAAAADAAAD | DDDDAAAAAA | DADDDDDDDD | DDDAAAAADA | ADDDAADDDD | AAAADDDAAA | A |
| 20 | AAADDAADDD | AADDAAADDD | AAADDDAAAA | ADDAADAAAD | DDDDDAAAAA | ADAAADDDAA | | |
| 21 | DDDAAADDAA | AADDDDAADD | DAADAADADA | AADDDAADAA | AAADDAAAA | | | |
| 22 | DDDDDADDAA | ADAAAADAAA | DAAAADAADA | A | | | | |
| 23 | AAADAADAAA | AA | | | | | | |
| 24 | AAAA | | | | | | | |
| | **PEAK PRICING & QUOTAS SCENARIO** | | | | | | | |
| 6 | | | | | | | | |
| 7 | DADDDDDDDD | ADDDDDDADD | DDDDAAAADD | DDDADA | | | | |
| 8 | DDDAADDDDD | AADADADDDA | ADDAADDDDA | AAADDAADD | | | | |
| 9 | DAAADDADDD | DADDADADDD | DDADDAAADA | ADDDDADAAD | AADD | | | |
| 10 | DDADADDAAA | DDDAADAADD | DAAADDDAAA | DDAADDADDD | DAAAA | | | |
| 11 | DDDAADDAAD | DDDAADDADD | AAADDAAADD | DADDDDAADD | AAD | | | |
| 12 | DAADDDDDAA | AADDAAADDD | DDDDAAAADA | AAAADDADDD | AADDDAADA | | | |
| 13 | DDAADDDAAA | AADDDAADAD | DDDAAADDDA | ADDAADDAAA | ADDDAADDAA | | | |
| 14 | DAAADAADDD | DAAADDAADD | DDDAAAADDA | AAADAAAADD | DDDDDDAAAD | DDAA | | |
| 15 | DADDDDDAAA | AADDDAAAAD | DAADDAAAAD | DDAADAADDA | DDDAAAA | | | |
| 16 | DAAADAADDD | DAADDDDDAA | AADDAAAADD | DAADAADDDA | AADDDAADDA | A | | |
| 17 | DDAAADDADA | AAADDDDAAD | DDDAAAAAAA | DDAAADDDDA | AADDDA | | | |
| 18 | DDDDDAAADD | DDAAAADDAA | ADDDDDAAAA | AAADAADDDD | AADDDDAADA | A | | |
| 19 | DDADAAAADA | DDDAAAADDD | DADAAAADDD | DDAAAAAADD | DADAAAA | | | |
| 20 | DDDDDAAAAD | DDDAAAAADD | DDDAAADAAA | ADDDDDDDDA | DDADAADDDA | AADAA | | |
| 21 | DDAAAADAAA | ADDDADDDAA | DDDAADDDAA | ADADDDADAA | AAAAAADDDD | DDDDAAAA | | |
| 22 | DDDDDDADAA | DDAAADDDAA | AADADDAAAA | AAAAAAA | | | | |
| 23 | AAAAAAAAAA | AAAAA | | | | | | |
| 24 | AAAAAAAAAA | AAA | | | | | | |

A: ARRIVAL
B: DEPARTURE

## TABLE H-4
## TIME OF DAY PROFILE OF AIRPORT ACTIVITY
## TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
## YEAR 2000 FORECAST

**CLEVELAND**

NUMBER OF ARRIVALS AND DEPARTURES

| TIME OF DAY | | 10 | 20 | 30 | 40 | 50 | 60 |
|---|---|---|---|---|---|---|---|
| | BASE CASE SCENARIO | | | | | | |
| 6 | | | | | | | |
| 7 | DDDDDDDD | | | | | | |
| 8 | DADDDDAADA | AD | | | | | |
| 9 | DDDDDADAAA | DDDADDDDDD | | | | | |
| 10 | AAADDDAAAD | AADDDDADDA | AADDA | | | | |
| 11 | DAADDADDDD | DAADAAAADA | | | | | |
| 12 | AADDDAADDA | ADDDDDDDAA | | | | | |
| 13 | DAAAAADDAD | DDDDAAAAAD | | | | | |
| 14 | DDAADDADAA | DDDAD | | | | | |
| 15 | AAAADDAADA | DAAAADADDD | | | | | |
| 16 | DAADDADDAA | ADDDADAADA | AA | | | | |
| 17 | DDADDDDAAA | AAAADDDDDD | | | | | |
| 18 | ADAADDAAAD | AADDDADADA | | | | | |
| 19 | DDAAADADDA | DDAAADDADD | AADADDAAAD | | | | |
| 20 | DDADDDADAA | AAADADDADD | ADAA | | | | |
| 21 | ADDAAADDAA | AAAAAAA | | | | | |
| 22 | DDDDADAADA | | | | | | |
| 23 | DDAAAAAAAA | AA | | | | | |
| 24 | AAA | | | | | | |
| | PEAK PRICING & QUOTAS SCENARIO | | | | | | |
| 6 | | | | | | | |
| 7 | DDDDDDDDDD | | | | | | |
| 8 | DDADADDAAA | DDDDD | | | | | |
| 9 | AADDADADDD | DDADDDAAAD | D | | | | |
| 10 | AADADDDAAD | ADDDDADAAD | AAA | | | | |
| 11 | DDAADDADDD | DDAADAAAA | | | | | |
| 12 | DADDDDAADD | AAAAAADDAD | ADD | | | | |
| 13 | DADADADDDA | DDAAAA | | | | | |
| 14 | AADDDADDAD | ADDAAAADAA | | | | | |
| 15 | ADADDDDDDA | AAADAADADA | ADAD | | | | |
| 16 | DDDDDAAAAA | DDAADDDDDA | | | | | |
| 17 | AADDADAAAA | DDDAADDADD | AA | | | | |
| 18 | ADADADDDAA | DDDAAAAAAD | A | | | | |
| 19 | DAADADDDDA | DDAAAADDAA | DAA | | | | |
| 20 | DADDDDDDDA | AAADAADDAA | DADDAA | | | | |
| 21 | DADADADADA | AAAADAAADA | A | | | | |
| 22 | ADDDDADDAA | ADAA | | | | | |
| 23 | DAAAAAAAA | | | | | | |
| 24 | AAAA | | | | | | |

A: ARRIVAL
B: DEPARTURE

## TABLE H-5
## TIME OF DAY PROFILE OF AIRPORT ACTIVITY
## TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
## YEAR 2000 FORECAST

DALLAS/FT. WORTH

NUMBER OF ARRIVALS AND DEPARTURES

BASE CASE SCENARIO

| TIME OF DAY | 10 | 20 | 30 | 40 | 50 | 60 | |
|---|---|---|---|---|---|---|---|
| 6 | | | | | | | |
| 7 | DDDDDDDDDD | | | | | | |
| 8 | DADDDDDDDD | DDDDAAADDA | DDDD | | | | |
| 9 | ADDDADDDDD | AADDDDDAAD | DDDDAAD | | | | |
| 10 | DADAAADDDD | ADDADDDDAA | ADDADDDDDD | DAA | | | |
| 11 | DADDAADAAD | DDDDADDADD | DDADAADADD | DAAADAA | | | |
| 12 | DDAAAADDAD | AAAADDDDDD | DAADDDADDA | DADDDAA | | | |
| 13 | DAAAADAADD | AADDAADDAD | AADDAADDD | | | | |
| 14 | AAADDADDAA | ADADDAAADD | DAAADAADDD | AA | | | |
| 15 | DDDADDAAAA | ADDAAADDAA | AAADADADDD | DA | | | |
| 16 | DADDAAAADD | AAADDDAAAD | DDAA | | | | |
| 17 | AADDDDAAAD | DDAAAADAAD | AAAAADAADD | DDADAA | | | |
| 18 | AADDDDADDD | AAAADAADDA | DAAAAADDAD | AA | | | |
| 19 | DDADADDDDD | AADAADAAAA | AADAADADDA | ADDDA | | | |
| 20 | DAAADDDAAD | DAAADAADDA | DAADAADDDD | | | | |
| 21 | AAAAAAADDA | AAAADADDAD | DAAAAA | | | | |
| 22 | AADAADAAAA | AAAAADDAAA | | | | | |
| 23 | DAADAAAAA | | | | | | |
| 24 | AAAAA | | | | | | |

PEAK PRICING & QUOTAS SCENARIO

| TIME OF DAY | 10 | 20 | 30 | 40 | 50 | 60 | |
|---|---|---|---|---|---|---|---|
| 6 | | | | | | | |
| 7 | DDDDDDDDDD | DDD | | | | | |
| 8 | DDADDDDDDD | DDDDAAADDA | ADDDD | | | | |
| 9 | DDDAADDDDA | DDDDDDAADD | DDDDAADDA | | | | |
| 10 | DDAADAAAAA | DDDDAADDDD | DDDDADDDAA | | | | |
| 11 | DADDAADADD | DAAADDDDDA | DAAADADAAD | AA | | | |
| 12 | DDAAADDADD | DDAADDDDAA | ADAADAAADD | DDAAA | | | |
| 13 | DDADDDDADA | AAAADDADAA | ADDDAA | | | | |
| 14 | DADDDADADD | DAAADDAAAD | AADDDAADDD | A | | | |
| 15 | DDAADDAAAD | DDAAAAAADD | DDADAAA | | | | |
| 16 | DDAAADDADD | DDAAADDDAA | DDAADDAA | | | | |
| 17 | ADAAAADDAD | DADDAADAAA | DDAAADDADD | AA | | | |
| 18 | ADDAADDAAA | AAADDDAAAD | ADDDDADA | | | | |
| 19 | DDAADAADDD | AAAADAAAAA | DAAADDDDDA | ADD | | | |
| 20 | DDADDDDDAA | DAAADAADAA | DDAADAAAAD | DDA | | | |
| 21 | DAADDAAADA | AAAADDAADD | AAAAAD | | | | |
| 22 | AAADDDAAAD | ADAAAAAADA | DAAAAAAA | | | | |
| 23 | DAADAAAAAA | AA | | | | | |
| 24 | AAAAAAAA | | | | | | |

A: ARRIVAL
B: DEPARTURE

**TABLE H-6**
**TIME OF DAY PROFILE OF AIRPORT ACTIVITY**
**TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS**
**YEAR 2000 FORECAST**

**DENVER**

NUMBER OF ARRIVALS AND DEPARTURES

BASE CASE SCENARIO

| TIME OF DAY | 10 | 20 | 30 | 40 | 50 | 60 |
|---|---|---|---|---|---|---|
| 6 | | | | | | |
| 7 | DDDDDDDDDD | DDD | | | | |
| 8 | DDADDDDDDD | DADDADDDA | | | | |
| 9 | DDDDAADDAD | DDDAADDDDD | DD | | | |
| 10 | DAADADDDDD | ADDDDDAADD | AAADDAAAAD | AA | | |
| 11 | DDAAADDADD | DDDADDDDDA | DDADDDADDA | AAAAAA | | |
| 12 | DDDAAAADAD | DDDDDAAAAA | DDDDADAA | | | |
| 13 | DAAADADDDA | DAADDAAAAA | DDDADDADDD | A | | |
| 14 | DDDDAAADAA | DAADADDDAA | DAAA | | | |
| 15 | DADDAADAAA | ADDADDDAAD | DDADDA | | | |
| 16 | AAADDAAAAA | DAAADDDDAA | ADADAAAD | | | |
| 17 | DAADAAAAAA | AADDDDDDAD | D | | | |
| 18 | DAAADAADAD | AAAADAADDA | DDA | | | |
| 19 | DAAAADDAAA | DDAADDAAAA | DDAADAA | | | |
| 20 | AAADAADDDD | DDADAAADAD | ADA | | | |
| 21 | AADADAAADA | ADAADDAA | | | | |
| 22 | DAADAAAAAA | AAAA | | | | |
| 23 | AAAAAAA | | | | | |
| 24 | AA | | | | | |

PEAK PRICING & QUOTAS SCENARIO

| TIME OF DAY | 10 | 20 | 30 | 40 | 50 | 60 |
|---|---|---|---|---|---|---|
| 6 | | | | | | |
| 7 | DDDDDDDDDD | DDDADDD | | | | |
| 8 | DDDDAAADDA | DDDDAADA | | | | |
| 9 | DDDADDDAAA | DDDDDDDDA | | | | |
| 10 | DAADAAADAA | DADAADDAAA | DDDDAADAAA | | | |
| 11 | DAAADDDADD | DDAADDDADD | | | | |
| 12 | DAAADDAAAA | ADDADDDDAA | AADDD | | | |
| 13 | AAADAADDDD | DDAADDDADA | ADAAAD | | | |
| 14 | ADDADDAAAD | DADDAAAAAA | DDDDA | | | |
| 15 | DAADDDDDAA | ADDAADDAAD | DDAA | | | |
| 16 | AADDADAAAA | ADAADDDDDA | ADDDA | | | |
| 17 | DDDDADDAAA | AAADDAADDD | ADAA | | | |
| 18 | DAADAAAADD | AADADDDDDA | ADDDDAADD | | | |
| 19 | AADADADDAA | AADADDDDA | | | | |
| 20 | AADDDAADAD | ADADAAAADD | AA | | | |
| 21 | ADDADDDDDA | AADDAADAAD | A | | | |
| 22 | DDDAADAAAD | AAAAAAAAAA | | | | |
| 23 | AAAAAAAAA | | | | | |
| 24 | AAAAAAA | | | | | |

A: ARRIVAL
B: DEPARTURE

## TABLE H-7
## TIME OF DAY PROFILE OF AIRPORT ACTIVITY
## TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
## YEAR 2000 FORECAST

DETROIT

NUMBER OF ARRIVALS AND DEPARTURES

**BASE CASE SCENARIO**

| TIME OF DAY | 10 | 20 | 30 | 40 | 50 | 60 |
|---|---|---|---|---|---|---|
| 6 | | | | | | |
| 7 | DDDDDDDDD | | | | | |
| 8 | DDADDDDDDA | DDDAD | | | | |
| 9 | AAADDDDDDA | AADDDDDDDA | DAA | | | |
| 10 | DDDDDAAADD | AADDDDAADD | DAADAAADDA | AAAD | | |
| 11 | DDDADDDAAA | DDDDAADDDA | ADDAAAAADA | | | |
| 12 | AADDDDDAAD | DDDDAAAAAA | ADAD | | | |
| 13 | DDDDADAADD | DAADDAAAAD | ADDAAD | | | |
| 14 | DDDAAADAAD | DADDDAAAAD | A | | | |
| 15 | AAADDDDDDA | AAAAAAAADD | DDDDAAA | | | |
| 16 | DDADAAAADA | DDDDDAADDD | AA | | | |
| 17 | DAADAADAAA | ADDDADDDAA | DDDDAAAD | | | |
| 18 | DDDAAAAADD | ADDAADDDAA | AADDDAAADA | | | |
| 19 | DDADDDAADA | AADDDADDAD | DADAAAAADD | AA | | |
| 20 | DDDAADDDDA | AADADADADA | DDAAADDAAA | AA | | |
| 21 | DAAADDDADA | DADAAAADAA | AAA | | | |
| 22 | DDAAAADADD | AAAAADD | | | | |
| 23 | AADDAAAAAA | A | | | | |
| 24 | AAAAAA | | | | | |

**PEAK PRICING & QUOTAS SCENARIO**

| TIME OF DAY | 10 | 20 | 30 | 40 | 50 | 60 |
|---|---|---|---|---|---|---|
| 6 | | | | | | |
| 7 | DDDDDDDDDD | D | | | | |
| 8 | DDDDADDDDA | ADDDDDADA | | | | |
| 9 | ADDDAAADDD | DDAADDDADD | A | | | |
| 10 | AAAAADDADD | DADDDADDDA | AAADDDA | | | |
| 11 | AADDADDDAD | AADDAADADD | DADDADADA | | | |
| 12 | DAAADDAADA | AADDDADDAA | DDAAAADDD | | | |
| 13 | DADAAAAAAA | DDDDDADDAD | | | | |
| 14 | DADDAADDAD | ADAADADADA | DDDAAAA | | | |
| 15 | AADDDAAADA | AAAADDDDDD | DAAA | | | |
| 16 | DAADADDAAA | ADDAAAADDD | DA | | | |
| 17 | DDADDADADA | AADAADDDDD | AAAA | | | |
| 18 | DDADADDAAA | DADADAADDD | ADDDAAA | | | |
| 19 | ADDDADDDAA | DADADDAAAD | ADAADAAADA | AA | | |
| 20 | DDDDDAADDD | DAAADADDAA | AADAAAA | | | |
| 21 | DAAADDDDDD | DAAAADDAAA | DAADADA | | | |
| 22 | DAADDDDAAA | AAADAAADDA | | | | |
| 23 | ADAAAAAAAA | A | | | | |
| 24 | AAAAA | | | | | |

A: ARRIVAL
B: DEPARTURE

## TABLE H-8
## TIME OF DAY PROFILE OF AIRPORT ACTIVITY
## TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
## YEAR 2000 FORECAST

HONOLULU

NUMBER OF ARRIVALS AND DEPARTURES

BASE CASE SCENARIO

| TIME OF DAY | 0–10 | 10–20 | 20–30 | 30–40 | 40–50 | 50–60 | 60– |
|---|---|---|---|---|---|---|---|
| 6 | | | | | | | |
| 7 | DDDDD | | | | | | |
| 8 | DDDDDDDDDD | D | | | | | |
| 9 | DDDDDDDDDD | DDDD | | | | | |
| 10 | DDDDDDDDDD | DDD | | | | | |
| 11 | DDDDDDAADD | DDDDDD | | | | | |
| 12 | DDDADDDDAA | DDADD | | | | | |
| 13 | DADDAADDDA | DAAA | | | | | |
| 14 | DDAAADAADD | AADAAA | | | | | |
| 15 | DAAADAADAA | DDADD | | | | | |
| 16 | AAADAAAA | | | | | | |
| 17 | AAAAA | | | | | | |
| 18 | AAAA | | | | | | |
| 19 | AAAAAA | | | | | | |
| 20 | AAAAAAAAAA | A | | | | | |
| 21 | AAAAAAAAA | | | | | | |
| 22 | AAAAAAAAAA | | | | | | |
| 23 | AAAAAA | | | | | | |
| 24 | | | | | | | |

PEAK PRICING & QUOTAS SCENARIO

| TIME OF DAY | 0–10 | 10–20 | 20–30 | 30–40 | 40–50 | 50–60 | 60– |
|---|---|---|---|---|---|---|---|
| 6 | DD | | | | | | |
| 7 | DDDDDDDDDD | | | | | | |
| 8 | DDDDDDDDDD | D | | | | | |
| 9 | DDDDDDDADD | DA | | | | | |
| 10 | DDADADDDAA | DDADA | | | | | |
| 11 | DDDDADDADD | DADDAADDA | | | | | |
| 12 | DDDADADDAD | DDDA | | | | | |
| 13 | AADDDADDDA | ADDDA | | | | | |
| 14 | DDADDAADDD | AADDDAA | | | | | |
| 15 | DDADADDDAD | AADDA | | | | | |
| 16 | AAAAAA | | | | | | |
| 17 | AAAAA | | | | | | |
| 18 | AAAAA | | | | | | |
| 19 | AAAAAAA | | | | | | |
| 20 | AAAAAA | | | | | | |
| 21 | AAAAAA | | | | | | |
| 22 | AAAAAAA | | | | | | |
| 23 | AAAAA | | | | | | |
| 24 | AAAAAAAAA | | | | | | |

A: ARRIVAL
B: DEPARTURE

## TABLE H-9
## TIME OF DAY PROFILE OF AIRPORT ACTIVITY
## TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
## YEAR 2000 FORECAST

HOUSTON

| TIME OF DAY | NUMBER OF ARRIVALS AND DEPARTURES | 10 | 20 | 30 | 40 | 50 | 60 |
|---|---|---|---|---|---|---|---|
| | BASE CASE SCENARIO | | | | | | |
| 6 | | | | | | | |
| 7 | DDDDDDDD | | | | | | |
| 8 | ADDDDDDADD | DADADDDD | | | | | |
| 9 | DDDADDDDAA | DDAADDDAAA | | | | | |
| 10 | DDDADDDDDD | DADDDADDAD | DDAA | | | | |
| 11 | DDAADAADDD | DDADDAADAD | AAAADAA | | | | |
| 12 | AADDDADADD | DDDDDAAAAD | ADAA | | | | |
| 13 | DDADDDDAAA | DAAAADDADD | A | | | | |
| 14 | ADADDAADAD | ADADADDDAA | DDA | | | | |
| 15 | DDAAAAADDD | AADDDDDAA | | | | | |
| 16 | ADADDAAADD | DAAAADAA | | | | | |
| 17 | DDAAAAADDA | DAADDDAADD | AAA | | | | |
| 18 | ADAADDDADA | ADAAAADAA | | | | | |
| 19 | DDAADDAADD | ADDADAADAA | A | | | | |
| 20 | DAADAADDAD | AADAAAAADD | D | | | | |
| 21 | DDAAAAAAAD | DAADAAAAAA | | | | | |
| 22 | DAAAAAAADA | | | | | | |
| 23 | AADAAA | | | | | | |
| 24 | AAA | | | | | | |
| | PEAK PRICING & QUOTAS SCENARIO | | | | | | |
| 6 | | | | | | | |
| 7 | DDDDDDDDDD | | | | | | |
| 8 | ADDDDDADAD | ADDD | | | | | |
| 9 | DDDAADDDDA | DDDDDAAAAA | D | | | | |
| 10 | DDDADDDDDA | ADDDDAADAD | ADA | | | | |
| 11 | DAADDDDADD | AAADAAAADD | | | | | |
| 12 | ADDDAAAADA | DDDAADDDDD | DAAA | | | | |
| 13 | DDADDAADAD | DAADAAAD | | | | | |
| 14 | DAAADDAAAD | DAADDDDDAD | | | | | |
| 15 | DADDAAADAD | DAADADDA | | | | | |
| 16 | AADDDAADAD | DAADDAD | | | | | |
| 17 | AAAAADDDAD | AAADDDDAAA | ADA | | | | |
| 18 | DAADDAADDA | DAADDAA | | | | | |
| 19 | AAADDDADAD | ADAADADDAA | | | | | |
| 20 | DAADDAAADA | DDADADAAAD | DD | | | | |
| 21 | DDAAAAAAAA | ADAAAAAAD | | | | | |
| 22 | DDDDAAAADA | AAAA | | | | | |
| 23 | AADAA | | | | | | |
| 24 | AAAAAA | | | | | | |

A: ARRIVAL
B: DEPARTURE

## TABLE H-10
## TIME OF DAY PROFILE OF AIRPORT ACTIVITY
## TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
## YEAR 2000 FORECAST

KANSAS CITY

NUMBER OF ARRIVALS AND DEPARTURES

**BASE CASE SCENARIO**

| TIME OF DAY | 10 | 20 | 30 |
|---|---|---|---|
| 6 | | | |
| 7 | DDDDDD | | |
| 8 | DADDDDDDAD | ADDA | |
| 9 | ADDDDDADDD | AADAADD | |
| 10 | DDAADDDDAD | DADADADADD | D |
| 11 | ADADDDAAAA | ADDDDDDDDD | AAAA |
| 12 | AAAADADDDD | DAADADAAAD | DA |
| 13 | DDDDAADADA | ADDADAD | |
| 14 | AADAAADDDA | ADAADAAD | |
| 15 | DAADDDADDA | DAAADADA | |
| 16 | ADDDDDAADA | DAADADDA | |
| 17 | DAAAADAAAA | DDAAADADDD | DAA |
| 18 | DDDAAAAADD | DDAAADD | |
| 19 | DDAAADAADD | AAADDAADDA | ADA |
| 20 | ADDAADADAD | DDAAAAAADA | DD |
| 21 | AADAADADAA | AAAADDAD | |
| 22 | AAAAAAADDA | D | |
| 23 | ADAAA | | |
| 24 | AA | | |

**PEAK PRICING & QUOTAS SCENARIO**

| TIME OF DAY | 10 | 20 | 30 |
|---|---|---|---|
| 6 | | | |
| 7 | DDDDDDD | | |
| 8 | DADDDDDDAD | DADAADD | |
| 9 | DADDADAADD | DDADDA | |
| 10 | DADADADADA | DDDDDDAA | |
| 11 | ADAADADDAA | DAADDDD | |
| 12 | AAADDDAAAD | AADDAADAAD | DDD |
| 13 | AADDDADAAD | DDDA | |
| 14 | AAADAADADD | ADADDAAA | |
| 15 | AAADADDADA | ADADDAD | |
| 16 | DDADDDDDAA | AADADA | |
| 17 | DDAADAADAD | AAAADDADDA | |
| 18 | DDDAADAAAD | AAAADDDA | |
| 19 | DADDADDDAA | AAAAADADDA | |
| 20 | DDAADDAAAD | AADAADDAA | |
| 21 | ADADDADAAD | DDADAA | |
| 22 | AADAADDAAA | DADAAA | |
| 23 | AAAAAAAA | | |
| 24 | AA | | |

A: ARRIVAL
B: DEPARTURE

## TABLE H-11
## TIME OF DAY PROFILE OF AIRPORT ACTIVITY
## TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
## YEAR 2000 FORECAST

LAS VEGAS

NUMBER OF ARRIVALS AND DEPARTURES

| TIME OF DAY | 0–10 | 10–20 | 20–30 | 30–40 | 40–50 | 50–60 | 60+ |
|---|---|---|---|---|---|---|---|
| **BASE CASE SCENARIO** | | | | | | | |
| 6 | | | | | | | |
| 7 | DDDDDDDD | | | | | | |
| 8 | DDAADDDDDD | ADAADDD | | | | | |
| 9 | DDDDDDADDD | AAADD | | | | | |
| 10 | DDDDDDDAAD | DADDDAAADD | D | | | | |
| 11 | DADDADAAAD | DADDADAADA | ADDA | | | | |
| 12 | DAADDDADAA | DDDDADDAAA | D | | | | |
| 13 | ADAAAADDDA | DAADDDD | | | | | |
| 14 | ADDADAAAAD | DADADADA | | | | | |
| 15 | DAADAAAADA | DDDDDDD | | | | | |
| 16 | ADADAADDDA | A | | | | | |
| 17 | AAADADDAAA | DAAA | | | | | |
| 18 | ADADDADDAA | AAAAA | | | | | |
| 19 | DDDAADDAAA | AAAADAADDA | | | | | |
| 20 | AADADAAADA | ADA | | | | | |
| 21 | AAAADDAAAA | AA | | | | | |
| 22 | ADAAAAADA | | | | | | |
| 23 | DA | | | | | | |
| 24 | AA | | | | | | |
| **PEAK PRICING & QUOTAS SCENARIO** | | | | | | | |
| 6 | | | | | | | |
| 7 | DDDDDDDADD | DDA | | | | | |
| 8 | DDDAADDDAD | A | | | | | |
| 9 | DADDDDADAA | DDAD | | | | | |
| 10 | DDDADDDDAD | DDAADADDAA | | | | | |
| 11 | DADADAADDA | DAADADDDA | | | | | |
| 12 | DADADDAADD | DDAAAA | | | | | |
| 13 | DDDADAADAA | ADDDAADD | | | | | |
| 14 | DADDAADAAD | DDAAADAA | | | | | |
| 15 | ADDADDADDA | DADADA | | | | | |
| 16 | AADDADDADD | DDA | | | | | |
| 17 | AAAADAAADD | DADDA | | | | | |
| 18 | AADAADDADD | AAA | | | | | |
| 19 | ADAADAADAA | AAADDDA | | | | | |
| 20 | ADAAADAAAA | | | | | | |
| 21 | DDAADADAAA | DA | | | | | |
| 22 | DAAADAADAA | AA | | | | | |
| 23 | AAA | | | | | | |
| 24 | | | | | | | |

A: ARRIVAL
B: DEPARTURE

## TABLE H-12
## TIME OF DAY PROFILE OF AIRPORT ACTIVITY
## TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
## YEAR 2000 FORECAST

LOS ANGELES

NUMBER OF ARRIVALS AND DEPARTURES

BASE CASE SCENARIO

| TIME OF DAY | 10 | 20 | 30 | 40 | 50 | 60 | |
|---|---|---|---|---|---|---|---|
| 6 | | | | | | | |
| 7 | DDDDDDDDDD | DDDDDDDDDD | D | | | | |
| 8 | DDDDADDDDD | DADDDDDDDD | DDDADDDDDD | DAADDDDDDD | D | | |
| 9 | DDDDDDDDDD | DDDADDDDDA | DDDDADDDDD | DDDDADDADD | DDDADDDD | | |
| 10 | DDDADDADDD | DDADADDDDD | ADDADDDDDD | DDDDADDAAA | DDDADDDADD | DA | |
| 11 | DDDDDDAADD | DDDAADDDDD | DDAAADDDDD | DDDAAAAAAA | DDDDDADDDA | DDDDDADDDD | DAAAA |
| 12 | DAAADDDDDD | AAADDDDDDA | AAADDADDDD | DADADDDDAA | DDAADDDAAD | DDDDAAA | |
| 13 | DDDDAAAADD | DDADAAADDD | DDDAAADDAA | ADADDDDDAA | ADAADDDDAA | DADDDDAA | |
| 14 | DDAADADDDA | DDAAAAADDA | AADAADAADD | DAADDDAAAA | DADDADAAA | | |
| 15 | DDDAADDAAD | DADAAAAADD | DAADDAAAAA | ADDDAADDDD | DAAAAAAADA | A | |
| 16 | DDAAADDDDA | DDDAAAAADD | AADDAAAAAA | DAAADDDDDA | AAAA | | |
| 17 | DAAAADADDD | DADAAADDAA | AAAAAADDAA | ADADAAAADD | AAA | | |
| 18 | AAAADADAAA | ADDDAAAADA | AAAADADAAA | DAAADDAAAA | A | | |
| 19 | DDDAAAAADD | ADAAAAAADA | ADAAAADDAA | AAAAAADDAA | AAAADAAAAD | | |
| 20 | AAAADADAAA | DAAADAAAAD | AAADAADAAA | AADAAAADAA | ADDAA | | |
| 21 | AAAAAAAAAA | DAADADAAAA | AAAAAAAAAA | DAAAAAAA | | | |
| 22 | AAAADAAAAA | AAAAAADAAA | AAAAAAAAAA | | | | |
| 23 | AAADAAADAA | AA | | | | | |
| 24 | AAAAAAA | | | | | | |

PEAK PRICING & QUOTAS SCENARIO

| TIME OF DAY | 10 | 20 | 30 | 40 | 50 | 60 | |
|---|---|---|---|---|---|---|---|
| 6 | D | | | | | | |
| 7 | DDDDDDDDDD | DDDDDDDDDD | DDDDDDDDDD | ADDDDD | | | |
| 8 | DDDDADDDAD | DDADDDDDAD | DADADDDDDD | DDDAADDAAA | | | |
| 9 | DDDDDAADDD | DDDAADDDDD | DDAAAADDDA | ADAAADDDAA | ADDDDDA | | |
| 10 | DAADDDADDD | DAADAADDDD | DDAAADDDDD | AADAADDDDA | DDDAAADDAD | AAA | |
| 11 | DADDDAADDA | DDDDAADDDD | DADDDADAAA | DAADAADDDD | DDDDAAADDA | | |
| 12 | DAADDDDAAD | AAAADDDAAD | DDDDDDADDD | ADADDAADDD | AADDDAADDD | DAAA | |
| 13 | DDDDADDDAA | AAADDDDDAA | DDDADDADAD | AAADDDDDAA | DDADDDDA | | |
| 14 | DAAAADDADD | DAAADDDDDD | AADADDADDD | ADDDAAAADD | DDAAAAADDD | A | |
| 15 | DDDDADDDDA | AAAADADDDD | DDAAADDDDD | DAAAAADADA | ADDDAADDAA | ADDDAAAA | |
| 16 | ADDDAAAADD | AADDADAAAD | ADDAAAADDD | DAAAAAAAAA | | | |
| 17 | DDAADDDDAA | ADDAAAADDA | AAADAADDDA | ADDAAADAAA | ADADDA | | |
| 18 | DDAAAAADDD | DDDAAAAADA | AADDDAAAAD | ADDDDDAAAD | AAAAAA | | |
| 19 | DDADDDAAAA | DDAAADDDDA | AAAADADAAA | DAADDAAAAD | A | | |
| 20 | DAAAAAAAAA | ADAADAAADA | AADAADDAAA | AAAAA | | | |
| 21 | DDDAADADAA | AAADDDDDDD | AAADAADAAA | AAAAAADAA | | | |
| 22 | DAAADAAADA | AAAAAAAAAD | ADAAAAAAAA | A | | | |
| 23 | AAAAAAAAAA | AAAAAAAAAA | AAAAAAA | | | | |
| 24 | AAAAAAAAAA | AAA | | | | | |

A: ARRIVAL
B: DEPARTURE

## TABLE H-13
## TIME OF DAY PROFILE OF AIRPORT ACTIVITY
## TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
## YEAR 2000 FORECAST

MIAMI

| TIME OF DAY | NUMBER OF ARRIVALS AND DEPARTURES (1–10) | 10–20 | 20–30 | 30–40 | 40–50 | 50–60 |
|---|---|---|---|---|---|---|
| | **BASE CASE SCENARIO** | | | | | |
| 6 | | | | | | |
| 7 | DDDDDDDDDD | | | | | |
| 8 | DADDDDDDDD | DDDDDD | | | | |
| 9 | DADADDDDDD | DDDADDDADD | A | | | |
| 10 | DDDDDDDAAA | DDDDDDAAAA | ADADDDADDA | | | |
| 11 | DADDDADADA | ADDDAAAADA | AADADADA | | | |
| 12 | ADDDDDAAAA | ADDDDDADAA | DDAADDAAAA | | | |
| 13 | DDDAADDDAA | DAAADDDAAA | DDAADDAADD | AA | | |
| 14 | DDDDADDADD | AAADDDAAAA | ADAA | | | |
| 15 | DDDAADDAAA | ADDADADADD | AADDAAADDD | DAAA | | |
| 16 | AADDAADAAA | DDAADDADA | | | | |
| 17 | DAAADDAAAD | DAAADADDDA | AAADDADDDD | AAA | | |
| 18 | DADAADDDDA | ADDADAADAD | DDAAADAAA | | | |
| 19 | DAAADDDDAA | DDDADDADDA | AAA | | | |
| 20 | DDDAAAADDA | ADADADADDA | ADAAADAAA | | | |
| 21 | ADDDADDAAA | AADDDDADAD | AAAAD | | | |
| 22 | AAAAAAAAAA | DAA | | | | |
| 23 | DAAAAAAAAA | AAA | | | | |
| 24 | AAAAAAA | | | | | |
| | **PEAK PRICING & QUOTAS SCENARIO** | | | | | |
| 6 | | | | | | |
| 7 | DDDDDDDDDD | | | | | |
| 8 | DDDDDADDDD | DDDDDD | | | | |
| 9 | DDDADDDDAD | DADDDDDAD | | | | |
| 10 | DDDADDAAAD | DDAADDDAAD | ADDADDADDA | | | |
| 11 | DDAADDAAAD | ADAAADDDAA | DDDAADAA | | | |
| 12 | DADDDAADAA | DDAADDADDD | ADDAADA | | | |
| 13 | DAAADAADAA | DAADDAADDD | DAADDAADAA | | | |
| 14 | DDDDAADDAA | ADADDDAAAD | ADA | | | |
| 15 | DDAADADADD | AAADDAAAAD | DDDDDDAAA | | | |
| 16 | ADAADDADAA | DAAAAADDAD | A | | | |
| 17 | DADAAADDDD | AAAAAADDDA | ADDDDDAAA | | | |
| 18 | DDDDAAADDA | DADDAAADDA | ADDDADAAA | | | |
| 19 | ADDAAADDDD | DDAAADDADA | AA | | | |
| 20 | DDAAADDDAA | ADADDDADAD | AADAAAAA | | | |
| 21 | AAADDDDDDD | ADDDDDAAAD | DAAAADAAA | | | |
| 22 | ADADAAAAAA | ADDAA | | | | |
| 23 | AAAAAAAAAA | AAAA | | | | |
| 24 | AAAAAAAAA | | | | | |

A: ARRIVAL
B: DEPARTURE

**TABLE H-14**
**TIME OF DAY PROFILE OF AIRPORT ACTIVITY**
**TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS**
**YEAR 2000 FORECAST**

**MINNEAPOLIS/ST. PAUL**

| TIME OF DAY | NUMBER OF ARRIVALS AND DEPARTURES (1–10) | 10–20 | 20–30 | 30–40 | 40–50 | 50–60 |
|---|---|---|---|---|---|---|
| | BASE CASE SCENARIO | | | | | |
| 6 | | | | | | |
| 7 | DDDDA | | | | | |
| 8 | DDDDADD | | | | | |
| 9 | ADADDDDDDA | DDDADADADD | ADDA | | | |
| 10 | DDDDDDDAAD | AAADADD | | | | |
| 11 | DDADDAAAAD | AADADAAA | | | | |
| 12 | DDDDDADAAA | DDDDDADADA | ADDDA | | | |
| 13 | AADADADAAD | ADADADDDAA | | | | |
| 14 | ADDAADDAAD | AAAADDA | | | | |
| 15 | ADDDAAAAAA | ADDDD | | | | |
| 16 | DDADDADAAA | DADDAADAA | | | | |
| 17 | ADAAADAADA | ADDDAADDDD | AD | | | |
| 18 | DAAADADDDA | DADAADADAA | AA | | | |
| 19 | ADDDADDDAA | AADAA | | | | |
| 20 | DDDADDAADD | AAAAAADAAA | DDAAA | | | |
| 21 | DDADAADAAA | DDAD | | | | |
| 22 | AADADAAA | | | | | |
| 23 | ADAA | | | | | |
| 24 | A | | | | | |
| | PEAK PRICING & QUOTAS SCENARIO | | | | | |
| 6 | | | | | | |
| 7 | DDDDDDDDA | | | | | |
| 8 | DDADDDDDAA | D | | | | |
| 9 | DDADDDADAD | DDAADDDDDA | | | | |
| 10 | AADDDDDDAA | AAADDD | | | | |
| 11 | DAADDDADDA | AAAADDDAA | | | | |
| 12 | ADDDADADDD | DAAADAAADD | | | | |
| 13 | DDDDDAAAAA | DDDAADAD | | | | |
| 14 | ADDDAAAAAA | DDDDDDADA | | | | |
| 15 | AADAADDADA | AADD | | | | |
| 16 | AADDDDAAAA | ADDDADDADA | A | | | |
| 17 | DAAADAADAD | ADDDDA | | | | |
| 18 | DADAADADDA | DDAADADDAA | | | | |
| 19 | AADDAADDDA | AAADA | | | | |
| 20 | DDADDADDDA | DAAADAAAAD | DAA | | | |
| 21 | DADDAADADA | AAADADDDA | | | | |
| 22 | ADDDADAAAA | AAA | | | | |
| 23 | AAAAA | | | | | |
| 24 | AAA | | | | | |

A: ARRIVAL
B: DEPARTURE

## TABLE H-15
## TIME OF DAY PROFILE OF AIRPORT ACTIVITY
## TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
## YEAR 2000 FORECAST

NEW ORLEANS

| TIME OF DAY | NUMBER OF ARRIVALS AND DEPARTURES | | |
|---|---|---|---|
| | BASE CASE SCENARIO 10 | 20 | 30 |
| 6 | | | |
| 7 | DDDDD | | |
| 8 | DADDDDDAAA | DD | |
| 9 | DADDDDADDD | AAAADADDDD | |
| 10 | DDADDDAAAD | AADDDDAA | |
| 11 | ADADADADDA | AADDDA | |
| 12 | DAADDAADDA | AAAAADDDD | |
| 13 | DDDADDAADA | ADAAADDAA | |
| 14 | DADDDDDAAA | DAA | |
| 15 | DADDDDAAAA | AAADDDDDA | |
| 16 | ADDADDAADD | AAAD | |
| 17 | ADDAAADAAA | DDDDDDDAAA | |
| 18 | DAAADDDAAA | DD | |
| 19 | DAAAADDAAA | DDAAADDDAA | A |
| 20 | DDDDDAAAAA | DDDADADAAD | |
| 21 | AAADDAADAA | A | |
| 22 | AAADAAAADA | | |
| 23 | DAAA | | |
| 24 | A | | |
| | PEAK PRICING & QUOTAS SCENARIO | | |
| 6 | | | |
| 7 | DDDDDD | | |
| 8 | DDADDDDDAA | ADDD | |
| 9 | ADDDAADDDD | AAAADADD | |
| 10 | DADDADDAAA | DDADA | |
| 11 | DAADAADDAA | ADDDDDA | |
| 12 | DADAAAADDA | AADDDDDD | |
| 13 | ADAAADDDAA | A | |
| 14 | AADDAAAAAD | AADADDDDDA | A |
| 15 | DDDDDAAAAA | DDA | |
| 16 | ADDAADDADA | DAAD | |
| 17 | DDDAADAAAD | ADDADA | |
| 18 | DDADAAADDA | DDDAAA | |
| 19 | AADDDDAADD | AAADAD | |
| 20 | ADDDDAAAAA | AADDADDAD | |
| 21 | ADADDAADDA | DAADA | |
| 22 | AADAADA | | |
| 23 | DAAAAAAAA | | |
| 24 | AAA | | |

Scale columns 40, 50 and 60 are printed across the head of the table but contain no entries.

A: ARRIVAL
B: DEPARTURE

## TABLE H-16
## TIME OF DAY PROFILE OF AIRPORT ACTIVITY
## TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
## YEAR 2000 FORECAST

NEW YORK CITY

NUMBER OF ARRIVALS AND DEPARTURES

BASE CASE SCENARIO

| TIME OF DAY | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | |
|---|---|---|---|---|---|---|---|---|---|
| 6 | | | | | | | | | |
| 7 | DDDDDDDDDD | DDDDAADDD | | | | | | | |
| 8 | DDDDDDDDDD | DDAAADDDDD | DDDAAADDDA | ADDDDDDDAA | | | | | |
| 9 | DDADDDDDDD | ADDDDDAADD | DAADDDDDAD | AADDDAADDD | DDAADDDDDA | DAADAA | | | |
| 10 | DDDDDDDAAA | DAAADDAAAD | DDADDDDDAA | DDDDAAAAAD | DDDDAAADDD | AADDDAAADD | DAAADAADDA | AA | |
| 11 | DDDDDAAAAD | DAAADDAAAD | DADDDAAAAA | ADDDDDAAAA | DDDAAAAAAD | DDADAAAAAD | DDAAAAADDAA | ADDDAA | |
| 12 | DDAAAADDDD | ADDDDDAAAA | ADDDDAAADD | DAAAAADDAA | AADDDAAAAD | DDDAAAADDA | AADDDAADDD | AAAAADDDDA | A |
| 13 | DDDAAAAADD | ADDDAAAAAA | AAADDDDDDA | AADDDDADDA | AAADDAAAAD | DDDAAAADDA | AAAADAADDD | AAA | |
| 14 | DDAAAADDDD | DDAADDAAAD | AAAADDDDDD | ADDAAADDAA | AAADDDDAAA | AADDDAAADD | DAADDAAAAA | | |
| 15 | DAADAAAADD | DAAADDDDDD | AAADAADDDD | AADDDDDAAA | ADDAAAAAAA | AAADDAAAAD | DAAADDDDD | | |
| 16 | DDDDAAAAAA | DADAAAAAAD | DDDADDAAAA | AAADDAAAAD | ADDDDDDDAA | AADDAAAAAD | DDAADAADAA | AAA | |
| 17 | DDDDDDAAAD | DDAAADDDDD | AAAAAAAADD | DDAAAAAAAD | DDDADDDAAA | AADDDAAAAA | ADDDDDDAAA | DDDDAAADDD | DDAAAADD |
| 18 | DDDAAADDDD | DDAADDDDAA | AAAADDDDDA | ADADDDDDDA | AAAADDDDAA | AADDDDDDDA | ADDAAAAADD | DDDDAAAADD | DDAAAAAD |
| 19 | DDDDDDDDDA | DDDAAAAADD | DDDAADDDAA | AAAADDDAAD | DAAADDDDAA | DDDDDDAAAA | DDDAAAAAAD | DDDAADDAAA | DDDDDA |
| 20 | DDDDAADDDD | DDAAAAADDD | DDDDAAAAAA | ADDDDDAADD | DAAADAAADD | DDDDAAAAAA | DDDDDADDAA | AAADAAAADD | DDAAA |
| 21 | DAAADADDDA | AAADDDAAAD | DAADAADDDD | AAAADDDADD | DDAADDDAAD | DADDDAA | | | |
| 22 | DDDDAAAADA | AADAADAAAA | DAADAAAAAA | AAAAAA | | | | | |
| 23 | DDDAAAADDA | AAAAAADDAA | AAAAAAA | | | | | | |
| 24 | AAAAAAAAAA | AA | | | | | | | |

PEAK PRICING & QUOTAS SCENARIO

| TIME OF DAY | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | |
|---|---|---|---|---|---|---|---|---|---|
| 6 | | | | | | | | | |
| 7 | DDDDDDDDDD | DDDDDDDDDD | DDDDAADDDD | | | | | | |
| 8 | DAADDDDDDD | DDAAADDDAD | DDDDDDDDAD | DAAADDDDDD | DAADD | | | | |
| 9 | DDDADDDAAD | DDDDDDDADA | AADDDDDAAD | DDDDDAAADD | AADDAA | | | | |
| 10 | DDDDDDAAAA | DADDAADDDA | ADDDADAAAD | DDDDDAAAAA | DDDDDAADDA | ADDDAAADDD | DAAAA | | |
| 11 | DAAAADDDDD | AADAAADDDA | ADDDDAAAAD | DDAAADDDAA | AADDDAAAAD | AAAADDDADD | DDAAAAAAADD | | |
| 12 | DDDAAAADDD | DAADDDDAAA | DDDAADAAAA | DDAAAADDDA | AAADDDAADA | AAADDDDDAA | DDAAAAAADDA | A | |
| 13 | DDDDDAAAAA | DDDAAAAAAD | DDAADDDDDD | AADAADDDAA | AADDDDAAAA | DAAADDDAAA | AADDADDDD | | |
| 14 | DDAAAAAAAD | DDDAAADAAD | DAAAADDDDD | DADAAADDAA | AADDDDAAAD | DDDADAAADD | DDDDDDAAAA | AAA | |
| 15 | DAAADDDAAA | AADDDAAADD | DDAAAAAAAA | DDDDDDAAAD | DDDAAAAAAA | AADDAAAADD | DDAAADDAAA | DDDDAAA | |
| 16 | DAAADDAAAD | DDDDAAAADD | ADDAAAAADD | DAAAAADDAA | ADDDDDDAAA | DDAAADDAAA | DDADDAAAAA | AAAA | |
| 17 | DDDDDDADDA | ADDDAAAAAD | DDDDAAADAA | AADAAADDAA | AAADDDDADD | DDDDAAAAAD | DDDAADDDAA | ADDDAAAA | |
| 18 | DDDDAAADDA | ADDDDDAAAD | DDDAAADDAA | AADDDDDAAD | DDAAADDDDD | AAAADDDDAA | DDDAAAAADA | AADAAAA | |
| 19 | DDDDDDDAAA | ADDDDDAAAA | DDDAADDDDA | AAAAADDDDA | AAADDDAAAD | DDDDAADAAA | DDDDDAAAAD | DAADAA | |
| 20 | DDDDDAAADD | DDDDAAAAAD | DDDDADAAAD | DDAAAADDAA | DDAADDDDDD | AAAADDDDDA | AAAADDDDAA | AAAADAAA | |
| 21 | DAAAADDAAA | AADDDDADDD | DAAAADDDDD | AADDDDAADD | AAADDDDDAA | DDDDDDAAAD | ADDAAADDDD | DAAAA | |
| 22 | DDDADDAAAD | DDAAAAADAA | ADDAAAAAAD | AAAAAADDDA | AAAAAAAA | | | | |
| 23 | DAAAADDAAA | AAAAAAAAAA | AAAAAAAAA | | | | | | |
| 24 | AAAAAAAAAA | AAA | | | | | | | |

A: ARRIVAL
B: DEPARTURE

## TABLE H-17
## TIME OF DAY PROFILE OF AIRPORT ACTIVITY
## TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
## YEAR 2000 FORECAST

PHILADELPHIA

NUMBER OF ARRIVALS AND DEPARTURES

| TIME OF DAY | 0–10 | 10–20 | 20–30 | 30–40 | 40–50 | 50–60 | 60– |
|---|---|---|---|---|---|---|---|
| **BASE CASE SCENARIO** | | | | | | | |
| 6 | | | | | | | |
| 7 | DDDDDDD | | | | | | |
| 8 | DDAADDDDAD | ADDDD | | | | | |
| 9 | ADDAADADAD | DDDDDADA | | | | | |
| 10 | DDDAAADDDA | AAADDADDDD | AAADD | | | | |
| 11 | DDAAAADDAA | DDDAADDDAA | DDDAAA | | | | |
| 12 | ADAAAAADDA | ADDADDAADA | DDA | | | | |
| 13 | DADDAAADDD | AAADDDADDA | AAA | | | | |
| 14 | AAADDAAADD | DDADAAADD | | | | | |
| 15 | AADAADDDDD | ADDAADAAAD | AADD | | | | |
| 16 | DADAAAADAA | AADDDDDDAA | ADDAA | | | | |
| 17 | AAADDADDAD | DDADAADADA | AADADA | | | | |
| 18 | DDDADDAAAD | DADAADDDDA | AADADAA | | | | |
| 19 | DDDDDAADAA | DADAAADDDA | AADDADDAAA | DAADDA | | | |
| 20 | DDADDDADAD | AAADADDDAA | DADDA | | | | |
| 21 | ADADDADADA | DADAAA | | | | | |
| 22 | DDAAADADAA | AAA | | | | | |
| 23 | ADDAAAAAAA | AA | | | | | |
| 24 | | | | | | | |
| **PEAK PRICING & QUOTAS SCENARIO** | | | | | | | |
| 6 | | | | | | | |
| 7 | DDDDDDDDDD | D | | | | | |
| 8 | DDDAADAADA | DDAAADDDDD | | | | | |
| 9 | ADADDDDDDD | AADDA | | | | | |
| 10 | DADAADDDDD | AADADAAAA | | | | | |
| 11 | DDADDDDDAD | DDADAAAAA | | | | | |
| 12 | DAADADDDDA | DAADDDDDA | | | | | |
| 13 | DDADDAADAA | AAADADADDD | | | | | |
| 14 | DAADAADDAA | ADAADDDDDD | A | | | | |
| 15 | ADDADAAAAD | DAADDADAAD | A | | | | |
| 16 | DAADDAAAAD | DDDDADDDDA | A | | | | |
| 17 | ADDAAAAADD | DDAAAAAADD | A | | | | |
| 18 | ADDAADDDDD | DAADAAAADD | AA | | | | |
| 19 | DAAAAADDDD | DAAADDDAAA | A | | | | |
| 20 | AADDDDDDDA | AADAAAAADD | DDDD | | | | |
| 21 | DADAAAAADD | DDDDADDDDA | | | | | |
| 22 | AAADDDAAAA | AAADDAAAAA | | | | | |
| 23 | AAAAAAAA | | | | | | |
| 24 | AAAAAA | | | | | | |

A: ARRIVAL
B: DEPARTURE

## TABLE H-18
## TIME OF DAY PROFILE OF AIRPORT ACTIVITY
## TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
## YEAR 2000 FORECAST

PITTSBURGH

NUMBER OF ARRIVALS AND DEPARTURES

| TIME OF DAY | 10 | 20 | 30 | 40 | 50 | 60 |
|---|---|---|---|---|---|---|
| | BASE CASE SCENARIO | | | | | |
| 6 | | | | | | |
| 7 | DDDDD | | | | | |
| 8 | DDDDDAADDD | ADADDDD | | | | |
| 9 | DAADDDADDA | ADDDDADDAD | DDA | | | |
| 10 | DDADDDDAAA | AAADDAADDD | DAA | | | |
| 11 | DADDDDDAAA | DDDADDAADA | AADAA | | | |
| 12 | DDADADDDAD | AAAADDAADA | ADDD | | | |
| 13 | ADDAAADDAA | DDDAAAA | | | | |
| 14 | ADADDAAADA | DDAD | | | | |
| 15 | AADDDDDDDA | AADADADDAD | DAA | | | |
| 16 | AAADDAAAAD | DADDADADDA | A | | | |
| 17 | AADDDDDADA | ADDADAAD | | | | |
| 18 | DAADDADADA | DAAAADDADD | ADDAD | | | |
| 19 | DDAAADADDA | ADDADAADAA | DAA | | | |
| 20 | DADDDDDAAD | DAAAADDDAD | DADAA | | | |
| 21 | DAADADAAAA | AADADDA | | | | |
| 22 | DDADDAAAAA | ADAAAA | | | | |
| 23 | DDDAAAAAAA | | | | | |
| 24 | AAA | | | | | |
| | PEAK PRICING & QUOTAS SCENARIO | | | | | |
| 6 | | | | | | |
| 7 | DDDDDDD | | | | | |
| 8 | DDDDDAAAAD | DDDDDDADDD | | | | |
| 9 | AADDDAADDA | DAADDA | | | | |
| 10 | DDADADADDD | ADADAADAAD | A | | | |
| 11 | ADDADADDDA | ADDDADAA | | | | |
| 12 | DDAAAADADD | ADAAADDAAA | DDDDD | | | |
| 13 | DADAADAADD | AAAAD | | | | |
| 14 | DDADADAAAD | AADDDDDAAA | A | | | |
| 15 | DDADDDAAAD | DADADAAD | | | | |
| 16 | DAADAADAAA | AADDDAAADD | DDD | | | |
| 17 | DDDDADDAAA | AADADAAAA | | | | |
| 18 | DDADDAADDD | DDAADAAA | | | | |
| 19 | ADDAADADDD | DAADAAADAA | A | | | |
| 20 | DAADDDDDAA | AAADADDDDD | AA | | | |
| 21 | DAADADADDA | AAADADDAAA | DAA | | | |
| 22 | DADDAADDAA | AAAAA | | | | |
| 23 | ADAAAAAA | | | | | |
| 24 | AAA | | | | | |

A: ARRIVAL
B: DEPARTURE

TABLE H-19
TIME OF DAY PROFILE OF AIRPORT ACTIVITY
TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
YEAR 2000 FORECAST

ST. LOUIS

NUMBER OF ARRIVALS AND DEPARTURES

BASE CASE SCENARIO

| TIME OF DAY | 10 | 20 | 30 | 40 | 50 | 60 | |
|---|---|---|---|---|---|---|---|
| 6 | | | | | | | |
| 7 | DDDDDDDDDA | DDA | | | | | |
| 8 | DDDAADDDAD | DDDADADDD | | | | | |
| 9 | AAAAADDDDA | DDAADDADDA | DAADADDAD | | | | |
| 10 | DDDDDDAAAD | DADDAADAAA | ADDDDADDDA | ADD | | | |
| 11 | DDDADDDAAA | ADAAAADDAA | ADAADDDDAA | ADDA | | | |
| 12 | DADDDAADDA | DDDADAADDD | AAADADD | | | | |
| 13 | AADAADDADD | AAAADDDDDA | AAADAADAA | | | | |
| 14 | DADAAADDAD | ADDAADADAD | DDDAA | | | | |
| 15 | DAADDDDADA | ADAAAADAAA | DDDAAA | | | | |
| 16 | DADADDDADD | ADDADDAAAD | A | | | | |
| 17 | AADDDDDAAA | DADADAAADD | DADDAAADDD | AAA | | | |
| 18 | DDADDAAAAD | AAADDAADAD | DDDDAADAAA | | | | |
| 19 | DDDDDAAAAA | AAADADADDA | DDAADDAA | | | | |
| 20 | DADDDDDDAA | AAADDAADAA | DADDAAADAD | DAAADDDA | | | |
| 21 | AAADAAADDA | DAAADADAA | | | | | |
| 22 | DADADADDAA | AAADAAA | | | | | |
| 23 | ADADAAAA | | | | | | |
| 24 | AAA | | | | | | |

PEAK PRICING & QUOTAS SCENARIO

| TIME OF DAY | 10 | 20 | 30 | 40 | 50 | 60 | |
|---|---|---|---|---|---|---|---|
| 6 | | | | | | | |
| 7 | DDDDDDDDDD | AADDDDD | | | | | |
| 8 | DDDADAAAAA | DDDADDADDA | AAADDDDDA | | | | |
| 9 | AADADADDDD | AADDAADADA | | | | | |
| 10 | DADDDDDAAA | DDDAAADDDA | AADDDDDD | | | | |
| 11 | AAAAAAADAA | DADDDDADDD | ADDAAA | | | | |
| 12 | DAADAADDAA | DAAADDDADD | DDAAAADDA | | | | |
| 13 | DAAADDDDAA | ADDADADAAA | DDADA | | | | |
| 14 | ADAAAADDDD | DDAADDADAA | DDDDDDAAD | | | | |
| 15 | AADADDAAAD | AAAADDAADD | ADDDDDAA | | | | |
| 16 | DAAADADDAA | AADADAAADD | DDAA | | | | |
| 17 | DDDAADADDD | DAAAADDAAA | DAADDDA | | | | |
| 18 | DDDADAAADD | DDAAAAADAD | ADDDDDAAAA | A | | | |
| 19 | ADDAAAAADD | DDADDDDAAD | DDAD | | | | |
| 20 | AADDDDDAAA | AAAAADAADA | DAADDDDADA | A | | | |
| 21 | DDDAAADDDD | DAADAADDAA | DAAADDDAAD | | | | |
| 22 | AADDDADDDD | AAAADDAAAA | AAA | | | | |
| 23 | AAAAAAAAAA | A | | | | | |
| 24 | AA | | | | | | |

A: ARRIVAL
B: DEPARTURE

TABLE H-20
TIME OF DAY PROFILE OF AIRPORT ACTIVITY
TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
YEAR 2000 FORECAST

SAN FRANCISCO

NUMBER OF ARRIVALS AND DEPARTURES

BASE CASE SCENARIO

| TIME OF DAY | 10 | 20 | 30 | 40 |
|---|---|---|---|---|
| 6 | | | | |
| 7 | DDDDDDDDDD | D | | |
| 8 | DDDDDDADDD | DDDDDDDDDD | AADDDDDDDD | |
| 9 | DDDDDDDDAA | DDDDDDADDD | DDADADDDDD | |
| 10 | DDADDDDDDA | DDDADDDDDA | DDDDDDADDD | ADDDADD |
| 11 | DDDDAADDAD | DDAAADDADD | DDDADDAADD | DADDDAAAAA |
| 12 | DDDDDDADDD | DDADDDDDAA | AAADDDAADA | ADDDAADDD |
| 13 | AAADDDDDDD | DDAAAAAAAA | DAADDDADDA | AAAADDDA |
| 14 | DDDADDADAA | DDDAADAADA | DAADAAADDA | |
| 15 | DDDAAAAAAD | DDDAADAADD | AAADDDAAAD | ADDDA |
| 16 | DAAADAAAAD | DAADAADDAA | AAADDDDA | |
| 17 | AAAADDAAAD | AAAAADADDA | AAADA | |
| 18 | DAAADADAAA | DADDADAAAA | AADDAADAAA | |
| 19 | DDADAAAADD | AADAAAADAA | AAADDAAAA | |
| 20 | AADDAAADAA | AAADDADAAD | AAAAADAAD | |
| 21 | AAAAAADAAA | DAAAAAAAAA | DAAAADAA | |
| 22 | AAAAAAAAAA | ADAAAAAADA | | |
| 23 | AAAAAADAAA | | | |
| 24 | AAA | | | |

PEAK PRICING & QUOTAS SCENARIO

| TIME OF DAY | 10 | 20 | 30 | 40 |
|---|---|---|---|---|
| 6 | | | | |
| 7 | DDDDDDDDDD | DDDDDDDDDD | DDDD | |
| 8 | DADDDDDDDD | DDDDAADDDD | DDAA | |
| 9 | DDDDADDADD | ADDDDDAADD | DAADADDD | |
| 10 | DAADDDAAAD | DDDAAADDDD | DDAAADDADA | ADDDDDAA |
| 11 | DDADADAAAA | DDDDAADAAD | DDDDAADADD | ADD |
| 12 | DAADDDDAAD | DDDDDAADDA | AADDDDDAAD | ADA |
| 13 | DDDAADDAAD | DADAAADDDD | DDADDDAAAD | DADDDDDA |
| 14 | AAAADDDADD | DDAADDDADD | DDDADAADAA | ADA |
| 15 | DDDADDDDAA | AAAADDDDAA | DADDADDAAA | DDADDD |
| 16 | ADAAAAADDA | DDAAADADDA | DAADAAAAA | |
| 17 | DAADAAAADD | DADAAADADD | DAAADDAA | |
| 18 | AAAADAADDD | ADDDDAAADD | AAADDDAAAA | AA |
| 19 | DDADDADAAA | DAADDAADAA | DAAAA | |
| 20 | ADDAAAAADD | AAADAADDAA | AAADA | |
| 21 | AAAAADADDA | DDADDAAAAD | AAA | |
| 22 | AAAADAADDA | AAAAAADAAA | AAA | |
| 23 | AAAAAAAAAA | AAAAAAAA | | |
| 24 | AAAAAAAA | | | |

A: ARRIVAL
B: DEPARTURE

TABLE H-21
TIME OF DAY PROFILE OF AIRPORT ACTIVITY
TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
YEAR 2000 FORECAST

SEATTLE

NUMBER OF ARRIVALS AND DEPARTURES (scale: 10, 20, 30, 40, 50, 60)

| TIME OF DAY | BASE CASE SCENARIO |
|---|---|
| 6 | |
| 7 | DDDDDDD |
| 8 | DDDDDDD |
| 9 | DDDDDDADDA DDDDDA |
| 10 | DDDDDDADAD DA |
| 11 | DDDDDAAAAD DDADADD |
| 12 | DADDDADDAD DADDDAAA |
| 13 | ADDAAAADDD DAAADDDADA |
| 14 | DDDDAAADAA A |
| 15 | ADDDAADADA DADDDD |
| 16 | ADAAAADDAD DA |
| 17 | ADAAAAADAA DAA |
| 18 | ADAADAAADD A |
| 19 | DAAAAADAAD DAAA |
| 20 | AAAADAADDA AA |
| 21 | DAAAADAAA |
| 22 | AAAAAAA |
| 23 | AAAAA |
| 24 | A |

| TIME OF DAY | PEAK PRICING & QUOTAS SCENARIO |
|---|---|
| 6 | |
| 7 | DDDDDDDDDD D |
| 8 | DDDDA |
| 9 | DADDDAADAA ADD |
| 10 | DDDDADADD |
| 11 | AAADDDAADD DDAAD |
| 12 | AAAADDDDDD DAADA |
| 13 | DDADDADADD AA |
| 14 | ADAAADDDAA AADDDAA |
| 15 | DDDDDDADAA A |
| 16 | DADDADAAAA ADA |
| 17 | DDDDADAADD ADAA |
| 18 | ADAADADDAD DDD |
| 19 | AAADDAADDA |
| 20 | AAADAAAAAA AD |
| 21 | DDDAADADA |
| 22 | AADAADAAA |
| 23 | AAAAAAAAA |
| 24 | AAA |

A: ARRIVAL
B: DEPARTURE

## TABLE H-22
## TIME OF DAY PROFILE OF AIRPORT ACTIVITY
## TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS
## YEAR 2000 FORECAST

TAMPA

NUMBER OF ARRIVALS AND DEPARTURES

**BASE CASE SCENARIO**

| TIME OF DAY | 10 | 20 | 30 | 40 | 50 | 60 |
|---|---|---|---|---|---|---|
| 6 | | | | | | |
| 7 | DDDDDD | | | | | |
| 8 | DDADDDDDDD | DDDADDDD | | | | |
| 9 | DDADDDADDD | DDDDAAA | | | | |
| 10 | DDDDAADADD | DAAADADDDD | AADAA | | | |
| 11 | DADAAAADDD | AADDDADAAA | DDAAAAADD | | | |
| 12 | ADDDDDAADD | DDAAADAADD | DAAAA | | | |
| 13 | DDAADDDAAA | DDDAADDA | | | | |
| 14 | AADDDDAADA | DADAAADADA | AADA | | | |
| 15 | DADDDADDDA | AAADDDDAAA | DDA | | | |
| 16 | DDDADAAAAA | ADADAAADA | | | | |
| 17 | DADDAADDAD | AADDDDADAA | ADADDA | | | |
| 18 | DAADAAADDA | DDAAADDDAD | A | | | |
| 19 | DDDDAAAADD | DADDDAADAA | AADA | | | |
| 20 | ADDDDAADAA | DAADDAAADD | | | | |
| 21 | AAADDADAAD | DDDADDADAA | A | | | |
| 22 | AAAAAAAAAA | DAAA | | | | |
| 23 | DAAAAAAAAA | A | | | | |
| 24 | AAA | | | | | |

**PEAK PRICING & QUOTAS SCENARIO**

| TIME OF DAY | 10 | 20 | 30 | 40 | 50 | 60 |
|---|---|---|---|---|---|---|
| 6 | | | | | | |
| 7 | DDDDDDD | | | | | |
| 8 | DDDDDADDDD | DADDDDD | | | | |
| 9 | DDADDDADDD | DDDDAAA | | | | |
| 10 | DDAAADDADD | DAAADDDDAA | DADAADDDA | | | |
| 11 | DAADDDAADA | DADADADAAD | DA | | | |
| 12 | ADDAAAADDD | ADADADDAAD | DDA | | | |
| 13 | ADAADADCAA | DAAAADDDDD | D | | | |
| 14 | ADAADAAAAD | DAAADDDDAA | D | | | |
| 15 | ADDDDDAAAD | DAADADDDA | | | | |
| 16 | ADDAAAAAAD | DADDDADAD | | | | |
| 17 | DAAADADADD | AADAADDAA | | | | |
| 18 | DAADDAAAAD | DDDDADAAAA | ADDAA | | | |
| 19 | DADDDADADD | DAAADADAA | | | | |
| 20 | ADDDDDAADA | AADADADAAD | ADA | | | |
| 21 | AAADDADDAD | DAADDDADAD | AA | | | |
| 22 | AAAAAAAAAA | ADDAA | | | | |
| 23 | AAAAAAAA | | | | | |
| 24 | AAAAAA | | | | | |

A: ARRIVAL
B: DEPARTURE

**TABLE H-23**
**TIME OF DAY PROFILE OF AIRPORT ACTIVITY**
**TRAFFIC OPERATIONS BETWEEN 25 LARGE HUB AIRPORTS**
**YEAR 2000 FORECAST**

**WASHINGTON, D.C.**
**(National Airport)**

NUMBER OF ARRIVALS AND DEPARTURES

**BASE CASE SCENARIO**

| TIME OF DAY | 10 | 20 | 30 | 40 | 50 | 60 |
|---|---|---|---|---|---|---|
| 6 | | | | | | |
| 7 | DDDDDDDDDA | A | | | | |
| 8 | DDDDADADAD | DDDDDDDAAA | ADDA | | | |
| 9 | DDDDAADDAD | DDDADDDAAD | DDDAAAADA | | | |
| 10 | DDDDAAADDA | DADAADDAAA | ADDADDDDAD | DDDDAA | | |
| 11 | DADDAAAAAA | DDAAAAADAD | DDAAAAADAA | AD | | |
| 12 | DDDAAAADDA | ADAAADDDDD | AAAADDDAAA | AAAA | | |
| 13 | DADAAADAAA | DDDDDAAADD | DDDAADDAAA | D | | |
| 14 | AAADAAAAAA | DAADDDDAAA | DADAAA | | | |
| 15 | ADDDDDDAAD | ADAAAADAAD | DDDDDDA | | | |
| 16 | DAADAAAAAA | DDDDDDADDD | ADDAA | | | |
| 17 | DDÁAAADDDA | DAAAADDDDA | ADADDAAAAD | DDDDDDAA | | |
| 18 | DAADADADDD | AAADDDADAD | DADDDAADA | | | |
| 19 | DDADDDAAAA | DDADAAADDD | DDDAADADAA | DDDDAAAAAA | AD | |
| 20 | DADADDDAAD | DDAAAAADAA | DDDADDDDDA | AA | | |
| 21 | AADADDDDDA | DAAAADDAAA | DDADDAAA | | | |
| 22 | ADADAAADDA | DDAA | | | | |
| 23 | DDAADAAAAD | AAAADAAAA | | | | |
| 24 | AAAAA | | | | | |

**PEAK PRICING & QUOTAS SCENARIO**

| TIME OF DAY | 10 | 20 | 30 | 40 | 50 | 60 |
|---|---|---|---|---|---|---|
| 6 | | | | | | |
| 7 | DDDDDDDDDD | DDDDADD | | | | |
| 8 | DDDADDDAAD | DADAADAADD | AADDDDADD | | | |
| 9 | DDADADDAAD | AAADDAADAA | ADDDDD | | | |
| 10 | DAADDADDDA | DDAADADAAD | ADAADDDDAA | | | |
| 11 | DADAAAADDA | AAAADADADD | DADAADDDAA | A | | |
| 12 | DADADDAADD | DAADDADDAA | DDDDAAADDA | | | |
| 13 | DAAADAAADA | ADDDADAAAD | ADADDAADDA | ADA | | |
| 14 | DAAADDDDDD | AAADADADAA | DDADDDDDDA | A | | |
| 15 | ADAAAADDAD | ADDAADDAAA | DAAAADDADD | DAAA | | |
| 16 | ADDDDADADA | AADADDAADD | AADDDDA | | | |
| 17 | DAAADADDAA | DDDAADAAAA | DDADADDDAA | AA | | |
| 18 | DAADADDDDA | AAADAADDDA | ADDADDAD | | | |
| 19 | DAAAAAADDA | ADDDDDDAAA | ADDAADDDDA | ADD | | |
| 20 | DAAADAADAD | DDAAAAADAD | DAADDDAADA | | | |
| 21 | DDDDAAAAAD | AADDDDAADA | DDDDAAADDA | A | | |
| 22 | DDAAADDDDA | DDAAAAADDD | DAAADAAAAA | | | |
| 23 | AAAAAAAAAA | AAAA | | | | |
| 24 | AAAAAAA | | | | | |

A: ARRIVAL
B: DEPARTURE

## APPENDIX I

## SCHEDULED FLIGHTS TO OTHER AIRPORTS IN THE 23 CITY NETWORK AS PERCENTAGE OF TOTAL NETWORK OPERATIONS

| AIRPORT | PERCENTAGE |
|---|---|
| ORD | 43 |
| BOS | 40 |
| SFO | 47 |
| STL | 50 |
| DEN | 39 |
| LAX | 45 |
| SEA | 30 |
| PHL | 52 |
| CLE | 58 |
| NYC | 52 |
| DCA | 62 |
| ATL | 48 |
| MSP | 44 |
| DTW | 55 |
| MCI | 39 |
| DFW | 42 |
| HLU | 23 |
| IAH | 47 |
| MIA | 40 |
| PIT | 44 |
| TPA | 54 |
| LAS | 46 |

Source: OAG, June 1, 1975.

# APPENDIX J

IMPACT OF QUOTAS/PEAK PRICING
ALTERNATIVES ON AIRPORT DELAY

02/27/76

PROJECTED AIR CARRIER DELAY
(MILLIONS OF MINUTES)

SCENARIO #1
BASELINE CONFIGURATION

| | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ORD | 6.8 | 7.0 | 7.1 | 7.3 | 7.5 | 7.7 | 7.9 | 8.0 | 8.2 | 8.4 | 8.8 | 9.2 | 9.5 | 9.9 | 10.3 | 11.0 | 11.7 | 12.3 | 13.0 | 13.7 | 14.7 | 15.7 | 16.7 | 17.7 | 18.7 |
| WAS | 1.0 | 1.1 | 1.1 | 1.2 | 1.2 | 1.2 | 1.3 | 1.3 | 1.4 | 1.4 | 1.5 | 1.7 | 1.8 | 2.0 | 2.1 | 2.2 | 2.3 | 2.5 | 2.6 | 2.7 | 2.9 | 3.2 | 3.4 | 3.7 | 3.9 |
| SFO | 1.8 | 1.9 | 2.1 | 2.3 | 2.4 | 2.6 | 2.8 | 3.0 | 3.1 | 3.3 | 4.0 | 4.8 | 5.5 | 6.3 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 |
| STL | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .6 | 1.1 | 1.5 | 2.0 | 2.5 | 3.1 | 3.7 | 4.3 | 4.9 | 5.5 | 6.5 | 7.4 | 8.4 | 9.3 | 10.3 |
| DEN | .2 | .3 | .3 | .4 | .4 | .4 | .5 | .5 | .6 | .6 | 1.1 | 1.6 | 2.0 | 2.5 | 3.0 | 3.4 | 3.8 | 4.2 | 4.6 | 5.0 | 5.4 | 5.8 | 6.3 | 6.7 | 7.1 |
| LAX | .3 | .3 | .4 | .5 | .5 | .6 | .7 | .8 | .8 | .9 | 1.1 | 1.3 | 1.6 | 1.8 | 2.0 | 2.3 | 2.7 | 3.0 | 3.4 | 3.7 | 4.8 | 5.9 | 7.0 | 8.1 | 9.2 |
| SEA | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .3 | .5 | .8 | 1.0 | 1.2 | 1.4 | 1.5 | 1.7 | 1.8 | 2.0 | 2.2 | 2.4 | 2.7 | 2.9 | 3.1 |
| PHL | .1 | .1 | .1 | .1 | .1 | .2 | .2 | .2 | .2 | .2 | .2 | .3 | .3 | .4 | .4 | .4 | .4 | .5 | .5 | .5 | .9 | 1.3 | 1.6 | 2.0 | 2.4 |
| CLE | - | - | .1 | .1 | .1 | .1 | .1 | .2 | .2 | .2 | .2 | .2 | .3 | .3 | .3 | .3 | .4 | .4 | .5 | .5 | .6 | .7 | .7 | .8 | .9 |
| NYC | - | - | - | - | - | - | - | - | - | - | .2 | .4 | .7 | .9 | 1.1 | 1.6 | 2.1 | 2.6 | 3.1 | 3.6 | 4.9 | 6.2 | 7.6 | 8.9 | 10.2 |
| DCA | .9 | 1.0 | 1.0 | 1.1 | 1.2 | 1.3 | 1.4 | 1.4 | 1.5 | 1.6 | 1.8 | 2.0 | 2.1 | 2.3 | 2.5 | 2.7 | 2.9 | 3.0 | 3.2 | 3.4 | 3.6 | 3.8 | 4.1 | 4.3 | 4.5 |
| ATL | - | .1 | .1 | .1 | .1 | .2 | .2 | .2 | .3 | .3 | .5 | .6 | .8 | .9 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.4 | 1.7 | 2.0 | 2.3 | 2.6 |
| MSY | - | - | - | - | - | - | - | - | - | - | .1 | .2 | .2 | .3 | .4 | .4 | .4 | .4 | .4 | .4 | .5 | .6 | .8 | .9 | 1.0 |
| MSP | - | .1 | .1 | .1 | .1 | .2 | .2 | .2 | .3 | .3 | .4 | .5 | .5 | .6 | .7 | .7 | .7 | .8 | .8 | .8 | 1.0 | 1.3 | 1.5 | 1.8 | 2.0 |
| DTW | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MCI | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | .1 | .2 | .4 | .5 | .6 |
| DFW | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MLU | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| IAH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MIA | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| PIT | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| TPA | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| LAS | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| TOT | 11.4 | 12.0 | 12.7 | 13.4 | 14.0 | 14.7 | 15.4 | 16.1 | 16.7 | 17.4 | 20.8 | 24.3 | 27.7 | 31.2 | 34.6 | 37.7 | 40.7 | 43.8 | 46.8 | 49.9 | 56.6 | 63.3 | 70.1 | 76.8 | 83.5 |

# APPENDIX J

IMPACT OF QUOTAS/PEAK PRICING
ALTERNATIVES ON AIRPORT DELAY

02/27/76

SCENARIO #2
QUOTAS & PEAK PRICING
BASELINE CONFIGURATION

PROJECTED AIR CARRIER DELAY
(MILLIONS OF MINUTES)

| | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ORD | 6.2 | 5.8 | 5.4 | 5.0 | 4.6 | 4.3 | 3.9 | 3.5 | 3.1 | 2.7 | 3.2 | 3.6 | 4.1 | 4.5 | 5.6 | 5.4 | 5.8 | 6.1 | 6.5 | 6.9 | 7.1 | 7.3 | 7.6 | 7.8 | 8.0 |
| BOS | .9 | .8 | .7 | .6 | .5 | .4 | .3 | .2 | .1 | - | .2 | .4 | .6 | .8 | 1.0 | 1.0 | 1.1 | 1.1 | 1.2 | 1.2 | 1.2 | 1.2 | 1.3 | 1.3 | 1.3 |
| SFO | 1.4 | 1.3 | 1.1 | 1.0 | .8 | .6 | .5 | .3 | .2 | - | .2 | .4 | .5 | .7 | .9 | .9 | .9 | 1.0 | 1.0 | 1.0 | 1.3 | 1.7 | 2.0 | 2.4 | 2.7 |
| STL | .1 | .1 | .1 | .1 | .1 | - | - | - | - | - | - | - | - | - | - | .1 | .1 | .2 | .2 | .3 | .4 | .5 | .6 | .7 | .8 |
| DEN | .2 | .2 | .1 | .1 | .1 | .1 | .1 | - | - | - | .1 | .2 | .2 | .3 | .4 | .4 | .4 | .4 | .4 | .4 | .5 | .5 | .5 | .6 | .7 |
| LAX | .2 | .2 | .1 | .1 | .1 | .1 | .1 | - | - | - | - | - | - | - | - | .1 | .2 | .4 | .5 | .6 | .9 | 1.2 | 1.6 | 1.9 | 2.2 |
| SEA | .1 | .1 | .1 | .1 | .1 | - | - | - | - | - | - | - | - | - | - | - | - | .1 | .1 | .1 | .1 | .1 | .2 | .2 | .2 |
| PHL | .1 | .1 | .1 | .1 | .1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | .1 | .1 | .1 |
| CLE | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | .1 | .1 | .2 | .2 | .2 | .2 | .2 | .2 | .2 |
| NYC | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | .1 | .2 | .3 | .4 | .5 | .6 | .7 | .7 | .8 | .9 |
| DCA | .7 | .6 | .6 | .5 | .4 | .3 | .2 | .2 | .1 | - | .1 | .1 | .2 | .2 | .3 | .3 | .3 | .3 | .3 | .3 | .4 | .5 | .5 | .6 | .7 |
| ATL | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | .1 | .1 | .1 | .1 | .1 | .2 | .2 | .2 |
| MSY | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .1 |
| MSP | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | .1 | .1 | .2 | .2 | .2 | .2 | .2 | .2 | .2 |
| DTW | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MCI | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | .1 | .1 | .1 |
| DFW | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| HOU | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| IAH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MIA | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| PIT | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| TPA | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| LAS | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| TOT | 9.9 | 9.1 | 8.3 | 7.5 | 6.7 | 5.9 | 5.1 | 4.3 | 3.5 | 2.7 | 3.7 | 4.7 | 5.6 | 6.6 | 7.6 | 8.5 | 9.3 | 10.2 | 11.0 | 11.9 | 13.2 | 14.5 | 15.8 | 17.1 | 18.4 |

## APPENDIX J

IMPACT OF QUOTAS/PEAK PRICING
ALTERNATIVES ON AIRPORT DELAY

02/28/76

PROJECTED AIR CARRIER DELAY
(MILLIONS OF MINUTES)

SCENARIO #3
UG3RD CONFIGURATION

| | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ORD | 6.2 | 5.8 | 5.5 | 5.1 | 4.7 | 4.3 | 3.9 | 3.6 | 3.2 | 2.8 | 3.5 | 4.2 | 4.8 | 5.5 | 6.2 | 7.3 | 8.4 | 9.4 | 10.5 | 11.6 | 12.3 | 13.0 | 13.7 | 14.4 | 15.1 |
| BOS | 1.0 | 1.0 | .9 | .9 | .9 | .9 | .9 | .8 | .8 | .8 | .9 | 1.0 | 1.0 | 1.1 | 1.2 | 1.2 | 1.3 | 1.3 | 1.4 | 1.4 | 1.5 | 1.5 | 1.6 | 1.6 | 1.7 |
| SFO | 1.6 | 1.5 | 1.5 | 1.5 | 1.5 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 1.5 | 1.7 | 2.0 | 2.2 | 2.4 | 2.5 | 2.5 | 2.6 | 2.6 | 2.7 | 3.4 | 4.1 | 4.7 | 5.4 | 6.1 |
| STL | .1 | .1 | .1 | .1 | .1 | .2 | .2 | .2 | .2 | .2 | .3 | .3 | .4 | .4 | .5 | .5 | .5 | .6 | .6 | .6 | .9 | 1.3 | 1.6 | 2.0 | 2.3 |
| DEN | .2 | .2 | .2 | .2 | .1 | .1 | .1 | .1 | .1 | .1 | .2 | .3 | .4 | .5 | .8 | .7 | .7 | .8 | .8 | .9 | 1.0 | 1.1 | 1.3 | 1.4 | 1.5 |
| LAX | .2 | .2 | .1 | .1 | .1 | .1 | .1 | - | - | - | - | - | - | - | - | .2 | .4 | .6 | .8 | 1.0 | 1.1 | 1.1 | 1.2 | 1.2 | 1.3 |
| SEA | .1 | .1 | .1 | .1 | .1 | - | - | - | - | - | - | - | - | - | - | .1 | .1 | .2 | .2 | .3 | .3 | .4 | .4 | .5 | .5 |
| PHL | .1 | .1 | .1 | .1 | .1 | - | - | - | - | - | - | - | - | - | - | - | - | .1 | .1 | .1 | .2 | .3 | .3 | .4 | .5 |
| CLE | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | .1 | .1 | .2 | .2 | .2 | .2 | .3 | .3 | .3 |
| NYC | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | .1 | .2 | .3 | .4 | .5 | .8 | 1.1 | 1.5 | 1.8 | 2.1 |
| DCA | .8 | .8 | .8 | .8 | .8 | .8 | .8 | .8 | .8 | .8 | .9 | 1.1 | 1.2 | 1.4 | 1.6 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.6 | 1.7 | 1.7 | 1.8 | 1.9 |
| ATL | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | .1 | .1 | .2 | .2 | .2 | .3 | .3 | .4 | .4 |
| MSY | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | .1 | .1 | .2 | .2 | .2 | .3 | .3 | .4 | .4 |
| MSP | - | - | - | - | - | - | - | - | - | - | .1 | .1 | .2 | .2 | .3 | .3 | .3 | .3 | .3 | .3 | .4 | .5 | .5 | .6 | .7 |
| DTW | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MCI | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | .1 | .1 | .2 | .2 |
| DFW | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| HOU | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| IAH | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MIA | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| PIT | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| TPA | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| LAS | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| TOT | 10.2 | 9.8 | 9.3 | 8.8 | 8.3 | 7.9 | 7.4 | 6.9 | 6.5 | 6.0 | 7.3 | 8.7 | 10.0 | 11.4 | 12.7 | 14.5 | 16.2 | 18.0 | 19.7 | 21.5 | 24.2 | 26.9 | 29.6 | 32.3 | 35.0 |

# APPENDIX J

IMPACT OF QUOTAS/PEAK PRICING
ALTERNATIVES ON AIRPORT DELAY

02/28/76

SCENARIO #4
QUOTAS & PEAK PRICING
UG3RD CONFIGURATION

PROJECTED AIR CARRIER DELAY
(MILLIONS OF MINUTES)

| | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ORD | 6.0 | 5.4 | 4.8 | 4.2 | 3.6 | 2.9 | 2.3 | 1.7 | 1.1 | .5 | .4 | .3 | .2 |
| BOS | .9 | .8 | .7 | .6 | .5 | .4 | .3 | .2 | .1 | - | - | - | - |
| SFO | 1.4 | 1.3 | 1.1 | 1.0 | .8 | .6 | .5 | .3 | .2 | - | - | - | - |
| STL | .1 | .1 | .1 | .1 | .1 | - | - | - | - | - | - | - | - |
| DEN | .2 | .2 | .1 | .1 | .1 | .1 | .1 | - | - | - | - | - | - |
| LAX | .2 | .2 | .1 | .1 | .1 | .1 | .1 | - | - | - | - | - | - |
| SEA | .1 | .1 | .1 | .1 | .1 | - | - | - | - | - | - | - | - |
| PHL | .1 | .1 | .1 | .1 | .1 | - | - | - | - | - | - | - | - |
| CLE | - | - | - | - | - | - | - | - | - | - | - | - | - |
| NYC | - | - | - | - | - | - | - | - | - | - | - | - | - |
| DCA | .7 | .6 | .6 | .5 | .4 | .3 | .2 | .2 | .1 | - | - | - | - |
| ATL | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MSY | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MSP | - | - | - | - | - | - | - | - | - | - | - | - | - |
| DTW | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MCI | - | - | - | - | - | - | - | - | - | - | - | - | - |
| DFW | - | - | - | - | - | - | - | - | - | - | - | - | - |
| HLU | - | - | - | - | - | - | - | - | - | - | - | - | - |
| IAH | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MIA | - | - | - | - | - | - | - | - | - | - | - | - | - |
| PIT | - | - | - | - | - | - | - | - | - | - | - | - | - |
| TPA | - | - | - | - | - | - | - | - | - | - | - | - | - |
| LAS | - | - | - | - | - | - | - | - | - | - | - | - | - |
| TOT | 9.7 | 8.7 | 7.6 | 6.6 | 5.6 | 4.6 | 3.6 | 2.5 | 1.5 | .5 | .4 | .3 | .2 |

| | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ORD | .1 | - | .3 | .5 | .8 | 1.0 | 1.3 | 1.5 | 1.7 | 1.8 | 2.0 | 2.2 |
| BOS | - | - | .2 | .3 | .5 | .6 | .8 | .8 | .8 | .9 | .9 | .9 |
| SFO | - | - | - | .1 | .1 | .2 | .2 | .4 | .5 | .7 | .8 | 1.0 |
| STL | - | - | - | .1 | .1 | .2 | .2 | .2 | .2 | .2 | .2 | .2 |
| DEN | - | - | - | .1 | .1 | .2 | .2 | .2 | .2 | .2 | .2 | .2 |
| LAX | - | - | - | - | .1 | .1 | .1 | .1 | .1 | .2 | .2 | .2 |
| SEA | - | - | - | - | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .1 |
| PHL | - | - | - | - | - | - | - | - | - | - | - | - |
| CLE | - | - | - | - | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .1 |
| NYC | - | - | - | - | .1 | .1 | .1 | .1 | .2 | .2 | .3 | .3 |
| DCA | - | - | - | - | .1 | .1 | .1 | .1 | .1 | .2 | .2 | .2 |
| ATL | - | - | - | - | - | - | - | - | - | - | - | - |
| MSY | - | - | - | - | - | - | - | - | - | - | - | - |
| MSP | - | - | - | - | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .1 |
| DTW | - | - | - | - | - | - | - | - | - | - | - | - |
| MCI | - | - | - | - | - | - | - | - | - | - | - | - |
| DFW | - | - | - | - | - | - | - | - | - | - | - | - |
| HLU | - | - | - | - | - | - | - | - | - | - | - | - |
| IAH | - | - | - | - | - | - | - | - | - | - | - | - |
| MIA | - | - | - | - | - | - | - | - | - | - | - | - |
| PIT | - | - | - | - | - | - | - | - | - | - | - | - |
| TPA | - | - | - | - | - | - | - | - | - | - | - | - |
| LAS | - | - | - | - | - | - | - | - | - | - | - | - |
| TOT | .1 | - | .7 | 1.3 | 2.0 | 2.6 | 3.3 | 3.7 | 4.2 | 4.6 | 5.1 | 5.5 |

## APPENDIX K

### TABLE K.1

COST OF AIRPORT DELAY
(MILLIONS OF DOLLARS)

AIRPORT ID: ATL

ANNUAL COST

| | SCENE 1 | SCENE 2 | SCENE 3 | SCENE 4 |
|---|---|---|---|---|
| 1975 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1976 | .78 | 0.00 | 0.00 | 0.00 |
| 1977 | 1.55 | 0.00 | 0.00 | 0.00 |
| 1978 | 2.33 | 0.00 | 0.00 | 0.00 |
| 1979 | 3.11 | 0.00 | 0.00 | 0.00 |
| 1980 | 3.88 | 0.00 | 0.00 | 0.00 |
| 1981 | 5.31 | 0.00 | 0.00 | 0.00 |
| 1982 | 6.20 | 0.00 | 0.00 | 0.00 |
| 1983 | 7.08 | 0.00 | 0.00 | 0.00 |
| 1984 | 7.97 | 0.00 | 0.00 | 0.00 |
| 1985 | 8.85 | 0.00 | 0.00 | 0.00 |
| 1986 | 14.43 | 0.00 | 0.00 | 0.00 |
| 1987 | 19.45 | 0.00 | 0.00 | 0.00 |
| 1988 | 24.47 | 0.00 | 0.00 | 0.00 |
| 1989 | 29.49 | 0.00 | 0.00 | 0.00 |
| 1990 | 34.51 | 0.00 | 0.00 | 0.00 |
| 1991 | 37.03 | .67 | 1.35 | 0.00 |
| 1992 | 37.03 | 1.35 | 2.69 | 0.00 |
| 1993 | 37.03 | 2.02 | 4.04 | 0.00 |
| 1994 | 37.03 | 2.69 | 5.39 | 0.00 |
| 1995 | 37.03 | 3.37 | 6.73 | 0.00 |
| 1996 | 51.02 | 4.37 | 8.75 | 0.00 |
| 1997 | 61.95 | 5.10 | 10.20 | 0.00 |
| 1998 | 72.88 | 5.83 | 11.66 | 0.00 |
| 1999 | 83.81 | 6.56 | 13.12 | 0.00 |
| 2000 | 94.74 | 7.29 | 14.58 | 0.00 |

Scenario 1 - Base Case Scenario
Scenario 2 - Peak Pricing, Quota Scenario
Scenario 3 - UG3RD Scenario
Scenario 4 - Peak Pricing, UG3RD Scenario

## APPENDIX K

### TABLE K.1

COST OF AIRPORT DELAY
(MILLIONS OF DOLLARS)

AIRPORT ID: BOS

| | ANNUAL COST | | | |
|---|---|---|---|---|
| | SCENE 1 | SCENE 2 | SCENE 3 | SCENE 4 |
| 1975 | 28.24 | 28.24 | 28.24 | 28.24 |
| 1976 | 29.37 | 25.42 | 27.68 | 25.42 |
| 1977 | 30.50 | 22.59 | 27.11 | 22.59 |
| 1978 | 31.63 | 19.77 | 26.55 | 19.77 |
| 1979 | 32.76 | 16.94 | 25.98 | 16.94 |
| 1980 | 33.89 | 14.12 | 25.42 | 14.12 |
| 1981 | 42.74 | 13.79 | 30.33 | 13.79 |
| 1982 | 44.12 | 10.34 | 29.64 | 10.34 |
| 1983 | 45.50 | 6.89 | 28.95 | 6.89 |
| 1984 | 46.88 | 3.45 | 28.27 | 3.45 |
| 1985 | 48.26 | 0.00 | 27.58 | 0.00 |
| 1986 | 55.53 | 7.21 | 31.73 | 0.00 |
| 1987 | 60.58 | 14.42 | 34.62 | 0.00 |
| 1988 | 65.63 | 21.64 | 37.50 | 0.00 |
| 1989 | 70.68 | 28.85 | 40.39 | 0.00 |
| 1990 | 75.73 | 36.06 | 43.27 | 0.00 |
| 1991 | 84.72 | 39.69 | 47.32 | 6.11 |
| 1992 | 89.29 | 41.21 | 48.84 | 12.21 |
| 1993 | 93.87 | 42.74 | 50.37 | 18.32 |
| 1994 | 98.45 | 44.27 | 51.90 | 24.42 |
| 1995 | 103.03 | 45.79 | 53.42 | 30.53 |
| 1996 | 116.16 | 48.20 | 57.68 | 32.40 |
| 1997 | 125.64 | 48.99 | 60.06 | 33.19 |
| 1998 | 135.12 | 49.78 | 62.43 | 33.98 |
| 1999 | 144.61 | 50.57 | 64.80 | 34.77 |
| 2000 | 154.09 | 51.36 | 67.17 | 35.56 |

Scenario 1 - Base Case Scenario
Scenario 2 - Peak Pricing, Quota Scenario
Scenario 3 - UG3RD Scenario
Scenario 4 - Peak Pricing, UG3RD Scenario

APPENDIX K

TABLE K.1

COST OF AIRPORT DELAY
(MILLIONS OF DOLLARS)

AIRPORT ID: CLE

| | ANNUAL COST | | | |
|---|---|---|---|---|
| | SCENE 1 | SCENE 2 | SCENE 3 | SCENE 4 |
| 1975 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1976 | .52 | 0.00 | 0.00 | 0.00 |
| 1977 | 1.04 | 0.00 | 0.00 | 0.00 |
| 1978 | 1.56 | 0.00 | 0.00 | 0.00 |
| 1979 | 2.08 | 0.00 | 0.00 | 0.00 |
| 1980 | 2.60 | 0.00 | 0.00 | 0.00 |
| 1981 | 3.46 | 0.00 | 0.00 | 0.00 |
| 1982 | 4.03 | 0.00 | 0.00 | 0.00 |
| 1983 | 4.61 | 0.00 | 0.00 | 0.00 |
| 1984 | 5.18 | 0.00 | 0.00 | 0.00 |
| 1985 | 5.76 | 0.00 | 0.00 | 0.00 |
| 1986 | 6.69 | 0.00 | 0.00 | 0.00 |
| 1987 | 7.30 | 0.00 | 0.00 | 0.00 |
| 1988 | 7.91 | 0.00 | 0.00 | 0.00 |
| 1989 | 8.52 | 0.00 | 0.00 | 0.00 |
| 1990 | 9.13 | 0.00 | 0.00 | 0.00 |
| 1991 | 10.76 | 1.27 | 1.27 | .63 |
| 1992 | 12.03 | 2.53 | 2.53 | 1.27 |
| 1993 | 13.29 | 3.80 | 3.80 | 1.90 |
| 1994 | 14.56 | 5.06 | 5.06 | 2.53 |
| 1995 | 15.82 | 6.33 | 6.33 | 3.16 |
| 1996 | 19.52 | 6.73 | 7.40 | 3.36 |
| 1997 | 22.21 | 6.73 | 8.08 | 3.36 |
| 1998 | 24.90 | 6.73 | 8.75 | 3.36 |
| 1999 | 27.59 | 6.73 | 9.42 | 3.36 |
| 2000 | 30.28 | 6.73 | 10.09 | 3.36 |

Scenario 1 - Base Case Scenario
Scenario 2 - Peak Pricing, Quota Scenario
Scenario 3 - UG3RD Scenario
Scenario 4 - Peak Pricing, UG3RD Scenario

## APPENDIX K

### TABLE K.1

COST OF AIRPORT DELAY
(MILLIONS OF DOLLARS)

AIRPORT ID: DCA

| | ANNUAL COST | | | |
|---|---|---|---|---|
| | SCENE 1 | SCENE 2 | SCENE 3 | SCENE 4 |
| 1975 | 20.59 | 20.59 | 20.59 | 20.59 |
| 1976 | 22.65 | 18.53 | 20.59 | 18.53 |
| 1977 | 24.71 | 16.47 | 20.59 | 16.47 |
| 1978 | 26.77 | 14.41 | 20.59 | 14.41 |
| 1979 | 28.83 | 12.36 | 20.59 | 12.36 |
| 1980 | 30.89 | 10.30 | 20.59 | 10.30 |
| 1981 | 37.79 | 9.45 | 23.62 | 9.45 |
| 1982 | 40.15 | 7.08 | 23.62 | 7.08 |
| 1983 | 42.51 | 4.72 | 23.62 | 4.72 |
| 1984 | 44.87 | 2.36 | 23.62 | 2.36 |
| 1985 | 47.23 | 0.00 | 23.62 | 0.00 |
| 1986 | 55.86 | 1.88 | 29.50 | 0.00 |
| 1987 | 61.50 | 3.77 | 33.89 | 0.00 |
| 1988 | 67.15 | 5.65 | 38.28 | 0.00 |
| 1989 | 72.80 | 7.53 | 42.68 | 0.00 |
| 1990 | 78.45 | 9.41 | 47.07 | 0.00 |
| 1991 | 90.42 | 10.12 | 50.61 | .67 |
| 1992 | 96.50 | 10.12 | 50.61 | 1.35 |
| 1993 | 102.57 | 10.12 | 50.61 | 2.02 |
| 1994 | 108.64 | 10.12 | 50.61 | 2.70 |
| 1995 | 114.72 | 10.12 | 50.61 | 3.37 |
| 1996 | 130.75 | 13.73 | 57.07 | 4.33 |
| 1997 | 138.70 | 16.62 | 59.96 | 5.06 |
| 1998 | 146.65 | 19.50 | 62.85 | 5.78 |
| 1999 | 154.59 | 22.39 | 65.74 | 6.50 |
| 2000 | 162.54 | 25.28 | 68.63 | 7.22 |

Scenario 1 - Base Case Scenario
Scenario 2 - Peak Pricing, Quota Scenario
Scenario 3 - UG3RD Scenario
Scenario 4 - Peak Pricing, UG3RD Scenario

## APPENDIX K

### TABLE K.1

COST OF AIRPORT DELAY
(MILLIONS OF DOLLARS)

AIRPORT ID: DEN

| | ANNUAL COST | | | |
|---|---|---|---|---|
| | SCENE 1 | SCENE 2 | SCENE 3 | SCENE 4 |
| 1975 | 5.34 | 5.34 | 5.34 | 5.34 |
| 1976 | 6.41 | 4.81 | 5.07 | 4.81 |
| 1977 | 7.48 | 4.27 | 4.81 | 4.27 |
| 1978 | 8.54 | 3.74 | 4.54 | 3.74 |
| 1979 | 9.61 | 3.20 | 4.27 | 3.20 |
| 1980 | 10.68 | 2.67 | 4.00 | 2.67 |
| 1981 | 13.71 | 2.49 | 4.36 | 2.49 |
| 1982 | 14.95 | 1.87 | 4.05 | 1.87 |
| 1983 | 16.20 | 1.25 | 3.74 | 1.25 |
| 1984 | 17.44 | .62 | 3.43 | .62 |
| 1985 | 18.69 | 0.00 | 3.11 | 0.00 |
| 1986 | 34.59 | 2.56 | 6.41 | 0.00 |
| 1987 | 49.97 | 5.12 | 9.61 | 0.00 |
| 1988 | 65.34 | 7.69 | 12.81 | 0.00 |
| 1989 | 80.72 | 10.25 | 16.01 | 0.00 |
| 1990 | 96.09 | 12.81 | 19.22 | 0.00 |
| 1991 | 117.13 | 13.78 | 22.74 | 1.38 |
| 1992 | 130.91 | 13.78 | 24.80 | 2.76 |
| 1993 | 144.69 | 13.78 | 26.87 | 4.13 |
| 1994 | 158.47 | 13.78 | 28.94 | 5.51 |
| 1995 | 172.25 | 13.78 | 31.00 | 6.89 |
| 1996 | 193.87 | 16.45 | 36.49 | 7.15 |
| 1997 | 208.90 | 18.60 | 40.78 | 7.15 |
| 1998 | 223.92 | 20.75 | 45.07 | 7.15 |
| 1999 | 238.94 | 22.89 | 49.36 | 7.15 |
| 2000 | 253.97 | 25.04 | 53.65 | 7.15 |

Scenario 1 - Base Case Scenario
Scenario 2 - Peak Pricing, Quota Scenario
Scenario 3 - UG3RD Scenario
Scenario 4 - Peak Pricing, UG3RD Scenario

APPENDIX K

TABLE K.1

COST OF AIRPORT DELAY
(MILLIONS OF DOLLARS)

AIRPORT ID: LAX

ANNUAL COST

| | SCENE 1 | SCENE 2 | SCENE 3 | SCENE 4 |
|---|---|---|---|---|
| 1975 | 5.93 | 5.93 | 5.93 | 5.93 |
| 1976 | 8.01 | 5.34 | 5.34 | 5.34 |
| 1977 | 10.08 | 4.75 | 4.75 | 4.75 |
| 1978 | 12.16 | 4.15 | 4.15 | 4.15 |
| 1979 | 14.24 | 3.56 | 3.56 | 3.56 |
| 1980 | 16.31 | 2.97 | 2.97 | 2.97 |
| 1981 | 22.31 | 2.88 | 2.88 | 2.88 |
| 1982 | 24.83 | 2.16 | 2.16 | 2.16 |
| 1983 | 27.35 | 1.44 | 1.44 | 1.44 |
| 1984 | 29.87 | .72 | .72 | .72 |
| 1985 | 32.39 | 0.00 | 0.00 | 0.00 |
| 1986 | 42.19 | 0.00 | 0.00 | 0.00 |
| 1987 | 50.48 | 0.00 | 0.00 | 0.00 |
| 1988 | 58.77 | 0.00 | 0.00 | 0.00 |
| 1989 | 67.05 | 0.00 | 0.00 | 0.00 |
| 1990 | 75.34 | 0.00 | 0.00 | 0.00 |
| 1991 | 91.26 | 4.68 | 7.80 | .78 |
| 1992 | 104.52 | 9.36 | 15.60 | 1.56 |
| 1993 | 117.78 | 14.04 | 23.40 | 2.34 |
| 1994 | 131.04 | 18.72 | 31.20 | 3.12 |
| 1995 | 144.30 | 23.40 | 39.00 | 3.90 |
| 1996 | 196.85 | 37.73 | 43.47 | 4.92 |
| 1997 | 241.96 | 50.85 | 45.93 | 5.74 |
| 1998 | 287.07 | 63.98 | 48.39 | 6.56 |
| 1999 | 332.18 | 77.10 | 50.85 | 7.38 |
| 2000 | 377.29 | 90.22 | 53.31 | 8.20 |

Scenario 1 - Base Case Scenario
Scenario 2 - Peak Pricing, Quota Scenario
Scenario 3 - UG3RD Scenario
Scenario 4 - Peak Pricing, UG3RD Scenario

APPENDIX K

TABLE K.1

COST OF AIRPORT DELAY
(MILLIONS OF DOLLARS)

AIRPORT ID: MCI

ANNUAL COST

| | SCENE 1 | SCENE 2 | SCENE 3 | SCENE 4 |
|---|---|---|---|---|
| 1975 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1976 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1977 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1978 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1979 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1980 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1981 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1982 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1983 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1984 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1985 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1986 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1987 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1988 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1989 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1990 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1991 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1992 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1993 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1994 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1995 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1996 | 3.89 | .65 | 1.30 | 0.00 |
| 1997 | 7.78 | 1.30 | 2.59 | 0.00 |
| 1998 | 11.67 | 1.95 | 3.89 | 0.00 |
| 1999 | 15.57 | 2.59 | 5.19 | 0.00 |
| 2000 | 19.46 | 3.24 | 6.49 | 0.00 |

Scenario 1 - Base Case Scenario
Scenario 2 - Peak Pricing, Quota Scenario
Scenario 3 - UG3RD Scenario
Scenario 4 - Peak Pricing, UG3RD Scenario

APPENDIX K

TABLE K.1

COST OF AIRPORT DELAY
(MILLIONS OF DOLLARS)

AIRPORT ID: MSP

ANNUAL COST

| | SCENE 1 | SCENE 2 | SCENE 3 | SCENE 4 |
|---|---|---|---|---|
| 1975 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1976 | .82 | 0.00 | 0.00 | 0.00 |
| 1977 | 1.63 | 0.00 | 0.00 | 0.00 |
| 1978 | 2.45 | 0.00 | 0.00 | 0.00 |
| 1979 | 3.27 | 0.00 | 0.00 | 0.00 |
| 1980 | 4.08 | 0.00 | 0.00 | 0.00 |
| 1981 | 5.82 | 0.00 | 0.00 | 0.00 |
| 1982 | 6.79 | 0.00 | 0.00 | 0.00 |
| 1983 | 7.76 | 0.00 | 0.00 | 0.00 |
| 1984 | 8.73 | 0.00 | 0.00 | 0.00 |
| 1985 | 9.70 | 0.00 | 0.00 | 0.00 |
| 1986 | 12.63 | 0.00 | 1.99 | 0.00 |
| 1987 | 15.29 | 0.00 | 3.99 | 0.00 |
| 1988 | 17.95 | 0.00 | 5.98 | 0.00 |
| 1989 | 20.61 | 0.00 | 7.98 | 0.00 |
| 1990 | 23.27 | 0.00 | 9.97 | 0.00 |
| 1991 | 25.13 | 1.40 | 10.47 | .70 |
| 1992 | 25.83 | 2.79 | 10.47 | 1.40 |
| 1993 | 26.52 | 4.19 | 10.47 | 2.09 |
| 1994 | 27.22 | 5.58 | 10.47 | 2.79 |
| 1995 | 27.92 | 6.98 | 10.47 | 3.49 |
| 1996 | 38.74 | 7.45 | 14.15 | 3.72 |
| 1997 | 47.68 | 7.45 | 17.13 | 3.72 |
| 1998 | 56.62 | 7.45 | 20.11 | 3.72 |
| 1999 | 65.56 | 7.45 | 23.09 | 3.72 |
| 2000 | 74.50 | 7.45 | 26.07 | 3.72 |

Scenario 1 - Base Case Scenario
Scenario 2 - Peak Pricing, Quota Scenario
Scenario 3 - UG3RD Scenario
Scenario 4 - Peak Pricing, UG3RD Scenario

APPENDIX K

TABLE K.1

COST OF AIRPORT DELAY
(MILLIONS OF DOLLARS)

AIRPORT ID: MSY

ANNUAL COST

| | SCENE 1 | SCENE 2 | SCENE 3 | SCENE 4 |
|---|---|---|---|---|
| 1975 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1976 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1977 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1978 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1979 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1980 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1981 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1982 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1983 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1984 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1985 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1986 | 2.41 | 0.00 | 0.00 | 0.00 |
| 1987 | 4.82 | 0.00 | 0.00 | 0.00 |
| 1988 | 7.23 | 0.00 | 0.00 | 0.00 |
| 1989 | 9.64 | 0.00 | 0.00 | 0.00 |
| 1990 | 12.05 | 0.00 | 0.00 | 0.00 |
| 1991 | 12.84 | .64 | 1.28 | 0.00 |
| 1992 | 12.84 | 1.28 | 2.57 | 0.00 |
| 1993 | 12.84 | 1.93 | 3.85 | 0.00 |
| 1994 | 12.84 | 2.57 | 5.13 | 0.00 |
| 1995 | 12.84 | 3.21 | 6.42 | 0.00 |
| 1996 | 17.59 | 3.38 | 8.12 | 0.00 |
| 1997 | 21.64 | 3.38 | 9.47 | 0.00 |
| 1998 | 25.70 | 3.38 | 10.82 | 0.00 |
| 1999 | 29.76 | 3.38 | 12.18 | 0.00 |
| 2000 | 33.82 | 3.38 | 13.53 | 0.00 |

Scenario 1 - Base Case Scenario
Scenario 2 - Peak Pricing, Quota Scenario
Scenario 3 - UG3RD Scenario
Scenario 4 - Peak Pricing, UG3RD Scenario

## APPENDIX K

### TABLE K.1

COST OF AIRPORT DELAY
(MILLIONS OF DOLLARS)

AIRPORT ID: NYC

ANNUAL COST

| | SCENE 1 | SCENE 2 | SCENE 3 | SCENE 4 |
|---|---|---|---|---|
| 1975 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1976 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1977 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1978 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1979 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1980 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1981 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1982 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1983 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1984 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1985 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1986 | 8.66 | 0.00 | 0.00 | 0.00 |
| 1987 | 17.32 | 0.00 | 0.00 | 0.00 |
| 1988 | 25.98 | 0.00 | 0.00 | 0.00 |
| 1989 | 34.65 | 0.00 | 0.00 | 0.00 |
| 1990 | 43.31 | 0.00 | 0.00 | 0.00 |
| 1991 | 66.58 | 4.16 | 4.16 | .83 |
| 1992 | 87.38 | 8.32 | 8.32 | 1.66 |
| 1993 | 108.19 | 12.48 | 12.48 | 2.50 |
| 1994 | 128.99 | 16.64 | 16.64 | 3.33 |
| 1995 | 149.80 | 20.80 | 20.80 | 4.16 |
| 1996 | 208.26 | 24.55 | 34.71 | 5.93 |
| 1997 | 264.14 | 27.94 | 48.26 | 7.62 |
| 1998 | 320.01 | 31.32 | 61.80 | 9.31 |
| 1999 | 375.89 | 34.71 | 75.35 | 11.01 |
| 2000 | 431.77 | 38.10 | 88.89 | 12.70 |

Scenario 1 - Base Case Scenario
Scenario 2 - Peak Pricing, Quota Scenario
Scenario 3 - UG3RD Scenario
Scenario 4 - Peak Pricing, UG3RD Scenario

APPENDIX K

TABLE K.1

COST OF AIRPORT DELAY
(MILLIONS OF DOLLARS)

AIRPORT ID: ORD

ANNUAL COST

| | SCENE 1 | SCENE 2 | SCENE 3 | SCENE 4 |
|---|---|---|---|---|
| 1975 | 182.62 | 182.62 | 182.62 | 182.62 |
| 1976 | 187.60 | 171.83 | 172.11 | 165.74 |
| 1977 | 192.58 | 161.04 | 161.59 | 148.86 |
| 1978 | 197.56 | 150.25 | 151.08 | 131.99 |
| 1979 | 202.54 | 139.46 | 140.56 | 115.11 |
| 1980 | 207.52 | 128.67 | 130.05 | 98.23 |
| 1981 | 256.05 | 142.03 | 144.03 | 98.02 |
| 1982 | 262.05 | 129.03 | 131.36 | 77.68 |
| 1983 | 268.05 | 116.02 | 118.69 | 57.34 |
| 1984 | 274.05 | 103.02 | 106.02 | 37.01 |
| 1985 | 280.06 | 90.02 | 93.35 | 16.67 |
| 1986 | 308.09 | 110.88 | 122.11 | 14.04 |
| 1987 | 321.42 | 127.03 | 145.97 | 10.53 |
| 1988 | 334.76 | 143.17 | 169.84 | 7.02 |
| 1989 | 348.09 | 159.31 | 193.70 | 3.51 |
| 1990 | 361.43 | 175.45 | 217.56 | 0.00 |
| 1991 | 409.22 | 200.51 | 271.33 | 9.69 |
| 1992 | 434.57 | 214.68 | 311.58 | 19.38 |
| 1993 | 459.91 | 228.84 | 351.83 | 29.07 |
| 1994 | 485.26 | 243.00 | 392.08 | 38.76 |
| 1995 | 510.60 | 257.16 | 432.33 | 48.45 |
| 1996 | 578.89 | 280.39 | 484.37 | 58.28 |
| 1997 | 618.27 | 289.05 | 511.94 | 65.37 |
| 1998 | 657.65 | 297.71 | 539.51 | 72.46 |
| 1999 | 697.03 | 306.38 | 567.07 | 79.55 |
| 2000 | 736.41 | 315.04 | 594.64 | 86.64 |

Scenario 1 - Base Case Scenario
Scenario 2 - Peak Pricing, Quota Scenario
Scenario 3 - UG3RD Scenario
Scenario 4 - Peak Pricing, UG3RD Scenario

APPENDIX K

TABLE K.1

COST OF AIRPORT DELAY
(MILLIONS OF DOLLARS)

AIRPORT ID: PHL

| | ANNUAL COST | | | |
|---|---|---|---|---|
| | SCENE 1 | SCENE 2 | SCENE 3 | SCENE 4 |
| 1975 | 2.62 | 2.62 | 2.62 | 2.62 |
| 1976 | 2.89 | 2.36 | 2.36 | 2.36 |
| 1977 | 3.15 | 2.10 | 2.10 | 2.10 |
| 1978 | 3.41 | 1.84 | 1.84 | 1.84 |
| 1979 | 3.67 | 1.57 | 1.57 | 1.57 |
| 1980 | 3.94 | 1.31 | 1.31 | 1.31 |
| 1981 | 4.76 | 1.19 | 1.19 | 1.19 |
| 1982 | 5.06 | .89 | .89 | .89 |
| 1983 | 5.36 | .60 | .60 | .60 |
| 1984 | 5.66 | .30 | .30 | .30 |
| 1985 | 5.95 | 0.00 | 0.00 | 0.00 |
| 1986 | 7.52 | 0.00 | 0.00 | 0.00 |
| 1987 | 8.78 | 0.00 | 0.00 | 0.00 |
| 1988 | 10.03 | 0.00 | 0.00 | 0.00 |
| 1989 | 11.29 | 0.00 | 0.00 | 0.00 |
| 1990 | 12.54 | 0.00 | 0.00 | 0.00 |
| 1991 | 13.91 | 0.00 | .66 | 0.00 |
| 1992 | 14.57 | 0.00 | 1.32 | 0.00 |
| 1993 | 15.24 | 0.00 | 1.99 | 0.00 |
| 1994 | 15.90 | 0.00 | 2.65 | 0.00 |
| 1995 | 16.56 | 0.00 | 3.31 | 0.00 |
| 1996 | 29.29 | .67 | 5.99 | 0.00 |
| 1997 | 41.93 | 1.33 | 8.65 | 0.00 |
| 1998 | 54.58 | 2.00 | 11.32 | 0.00 |
| 1999 | 67.23 | 2.66 | 13.98 | 0.00 |
| 2000 | 79.87 | 3.33 | 16.64 | 0.00 |

Scenario 1 - Base Case Scenario
Scenario 2 - Peak Pricing, Quota Scenario
Scenario 3 - UG3RD Scenario
Scenario 4 - Peak Pricing, UG3RD Scenario

## APPENDIX K

### TABLE K.1

COST OF AIRPORT DELAY
(MILLIONS OF DOLLARS)

AIRPORT ID: SFO

ANNUAL COST

| | SCENE 1 | SCENE 2 | SCENE 3 | SCENE 4 |
|---|---|---|---|---|
| 1975 | 45.52 | 45.52 | 45.52 | 45.52 |
| 1976 | 50.36 | 40.97 | 44.67 | 40.97 |
| 1977 | 55.19 | 36.42 | 43.81 | 36.42 |
| 1978 | 60.03 | 31.86 | 42.96 | 31.86 |
| 1979 | 64.87 | 27.31 | 42.11 | 27.31 |
| 1980 | 69.70 | 22.76 | 41.25 | 22.76 |
| 1981 | 89.24 | 21.80 | 48.37 | 21.80 |
| 1982 | 95.03 | 16.35 | 47.34 | 16.35 |
| 1983 | 100.82 | 10.90 | 46.32 | 10.90 |
| 1984 | 106.61 | 5.45 | 45.30 | 5.45 |
| 1985 | 112.40 | 0.00 | 44.28 | 0.00 |
| 1986 | 144.79 | 6.45 | 54.48 | 0.00 |
| 1987 | 171.32 | 12.90 | 62.36 | 0.00 |
| 1988 | 197.84 | 19.35 | 70.25 | 0.00 |
| 1989 | 224.36 | 25.80 | 78.13 | 0.00 |
| 1990 | 250.88 | 32.26 | 86.02 | 0.00 |
| 1991 | 267.40 | 35.14 | 93.97 | 1.53 |
| 1992 | 267.40 | 35.91 | 96.26 | 3.06 |
| 1993 | 267.40 | 36.67 | 98.56 | 4.58 |
| 1994 | 267.40 | 37.44 | 100.85 | 6.11 |
| 1995 | 267.40 | 38.20 | 103.14 | 7.64 |
| 1996 | 277.83 | 53.18 | 134.15 | 14.29 |
| 1997 | 277.83 | 66.68 | 161.14 | 20.64 |
| 1998 | 277.83 | 80.17 | 188.13 | 26.99 |
| 1999 | 277.83 | 93.67 | 215.12 | 33.34 |
| 2000 | 277.83 | 107.16 | 242.11 | 39.69 |

Scenario 1 - Base Case Scenario
Scenario 2 - Peak Pricing, Quota Scenario
Scenario 3 - UG3RD Scenario
Scenario 4 - Peak Pricing, UG3RD Scenario

APPENDIX K

TABLE K.1

COST OF AIRPORT DELAY
(MILLIONS OF DOLLARS)

AIRPORT ID: SEA

ANNUAL COST

| | SCENE 1 | SCENE 2 | SCENE 3 | SCENE 4 |
|---|---|---|---|---|
| 1975 | 2.60 | 2.60 | 2.60 | 2.60 |
| 1976 | 2.60 | 2.34 | 2.34 | 2.34 |
| 1977 | 2.60 | 2.08 | 2.08 | 2.08 |
| 1978 | 2.60 | 1.82 | 1.82 | 1.82 |
| 1979 | 2.60 | 1.56 | 1.56 | 1.56 |
| 1980 | 2.60 | 1.30 | 1.30 | 1.30 |
| 1981 | 2.95 | 1.18 | 1.18 | 1.18 |
| 1982 | 2.95 | .89 | .89 | .89 |
| 1983 | 2.95 | .59 | .59 | .59 |
| 1984 | 2.95 | .30 | .30 | .30 |
| 1985 | 2.95 | 0.00 | 0.00 | 0.00 |
| 1986 | 10.13 | 0.00 | 0.00 | 0.00 |
| 1987 | 17.10 | 0.00 | 0.00 | 0.00 |
| 1988 | 24.06 | 0.00 | 0.00 | 0.00 |
| 1989 | 31.03 | 0.00 | 0.00 | 0.00 |
| 1990 | 37.99 | 0.00 | 0.00 | 0.00 |
| 1991 | 46.28 | .68 | 2.04 | .68 |
| 1992 | 51.73 | 1.36 | 4.08 | 1.36 |
| 1993 | 57.17 | 2.04 | 6.13 | 2.04 |
| 1994 | 62.62 | 2.72 | 8.17 | 2.72 |
| 1995 | 68.06 | 3.40 | 10.21 | 3.40 |
| 1996 | 77.34 | 4.18 | 11.85 | 3.48 |
| 1997 | 85.01 | 4.88 | 13.24 | 3.48 |
| 1998 | 92.67 | 5.57 | 14.63 | 3.48 |
| 1999 | 100.34 | 6.27 | 16.03 | 3.48 |
| 2000 | 108.00 | 6.97 | 17.42 | 3.48 |

Scenario 1 - Base Case Scenario
Scenario 2 - Peak Pricing, Quota Scenario
Scenario 3 - UG3RD Scenario
Scenario 4 - Peak Pricing, UG3RD Scenario

APPENDIX K

TABLE K.1

COST OF AIRPORT DELAY
(MILLIONS OF DOLLARS)

AIRPORT ID: STL

ANNUAL COST

| | SCENE 1 | SCENE 2 | SCENE 3 | SCENE 4 |
|---|---|---|---|---|
| 1975 | 2.64 | 2.64 | 2.64 | 2.64 |
| 1976 | 2.64 | 2.37 | 2.90 | 2.37 |
| 1977 | 2.64 | 2.11 | 3.16 | 2.11 |
| 1978 | 2.64 | 1.85 | 3.43 | 1.85 |
| 1979 | 2.64 | 1.58 | 3.69 | 1.58 |
| 1980 | 2.64 | 1.32 | 3.95 | 1.32 |
| 1981 | 2.91 | 1.16 | 4.66 | 1.16 |
| 1982 | 2.91 | .87 | 4.95 | .87 |
| 1983 | 2.91 | .58 | 5.24 | .58 |
| 1984 | 2.91 | .29 | 5.53 | .29 |
| 1985 | 2.91 | 0.00 | 5.82 | 0.00 |
| 1986 | 17.65 | 0.00 | 7.91 | 0.00 |
| 1987 | 32.26 | 0.00 | 9.74 | 0.00 |
| 1988 | 46.86 | 0.00 | 11.56 | 0.00 |
| 1989 | 61.47 | 0.00 | 13.39 | 0.00 |
| 1990 | 76.07 | 0.00 | 15.21 | 0.00 |
| 1991 | 94.24 | 1.82 | 15.81 | 1.22 |
| 1992 | 112.48 | 3.65 | 16.42 | 2.43 |
| 1993 | 130.72 | 5.47 | 17.02 | 3.65 |
| 1994 | 148.96 | 7.30 | 17.63 | 4.86 |
| 1995 | 167.20 | 9.12 | 18.24 | 6.08 |
| 1996 | 204.78 | 12.68 | 29.80 | 6.34 |
| 1997 | 235.21 | 15.85 | 40.58 | 6.34 |
| 1998 | 265.65 | 19.02 | 51.35 | 6.34 |
| 1999 | 296.08 | 22.19 | 62.13 | 6.34 |
| 2000 | 326.51 | 25.36 | 72.91 | 6.34 |

Scenario 1 - Base Case Scenario
Scenario 2 - Peak Pricing, Quota Scenario
Scenario 3 - UG3RD Scenario
Scenario 4 - Peak Pricing, UG3RD Scenario

# BIBLIOGRAPHY


1. Civil Aeronautics Board. Aircraft Operating Cost and Performance Report - 1975. Washington, D.C.

2. Civil Aeronautics Board. Aircraft Performance Data - 1974. Washington, D.C.

3. Civil Aeronautics Board. 1974 Annual Origin-Destination Tables. Washington, D.C.

4. Flight International. January 3, 1974.

5. Harris, R. M. Models for Runway Capacity Analysis. Report MITRE 4102, Rev. 2. McLean, Virginia: The MITRE Corporation, December 1972.

6. Hengsbach, G., and Odoni, A. R. Time Dependent Estimates of Delays and Costs at Major Airports. Massachusetts Institute of Technology, Flight Transportation Laboratory, FTL Report 74-4.

7. Hsin, C. C., and Swan, W. M. "Users Memo for Schedule Generation Used in Connection with Reducta." Massachusetts Institute of Technology, Flight Transportation Laboratory, FTL Memorandum M 73-9.

8. Koopman, B. O. "Air Terminal Queues Under Time-Dependent Conditions," Operations Research. Vol.20, pages 1089-1114, 1972.

9. MITRE Corporation. Memorandum W 43-127.7, July 31, 1975.

10. Odoni, A. R. An Analytic Investigation of Air Traffic in the Vicinity of Terminal Areas. Massachusetts Institute of Technology, Operations Research Center, Technical Report 46, December 1969.

11. Odoni, A. R., and Vittek, Joseph F. Airport Quotas and Peak-Hour Pricing: Theory and Practice. Washington, D.C.: U.S. Department of Transportation, Federal Aviation Administration, May 1976.

12. Odoni, A., and Vittek, J. Peak-Load Pricing: Theory and Practice. Washington, D.C.: U.S. Department of Transportation, Federal Aviation Administration, May 1976.

13. Official Airline Guide, North American Edition. May 1974.

14. Official Airline Guide, North American Edition. June 1975.

15. Paalson, Thor. "An Evaluation of Reduct for Fleet Minimization," Massachusetts Institute of Technology, Flight Transportation Laboratory, FTL Memorandum M 69-1.

16. Simpson, R. W. "A Market Share Model for U.S. Domestic Airline Competitive Markets," Massachusetts Institute of Technology, Flight Transportation Laboratory, FTL Memorandum M 70-5.

17. Simpson, R., and Taneja, N. A Multi-Regression Analysis of IOC's. Massachusetts Institute of Technology, Flight Transportation Laboratory, FTL Report R 67-2.

18. Simpson, R. W. Scheduling and Routing Models for Airline Systems. Massachusetts Institute of Technology, Flight Transportation Laboratory, FTL Report R 68-3.

19. Simpson, R. W. Theory for Domestic Airline Economics. Massachusetts Institute of Technology, Flight Transportation Laboratory, FTL Report R 74-2.

20. Swan, W. M. "The Complete PA-4 Memo." Massachusetts Institute of Technology, Flight Transportation Laboratory, FTL Memorandum M 72-10.

21. Swan, W. M. "Explanation, Validity, and Use of Modal Split Models to Generate Traffic Frequency Curves." Massachusetts Institute of Technology, Flight Transportation Laboratory, FTL Memorandum M 73-7.

22. Thirry, H. "Reducta-Bugg Correction and Improvements." Massachusetts Institute of Technology, Flight Transportation Laboratory, FTL Memorandum M 70-2.

23. U.S. Department of Transportation, Federal Aviation Administration. Airline Delay Data: 1970-1974. Washington, D.C.: February 1975.

24. U.S. Department of Transportation, Federal Aviation Administration. Profiles of Scheduled Air Carrier Airport Operations-Top 100 U.S. Airports. Washington, D.C.: November 1973.

25. U.S. Department of Transportation, Federal Aviation Administration. Profiles of Scheduled Air Carrier Airport Operations-Top 100 U.S. Airports. Washington, D.C.: August 1974.

26. U.S. Department of Transportation, Federal Aviation Administration. Terminal Area Forecasts: 1976-1986. Washington, D.C.: September 1974.

27. U.S. Department of Transportation, Federal Aviation Administration. The National Aviation System: Challenges of the Decade Ahead, 1977-1986. Washington D.C.: 1976.

28. U.S. National Bureau of Standards. Analysis of a Capacity Concept for Runway and Final Approach Path Airspace. Report NBS-10111, AD-698-521, November 1969, DOT, FAA, Aviation Forecasts, FY 1975-1986.