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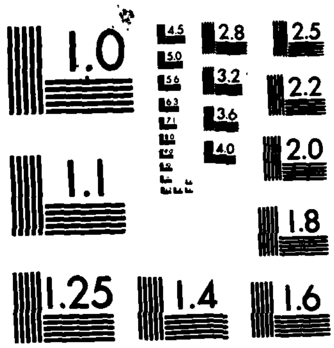

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ANALYSIS OF NON-CAPITAL ALTERNATIVES FOR HANDLING GENERAL AVIATION ACTIVITY AT BUSY AIRPORTS

SYSTEM CONSULTANTS, INC.

August 1977

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Office of Aviation Policy
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16. Abstract

The purpose of this study is to investigate the feasibility of alleviating congestion at high density airports through modification of the variables that affect aircraft traffic mix. The study examines the determinants affecting airport and airside demand and capacity, evaluates the effects of varying traffic mix parameters on demand and capacity and identifies candidate policies and procedures which could modify the traffic mix at a high density airport. The report also evaluates the feasibility of implementing possible policies/procedures and identifies the related advantages and disadvantages of each. It further examines the effectiveness of proposed alternatives through hypothetical implementation at the selected high density airports.

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TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

Under Contract No. DOT-FATQWA-3865, the FAA authorized a study effort to examine the aircraft traffic mix at high density airports. The purpose of this study effort is to investigate the feasibility of alleviating congestion at high density airports through modification of the aircraft traffic mix parameters. In support of this objective, Systems Consultants, Inc., has been tasked to:

- Examine the determinants affecting airport airside demand and capacity, and identify the manner in which these factors interrelate and contribute to airport saturation.
- Evaluate the effects of varying traffic mix parameters (e.g., aircraft type/performance characteristics, airport users, traffic distribution) on demand and capacity.
- Identify candidate policies and/or procedures which, if implemented, would modify the traffix mix at the high density airport with the resultant effect of postponing airport saturation.
- Evaluate the feasibility of implementing the candidate policies/procedures and identify the related advantages and disadvantages of each candidate option. Establish a range of probable statistical values for the traffic mix parameters that may be used as quantitative measurements of the potential effectiveness of the candidate options.
- Identify actual traffic mix conditions at certain selected airports that may be considered representative of national conditions.
- Examine the effectiveness of proposed alternatives through hypothetical implementation at the selected high density airports.

The alternative options for postponing saturation at the high density airports that are evaluated in this report are limited to those not requiring capital investment either at high density or the local reliever airports. Consequently, the common approaches for relieving airport airside congestion, e.g. construction of new runways, taxiways, runway extension, or installation of new avionics equipment, are not addressed.

1.1 Study Approach.

In selecting non-capital alternative approaches for postponing saturation at high density airports, techniques based on unique or individual airport characteristics were not considered; rather, candidate solutions were chosen and evaluated, based on their potential for broad application at high density airports nationwide. A set of high density airports was selected for the purpose of testing the effectiveness of the candidate alternatives. Airports were selected which are representative of the national population of high density air carrier airports.

In the past, lack of data on general aviation's contribution to airport traffic mix has been a major stumbling block. While this deficiency could not be entirely solved within the scope of this effort, existing national data on general aviation traffic characteristics combined with data collected at the selected test airports has proven adequate for the purpose of this study effort. Assumptions, where required to interpolate national data for individual airport application, are identified and support rationale provided.

The candidate options for postponing airside saturation at high density air carrier airports have been analyzed in detail and are listed below. The analysis has addressed quantitative and qualitative advantages and disadvantages of each option, the feasibility of implementing each option and the hypothetical results of implementation of the alternative options at the selected test airports. The candidate options are:

- Modify air traffic control traffic handling procedures to increase airport capacity. This option includes: grouping of aircraft by performance characteristics to minimize required separation and maximize use of the runway configurations that give optimum capacity.

- Grouping of aircraft arrivals and departures in order to increase the number of aircraft operations that can be accommodated during heavy traffic periods.

- Restrict and/or inhibit use of the high density airport by certain categories of aircraft (e.g., single engine piston aircraft) or certain groups of users (e.g., training).

- Redistribute portions of the high density airport busy period demand to non-busy hours.

- Do nothing. That is, presume that no special efforts, beyond those that have been used in the past, are involved. In this case, the natural forces that come into play as a consequence of delays and inconveniences are considered.

A basic tenet in the evaluation of the candidate options was that the only changes that could be advocated were those that were in concert with the interests of aviation and acceptable to the aviation community. While the benefits and disadvantages to the non-aviation community are a consideration, the principal consideration has been how aviation would be affected by the change in aviation policies and procedures.

1.2 Summary of Findings.

Analysis of the five candidate options indicates that only marginal benefits can be expected from concerted efforts to alter aircraft mix and airport use patterns at high density airports. This conclusion is based on presumed consequences of hypothetically implementing candidate options at selected test airports. The "no change" option, i.e., a continuation of current policies, is expected to have generally the same effect on airport congestion and saturation as the new candidate policies that are aimed specifically at traffic mix solutions.

The latter policies offer significant potential benefits but their probable benefits suffer as a result of the practical problems associated with their implementation. The most severe deterrent to implementation was recognized as area saturation, i.e., the demand versus capacity relationships at nearby general aviation airports. It must be noted that the specific high density airport and its unique set of conditions define the probable effectiveness of these options; therefore the above conclusions are sensitive to the test airports selected for review in this study. Summary findings regarding each of the five options are presented below.

- Option 1 - Modification of current air traffic control handling procedures was determined to be an ineffective means of postponing saturation since the present system already exhibits an efficiency that is unlikely to be achieved in other ways.

- Option 2 - Grouping of aircraft arrivals and departures is also an ineffective means of postponing saturation. Its advantages are marginal at best and are significantly outweighed by the inherent problems associated with safety and scheduling.

- Option 3 - Restricting or inhibiting use of the high density airport by categories of user and/or aircraft is theoretically useful as a means of postponing saturation at the high density airport but its practicality is dependent on area saturation, i.e., saturation of the high density airport combined with local neighboring airports. Area saturation limits the probability of effectively relocating general aviation away from the high density airport. It was found that the expected time frame for area saturation often closely followed the saturation date of the high density airport.

- Option 4 - Redistribution of traffic demand to the less busy hours was assessed as having the least difficulties associated with implementation but it is considered only marginally effective as a means of postponing saturation. This is attributed to the limited alternative non-busy hours to which general aviation could be relocated and the currently experienced voluntary redistribution by general aviation. This voluntary redistribution appears to be stimulated by the rising cost and inconvenience of operating during busy hours.

- Option 5 - Continued application of existing aviation policy appears to be effective in alleviating the same problems that are addressed in options 1 through 4. Interviews with airport personnel and historical data both indicate that general aviation is responding to the rising cost and inconvenience of operating in a congested environment by adjusting their use patterns either way from the high density airports or toward periods of non-peak operations.

2. STUDY DETERMINANTS

Aviation statistics in the United States indicate an expanding public interest in aviation. It is reflected in the increasing use of airline transportation, the burgeoning growth in air taxi utilization and the expanding popularity of private and business general aviation aircraft as modes of transportation. Concurrent with this growth, a complex network of airports has been privately and publicly developed to support the increasing demand. Public officials and private citizens involved in aviation are aware that, as in the past, future growth in the national airport system must be based on early planning with particular attention being given to aviation's efficient use of America's resources. Extensive funds and effort are being expended at the federal, state and local levels for the development of comprehensive state airport system plans, airport master plans and environmental impact studies. It is only upon this foundation of comprehensive planning that continued public support and interest in aviation can be assured.

A necessary part of this planning process must be a periodic reassessment of long standing aviation policies and a reevaluation of trends and patterns of airport use which have been established over the years. This element is particularly important to aviation because it has undergone considerable change during periods of rapid growth. Several of the more significant changes are:

- The increasing congestion at high density airports. There are adverse consequences in the areas of safety, the environment, personal time loss and added cost to the airport user.

- The divergence in the nature of general aviation and air carrier aircraft. In the earlier days of aviation little difference could be noted between the two in terms of aircraft performance (speed, weight, energy consumption, noise) or even in terms of number of people carried per flight.

Now magnitude differences exist in both performance and number of people carried per flight.

- The growth in sophistication of avionics equipment used in both general aviation and air carrier aircraft.

A reassessment of long standing aviation policies, trends and patterns relative to airport use is doubly important at this time due to the growing public resistance to the building of new and the expansion of the existing public airports. This resistance has in the past and is continuing to be led by environmentalists and local citizen groups interested in preserving the quality of the local environment. While the initial interest of these citizen groups was focused on assuring that airport development planning gave full consideration to the maintenance of the quality of the local environment, with greater and greater frequency there is now a questioning of the actual need for expanding local airport systems. Fundamentally then, the question being raised is whether or not existing aviation policy, trends and patterns are in fact making the most efficient use of existing airport facilities.

This study effort is intended to answer part of the question for both the planner and the environmentalist. Specifically, the question to be answered by this study effort is: Are there ways, without capital expenditures, that the aviation community can, through more efficient use of the existing airport system, postpone the need for construction of new airport airside facilities? How long airport airside saturation can be postponed at the high density air carrier airport is the quantitative measure which may be used to evaluate the effectiveness of the alternative noncapital options addressed in this study.

Airport saturation, on the surface, appears as an easy-to-understand concept. That is, an airport is saturated when the existing airport facilities cannot accommodate all the aircraft operators who desire to use the facilities. The idea that this concept is simple may be quickly dispersed, however, when it is pointed out:

• That demand levels used in planning for expansion of existing or development of new airport facilities are forecasts and as such are only subjective estimates in the view of airport expansion opponents.

• That there are several hours each day, each week or each month when the airport is not near being fully utilized but that the airport is saturated because for 500 or 1,000 hours each year the airport is overly congested. That is, an airport that is fully utilized for only a portion of the time may be classified as saturated.

• That there are high density airports experiencing aircraft traffic congestion, while five, ten or twenty miles away there are adequate airport facilities with extensive excess capacity.

• That capacity of an airport is dependent on the type of aircraft using the airport. For example, an airport able to accommodate 100 aircraft operations per hour when only the smaller general aviation aircraft are involved, might accommodate only 70 operations per hour if the larger air carrier jet aircraft were mixed with the general aviation aircraft. This same airport might only handle 50 aircraft operations per hour if all operations were by air carrier type aircraft.

The defense of demand forecasts will always be a difficult problem. The current federal policy of continually refining and improving forecasting techniques, appears to be the most viable response. The time and resources expended in pursuit of better and more accurate forecasts are justified considering the important role that forecasts play in the planning process and the high cost of expanding airport systems.

Confusion surrounding airport and airport system capacity is directly traceable to the interrelationship of demand and capacity. The capacity of an airport cannot be determined without full consideration of all aspects of the airport user demand and of particular importance is the distribution of demand. The principal question appears to be, does available capacity determine demand and demand distribution or does demand distribution determine how much capacity must be provided? The study approach must therefore address:

- Is it feasible to redistribute demand from busy hours to non-busy hours or from congested airports to less busy local airports? and,
- If feasible, what are the full advantages and disadvantages associated with such a redistribution of demand? and,
- What policies or procedures can be implemented which would cause a redistribution of demand?

The current distribution of aircraft demand is also a function of the free intermixing of general aviation and air carrier traffic at airports. The practice is primarily a carry-over from earlier times when airport traffic of all sorts was light and consequently of little concern. At the time there was no logic in segregating traffic and with a precedent set and no pressing reason for a change, airports evolved into high density traffic terminals with both types of activity contributing to the congestion. This evolution period marked a significant divergence in the individual nature of general aviation and air carrier activity. Whereas in earlier times, little difference could be noted between the two in terms of aircraft performance, (speed, weight, energy consumption, noise) or even in terms of number of people carried per flight, orders of magnitude differences now exist. The air carrier industry, capitalizing on technology, has since become the significant common carrier in the country, employing aircraft capable of carrying hundreds of people at near sonic speeds. On the other hand, general aviation, without the drive for high performance aircraft, has changed at a much slower pace.

While this change has been taking place, there has been a considerable amount of growth in aviation resulting in substantial increases in the frequency with which aircraft use the airports. Consequently, congestion has become a major problem at certain airports. Its adverse consequences on safety, the environment and personal time loss, especially at air carrier airports, encourages scrutiny of the problem and ultimately leads to a questioning of whether or not general aviation and air carrier traffic should be mixed.

3. AIRPORT CAPACITY

The purpose of this paragraph is to briefly introduce the determinants of airport airside capacity and to define the role that airport airside capacity and its individual determinants play in this study effort.

As indicated in an earlier paragraph, a principal task in this study effort is to examine the effect that traffic mix parameters have on an airport's capacity. To that extent, this effort may be considered a capacity study. However, it must be stressed that capacity calculations performed in support of this effort are only approximations which have not been subjected to many of the extensive refinement techniques available for determining airport capacity. For this study, it sufficed to establish an approximate capacity of the selected test airport based on the airport's runway configuration and its current (1975 - 1976) traffic mix characteristics. The traffic mix parameters were then varied through their probable range of values to determine resultant changes in capacity. The minimal advantage to be gained from introducing refinements, such as wind rose calculations, did not warrant the extensive effort which would be required.

Airport capacity calculations were based on the methodology provided in FAA Advisory Circular 150/5060-1A Airport Capacity Criteria, dated July 8, 1968, and FAA Advisory Circular 150/5060-3A, Airport Capacity Criteria used in longrange planning, dated December 27, 1969.

Three different measures of airport airside capacity are normally developed, i.e., Practical Annual Capacity (PANCAP), VFR Weather Practical Hourly Capacity (VFR PHOCAP) and IFR Weather Practical Hourly Capacity (IFR PHOCAP). All three, which are discussed below, are based on acceptable average delays to aircraft operations. The guidelines provided in the above referenced FAA Advisory Circulars are that at an air carrier airport, a four minute average delay during the normal peak two hour period of the week for VFR departures, a one minute average delay for VFR arrivals and a four minute average delay for IFR arrivals and departures are acceptable delay levels. At general aviation airports the recommended acceptable average delay level is two minutes for arrivals and departures. The practical hourly capacities obtained in this manner are the aircraft operation rates which result in a selected average delay per aircraft for a given one hour period. Consequently, when the delay per aircraft is averaged over a year, in the determination of the PANCAP, then there will be hours in which the demand level exceeds the PHOCAP, resulting in higher average delay per aircraft operation during those busy hours.

An airport's VFR and IFR PHOCAPs are estimates of the number of aircraft operations that can be accommodated in one hour under a specific set of capacity determinants. Since the parameters used in calculating capacity are not constant throughout the day, week, month, or year, the calculated PHOCAPs must be addressed and treated as the practical, optimum and typical hourly capacities; that is, the IFR and VFR PHOCAPs calculated are:

- Optimum from the standpoint that runway configuration used in calculation of capacity is the most advantageous available at the airport for the weather conditions being addressed, i.e., IFR or VFR.
- Typical from the standpoint that traffic mix of aircraft by performance characteristics is constantly varying and the typical or average traffic mix is used in capacity calculations.
- Practical in that the capacity level is based on a practical (i.e., acceptable) average delay level.

The practical annual capacity of an airport is an extension of the PHOCAP with consideration given to the expected distribution of traffic demand through a typical day. No airport can or will operate at or near PHOCAP continuously, day and night, 365 days of the year. Consequently, an airport's calculated PANCAP is a ballpark estimate subject to the uncertainties of weather and changes in airport user demand patterns.

The following descriptions of airport capacity determinants contain statements regarding the way that the determinants have been used in this study effort.

- Aircraft performance characteristics. The performance characteristics of interest are aircraft landing and take-off distance/speed, weight, and degree of wake vortex turbulence generated. These factors contribute to determining an airport's capacity through their effect on;

- Required aircraft separation for safety. That is, greater separation between aircraft, with resultant less frequent operations, is required when heavy jet aircraft are followed by smaller aircraft.

- Runway occupancy time. The length of time that an aircraft occupies a runway is based on required landing and take-off distance and speed and will be a determinant in the number of aircraft operations that can be accommodated.

- Runway restrictions due to aircraft performance. Frequently, heavy air carrier aircraft are restricted from certain runways due to runway length and/or load restrictions. This affects the mix of aircraft that can be accommodated at the airport.

Aircraft are categorized according to performance characteristics in the following manner for use in capacity calculations:

Category A	- 4-engine jet and larger
Category B	- 2- and 3-engine jet, 4-engine piston, and turbo prop
Category C	- Executive jet and transport type twin-engine piston
Category D&E	- Light twin-engine piston and single-engine piston.

A list of the typical aircraft assigned to each category is given in Table 3-1. Additional discussion of the quantitative effects of varying the mix of aircraft by performance characteristics is provided as part of the Alternative Options Analysis in a later section of this report.

- Peaking factor. Peaking factor deals with the distribution of traffic through the day. The percentage of daily aircraft activity which occurs during the peak hour of the day (average for the two consecutive busy hours) is defined as the "peaking factor." This factor reflects the pattern of airport use by the different users, i.e., air carriers, air taxi, general aviation and military. The feasibility, advantages, disadvantages and potential methods for changing an airport's use pattern is a primary consideration of this report and is discussed in detail in Section 5.

- Training activity. The level of pilot training activity at an airport affects the airport's capacity since an aircraft touch and go or practice ILS approach is treated as two aircraft operations but does not occupy a runway or runway approach airspace as long as a completed arrival and departure. Consequently, the greater the ratio of training operations to total operations, the greater the airport capacity. In like fashion, however, if training activity is restricted or inhibited at an airport with a resultant reduction in this ratio, the actual capacity of the airport is lowered.

- Runway configuration. The runway configuration determinant includes the number of runways, the length of runways, the aircraft weight that runways will support and the runway layout, that is, whether aircraft traffic on one runway restricts or precludes aircraft operations on another runway. For purposes of this study, the runway layout combination that gives the maximum PANCAP and PHOCAP was used for capacity calculation. No effort was expended to determine what percentage of time each feasible layout combination is normally utilized. This would be an unnecessary and time-consuming refinement of

Table 3-1 **AIRCRAFT CLASSIFICATION**

TYPE	DEFINITION	EXAMPLES
A	4 Engine Jet and Larger	DC-10, L-1011, SST, 747, Convair 990, 880, VC-10, Etc.
B	2 & 3-Engine Jet, 4-Engine Piston, and Turbo-Prop	727, DC-9, BAL-111, Lockheed Electra, Constellations, DC-6, DC-7, Vanguard, Martin, Etc.
C	Executive Jet & Heavy Twin-Engine Piston	F-27, Lear Jet, Jet Commander, Beech 18, Etc.
D	Light Twin Engine Piston and High Performance Single-Engine Piston	Aero Commander, Apache, Queen Air, Cessna 310, Bonanza, Etc.
E	Light Single-Engine Piston	Cessna 150, 172, 183, Cherokee, Etc.

SOURCE: Airport Capacity Criteria Used In Long-Range Planning, December 24, 1969, DOT/FAA, AC 150/5000-3A.

capacity calculations and not appropriate for the purpose of this study effort.

- Runway exit and taxiway configurations. Runway exit and taxiway configuration is a capacity determinant since it affects how quickly arriving aircraft can vacate the runway for the next aircraft operation and also determines if taxiing aircraft will interface with an aircraft operating on a runway (e.g., taxiways that cross runways).

- Runway/airspace restrictions. Examples of this capacity determinant are noise abatement restrictions and natural or man-made obstacles that limit full use of a runway configuration.

- IFR approach aids. The number of runways equipped with IFR approach aids and, in those cases where there is more than one IFR equipped runway, whether or not independent aircraft operations can be conducted simultaneously, has been used in calculation of IFR PHOCAP.

- Weather. The frequency of IFR weather has been used in this study effort to determine if the IFR PHOCAP is the capacity limiter at the selected test airports.

- Ratio of arrivals to departures. The significance of this determinant is based on the required separation of aircraft on final approach. As an example, for a single runway configuration with a mix of 20 percent, 20 percent and 60 percent category D&E, C and B aircraft, respectively, the hourly runway capacity would be:

  - Departures only - 73 aircraft operations
  - Arrivals only - 55 aircraft operations
  - Mixed one for one arrivals and departures - 64 aircraft operations

(Ref. FAA AC 150/5060-1A)

The basic reason for this difference is that the required separation for arriving aircraft is larger than for departing aircraft. According to FAA AC 150/5060-1A, if the ratio of arrivals to departures during the peak hours of the week is .6 to 1.1, then this ratio need not be considered in capacity calculations. However, if the ratio is above 1.1, a capacity correction factor must be introduced. In all of the cases investigated in this study, the ratio during the busy hour has been at or slightly below 1.

4. SELECTED TEST AIRPORTS

Early in the planning of this study it was recognized that a fruitless effort would result from an attempt to develop a generalized solution which would be applicable to the typical high density airport. The many airport-unique factors associated with this effort prohibited the use of such "averaging" techniques. Consequently, the planned approach was to examine a set of airports on an individual (i.e., a case study) basis and subsequently assess whether certain types of solutions were common to more than one airport. Obviously, the airports selected for case study analysis would determine the degree of universality that could be associated with the study's conclusions and therefore an importance was placed on the selection process. In lieu of the fictitious "typical" airport then, airports that represented the spectrum of high density airports (and their characteristics) were chosen.

4.1 Test Airports.

The following is the list of airports selected as representative of the variety of nationwide high density air carrier airports. These airports were used in this study effort to test the feasibility and probable effects of implementation of the non-capital alternative options.

- Phoenix Sky Harbor International Airport (PHX)
  Phoenix, Arizona.
- San Diego International Airport (SAN)
  San Diego, California.
- San Jose Municipal Airport (SJC)
  San Jose, California.
- Denver Stapleton International Airport (DEN)
  Denver, Colorado.
- Fort Lauderdale-Hollywood International (FLL)
  Fort Lauderdale, Florida.
- Detroit Metropolitan Wayne County Airport (DTW)
  Detroit, Michigan.
- Cleveland-Hopkins International Airport (CLE)
  Cleveland, Ohio.
- Memphis International Airport (MEM)
  Memphis, Tennessee.
- Nashville Metropolitan Airport (BNA)
  Nashville, Tennessee.

percentages of 1975 traffic at the selected airports which are attributable to air carrier and general aviation local or itinerant traffic. The mix spectrum ranges from 13 percent air carrier, at San Jose Municipal, to 69 percent at Detroit Wayne.

PERCENTAGE OF TOTAL AIRCRAFT OPERATIONS (1975)

AIRPORT ID	AIR CARRIER	GENERAL AVIATION LOCAL	GENERAL AVIATION ITINERANT
SJC	13%	49%	36%
FLL	21%	26%	49%
PHX	21%	21%	54%
BNA	28%	12%	50%
MEM	36%	5%	48%
SAN	36%	17%	38%
CLE	50%	12%	26%
DEN	53%	5%	36%
DTW	69%	0%	26%

Table 4-2

4.2.3 Forecast Saturation.

Application of this criterion ensured that the selected airports would include both airports forecast for saturation in the 1976 to 1987 time frame as well as airports free from saturation considerations. Using the FAA Terminal Area Forecast (TAF) for 1976 - 1987 as the source document, four of the nine selected airports are forecast for airside saturation during this period.

4.2.4 Terminal and Transfer Points.

The objective of this criterion was to ensure the selection of a mix of terminal and transfer airports. A terminal airport is defined as one which predominantly serves only

4.2 Test Airport Selection Criteria.

The non-capital alternative options for postponing saturation at high density airports have been chosen and evaluated based on their potential for broad application at high density airports nationwide. Consequently, in developing and applying the selection criteria for choosing test airports, the principal consideration has been that the airports represent examples of the variety of high density air carrier airports. The following subsections discuss selection criteria.

4.2.1 Airport Traffic Growth.

The objective of this criterion was to select airports with a variety of growth patterns. Table 4-1 shows the traffic growth, relative to 1961, for the selected airports. As evident, the range of values (i.e., traffic growth percentages) is quite wide for all three categories, that is, 5 percent to 221 percent, 3 percent to 300 percent and -33 percent to 208 percent for total traffic, air carrier traffic and general aviation traffic, respectively.

Table 4-1 PERCENTAGE GROWTH 1961 THROUGH 1975

AIRPORT ID	TOTAL TRAFFIC	AC TRAFFIC	GA TRAFFIC
CLE	5%	3%	4%
DEN	44%	115%	0%
DTW	50%	193%	-33%
PHX	50%	62%	48%
SAN	68%	87%	62%
LNA	72%	51%	103%
MEM	92%	102%	83%
FLL	120%	240%	91%
SJC	221%	300%	208%

4.2.2 General Aviation and Air Carrier Traffic Mix.

The objective of this criterion is to ensure that the selected airports exhibit a wide range of air carrier and general aviation mix, allowing measurement of the effectiveness of the alternative options through the mix spectrum. Table 4-2, shows the departing and arriving airline passengers, i.e., beginning or ending the airline portion of their travel; on the other hand, a transfer airport services a high percentage of interconnecting passengers. San Diego International Airport is a prime example of a terminal airport with little passenger transfer between planes while Denver Stapleton International Airport is an excellent example of a transfer airport with a significant number of interconnecting passengers. Five of the nine selected airports are terminal airports. This criterion was chosen based on the expectation that the type of airport (transfer or terminal) may affect the aircraft traffic distribution at the airport.

4.2.5 Other Criteria.

Reliever Airport Availability. The availability of alternative airports in the vicinity of the high density air carrier airport is a factor considered in the analysis of the noncapital alternative options. Consequently, this selection criterion has been used to ensure that the selected test airports reflected instances where relievers were or were not likely to be effective in accommodating traffic overflow.

Geographical distribution. The objective of this criterion was the selection of test airports with varying types of weather so that the effect of IFR flying could be examined. The Western, Southern, Great Lakes and Rocky Mountain Regions are represented in the selected set of airports.

4.3 Selected Test Airport Data Base.

Three principal sources of data have been used in the development of the data base for the selected test airports. Where feasible, data has been cross-checked between sources to ensure that the most current and accurate data is used in this study effort. The data sources are:

- FAA Documentation. This includes both statistical data such as the Annual Air Traffic Activity Report and guidance documents such as the FAA Advisory Circulars dealing with airport airside capacity calculations. A complete list of the FAA documentation used in support of this study effort is provided at the end of this report.

- Independent contractor studies. During the course of airport visits, numerous airport master plans, state airport system plans, and airport related environmental studies were collected. The data contained in these documents have been used as a secondary source, that is, for cross checking of other data sources. The independent contractor studies available for reference during the course of this study effort are identified in the source documentation list referenced above.

- Interviews with airport personnel. Site visits were made at each of the selected test airports and interviews were conducted in support of this study effort with the airport manager's office and the FAA airport tower chief. Information collected from these interviews is synopsized later in this section.

The following is a brief explanation of the selected test airport data base. It should be noted that due to the large volume of data compiled on the selected test airports, only a sample of each table and figure is provided in the body of this report with the full set of data being provided in the Data Base Appendix at the end of this report.

4.3.1 General Airport Data.

Table 4-3 is a tabulation of certain quantitative and qualitative data on Fort Lauderdale-Hollywood International Airport and selected local airports surrounding this high density air carrier airport. This table is a sample with the complete set of nine tables, one for each of the selected test airports, provided in the Data Base Appendix. The Table 4-3 format was chosen to document a variety of data which was required to analyze the alternative options for postponing airport saturation. The following paragraphs further clarify Table 4-3.

GENERAL AIRPORT DATA

FOR

FT. LAUDERDALE - HOLLYWOOD & SELECTED NEIGHBORING AIRPORTS

ITEM NO.	DATA SUBJECT			
1.	Airport Name	FT. LAUDERDALE-HOLLYWOOD	FT. LAUDERDALE EXECUTIVE	NORTH PERRY
2.	Dist. From HUB A/P	N/A	8 Miles North	8 Miles Southwest
3.	Normal Runway Configuration	2 Parallel 8,054' 3,201' 6,020' Config P	3 Intersecting 6,000' 4,000' 4,000' Config M	4 Parallel 3,050' 3,003' 3,068' 3,000' Config A + B
4.	Tower Approach Aid	Yes Precision	Yes Non Precision	Yes None
5.	Public/Private	Public	Public	Public
6.	Air Space Control	TRSA Stage III	TRSA Stage I	None
7.	Aircraft Mix (Traffic)	A - 3% B - 15% C - 12% D&E - 70%	C - 10% D&E - 90%	D&E - 100%
8.	VFR PHOCAP	190	175	300
9.	IFR PHOCAP	96	14	—
10.	PANCAP (000)	500	375	600
11.	Based Aircraft	S.E. - 291 M.E. - 154 JET 6 TOTAL 451	S.E. - 158 M.E. - 40 JET 6 TOTAL 204	S.E. - 183 M.E. - 30 TOTAL 213

TABLE 4-3 Sheet 1

GENERAL AIRPORT DATA

FOR

FT. LAUDERDALE - HOLLYWOOD & SELECTED NEIGHBORING AIRPORTS

ITEM NO.	DATA SUBJECT		
1.	Airport Name	POMPANO BEACH	OPA LOCKA
2.	Dist. From HUB A/P	12 Miles North	14 Miles South
3.	Normal Runway Configuration	3 Intersecting 4,400' 4,025' 3,500' Config M	5 Parallel 8,000' 3,300' 3,756' Config H 3,500' 3,280' 5,170'
4.	Tower Approach Aid	Yes Non Precision	Yes Non Precision
5.	Public/Private	Public	Public
6.	Air Space Control	TRSA Stage I	TRSA State I
7.	Aircraft Mix (Traffic)	D&E - 100%	C - 10% D&E - 90%
8.	VFR PHOCAP	175	390
9.	IFR PHOCAP	61	61
10.	PANCAP (000)	375	770
11.	Based Aircraft	S.E. - 101 M.E. - 23 TOTAL 125	S.E. - 392 M.E. - 126 JET - 9 TOTAL 529

TABLE 4-3 Sheet 2

• Airports (Item No. 1). This data (neighboring airports) was used to assess the availability of nearby airports and the likelihood that users might relocate to a local neighboring airport, that is, to stop or reduce their use of the high density air carrier airport.

• Distance from HUB Airport (Item No. 2). This data item includes the distance in statute miles and direction of the local neighboring airports from the related high density air carrier airport.

• Normal runway configuration (Item No. 3). Included in this data item is the length of each airport runway and a description of the runway configuration used in the estimation of airport airside capacity. Unless otherwise indicated, the runways identified are paved. The codes used in this table to identify an airport's runway configuration (e.g., A, B, or A&B) are explained in the FAA Advisory Circular 150/5060-3A, dated December 27, 1969.

• Tower/Approach Aids (Item No. 4). These data items indicate the availability of certain aviation support facilities and equipment. This data is used in two ways. The facilities/ equipment availability will determine at which airports certain operations can be performed (e.g., practice instrument landing system (ILS) approaches, IFR weather landings). Also, support facilities will contribute to the user's choice of an alternate local airport at which to operate. The following is a brief explanation of the entries in Table 4-3 for these items.

Tower. The "yes" entry indicates that there is an air traffic control tower located at the subject airport and that, consequently, the airport tower related services are available to the airport user.

Airport Approach Aids. Possible table entries are precision, non-precision and none. The meanings of these entries are "Precision": indicates that electronic precision equipment is available at the subject airport, for example, an instrument landing system (ILS) or precision approach radar; "Non-precision": indicates that a standard instrument approach procedure, in which no electronic glide scope is provided, is available at the subject airport, for example, very high frequency omnidirectional range station (VOR), tactical air navigation station (TACAN), non-directional beacon (NDB) or localizer.

- Public/Private (Item No. 5). This item indicates whether the airport is publicly or privately owned. All airports addressed in this study effort are open for public use.

- Airspace Control (Item No. 6). This item identifies the level of control which has been assigned by the FAA to the airspace in the immediate vicinity of the airport. The entries in this table indicate the level of control assigned in excess of basic rules prescribed for airport traffic areas. The possible entries in this table item are:

  - None. Indicates that no additional control beyond those prescribed for airport traffic areas are in effect.

  - TRSA Stage I, II or III. Indicates the availability of terminal radar service stage I, Stage II, or Stage III. Stage I/Radar Advisory Service for VFR Aircraft: provides traffic information and limited vectoring to VFR aircraft on a workload permitting basis. State II/Radar Advisory and Sequencing for VFR Aircraft: provides, in addition to State I service, vectoring and sequencing on a full-time basis to arriving VFR aircraft. The flow of arriving IFR and VFR aircraft into traffic pattern is adjusted and traffic advisories are given to departing VFR aircraft. Stage III/Radar Sequencing and Separation Service for VFR Aircraft: provides, in addition to State II services, separation between all participating aircraft. Separation is provided between all participating VFR aircraft and all IFR aircraft operating within the airspace.

  - Terminal Control Area (TCA) Group I or II. Airports designated as Terminal Control Areas have more extensive operating rules and requirements than are normally prescribed for airport traffic areas. Regardless of weather conditions, ATC authorization is required prior to operating within a TCA. Additionally, certain requirements (with minor exceptions and waivers) must be met in order to operate in a TCA. Included among these requirements are, for Group I TCA, a two-way radio capable of communicating with ATC on appropriate frequencies, a VOR or TACAN receiver, a 4090 code transponder with mode C automatic altitude reporting equipment, and a private pilot certificate or better. For Group II TCA, principally the same as Group I with the exception that a private pilot certificate and mode C automatic altitude reporting equipment are not required.

- Aircraft traffic mix (Item No. 7). This data item identifies the percentage mix of category A, B, C, and D&E aircraft that normally operate at each of the airports. The aircraft traffic mix data has been included for use in estimating airport airside capacity. While extensive effort has been expended to refine the estimates of aircraft traffic mix at the selected test airports, the aircraft traffic mixes for the local neighboring airports are approximations developed using the composition of the based aircraft fleet, annual aircraft traffic data and runway use limitations (e.g., aircraft weight restrictions) in force at the individual airports. The accuracy of the approximation technique used for the neighboring airports is adequate for the purposes for which the data is employed in this study effort.

- VFR PHOCAP, IFR PHOCAP and PANCAP (Items 8, 9, and 10). These estimates of airport airside capacity have been developed using the methodology provided in FAA published capacity estimating guidance documents (i.e., FAA AC 150/5060-1A and AC 150/5060-3A). The capacity estimates for the local neighboring airports are entirely based on runway configuration, estimated aircraft traffic mix and available information on runway use restrictions.

● Based aircraft (Item No. 11). S.E. and M.E. indicate single engine and multi-engine piston drive aircraft, respectively.

4.3.2 Traffic Demand Levels.

Table 4-4 contains the individual and cumulative aircraft traffic demand levels for the Fort Lauderdale-Hollywood International and selected local neighboring airports for the years 1975 (actual), 1982 (forecasted) and 1987 (forecasted). Similar data for the other airports are provided in the Data Base Appendix. This aircraft traffic demand level data is used in conjunction with the data discussed in paragraph 4.3.1 to estimate the expected resistance of certain airport users to relocate to neighboring airports. The aircraft traffic levels for individual airports have been extracted directly from the FAA 1976-1987 Terminal Area Forecast when provided. For those airports not specifically addressed in the TAF, the FAA forecast of general aviation growth rates by state have been used to estimate 1982 and 1987 traffic levels. (Reference Table 4-5). In those cases where airport saturation is forecast to occur prior to 1987, the expected traffic levels, if the airport's airside demand was not capacity constrained, have been used. The 1982 and 1987 military aircraft traffic levels have been held constant at all airports at the 1975 traffic level. This forecast of no change in military aircraft traffic levels at public airports is in accordance with the FAA recommendation provided in Advisory Circular 150/5070-5, Planning The Metropolitan Airport System, dated May, 1970.

4.3.3 Aircraft Traffic Mix.

Table 4-6 is a consolidation of aircraft mix data for the nine selected test airports. This data is used in the evaluation of the probable effectiveness of the candidate options in postponing saturation at the test airports. The elements of Table 4-6 are:

Table 4-4

FT. LAUDERDALE - HOLLYWOOD AND NEIGHBORING AIRPORTS

AIRCRAFT OPERATIONS DEMAND LEVELS

AIRPORT NAME	ACTUAL LEVELS 1975 OPERATIONS (000)						FORECAST LEVELS 1982 OPERATIONS (000)						1987 OPERATIONS (000)					
	TOT	AC	AT	GAL	GAI	MIL	TOT	AC	AT	GAL	GAI	MIL	TOT	AC	AT	GAL	GAI	MIL
FT. LAUDERDALE - HOLLYWOOD	331	68	16	85	160	2	540	88	35	141	274	2	700	103	62	176	357	2
FT. LAUDERDALE EXECUTIVE	179	0	0	109	70	0	249	0	0	146	103	0	339	0	0	208	131	0
NORTH PERRY	225	0	0	149	76	0	314	0	0	202	112	0	426	0	0	284	142	0
POMPANO BEACH	157	0	0	93	64	0	217	0	0	123	94	0	297	0	0	178	119	0
OPA LOCKA	429	0	0	217	200	12	700	0	0	357	331	12	774	0	0	329	433	12
TOTAL	1321	68	16	653	570	14	2020	88	35	969	914	14	2536	103	62	1175	1182	14

TOT - Total Aircraft Operations, AC - Air Carrier Operations, AT - Air Taxi Operations
GAL - General Aviation Local Operations, GAI - General Aviation Itinerant Operations
MIL - Military Aircraft Operations

Table 4-5 **FORECAST GENERAL AVIATION AIRCRAFT OPERATIONS GROWTH RATE**

(FOR AIRPORTS NOT ADDRESSED IN THE FAA TAF)

	ITINERANT OPERATIONS		TOTAL OPERATIONS	
	1987 Operations / 1975 Operations	'75 to '87 % Annual Growth Rate	1987 Operations / 1975 Operations	'75 to '87 % Annual Growth Rate
Arizona	2.50	8%	2.19	7%
Arkansas	2.63	8%	2.36	7%
California	1.43	3%	1.14	1%
Florida	2.22	7%	1.80	5%
Michigan	1.50	3%	1.30	2%
Mississippi	1.89	5%	1.97	5%
Ohio	2.25	7%	2.09	6%
Tennessee	1.31	2%	1.11	1%
Colorado	3.93	12%	3.55	11%

SOURCE: Federal Aviation Administration Terminal Area Forecast (TAF) for 1977 - 1987 (FAA-AVP-76-5), dated January, 1976.

Table 4-6

AIRCRAFT TRAFFIC MIX DATA

FOR THE SELECTED TEST AIRPORTS

AIRPORT	TRAFFIC MIX BY CATEGORY OF AIRCRAFT: TOTAL TRAFFIC	AIR CARRIER	GENERAL AVIATION	APPROX. CONTRIB. OF BASED AIRCRAFT TO GA ITINERANT TRAFFIC: % OF GA ITINERANT
PHOENIX SKY HARBOR	A= 9% C= 5% B=13% D&E=73%	A=41% B=59%	C= 5% D&E=95%	60%
SAN DIEGO LINDBERGH	A=11% C=11% B=27% D&E=51%	A=30% B=70%	C=13% D&E=87%	12%
SAN JOSE MUNICIPAL	B=12% D&E=83% C= 5%	B=100%	C= 6% D&E=94%	60%
DENVER STAPLETON	A= 8% C=10% B=48% D&E=34%	A=15% C= 2% B=83%	B=12% C=17% D&E=71%	50%
FT. LAUDERDALE HOLLYWOOD	A= 3% C=12% B=15% D&E=70%	A=25% B=75%	C=13% D&E=87%	60%
DETROIT METRO WAYNE	A=15% C=12% B=50% D&E=23%	A=21% C= 5% B=74%	C=30% D&E=70%	40%
CLEVELAND HOPKINS	A= 8% C=13% B= 42% D&E=36%	A=15% C= 6% B=79%	C=25% D&E=75%	60%
MEMPHIS INTL'	A= 2% C= 8% B=35% D&E=55%	A= 4% C= 0% B=96%	C=10% D&E=90%	50%
NASHVILLE METRO	B=25% D&E=68% C= 7%	A= 0% C=11% B=89%	C= 5% D&E=95%	30%

- Composite aircraft mix for the test airports (same data as provided in Table 4-4, Item No. 7).
- The general aviation and air carrier aircraft mixes for each of the test airports. It is noted that at each of the high density airports addressed in this study, the aircraft mix estimates used for air taxi and military operations have been 20 percent category C and 80 percent category D&E for air taxi and 40 percent category B, and 60 percent category C for military.
- The percentage of itinerant general aviation operations attributable to aircraft based at the airport. These estimates have been developed using available data on the number of based aircraft and aircraft traffic levels in 1975 in conjunction with a national estimate of the number of itinerant operations per based aircraft. (Reference Report No. FAA-AVP-76-7).

4.3.4 Historical and Forecast Traffic Levels.

Figure 4-1 depicts the historic and forecast levels of airport traffic at Fort Lauderdale-Hollywood International Airport for the years 1961 through 1987. The complete set of figures for the nine selected test airports are provided in the Data Base Appendix. The data has been presented in two ways; i.e., based on number of aircraft operations and based on percentage contribution of each category of user.

4.3.5 Hourly Traffic Distribution

Figure 4-2 identifies the hourly distribution of aircraft traffic at Fort Lauderdale-Hollywood International Airport during a normal day. Similar figures for all nine selected test airports are provided in the Data Base Appendix. This data is used in the analysis of the feasibility and expected effectiveness of redistributing demand away from the busy hours.

Figure 4-1

FORT LAUDERDALE-HOLLYWOOD AIRPORT

AIRCRAFT TRAFFIC

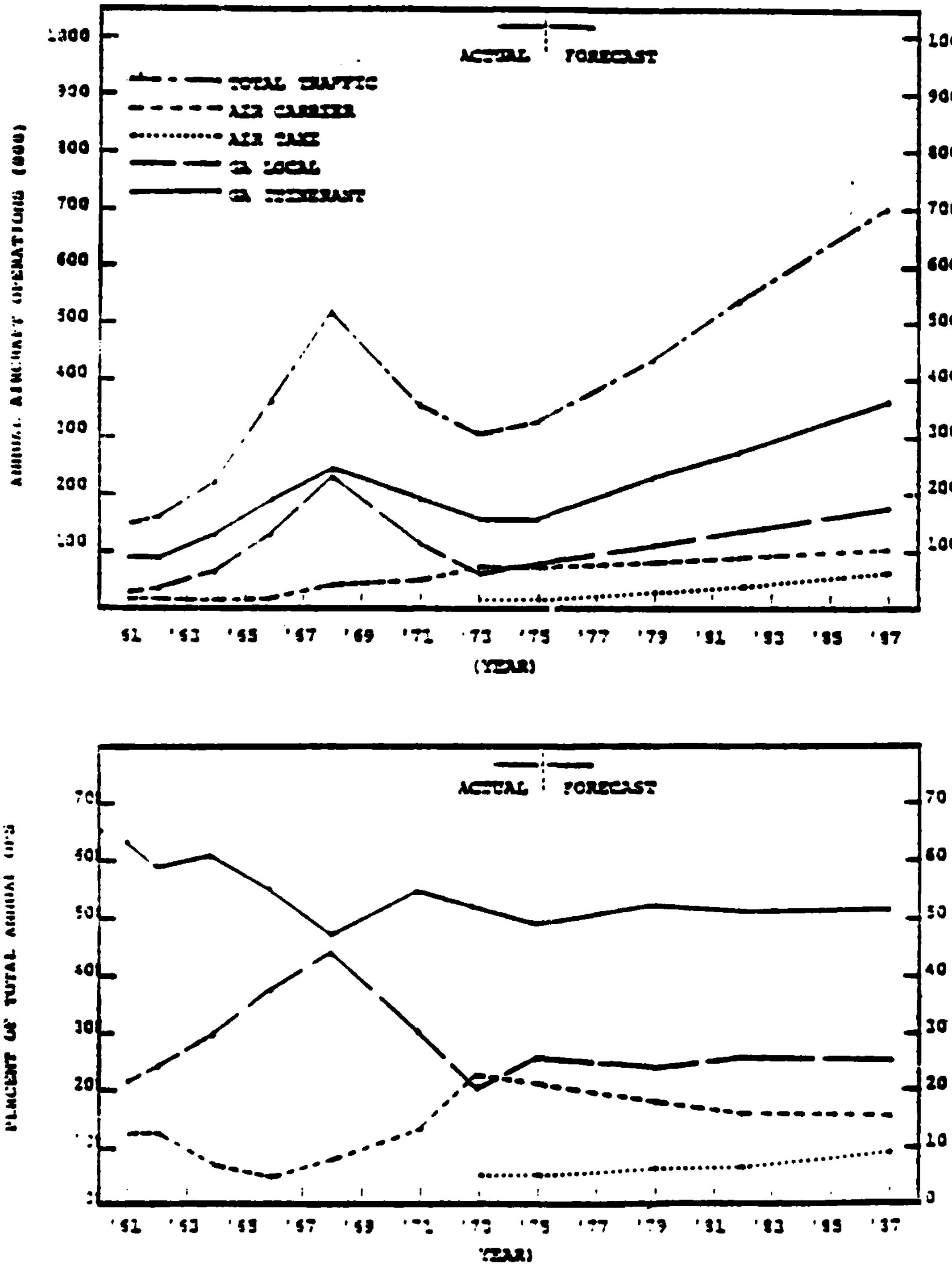
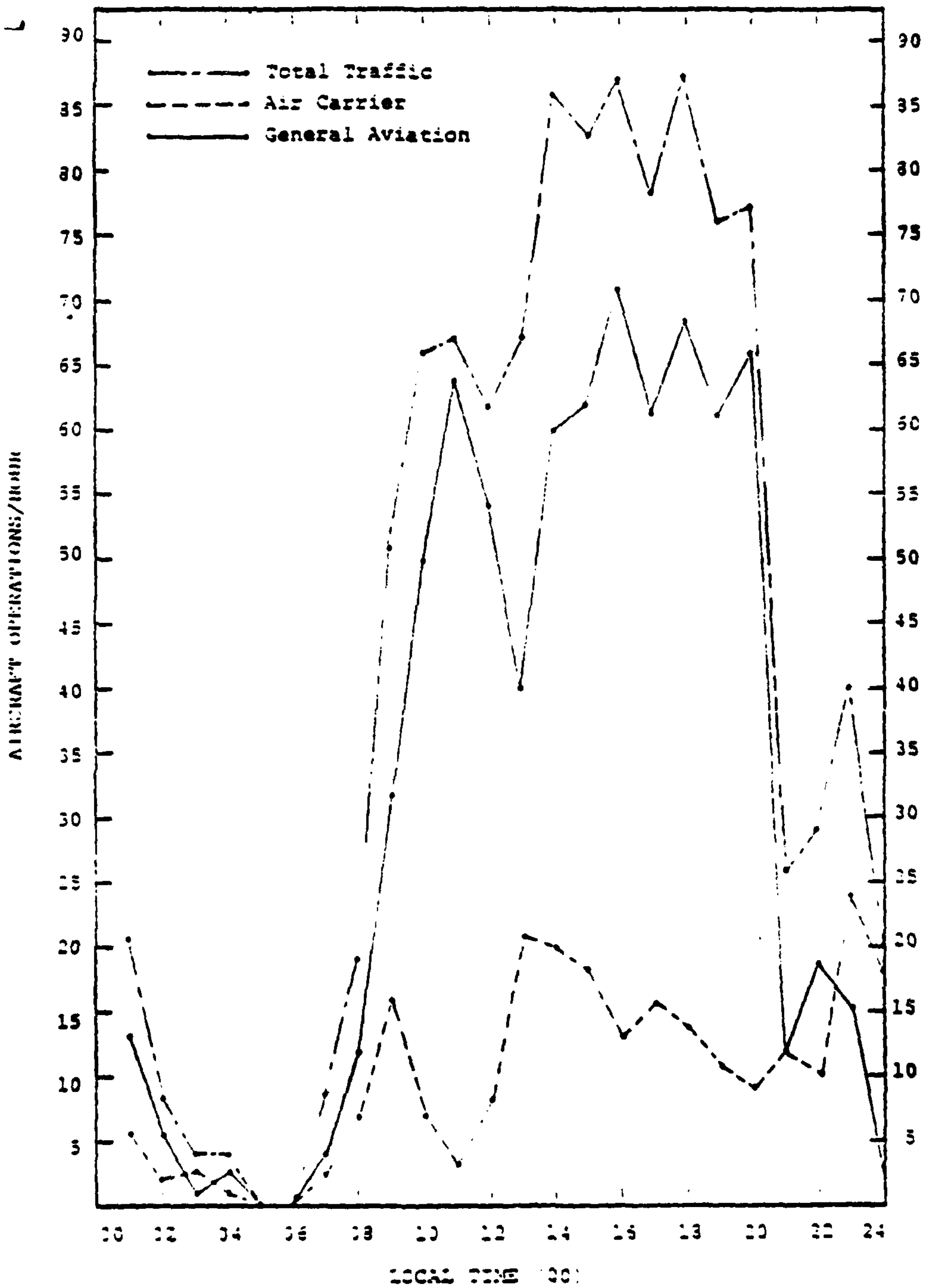


Figure 4-2 SAMPLE TRAFFIC DISTRIBUTION

FORT LAUDERDALE-HOLLYWOOD AIRPORT



4.3.6 Interviews with Airport Personnel.

The following is a synopsis of relevant inputs to this study effort acquired via interviews with airport personnel. Not included in this synopsis is data, such as hourly traffic distribution data, which has been incorporated into the Data Base Tables.

- Phoenix Sky Harbor Airport. Airport personnel indicated that existing airport capacity will be reduced as a result of a planned installation of a new air carrier terminal building (a new runway is also planned). The expected reduction in airside capacity appears to be principally tied to the need, under new terminal configuration, to mix the heavier air carrier and general aviation aircraft traffic with the lighter general aviation aircraft on both of the parallel runways. Currently, light and heavy aircraft can be segregated to different runways. It was the opinion of certain airport personnel that general aviation aircraft traffic would lessen as a natural process with the intermixing of heavy and light aircraft on both parallel runways and that additional reduction in general aviation traffic (displacement to other airports) could be induced through airport regulation of traffic. Tie-down space is limited and would be reduced with the planned airport expansion project. Airspace congestion in the Phoenix area can effectively be controlled through airspace management. Airspace congestion will not appreciably affect airport capacity in the foreseeable future. Airport personnel additionally stated that local traffic is virtually all training oriented, that is, touch and go operations or practice ILS approaches. The daily distribution of general aviation traffic varies significantly from season to season. During the hotter summer months, traffic peaks about noon and drops sufficiently in the afternoon, while during the winter months the traffic level peaks about 2:00 p.m.

• San Diego International Airport. Airport personnel indicated that the level of traffic was not a current or impending problem at this airport. It was felt that the general aviation traffic level was quite low and would not grow appreciably due to the fine general aviation airports in the vicinity of San Diego. While in 1975 there were 33,000 general aviation local operations, only about 10 percent were touch and go operations. The remainder were practice ILS approaches performed on runway nine on a non-interference basis with arrivals and departures. Aircraft arrivals are principally performed on runways twenty-seven and thirty-one. However, currently San Diego International Airport possesses the only ILS system in The San Diego area and if an ILS is not installed at one of the local general aviation airports, the availability of this airport to support practice ILS approaches on a non-interference basis will diminish as aircraft traffic levels continue to grow. It was the opinion of airport personnel that the future GA traffic level would not inhibit air carrier traffic or contribute significantly to airport congestion. However, if a GA/AC traffic mix should be a cause of congestion, it was felt that the introduction of a small landing fee would be effective in reducing general aviation traffic. Current inhibitors to general aviation traffic growth at San Diego International Airport are: as an air carrier airport, there are required security precautions which prevent the general aviation pilot from driving his car to his airplane tie down position, the increasing number of wide body air carrier aircraft and the high tie down fees which are approximately three times what is charged at the local general aviation airports. Additionally, there is a curfew imposed at this airport from midnight till 6 a.m. year round. This, to a small extent, limits the general aviation pilot's flexibility. The one exception to this curfew is that FAR Part 36 aircraft may land. A recent airport study indicates that IFR weather occurs less than 1 percent of the time.

• San Jose Municipal Airport. Airport personnel indicated that general aviation pilots operating at San Jose Municipal Airport are extremely sensitive to any change in airport operating policies and/or procedures which inhibit or restrict general aviation operations at this airport. This may be attributed to two things; the fact that San Jose Municipal Airport has historically been principally a general aviation airport with air carrier use only growing in significance in the past 10 years, and that there are few attractive alternative airports in the local area for general aviation operations to relocate. This limitation in attractive alternative airports for general aviation use is reflected in the five year waiting list for airport tie downs. There are currently 18 fixed base operators and 41 flying clubs located here. Airspace is a critical issue at this airport, with the problem being made more difficult by noise abatement requirements. It was the opinion of certain airport personnel that air carrier traffic would expand only if the noise issue is resolved.

• Denver International Airport. All of this airport's local aircraft operations are air carrier training operations which are conducted during the night, i.e., midnight to 6:00 a.m. General aviation training operations have been relocated to local neighboring airports. This decision by general aviation to relocate training operations is attributed to the extensive delays which are otherwise encountered at this high density air carrier airport. Jefferson County presently has, and Arapahoe County Airport will soon have an instrument landing system to accommodate general aviation practice ILS approaches. Airport personnel indicated that there was a significant shift of general aviation traffic to Arapahoe County Airport in the 1968 to 1970 time frame. This shift was due in part to efforts by Arapahoe County to attract the general aviation business and the desire of certain elements of general aviation to divert their operations away from the high density air carrier airport. Public officials in the Denver area are currently investigating the feasibility of constructing another general aviation airport southwest of the city. Certain airport personnel feel that the construction of this new airport will significantly reduce general aviation traffic at Denver. Airspace congestion is a problem in the Denver area. This problem is magnified by the mountains, location of residential areas and the proximity of airports equipped with instrument landing systems.

- Fort Lauderdale-Hollywood International Airport. A majority of the aircraft traffic at this airport use the two independent parallel runways. General aviation traffic principally uses the shorter parallel runway while air carrier aircraft operate on the other. Length constraints limit air carrier aircraft from operating on the shorter parallel runway. Use of the intersecting runway (13/31) is limited due to noise abatement restrictions. All jet and four-engine piston aircraft must arrive and depart over water due to noise restrictions. Airspace congestion is not now, nor forecast to be a problem; however, the airspace buffer zone required for this airport intrudes into the airspace required for VFR flight tracks at North Perry Airport causing a slight capacity constraint at both airports. There is virtually no IFR weather at this airport. Military traffic contribution to airport operations is insignificant and principally occurs during nonbusy periods. Local aircraft operations at this airport are virtually all training flights. According to airport personnel, practice ILS approaches account for 40 percent of local operations with the remainder being touch and go training operations.

- Memphis International Airport. General aviation and air carrier aircraft operations are segregated and virtually independent at this airport. The normal runway configuration use pattern employs runways 35L/R for air carrier operations and the remaining runways for general aviation operations. All local operations at this airport are practice ILS operations. While a number of flying schools continue to be located at Memphis, the related touch and go training operations are conducted at local neighboring airports. Transient general aviation traffic makes a significant contribution to this airport's general aviation itinerant traffic level. This is principally attributed by airport personnel to the strategic geographical location of Memphis which makes it an excellent refueling spot for the east-west and north-south general aviation traffic and the excellent quality of fixed base operator services provided. Additionally, itinerant aircraft operations are given priority over local operations by air traffic control for arrival and departure sequencing. The number of based aircraft has and is expected to remain constant. Airport personnel made the observation that both the based aircraft and transient general aviation aircraft contain more sophisticated avionics than the national general aviation fleet average with a disproportionate number IFR equipped. Additionally, there are ten corporate jets based at this airport. While it was felt by airport personnel that there was not a current need to reduce general aviation traffic at this airport, GA traffic would likely be reduced 20 percent if terminal control area operating procedures were to be implemented.

- Nashville Metropolitan Runway. Air carrier and general aviation jet aircraft operations are segregated from the smaller single and twin engine general aviation aircraft with the former using the longer parallel runway (2L/20R). The third runway (13/31) is principally used from 7 p.m. to 5 a.m. for noise abatement. Airspace congestion is not currently or forecast to be a problem for this airport. Virtually all local operations are practice ILS approaches. Huntsville Airport, 100 miles away, is the closest alternative facility with an ILS. While flight training schools continue to be located at this airport, the related touch and go training operations are conducted at Smyrna Airport. Six C130 military air national guard aircraft are based here but, as a rule, operate during non-busy hours. A new fixed based operator at this airport is currently trying to attract transient business/executive aircraft traffic at this airport. It was the opinion of certain airport personnel that corporate/business general aviation aircraft are becoming the predominant part of the based aircraft fleet and will be virtually the only general aviation based aircraft by 1990.

- Detroit Metropolitan Wayne Airport. The principal runways used at this airport are the two parallel runways which are separated by 4,400 feet. Approximately 70 percent of air carrier traffic and 10 percent of general aviation traffic use the longer parallel runway (3L/21R) while the remaining 30 percent AC traffic and 90 percent GA traffic use runway 3R/21L. Judicious use of the two parallel runways isolates the larger air carrier aircraft from the other aircraft. There is no local general aviation traffic at this airport and GA itinerant traffic is expected to remain constant. Less than 5 percent of the GA traffic is estimated to be pleasure oriented. Virtually no military operations occur at this airport. Growth of general aviation is discouraged at this airport by a freeze on expansion of general aviation facilities and the high tie down and landing fees. Fixed base operators have recently given up 30 tie downs due to lack of demand. Airport landing and use fees do not apply to based aircraft. The fees are based on maximum allowable landing weight with the commercial aircraft fee being twice that charged private aircraft of the same weight. Fees for private aircraft ranges from $1.50 for aircraft 0-3,000 lbs. to $.50/thousand pounds for aircraft in excess of 200,000 lbs. T-hangar and tie-down fee rentals range from $56 (870 sq. feet) to $120 (1,500 sq. feet) and $19 (0-3,000 pounds) to $600 (75,001 - 100,000 pounds), respectively. The private aircraft rates are 25 percent higher than commercial rates. IFR weather at this airport occurs 6 percent of the time.

- Cleveland Hopkins International Airport. The normal runway configuration used at this airport is two close parallel runways with air carrier and general aviation aircraft using both runways. Noise abatement is a local problem, but does not impact airport capacity. There is no curfew at this airport. Virtually all local operations are touch and go training operations. Approximately 90 percent of the local operations are performed on a turf runway; this activity is almost always independent of the traffic occuring at the other runways. Virtually no practice ILS approaches are performed at Cleveland Hopkins International Airport. Due to delays at this airport, practice ILS approaches are conducted at Burke Lakefront and Cuyahoga County Airports. IFR weather occurs approximately 13 percent of the time at this airport.

5. ANALYSIS OF THE ALTERNATIVE OPTIONS

The data presented in the previous section makes it possible to examine in detail the feasibility, advisability, advantages and disadvantages of implementing the candidate options for alleviating congestion at high density air carrier airports. It should be noted that the candidate options are not independent. That is, the advantages and disadvantages of implementing more than one of the options are not the cumulative result of implementing individual options. The data base used in the analysis of the selected test airports is provided in the Appendix to this report.

The five candidate options are individually addressed in paragraphs 5.1 through 5.5.

5.1 Option 1 - Modify air traffic control traffic handling procedures to increase airport capacity.

This was chosen as a candidate option for postponing airport airside saturation because of the strong influence that air traffic handling procedures can have on the airport capacity determinants. The principal capacity determinants affected by ATC practices/procedures are airport runway configuration and aircraft traffic mix by performance characteristics. It is noted that while modification (lowering) of aircraft separation requirements would affect capacity positively, the evaluation of this aspect of aircraft traffic handling is outside the scope of this study and has not been addressed.

The investigation of the current ATC practices and procedures relating to the relevant capacity determinants indicates that airport capacity would not be increased through modification of existing practices and procedures; ATC is acquiring maximum effectiveness of existing airport facilities through knowledgeable and conscientious application of the existing ATC aircraft traffic handling practices and procedures. The above conclusions are based on the following:

• Each airport is unique, both in its runway layout and traffic mix parameters and that to gain maximum effectiveness from each individual airport, the airport's ATC personnel must establish aircraft handling practices that take into consideration the unique characteristics of the individual airport, the airport users and the immediate conditions in the vicinity.

• While current federal aviation regulations dictate certain minimum safety requirements relative to aircraft traffic handling, they allow sufficient flexibility to the individual airport ATC centers and personnel to establish and exercise traffic handling procedures that maximize the effectiveness of the related facilities.

• Air traffic control personnel are cognizant of the important role they play in determining how effectively an airport is used and are conscientious in the performance of their duties.

The accuracy of the above premises was verified during the interviews conducted with air traffic control personnel during the airport visits performed in support of this study effort. The ATC personnel interviewed were proud of the role they play and were extremely concerned that they provided the best support feasible to the aircraft using their services and facilities. In all cases, site personnel were fully aware of those aspects of their job that could impact the effectiveness of airport operations and were quick to point out local practices and procedures employed to maximize their effectiveness in providing smooth, fast and safe traffic flow.

The following is a brief discussion of the capacity determinants affected by ATC aircraft handling procedures and typical ways that the local ATC personnel deal with these determinants.

The runway layout at the individual airports determines the complexity of the task of choosing the optimum runway configuration to be used in any situation. ATC personnel at the high density airports continuously reevaluate and select the runway or runway configuration that is best for the current situation. The resultant decision is usually based on a combination of preestablished local practices and procedures and on-the-spot judgment by a knowledgeable, well-trained professional. The myriad of factors that bear on and contribute to the air traffic controller's decision on which runway or runway configuration to use are the extent to which traffic on one runway will interfere with and/or restrict aircraft traffic on another runway, which runways have avionics equipment (e.g., ILS), weather/wind conditions, the current aircraft traffic level, the performance capabilities of aircraft arriving at or preparing to depart from the airport, aircraft taxi time required if a particular runway/runway configuration is to be used, the extent to which taxiways cross runways and interfere with runway traffic, the destination of departing and arriving aircraft and runway and airspace restrictions. In essence, there is an extensive list of airport unique factors that must be considered if an airport is to be used most efficiently. Effective practices and procedures require that both local conditions and the airport's characteristics be accounted for if capacity is to be maximized. Because the conditions are continually changing, the ATC personnel must be knowledgeable in evaluating their effect on airport capacity.

Air traffic control procedures can, to an extent, establish the mix of aircraft in accordance with performance characteristics. This can be accomplished in two ways; through approach and departure sequencing and through segregation of the heavier air carrier and general aviation aircraft from the lighter aircraft through use of separate runways when the airport configuration allows. This practice of controlling the mix of aircraft by performance characteristics, to the maximum extent possible considering the unique airport characteristics, was a normal practice at all airports visited.

The professionalism of ATC personnel combined with the flexibility inherent in current ATC traffic handling procedures make modification of the existing aircraft traffic handling procedures an invalid option for increasing airport capacity. Effective procedures are presently being implemented. The flexibility and the responsibility being exercised under the management of the present system already exhibits an efficiency that is unlikely to be achieved in any other way. In light of the above, it is recommended that this option not be considered further as a candidate noncapital option for postponing saturation at high density air carrier airports.

5.2 Option 2 - Grouping of aircraft arrivals and departures to increase capacity.

There are basically two ways of grouping aircraft arrivals and departures. They are: through segregation of arrivals and departures to separate runways and by setting aside alternating blocks of 5, 10 or 15 minutes on the same runway for aircraft arrivals only and aircraft departures only. While the initial analysis of the capacity determinants indicated that a possibly greater number of aircraft operations could be conducted at an airport if arrivals and departures were grouped, further analysis has shown that the grouping of aircraft arrivals and departures is not an effective technique for increasing airport airside capacity. The rationale supporting this conclusion is provided below.

Figure 5-1 and 5-2 on the following pages have been prepared using the FAA Advisory Circular 150/5060-1A Runway Capacity Curves. These figures are provided to support the discussion of the advantages and disadvantages of the two methods of grouping, i.e., by runway and by time block.

The quantitative advantage of segregating aircraft arrivals and departures to separate runways is shown in Figure 5-1. As evidenced by this data, the quantitative advantage realized from this technique drops to zero as the aircraft mix approaches 40 percent D&E, 30 percent C, and 30 percent B. Using the nine test airports and assuming the availability of

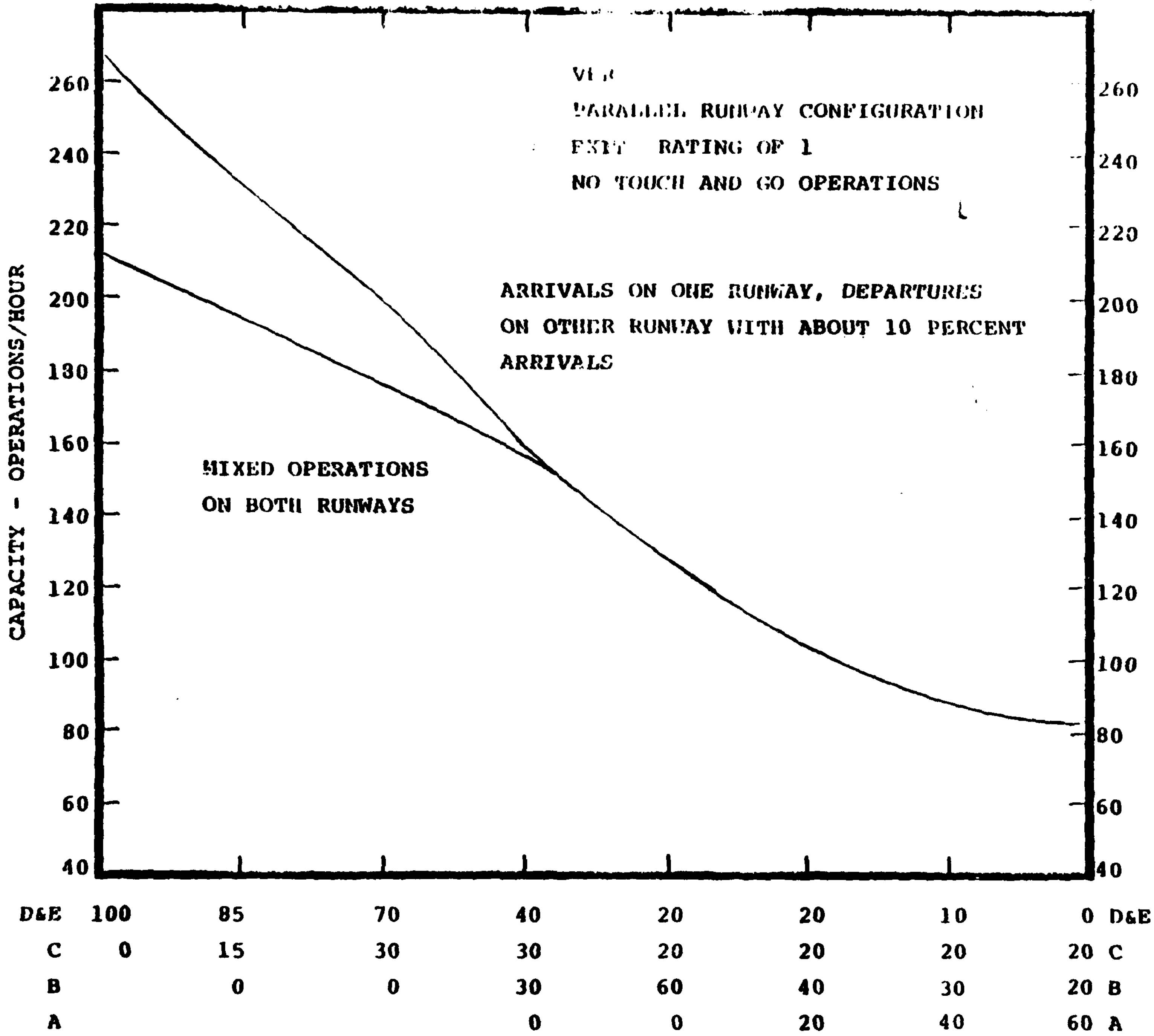
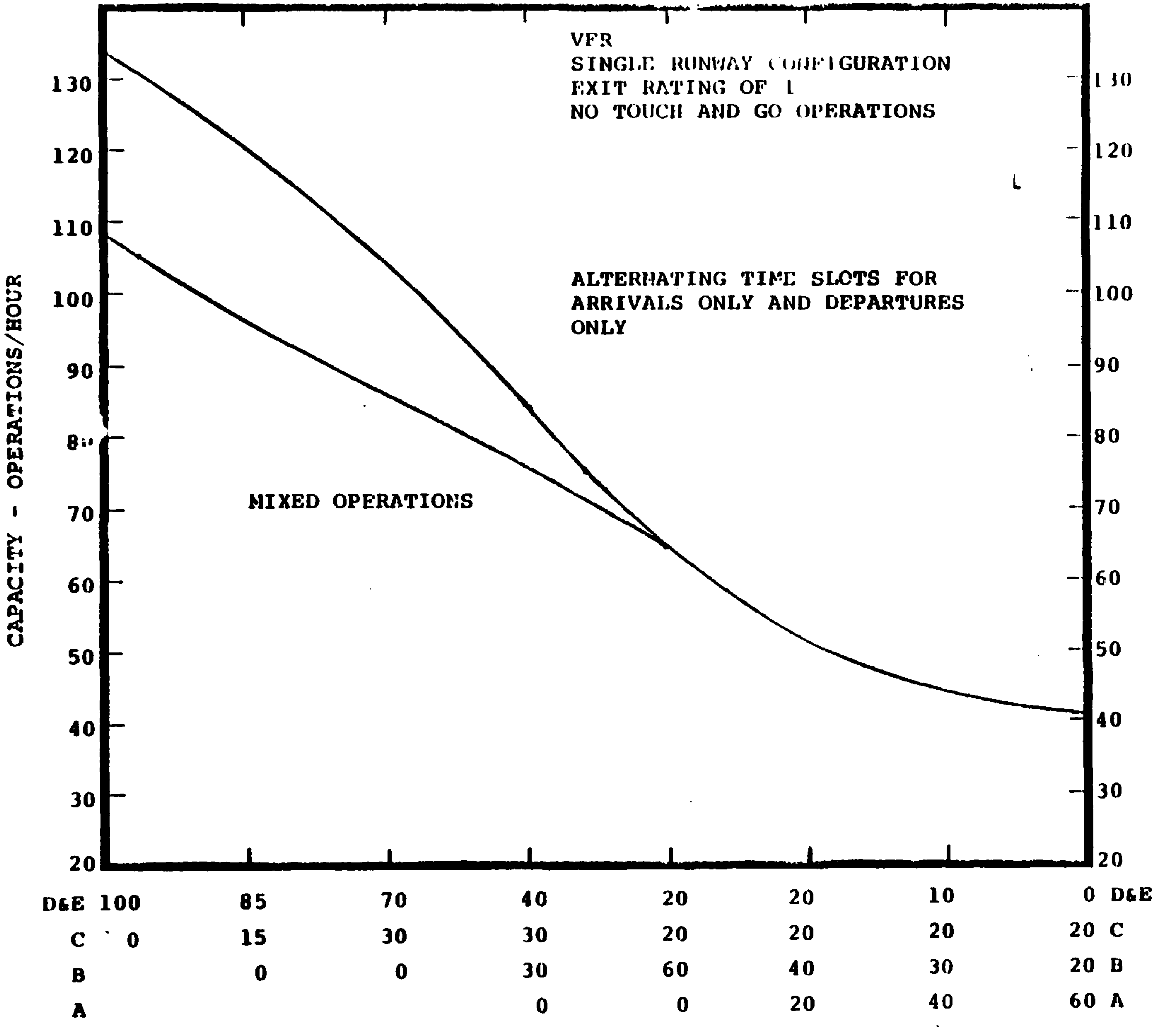

VFR
PARALLEL RUNWAY CONFIGURATION
EXIT RATING OF 1
NO TOUCH AND GO OPERATIONS
ARRIVALS ON ONE RUNWAY, DEPARTURES
ON OTHER RUNWAY WITH ABOUT 10 PERCENT
ARRIVALS
MIXED OPERATIONS
ON BOTH RUNWAYS
CAPACITY - OPERATIONS/HOUR
260
240
220
200
180
160
140
120
100
80
60
40
D&E 100 85 70 40 20 20 10 0 D&E
C 0 15 30 30 20 20 20 20 C
B 0 0 30 60 40 30 20 B
A 0 0 20 40 60 A
AIRCRAFT POPULATION IN PERCENT

FIGURE 5-1



VFR
SINGLE RUNWAY CONFIGURATION
EXIT RATING OF 1
NO TOUCH AND GO OPERATIONS
ALTERNATING TIME SLOTS FOR
ARRIVALS ONLY AND DEPARTURES
ONLY
MIXED OPERATIONS
CAPACITY - OPERATIONS/HOUR
130
120
110
100
90
80
70
60
50
40
30
20
D&E 100 85 70 40 20 20 10 0 D&E
C 0 15 30 30 20 20 20 20 C
B 0 0 30 60 40 30 20 B
A 0 0 20 40 60 A
AIRCRAFT POPULATION IN PERCENT

FIGURE 5-2

independent VFR runways, only three of the nine airports would experience a quantitative advantage in aircraft operations capacity with this technique. San Jose Municipal Airport could experience a 12 percent increase in VFR PHOCAP, Phoenix Sky Harbor Airport would experience a 9 percent increase in VFR PHOCAP and Fort Lauderdale Municipal Airport would experience a 7 percent increase in VFR PHOCAP. However, it must be pointed out that these quantitative advantages are somewhat optimistic. The optimism inherent in the estimates of the airport capacity with segregated operations becomes evident when it is noted that at an aircraft mix of 70 percent D&E and 30 percent C, 100 aircraft departures and 10 aircraft arrivals must occur on one of the runways. That is a departure approximately every 30 seconds involving aircraft with a mix of take-off speeds ranging from 80 to 130 or more miles per hour. It is questionable whether the FAR required 3,000 feet separation between departing aircraft can be maintained under these circumstances without slowing the departure rate with a resultant reduction in capacity.

The quantitative advantage of isolating aircraft arrivals from aircraft departures on a single runway by allocating alternating 5, 10 or 15 minute time slots to each type of aircraft operation is shown in Figure 5-2. The quantitative advantage realized from grouping arrivals and departures decreases to zero as the percentage of heavier jet aircraft increases. Though few of the high density airports are configured with a single runway, it is a common practice at these airports to isolate the lighter general aviation aircraft operations from the operations of heavier air carrier aircraft by assigning each to separate runways, with each having a different aircraft mix. In that event, there would be no advantage at the air carrier runway but an increase in VFR PHOCAP of up to 25 percent could be attained at the general aviation runway. However, this increase is also considered to be optimistic for the similar reasons given previously.

There are two major disadvantages to the grouping of arrivals and departures. They are congestion of airborne arriving and departing aircraft and scheduling of arrivals and departures.

The grouping of arrivals and departures during high traffic periods will result in the congestion of departing aircraft in the outbound airways concurrent with a possible congestion of arriving aircraft waiting to land. In addition to the increased risk to safe aircraft operations which is inherent in the grouping of airborne aircraft, a significant added workload will be placed on air traffic control in the monitoring of aircraft movements in the vicinity of the airport to ensure adequate separation between aircraft. The congestion of departing aircraft is particularly hazardous because of the differences in air speed that can be found in a normal mix of aircraft operating at high density air carrier airports.

The problems associated with scheduling airport arrivals and departures are equally perplexing in the case where arrivals and departures are grouped in the same runway via time slots. While the air carrier traffic schedule and arrival and departure time slots could possibly be adjusted to coincide, late arrivals or departures would result in increased delays to the passengers and cost to the airlines. General aviation traffic, by definition, is unscheduled and consequently this technique for grouping is equivalent to building a delay into the airport system. It should be expected that there would be a significant resistance by both general aviation and the air carriers to the use of time slots to group arrivals and departures.

Grouping of arrivals and departures is further complicated when airports must service touch and go training operations. Either the airport runway configuration must be able to support demand for touch and go operations on a separate runway or frequent time slots for these training operations must be provided. While the level of training operations varies significantly from airport to airport, the airports that could possibly gain the greatest quantitative advantage from grouping, that is, those with the highest level of single and twin engine piston aircraft traffic, also have the highest level of training activity which thereby reduces any quantitative advantages.

Based on the marginal, if not nonexistent, quantitative advantage of grouping aircraft arrivals and departures and the inherent problems associated with safety and scheduling, it is recommended that this not be considered for implementation as a means of postponing airside saturation of high density air carrier airports.

5.3 Option 3 - Restrict or inhibit use of categories of users and/or aircraft.

This candidate option for postponing airside saturation at high density air carrier airports affects both of the principal saturation determinants: demand and capacity. Restricting or inhibiting the use of an airport by a certain segment or segments of the aviation community, of course, will reduce aircraft traffic demand at this airport, with an associated reduction in airside congestion (delays) and possibly the creation of excess capacity which can be used by the uninhibited or unrestricted airport users. However, since airport demand characteristics are capacity determinants, any shift in these characteristics will cause a change in airport capacity. It is the combined effect that these two interrelated determinants have on airport saturation projections which will be the quantitative measures of the effectiveness of this candidate option.

For the purpose of this analysis, airport operations are categorized in two fashions: by purpose of the user and by type of aircraft. The airport user categories addressed in this analysis are air carrier, air taxi, general aviation and military. The general aviation aircraft traffic is further broken down into several overlapping subcategories: executive/business, touch and go training operations, practice ILS approach operations, pleasure, itinerant operations by based aircraft and itinerant operations by transient aircraft. The aircraft categorization by performance characteristics is described in detail in paragraph three of this report (i.e., A, B, C and D&E). These two methods of categorizing aircraft operations are highly related and consequently any change in one of these traffic mix parameters will almost certainly affect the other. For example, normally 95+ percent of touch and go training operations at the high density airports are performed using category D&E aircraft, while normally 95+ percent of the air carrier aircraft operations involve categories A and B aircraft. Consequently, any proposal to inhibit or restrict a particular airport user (e.g., touch and go training) will, to a large extent, determine which category or categories of aircraft will be affected. The reverse is true to a lesser extent. For example, a decision to inhibit or restrict a certain category of aircraft (e.g., D&E) could affect one or a number of users (e.g., training, pleasure, business) depending on the method(s) of implementing the decision.

The following topics are addressed in this subparagraph in the order indicated:

- General aviation and air carrier fleet mix.
- Quantitative effect on capacity of varying the aircraft and airport user traffic mix parameters.
- Feasibility of inhibiting or restricting use of high density airports by certain categories of users.
- Alternative methods of implementing this candidate option.
- Advantages and disadvantages of implementation.
- Summary and conclusion relating to this candidate option.

Since one of the principal considerations in the selection of the candidate options to be examined in this report was their potential for broad application nationwide, it was necessary in this study effort to examine the composition of the air carrier and general aviation aircraft fleets nationwide and the aircraft traffic fleet mix at the selected test airports to determine what, if any, conclusions can be drawn regarding airport traffic composition. Table 4-6 data has indicated a wide variation in air carrier traffic fleet composition at the test airports. Specifically, the values for these nine selected airports range from 0% of category A and 100% of category B aircraft to 41% of category A and 59% of category B aircraft. The air carrier air fleet composition nationwide is approximately 35% category A, 62% category B and 3% category C aircraft. Air carrier operations involving category C aircraft ranged from 0 to 11% at the test airports, but was generally at or near 0%. The determinants of an airport's air carrier fleet composition include:

- The composition of the fleets of airlines serving the airport.
- The geographic location of airport.
- The ability of the airport to accommodate certain categories of aircraft (i.e., runway limitations, approach and take-off restrictions/limitations, etc.).
- The proximity of the airport to other major air carrier airports.
- Airline management decisions based on competition, demand levels, load factors, scheduling, and other corporate management considerations.

The general aviation aircraft fleet mix at the test airports also exhibited a wide range of values, with the traffic mix parameter varying from 5% category C and 95% category D&E aircraft at Phoenix Sky Harbor to 30% category C and 70% category D&E aircraft at Detroit Metropolitan Wayne Airport. An estimate for the general aviation traffic aircraft mix nationwide is 5% category C and 95% category D&E. The interviews with airport personnel conducted in support of this study indicate that the sophistication of general aviation aircraft operating at the high density air carrier airports is greater than the national general aviation fleet average and that there is a pronounced trend of increasing sophistication (more avionics, faster, larger) in aircraft operating at these airports. This increasing sophistication is largely attributed to the increasing proportion of airport general aviation traffic that is business oriented. These observations by airport personnel are supported by the Table 4-4 data. For example, at Detroit Metropolitan Airport, 95 percent of general aviation traffic is for business purposes; its aircraft traffic mix is 30 percent category C and 70 percent category D&E aircraft. On the other hand, at Phoenix Sky Harbor, an estimated 15 percent or less of general aviation traffic is business oriented; its mix is 5 percent category C and 95 percent category D&E aircraft.

Figures 5-3 and 5-4 have been developed as simplified, typical examples of the quantitative effect that user mix has on VFR PHOCAP. These examples are simplified in that they address the most basic runway configuration (i.e., single runway, exit rating 1) and they ignore military and air taxi traffic. While inclusion of military and air taxi traffic would shift the capacity curve to a small extent, the exclusion of these two airport users and the use of a single runway configuration do not affect the basic concept being presented.

Figure 5-3 demonstrates the degree to which a reduction in the percentage of light general aviation operations during busy hours will result in a reduction in VFR PHOCAP. Examination of the complete range of mix, 0 to 100 percent air carrier traffic, indicates that the reduction in capacity resulting from the displacement of general aviation traffic by air carrier traffic to be in excess of 50 percent. That is, at least two general aviation aircraft operations must be deleted to allow sufficient excess capacity to accommodate one additional air carrier operation. The trade-off factor is more severe for the other more complex runway configurations. Furthermore, it must be pointed out that a reduction in general aviation operations does not necessarily mean that excess capacity is created for air

Figure 5-3 VFR CAPACITY CURVE

(No Touch and Go Operations)

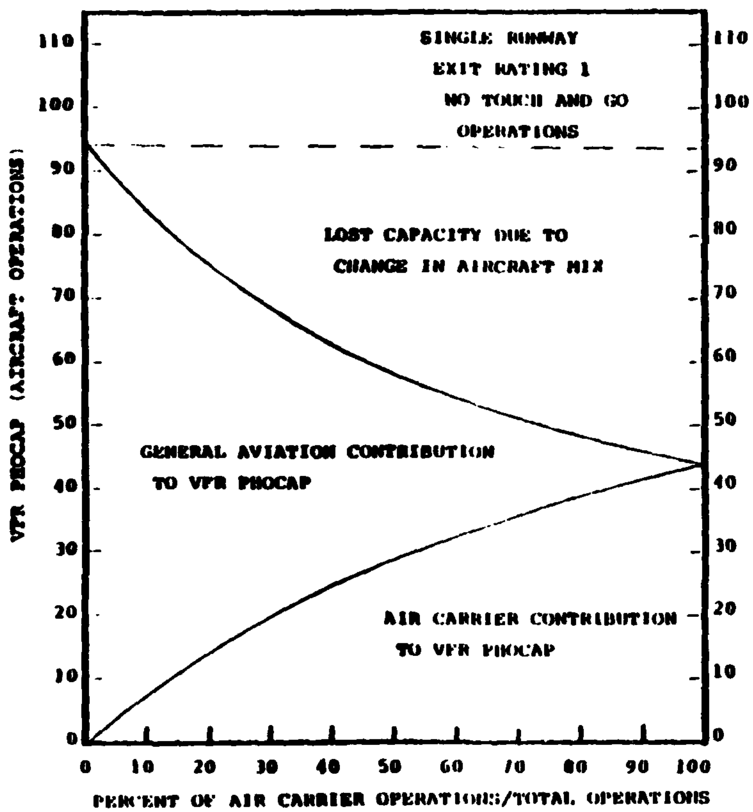
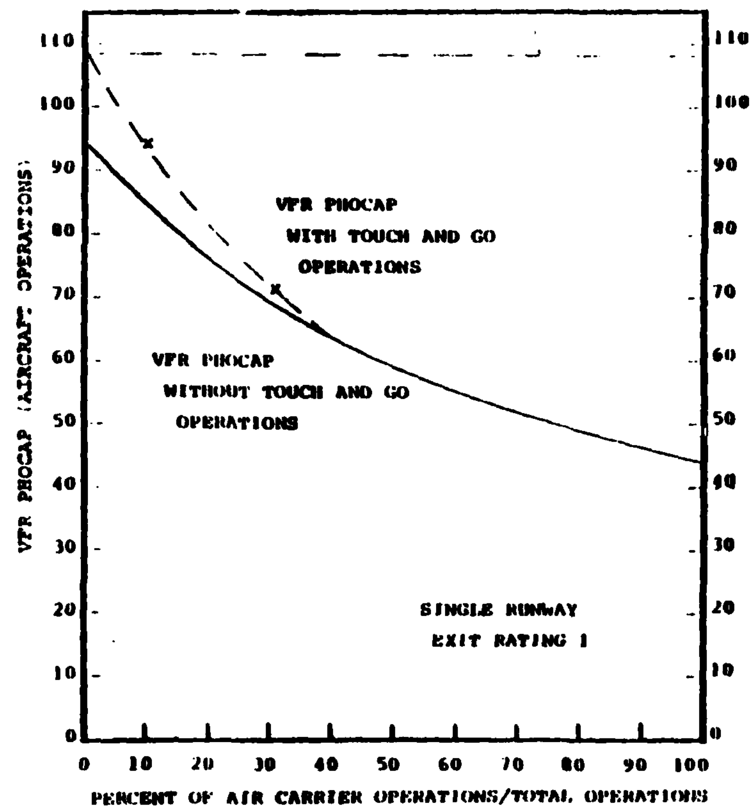


Figure 5-4 VFR CAPACITY CURVES

(With and Without Touch and Go Operations)



carrier operations. Reduced GA traffic is not an effective means of alleviating air carrier capacity problems when general aviation is displaced from a runway that cannot be used by air carrier aircraft. It is not uncommon at high density air carrier airports for there to be runways that are used by general aviation and unusable by air carrier. This factor must be considered in evaluating the effectiveness of inhibiting or restricting general aviation traffic at a particular airport.

Figure 5-4 demonstrates the effect that touch and go operations have on VFR PHOCAP and particularly the higher trade-off factor between general aviation touch and go operations and air carrier aircraft operations. This is reflected in the alternate curves when touch and go operations are considered. In Figure 5-4, it is presumed that 40 percent of total operations (at 0 percent air carrier) are touch and go's and these are the first elements of general aviation traffic deleted as the percentage of air carrier operations/total operations is increased.

An important consideration in determining the feasibility of inhibiting or restricting use of the high density air carrier airport by certain categories of users is the degree of user resistance to relocating to an alternate airport. The evaluation of airport user preferences in a particular metropolitan area requires examination of many factors that influence aviation in that locale. The following are some general statements, supported by the test airport interview results, regarding airport user preferences.

Generally, the pleasure and student pilot would, if aware of an attractive alternative airport where GA traffic is mixed with air carrier operations, (i.e., not segregated to a separate runway principally used only by general aviation aircraft). This desire to relocate becomes more pronounced at airports with category A aircraft, particularly jumbo jets (DC-10, 747 and L1011).

Increasing aircraft operation delays will cause aircraft operators, who do not have a strong reason for using the high density airport, to relocate to another less congested airport, if only for economic reasons.

In order to determine the airport users' resistance to relocate their aircraft operations to local neighboring airports, it was necessary to identify alternative airports in the local vicinity of the test airport and to examine the attractiveness of these alternatives to the high density airport user. The selected neighboring airports are identified and relevant airport data is provided in Data Base Tables A-1 through A-18. The methods used to select these airports and evaluate their attractiveness are addressed below:

- The alternative airports were principally selected based on acceptable distances from the high density airport. The rationale for this selection criteria is that the high density airport user initially selected that airport due to its convenience and that if the alternative airport(s) are too far from this airport, the increased inconvenience would be unacceptable. Twenty-five statute miles were arbitrarily chosen as the cut-off distance in this selection criteria. Additionally, whenever feasible, at least one alternative airport was chosen in each quadrant surrounding the test airport. While the above constituted the basic ground rules used to select alternative airports, judgment was exercised in the selection process to insure all possibly attractive airports were considered.

- The services and facilities available at the selected alternative airports were also considered when assessing their attractiveness to the high density airport user. The services and facilities considered in this evaluation were control tower services, IFR weather approach aids and runway lighting.

- The combined level of excess capacity at the alternative airports was a critical consideration in the determination of the expected level of resistance to relocate. Table 5-1 is a

Table 5-1 DEMAND TO CAPACITY RELATIONSHIP

METROPOLITAN AREA	ALTERNATIVE AIRPORTS (TOTAL)					HIGH DENSITY AIRPORT				
	PANCAP	DEMAND (000)		DEMAND/CAPACITY		PANCAP	DEMAND (000)		DEMAND/CAPACITY	
	(000)	1982	1987	1982	1987	(000)	1982	1987	1982	1987
PHOENIX	1500	1129	1459	.75	.97	650	701	783	1.08	1.20
SAN DIEGO	1585	1078	1288	.68	.81	320	320	400	1.00	1.25
SAN JOSE	915	803	1030	.88	1.13	560	560	953	1.00	1.70
DENVER	1740	1186	1731	.68	.99	500	497	770	.99	1.54
FORT LAUD.	2070	1480	1838	.71	.89	500	540	700	1.08	1.40
DETROIT	1431	1000	1261	.70	.88	340	340	425	1.00	1.25
CLEVELAND	1510	509	907	.34	.60	360	336	424	.93	1.18
MEMPHIS	1880	519	609	.28	.32	590	432	553	.73	.94
NASHVILLE	750	72	75	.10	.10	360	271	392	.75	1.09

Table 5-1 DEMAND TO CAPACITY RELATIONSHIP

METROPOLITAN AREA	ALTERNATIVE AIRPORTS (TOTAL)					HIGH DENSITY AIRPORT				
	PANCAP	DEMAND (000)		DEMAND/CAPACITY		PANCAP	DEMAND (000)		DEMAND/CAPACITY	
	(000)	1982	1987	1982	1987	(000)	1982	1987	1982	1987
PHOENIX	1500	1129	1459	.75	.97	650	701	783	1.08	1.20
SAN DIEGO	1585	1078	1288	.68	.81	320	320	400	1.00	1.25
SAN JOSE	915	803	1030	.88	1.13	560	560	953	1.00	1.70
DENVER	1740	1186	1731	.68	.99	500	497	770	.99	1.54
FORT LAUD.	2070	1480	1838	.71	.89	500	540	700	1.08	1.40
DETROIT	1431	1000	1261	.70	.88	340	340	425	1.00	1.25
CLEVELAND	1510	509	907	.34	.60	360	336	424	.93	1.18
MEMPHIS	1880	519	609	.28	.32	590	432	553	.73	.94
NASHVILLE	750	72	75	.10	.10	360	271	392	.75	1.09

summary of the area's demand to capacity relationship for the cumulative alternative airports and the high density airport. The TAF (Report No. FAA-AVP-76-5) was used as the source for the airport demand data.

Table 5-2 below summarizes the results of the evaluation of the expected level of user resistance to relocate. Resistance to relocating is used later in this analysis to estimate how effective the alternative methods of implementing this candidate option would be.

Table 5-2 RESISTANCE TO RELOCATE - GENERAL AVIATION

AIRPORT	LOCAL TOUCH AND GO OPERATIONS		LOCAL PRACTICE ILS APPROACHES		BASED AIRCRAFT ITINERANT OPERATIONS		TRANSIENT ITINERANT OPERATIONS	
	'82	'87	'82	'87	'82	'87	'82	'87
PHOENIX SKY HARBOR	MED	HIGH	HIGH	HIGH	MED	HIGH	MED	HIGH
SAN DIEGO LINDBERGH	LOW	LOW	HIGH	HIGH	LOW	LOW	LOW	LOW
SAN JOSE MUNICIPAL	MED	HIGH	HIGH	HIGH	MED	HIGH	MED	HIGH
DENVER STAPLETON	LOW	LOW	HIGH	HIGH	LOW	LOW	LOW	LOW
FT. LAUDERDALE INTL.	LOW	LOW	HIGH	HIGH	LOW	LOW	LOW	LOW
DETROIT-METRO WAYNE	LOW	LOW	LOW	LOW	LOW	LOW	LOW	LOW
CLEVELAND-HOPKINS	LOW	LOW	LOW	LOW	LOW	LOW	LOW	LOW
MEMPHIS INTL	MED	LOW	HIGH	HIGH	MED	LOW	MED	LOW
NASHVILLE METRO	MED	LOW	HIGH	HIGH	MED	LOW	MED	LOW

Examples of typical rationale used in assigning ratings are:

High - A high resistance to relocate rating was assigned when an ILS system is not available at the alternative airports to support practice ILS approaches and when there is no excess capacity forecast at the alternative airports.

Medium - A medium resistance to relocate was assigned in those cases where excess capacity is forecast to be available at the alternative airports but saturation is not eminent at the high density airport. A medium rating is assigned at San Jose Municipal and Phoenix Sky Harbor in contradiction to the above statement based on the fact that both have extremely large general aviation traffic levels and these general aviation communities will most probably resist any restriction of their operations at these airports.

Low - A low resistance rating was assigned in those cases where saturation is forecast to occur at the high density airport while there is forecast excess capacity at the alternative airports and the alternative airports are attractive in other aspects.

There are several possible methods of implementing this candidate option (inhibiting or restricting use of high density airport by certain user categories as a technique for postponing airport saturation).

1) Reduce level of support provided at the high density air carrier airport. There are principally two areas in which support could be reduced that may, depending on other factors, influence the aircraft traffic level. They are support provided by the FAA tower personnel and support available through the fixed base operators. The FAA tower personnel could, for example, eliminate certain current practices which have mainly been instituted for the convenience of airport user, such as a separate runway for touch and go training operations when available, the segregation of heavy air carrier traffic from the lighter general aviation aircraft when feasible and selection of runways to be utilized to minimize the airport user taxi time. In the FBO area,

the number of tie downs (for based and transient aircraft) could be reduced or a moratorium on upgrading or improving the general aviation facilities could reduce the desirability of the airport.

2) Implement terminal control Group 1 controls. This, of course, would eliminate student training activity and would limit the aircraft that can operate at the airport to those that possess Mode C Transponders.

3) Institute or increase landing fees for both transient and based aircraft operations.

4) Publicize potential delays that may be encountered by unscheduled airport users. This could be accomplished in two ways: through notices in the Airman's Information Manual that delays may be encountered at certain high density airports and recommending alternative airports with comparable facilities in the local area. This approach should primarily affect transient aircraft using the high density airport. A second approach is a campaign by airport management to inform based aircraft operators of the advantages in using alternative airports.

5) Impose overt restrictions on certain categories of users. There are several disadvantages with invoking this candidate option. Its implementation will impact the livelihood of the high density airport fixed based operators. The extent of the impact, of course, will depend on what airport users are restricted and how large the aircraft traffic level reduction is. For example, to relocate training operations without relocating the flying school would have a minimal impact. If the policy is aimed at restricting or inhibiting pleasure flying, FBO's who specialize in providing those services may be forced out of business, while a neighboring FBO may be unaffected. If the effect of implementation of this option is relocation of aircraft operations to local neighboring airports and if those restricted or inhibited from the HUB airport are not discouraged from flying then the economical impact to the local economy should be minimal and defensible.

Implementation of the last option may be interpreted as official discrimination against that element(s) of the aviation community affected. The degree to which those affected would resist or condemn implementation will depend on two factors. (1) the availability of attractive alternative airports to relocate to and (2) the attitude of the affected users regarding their rights in the use of the high density airport. San Jose Municipal Airport is an example of where both of these factors would seriously affect the level of resistance to these options. Air carrier traffic at this airport has only become substantial in the past ten years and even in 1975, accounted for only 13 percent of total aircraft traffic. Consequently, there is an apparent attitude exhibited by general aviation aircraft operators that it is a general aviation airport and that airport policies and procedures should be partial to general aviation.

The methods of implementing this candidate option will certainly require the voluntary cooperation of the affected pilots; consequently, the quantitative advantages are difficult to estimate accurately. The data in Table 5-3 indicates the maximum potential effectiveness that could be expected if all general aviation traffic were eliminated from these airports. No consideration has been given as to how this condition would be achieved. The estimated number of years that saturation could be postponed under this condition has been determined using an approximation of the individual airport's PANCAP presuming all traffic involved only air carrier and air taxi type aircraft (i.e., Categories A, B and C) and assuming a 5 percent annual growth rate from present traffic levels.

Table 5-4 contains a subjective estimate of the effectiveness that can be reasonably expected from implementation of this option. A comparison of Tables 5-3 and 5-4 data indicates that at three of the test airports, the maximum potential and expected effectiveness are the same. However, at the remaining six airports there is a wide range of divergence between the potential and the expected benefits. This

Table 5-3 MAXIMUM POTENTIAL EFFECTIVENESS OF ELIMINATING GENERAL AVIATION OPERATIONS

AIRPORT	FORECAST			ESTIMATED
	SATURATION (YEAR)	GENERAL AVIATION OPERATIONS (000)	GENERAL AVIATION % OF TOTAL OPERATIONS	NO. OF YEARS SAT. POSTPONED IF ALL GA TRAFFIC ELIMINATED
PHOENIX SKY HARBOR	1981	520	80%	19 YEARS
SAN DIEGO LINDBERGH	1982	194	61%	8 YEARS
SAN JOSE MUNICIPAL	1980	480	85%	17 YEARS
DENVER STAPLETON	1982	183	47%	5 YEARS
FT. LAUDERDALE INTERNATIONAL	1981	380	69%	9 YEARS
DETROIT METROPOLITAN	1982	143	40%	12 YEARS
CLEVELAND HOPKINS	1983	156	43%	7 YEARS
MEMPHIS INTERNATIONAL	1991	380	58%	12 YEARS
NASHVILLE METROPOLITAN	1987	250	69%	13 YEARS

Table 5-4 SUBJECTIVE ESTIMATE OF OPTION EFFECTIVENESS AT TEST AIRPORTS

AIRPORT	(1) ESTIMATE OF OPTION EFFECTIVENESS IN REDUCING GA TRAFFIC	ESTIMATED POSTPONEMENT SATURATION	REMARKS
PHOENIX SKY HARBOR	24%	4 YEARS	-
SAN DIEGO LINDBERGH	40%	8 YEARS	- SAME AS MAXIMUM POTENTIAL EFFECTIVENESS DUE TO AIR CARRIER USE LIMITATION ON SHORTER RUNWAY.
SAN JOSE MUNICIPAL	30%	3 YEARS	-
DENVER STAPLETON	70%	4 YEARS	-
FORT LAUDERDALE INTL	40%	6 YEARS	-
DETROIT METROPOLITAN	50%	5 YEARS	-
CLEVELAND HOPKINS	70%	7 YEARS	- SAME AS MAXIMUM POTENTIAL EFFECTIVENESS DUE TO AIR CARRIER USE LIMITATION ON SHORTER RUNWAY.
MEMPHIS	70%	7 YEARS	-
NASHVILLE	70%	13 YEARS	- SAME AS MAXIMUM POTENTIAL EFFECTIVENESS DUE TO AIR CARRIER USE LIMITATION ON SHORTER RUNWAY.

(1) PERCENTAGE REDUCTION IN GENERAL AVIATION TRAFFIC (e.g., 50 PERCENT ESTIMATED EFFECTIVE INDICATES THAT IF GA TRAFFIC CONTRIBUTES 36 PERCENT OF TOTAL TRAFFIC, THEN IT IS ESTIMATED THAT THIS CONTRIBUTION CAN BE REDUCED TO 18 PERCENT)

difference is principally attributable to the eventual saturation of the local neighboring airports. At these six locations, local neighboring airports, as well as the high density airport, will be approaching saturation during the '80's. Consequently, it can be presumed that few users of the high density airport would be inclined to relocate to another equally congested site and therefore saturation will occur earlier.

5.4 Option 4 - Redistribute traffic demand to less busy hours.

The calculation of an airport's annual capacity is dependent on the level of the airport's busy hour operations. But airports, similar to the highway systems at our metropolitan centers, experience wide ranges of demand resulting in high traffic levels at certain hours (e.g., the highway's rush hours) and unused facilities at other times. Offhand then, it would appear as if an airport's capacity could be increased if traffic demand could be transferred to the off-hours, in effect, reducing the peaking factor. It must be noted, however, that, to an extent, the capacity computation has already accounted for this by presuming that as an airport approaches capacity, its hourly distribution of demand will flatten out. Yet, this flattening assumption is significant only where air carrier operations represent greater than 80 percent of the total operations. Therefore, at airports which provide a substantial service to general aviation, this technique of redistributing demand to off-hours represents an option for potentially increasing capacity that should be investigated.

The relationships, at the high density test airports, between traffic demand peaking, practical hourly capacity and practical annual capacity were previously mentioned in Section 4 and it should be noted that the current hourly distribution of traffic at each of the selected airports is presented in the Data Base Appendix. Prior to proceeding with the analysis of this candidate option, two basic factors should be noted that limit the degree to which aircraft traffic demand has been considered. Redistribution of commercial aircraft traffic is not an alternative which has been addressed in this analysis. Commercial flight scheduling is a key factor in the competition between airlines; new rules governing air transportation competition which could impact on airport facilities are outside the scope of the study. Secondly, redistribution of traffic within an airport's prime 12 daylight hours of operations is emphasized in this analysis. This limitation is based on the apparent undesirability of night flying within general aviation as reflected in the current low percentage of general aviation operations performed during non-daylight hours.

There are two airport measurement parameters that are applicable in this analysis; they are peaking factor and busy-to-average hour ratio. The peaking factor is the percentage of the peak daily traffic that occurs during the peak hour of the week. This factor is used in calculation of Practical Annual Capacity. It is noted that in FAA capacity calculation guidance documents, peaking factor is estimated according to the airport's aircraft traffic mix, (increasing as the ratio of D&E operations to total traffic increases). Busy hour for air carrier airports is the average for the two adjacent busiest hours of a normal day. The busy-to-average hour ratio is calculated using the busy hour and the average hourly traffic level for the year.

These two interrelated measures of daily aircraft traffic peaking are affected by the aircraft mix (A, B, and C versus D&E). Because of the close relationship between type of aircraft and aircraft use, this is equivalent to saying that the percentage mix of general aviation to air carrier traffic is a determinant of peaking. Another apparent determinant of peaking is annual operations as indicated by Figure 5-5.

Caution must be used when reviewing busy hour and peaking factor related data. Busy hour data for airports, as shown in Figure 5-5 is the result of averaging over many airports,

BUSY/AVERAGE HOUR RATIO AS A FUNCTION OF ANNUAL OPERATIONS

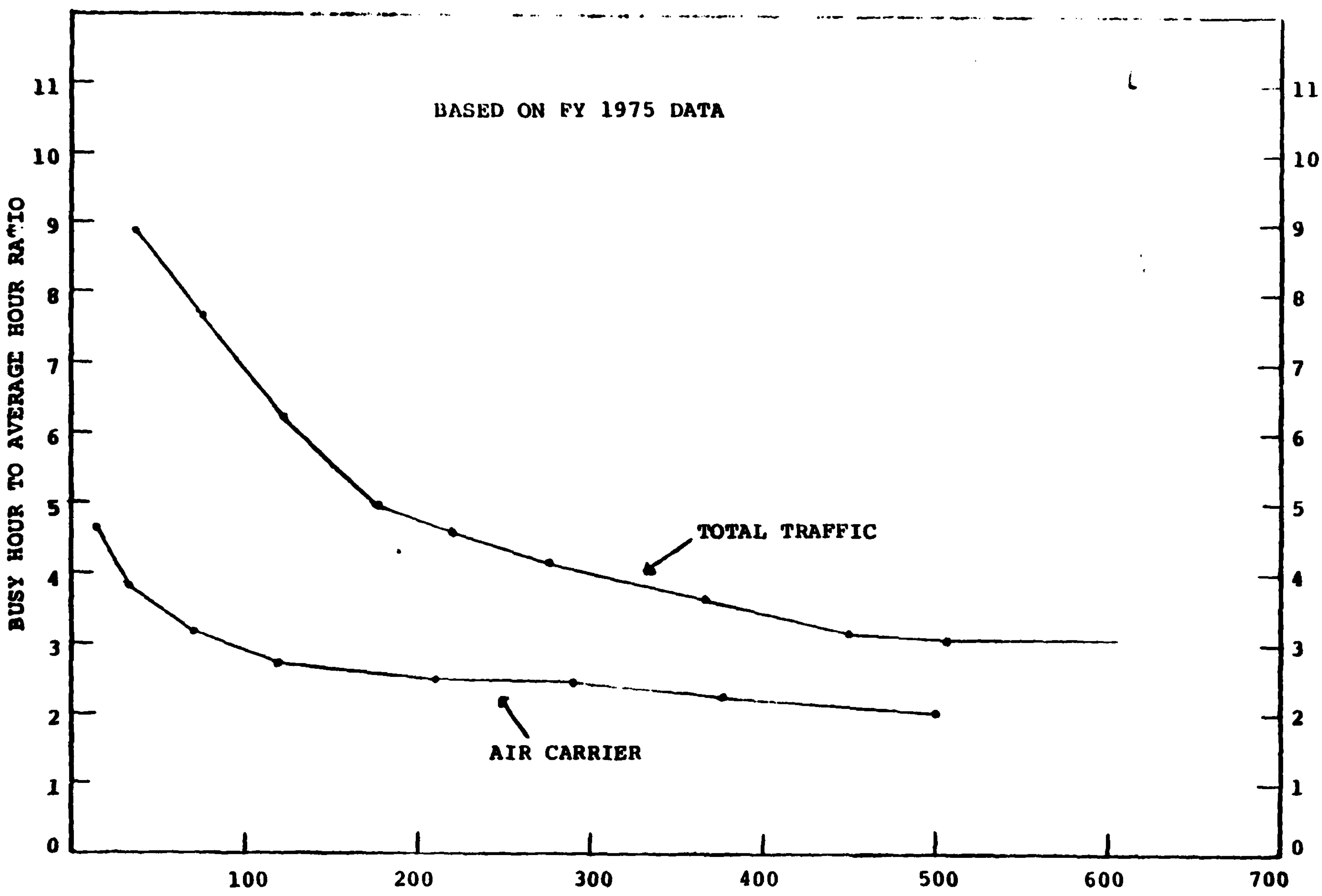


Figure 5-5

yet, busy hour data for individual airports frequently exhibit inconsistencies with the average. The actual, rather than the average value, of busy hour and peaking factor for an individual airport must be verified prior to its use for individual airport traffic distribution or capacity analysis.

It has been implied in the previous discussion of this option that the objective is to eliminate or minimize traffic peaking and to maintain a steady level of traffic demand during the daylight hours. This, however, is a simplified approach and in fact the optimum traffic distribution is not necessarily a constant level of total hourly traffic, but instead a constant ratio of hourly demand to hourly capacity. For example, examination of three hypothetical hours of airport operations at a single runway airport with the hypothetical traffic mix and resultant VFR PHOCAP as indicated in Table 5-5, it is readily seen that there can be a substantial difference in total hourly aircraft operations, but equally efficient use of airport facilities. The key point to be considered is that in practical cases, both air carrier and general aviation operations will be serviced by the airport and therefore traffic mixing must be accounted for. Because hourly capacity is reduced as the ratio of air carrier to total operations increases, an airport's capacity will vary from hour to hour depending on this ratio. Therefore, unless air carrier demand exhibits a flat distribution, the optimum capacity condition at an airport will be depicted by an uneven hourly distribution.

	Hour One	Hour Two	Hour Three
• **DEMAND**			
Air Carrier Operations (Cat. A, B)	0	16	44
General Aviation Operations (Cat. C, D&E)	108	54	0
• VFR PHOCAP	108	70	44
• Ratio of Demand/Capacity	1	1	1

Table 5-5 VARIABLE PHOCAP DUE TO DEMAND

Three candidate methods for implementing this option have been addressed in this study. They consist of applying landing fees, invoking airport use restrictions and publicizing delays.

Landing fees. Charging landing fees that are higher during busy hours than nonbusy hours is one means of implementing this option. This method would not restrict use by those who must, for business or personal reasons, use the airport during the high traffic hours but it should effectively minimize less essential use. If the fees were perceived by the airport users as discounts provided to stimulate airport use during nonbusy hours, greater acceptance should be expected.

Airport use restrictions. The principal advantage of this method is that it assures a predictable level of reduction in traffic during busy hours; the effectiveness of the other candidate methods are dependent on user motivational factors. Resistance by affected airport users to this method should be expected since it limits their flexibility to operate even occasionally during busy hours. It is noted that hourly use restrictions may result in a portion of the users choosing to relocate their aircraft to a local neighboring airport rather than adjust the time of day they use their aircraft.

Publicize potential delays. This method includes publicizing that severe delays may be encountered at the high density airport at specific times of the day and advising the aviation community that unscheduled flights will be given a low priority in arrival and departure sequencing.

Variations in daily aircraft traffic demand impact on the PANCAP calculation. The normal annual distribution used in PANCAP calculation assumes that 50 days a year, traffic will be substantially above the daily average, 200 days each year the traffic level will be at or about the average and that about 50 days will have below average traffic levels. The remaining days are IFR weather days. These variations in daily traffic levels may result from many factors; seasonal variations, weather, local tourist periods, holiday traffic and normal day of the week variations are a few of these. It is worthwhile, therefore, to determine the types of days represented in the sample hourly distribution graphs for the test airports (Figures A10 through A17 in the Data Base Appendix). The results of this examination are indicated in Table 5-6.

	SAMPLE DAY OPERATIONS			APPROXIMATE AVERAGE DAY OPERATIONS			TYPE DAY
	TOT	GA	AC	TOT	GA	AC	
FLL	1066	764	253	959	739	195	ABOVE AVG.
MEM	896	583	313	739	438	301	ABOVE AVG.
BNA	853	609	165	602	383	169	ABOVE AVG.
CLE	456	103	352	535	167	323	BELOW AVG.
DEN	987	390	597	1057	441	583	BELOW AVG.
SAN	466	217	249	487	293	194	AVERAGE
DET	647	170	477	643	167	441	AVERAGE
SJC	1441	1280	159	1249	1052	197	ABOVE AVG.

Table 5-6 AVERAGE DAILY OPERATIONS

From an examination of the sample daily traffic distribution curves for the test airports, estimates were made of maximum potential and probable effectiveness of implementation of this option at the test airports. At all of the test airports, the busy hour traffic levels were 25 percent to 50 percent of VFR PHOCAP. Consequently, implementation of this option as a technique for postponing saturation is not of immediate concern.

Table 5-7 indicates the estimated maximum potential increase in annual capacity that could be realized through implementation of this option. These figures represent the percentage

AIRPORT ID	ESTIMATED MAXIMUM POTENTIAL INCREASE IN CAPACITY
FLL	10%
MEM	15%
BNA	18%
CLE	17%
DEN	15%
SAN	25%
DET	15%
SJC	27%

POTENTIAL BENEFITS - OPTION 4
TABLE 5-7

AIRPORT ID	SUBJECTIVE ESTIMATE OF POTENTIAL OPTION EFFECTIVENESS
FLL	0%
MEM	0%
BNA	7%
CLE	0%
DEN	0%
SAN	10%
DET	7%
SJC	13%

PROBABLE BENEFITS - OPTION 4

TABLE 5-8

increase in annual capacity, with no VFR PHOCAP increase, which could be realized if the busy/average hour ratio for the 12 prime daylight hours were unity (i.e., no traffic peaking). Table 5-8 is a subjective estimate of the probable increase in PANCAP which would result from implementation of this option at the test airports.

The difficulties between Table 5-8 and 5-7 values are attributable to limiting factors inherent in the airport configuration or the existing traffic mix parameters. One limiting factor is the breadth of current busy periods. The number of hours during which the existing traffic level is at or near the busy hour level must not be so large nor the number of consecutive busy hours so broad that the alternative nonbusy hours are limited or undesirable to general aviation users. Six of the sample high density airports exhibited this limiting factor (Fort Lauderdale. Memphis, Nashville, Cleveland, Denver and San Diego).

Another factor is that peaking must consistently occur during specific identifiable hours. This factor is most critical at airports with a significant level of general aviation traffic. Significant variations in seasonal and daily traffic distributions would require too much flexibility in implementation procedures to be practical.

5.5 Option 5 - Implement no new changes.

Currently, there are activities that are occurring within the framework of existing FAA and airport management policies which are resulting in solutions or partial solutions to the airport saturation problem. The continuation of these practices (i.e., no changes to present policies), therefore, appears as an additional option warranting consideration.

Airport personnel interviewed during this study identified a number of changes in the high density airport and the airport system environment which are caused or allowed to occur under existing policies which result in a change in airport aircraft traffic mix and in turn, alleviate the saturation problem. These changes include:

- Implementation of TCA Group I or Group II airspace control procedures and requirements.
- Installation of new avionics at the high density airport or a local general aviation airport.
- Construction of new or expansion of existing public or privately owned local neighboring airports.
- Commissioning of a traffic control tower at a local general aviation airport.
- Shortages or increased cost of tie downs and T-hangars at the high density airport.
- Increased landing fees at the high density airport.
- Increased delays or congestion at the high density airport resulting from normal traffic growth.
- Introduction or increased frequency of air carrier jet aircraft operations.

These changes in the local airport system environment affect aircraft traffic mix through their impact on the general aviation operator's use patterns. The user's response to evolutionary changes in the airport system environment may take the following forms: (1) enduring the cost and inconvenience and continuing to operate as before, (2) relocating to an alternate local general aviation airport, (3) adjusting their flying schedule to avoid high traffic periods at the high density airport or (4) stop or reduce their frequency of flying. There are indications from historic and current aircraft traffic data that segments of the general aviation community are making these adjustments in their airport system use pattern. However, with available data, it cannot be ascertained which changes in airport system environment are most responsible for this effect.

Figure 5-5 and the hourly traffic distribution graphs indicate the current extent of general aviation flight schedule adjustment to avoid periods of high traffic congestion. This adjustment is reflected in the relatively even distribution of general aviation and total traffic during a majority of the daylight hours. It should be noted that congestion is a relative measure and is not necessarily synonymous with saturation or an environment in which aircraft delays are being experienced. This may explain why traffic tends to be evenly distributed even at airports where demand is considerably less than its capacity (all of the selected sample airports have busy hour demands that are ≤50% of VFR PHOCAP).

There is other evidence to suggest that natural forces are at work in modifying an airport's traffic mix which thereby reduces its saturation problems. Historical operations data pertaining to the largest airports (i.e., the high density airports) indicate that self-limiting conditions come into play when airports reach the higher operation levels. A review of the 25 largest air carrier airports as a whole shows that their total operations have grown little (less than 3 percent) beyond their level ten years ago. Though air carrier operations are 16 percent higher than ten years ago, this type of traffic has diminished more recently, i.e., during the last five years, as the wide-body jets have been introduced. Perhaps the most striking change is that which has occurred with general aviation traffic at the 25 largest airports. These airports presently average 68,000 GA operations per airport, yet ten years ago, their average was 112,000 operations; that is, 65 percent greater than today's level. Furthermore, local general aviation activity has decreased during this period from 10 percent to 3 percent of the airports' total operations.

Similar relationships can be noted for the group of test airports selected to be examined in this study, even though they, as a group, can be considered to be less saturated than the country's largest airports. Figure 5-6 illustrates the change in traffic during the last ten years at the sample airports; the average of the airports' cumulative operations is depicted. Again, it is noted that total operations appear to have

HISTORICAL TRAFFIC DATA - SAMPLE AIRPORTS

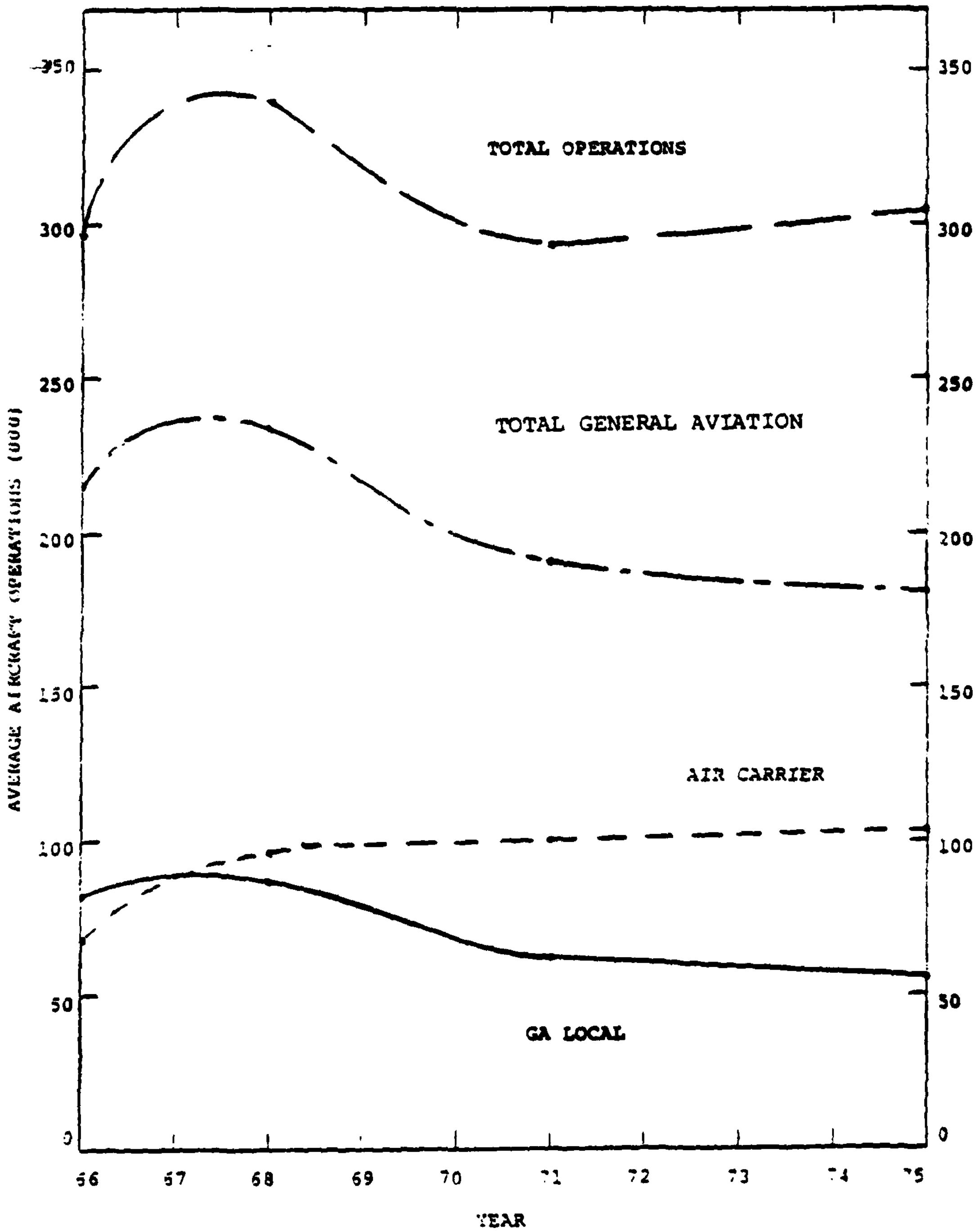


Figure 5-6

leveled even though air carrier operations show a continual increase during the decade. Although less dramatic than the change at the 25 largest airports, there is also a reduction in general aviation and particularly with local GA activity.

Consequently, this historical data indirectly implies that the general aviation community does in fact alter its use patterns at high density airports. Obviously, certain users have endured the different conditions and continue to operate as before. In support of this, it can be noted that at the nine selected sample airports, there has been a modest but continuous increase in the number of based aircraft during the last ten years. On the other hand, it can be reasoned that many users have altered their use patterns. Using the same based aircraft data, the relative increase in aircraft at these nine airports amounted to 18 percent over ten years, considerably less than the national increase of 61 percent during the same time, suggesting that many users relocated to other airports. It can also be reasoned that certain users either stopped or reduced their flying frequency during this period. The reasoning is based on the 1966 aircraft usage rate of 838 GA operations per based aircraft as compared with a value of 592, which applies to 1975.

Based on the above discussions, it is concluded that a significant portion of the advantages that might be realized from implementation of candidate options 3 and 4, will in fact be realized under the current aviation policies and procedures. Under the present policies, the disadvantages that are associated with implementation of these options may be avoided.

6.0 CONCLUSIONS

Based on an analysis of the five candidate options, it is concluded that only marginal benefits would be derived from implementation of new aviation policies specifically derived to change airport aircraft traffic mix parameters for the purpose of postponing saturation. The hypothetical implementation of the candidate options at the test airports indicates that the continuation of current aviation policy (Option 5) will have generally the same effect on the aircraft traffic mix parameters as the candidate new policies (Options 1 through 4).

This conclusion does not preclude the possibility of significant benefit from implementation of Options 1 through 4 in certain cases. While it was intended that the test airports would be selected to represent the spectrum of high density airports (and their characteristics), it is unlikely that such an objective was totally achieved. Consequently, there may be airports that have a certain combination of conditions wherein overt actions, for the sake of postponing saturation, would be effective. Decisions regarding the advisability of implementing the candidate options at a particular airport must be based on an evaluation of that airport's unique characteristics, including traffic mix, facilities configuration, and demand forecast. Additionally, when implementation of Option 3 is being considered, the equivalent data for the local neighboring airports must also be evaluated. The Section 5 analysis provides the basic framework for evaluation of potential benefits, disadvantages and advisability of implementing the candidate options at a particular airport.

The following summarizes the conclusions that may be drawn about each of the options.

- Option 1 - Modification of air traffic control handling procedures was assessed as an ineffective means of postponing saturation since the present system already exhibits an efficiency that is unlikely to be achieved in another way. It is noted, however, that this assessment is based on an evaluation of procedures at airports with traffic demand at 50 percent or less of capacity. While the above conclusions are presumed to apply at saturation, the airport environment when at or near saturation may be significantly different and consequently warrant a reassessment of traffic handling procedures. This could be particularly applicable at airports with complex configurations, such as Memphis International Airport, where significant advantages are realized from efficient traffic handling.

- Option 2 - Grouping of aircraft arrivals and departures is not an effective means of postponing saturation. It has marginal, perhaps nonexistent, advantages and the inherent problems associated with safety and scheduling do not warrant its application.

- Option 3 - Restricting or inhibiting use of the high density airports by categories of user and/or aircraft is a marginally effective means of postponing saturation. While the hypothetical implementation of this option at the test airports indicates a potential for significant benefit, it assumes no voluntary relocation by general aviation. However, as pointed out in the Option 5 analysis, historical traffic growth data indicates that towered airports are not experiencing their proportionate share of the national general aviation traffic growth. This, in fact, is indicative of voluntary relocation by general aviation. Consequently, the expected effectiveness identified through the hypothetical implementation of this option is largely "fictitious." This option is not completely dismissed as ineffective, however, due to its potential in those cases where voluntary relocation is not adequately effective. While the effectiveness of this option would be limited at airports which have or are becoming predominantly business GA aircraft operation oriented, such as Detroit and Cleveland, a greater possible benefit could be realized at airports where pleasure and training operations are significant, such as Fort Lauderdale.

Implementation of this option at the selected airports resulted in an estimate that the maximum potential effectiveness for postponing saturation would be 5 to 19 years. However, its expected effectiveness was from 3 to 13 years. The differences between the potential and expected benefits are principally attributable to the eventual saturation of the local area, i.e., the high density airport combined with the local neighboring airports. In this area saturated environment, further relocation of airport users would be impractical.

- Option 4 - Redistribution of traffic demand to the less busy hours was also determined to be a marginally effective means of postponing saturation. The effectiveness of this option was measured by the increased PANCAP that could be realized. The hypothetical implementation of this option at the selected airports resulted in a maximum potential PANCAP increase of 10 percent to 25 percent. However, its estimated expected effectiveness was 0 percent to 13 percent. The principal limiting factors were the undesirability of nonbusy hours to general aviation users and the required flexibility necessary to accommodate inconsistencies in busy hour occurrence. This option would be most effective at airports which experience the higher levels of general aviation traffic, 60 percent plus, such as San Jose Municipal, Phoenix Sky Harbor, and Nashville Metropolitan.

- Option 5 - Continued application of existing FAA and airport management policies already appears to be effective in reducing the problems posed for tentative solution. Interviews with airport personnel and historical data indicate that a significant portion of the quantitative advantage that could be realized from implementation of candidate options 3 and 4, will in fact be realized through continued application of existing aviation policies. This change is attributed to the continuing adjustment of airport use patterns by general aviation in an effort to minimize the cost and inconvenience of flying. General aviation's quest for lower costs and reduced inconvenience naturally leads to more efficient airport system use, which in turn leads to a delay in saturation. Application of this option, that is, continued use of existing aviation policy, would be most appropriate at airports which are at 80 percent or less saturated, which includes all the test airports.

In summary, from the above conclusions, it appears that the recommended approach is not to invoke special activities to alleviate the saturation problem but rather to continue with the present procedures which are effective in achieving nearly the same level of benefits, yet avoid the disadvantages that are associated with the new procedures. This no action policy, however, should not imply that the problem solution is at hand. This study has only concluded that new noncapital procedures are unwarranted. The problems of congestion and airport saturation must still be faced and by a process of elimination, the study implies that solutions must necessarily be ones that involve capital expenditures.

While the study guidelines directed that only noncapital alternatives be addressed in this effort, a brief statement regarding capital alternatives is in order. This study has pointed out that area saturation is a limiting factor in the effectiveness of the noncapital alternatives and consequently is a contributing factor to the saturation problem at the high density airport. It becomes readily apparent that an effective type of action warranting implementation involves upgrading the GA reliever airports in the hub area. Consideration must be given to installation of ILS at these sites for use in training functions. Because we anticipate that area saturation will coincide with high density airport saturation, it is equally clear that expansion programs at local GA airports are warranted; such effort may be further justified in light of their lesser costs and their lesser environmental impact.

APPENDIX A

TEST AIRPORT

DATA BASE

GENERAL AIRPORT DATA

FOR

PHOENIX SKY HARBOR & SELECTED NEIGHBORING AIRPORTS

ITEM NO.	DATA SUBJECT			
1.	Airport Name	PHOENIX SKY HARBOR	LITCHFIELD MUNICIPAL	FALCON FIELD
2.	Dist. From HUB A/P	N/A	20 Miles West	16 Miles East
3.	Normal Runway Configuration	2 Parallel 8753' 10300' Config C	Single Runway 8500' Config A	Single Runway 4300' Config A
4.	Tower Approach Aid	Yes Precision	Yes Non Precision	No None
5.	Public/Private	Public	Public	Public
6.	Air Space Control	TRSA State III	None	None
7.	Aircraft Mix (Traffic)	A - 9% B - 13% C - 5% D&E - 73%	D&E - 100%	D&E - 100%
8.	VFR PHOCAP	310	99	99
9.	IFR PHOCAP	80	—	—
10.	PANCAP (000)	650	215	215
11.	Based Aircraft	S.E. - 448 M.E. - 146 TOTAL 594	S.E. - 71 M.E. - 20 TOTAL 91	S.E. - 180 M.E. - 25 TOTAL 205

TABLE A-1 Sheet 1

GENERAL AIRPORT DATA

FOR

PHOENIX SKY HARBOR & SELECTED NEIGHBORING AIRPORTS

ITEM NO.	DATA SUBJECT			
1.	Airport Name	DEER VALLEY MUNICIPAL	SCOTTSDALE	CHANDLER
2.	Dist. From HUB A/P	18 Miles North	14 Miles North North East	16 Miles South East
3.	Normal Runway Configuration	2 Parallel 5100' 4100' Config D	Single Runway 4800' Config A	Single Runway 2610' Config A
4.	Tower Approach Aid	Yes (Non Federal) None	Yes Non Precision	No None
5.	Public/Private	Public	Public	Public
6.	Air Space Control	None	None	None
7.	Aircraft Mix (Traffic)	D&E - 100%	D&E - 100%	D&E - 100%
8.	VFR PHOCAP	198	99	99
9.	IFR PHOCAP	—	53	—
10.	PANCAP (000)	425	215	215
11.	Based Aircraft	S.E. - 234 M.E. - 6 TOTAL 304	S.E. - 92 M.E. - 19 TOTAL 111	S.E. - 26 M.E. - 2 TOTAL 28

TABLE A-1 Sheet 2

GENERAL AIRPORT DATA

FOR

PHOENIX SKY HARBOR & SELECTED NEIGHBORING AIRPORTS

ITEM NO.	DATA SUBJECT	
1.	Airport Name	GLENDALE
2.	Dist. From HUB A/P	15 Miles North West
3.	Normal Runway Configuration	Single Runway 2400' Config A
4.	Tower Approach Aid	No None
5.	Public/Private	Public
6.	Air Space Control	None
7.	Aircraft Mix (Traffic)	D&E - 100%
8.	VFR PHOCAP	99
9.	IFR PHOCAP	—
10.	PANCAP (000)	215
11.	Based Aircraft	S.E. - 60 M.E. - 2 TOTAL 62

TABLE A-1 Sheet 3

GENERAL AIRPORT DATA

FOR

SAN DIEGO LINDBERG & SELECTED NEIGHBORING AIRPORTS

ITEM NO.	DATA SUBJECT			
1.	Airport Name	SAN DIEGO LINDBERG	MONTGOMERY	BROWN MUNI.
2.	Dist. From HUB A/P	N/A	5 Miles North North East	17 Miles South East
3.	Normal Runway Configuration	2 Intersection 9400' 4439' Config L	2 Parallel 3401' 3400' 3401' Config B plus Interesting Runway	2 Parallel 7999' 2498' Config B
4.	Tower Approach Aid	Yes Precesion	Yes None	Yes None
5.	Public/Private	Public	Public	Public
6.	Air Space Control	TRSA Stage II	TRSA Stage I	TRSA Stage I
7.	Aircraft Mix (Traffic)	A - 11% B - 27% C - 11% D&E - 51%	D&E - 100%	D&E - 100%
8.	VFR PHOCAP	125	250	198
9.	IFR PHOCAP	42	—	—
10.	PANCAP (000)	320	600	385
11.	Based Aircraft	S.E. - 19 M.E. - 21 TOTAL 40	S.E. - 415 M.E. - 110 TOTAL 525	S.E. - 381 M.E. - 41 TOTAL 422

TABLE A-2 Sheet 1

GENERAL AIRPORT DATA

FOR

SAN DIEGO LINDBERG & SELECTED NEIGHBORING AIRPORTS

ITEM NO.	DATA SUBJECT	
1.	Airport Name	GILLESPIE FIELD
2.	Dist. From HUB A/P	14 Miles North East
3.	Normal Runway Configuration	2 Parallel 5341' 2737' 4147' Config A + B
4.	Tower Approach Aid	Yes Non Precision
5.	Public/Private	Public
6.	Air Space Control	TRSA Stage I
7.	Aircraft Mix (Traffic)	D&E - 100%
8.	VFR PHOCAP	297
9.	IFR PHOCAP	53
10.	PANCAP (OCO)	600
11.	Based Aircraft	S.E. - 121 M.E. - 10 TOTAL 131

TABLE A-2 Sheet 2

GENERAL AIRPORT DATA

FOR

SAN JOSE MUNICIPAL & SELECTED NEIGHBORING AIRPORTS

ITEM NO.	DATA SUBJECT			
1.	Airport Name	SAN JOSE MUNICIPAL	PALO ALTO	REID HILLVIEW
2.	Dist. From HUB A/P	N/A.	12 Miles Northwest	5 Miles Southeast
3.	Normal Runway Configuration	3 Parallel 4,419' 8,900' 3,000'	Single Runway 2,500'	2 Parallel 3,101' 3,101'
		Config E	Config A	Config B
4.	Tower Approach Aid	Yes Precision	Yes None	Yes None
5.	Public/Private	Public	Public	Public
6.	Air Space Control	TRSA Stage 1	None	TRSA Stage 1
7.	Aircraft Mix (Traffic)	B-12% C- 5% D&E-83%	D&E-100%	D&E-100%
8.	VFR PHOCAP	260	99	200
9.	IFR PHOCAP	44	—	—
10.	PANCAP (000)	560	300	400
11.	Based Aircraft	S.E. - 436 M.E. - 109 Total- 545	S.E. - 281 M.E. - 20 Total- 301	S.E. - 509 M.E. - 28 Total 537

TABLE A-3 Sheet 1

GENERAL AIRPORT DATA

FOR

SAN JOSE MUNICIPAL & SELECTED NEIGHBORING AIRPORTS

ITEM NO.	DATA SUBJECT	
1.	Airport Name	FREEMONT
2.	Dist. From HUB A/P	7 Miles North
3.	Normal Runway Configuration	Single Runway 2,310' Dirt Config A
4.	Tower Approach Aid	No None
5.	Public/Private	Public
6.	Air Space Control	None
7.	Aircraft Mix (Traffic)	D & E - 100%
8.	VFR PHOCAP	99
9.	IFR PHOCAP	-
10.	PANCAP (000)	215
11.	Based Aircraft	S.E. - 32

TABLE A-3 Sheet 2

GENERAL AIRPORT DATA

FOR

DENVER STAPLETON & SELECTED NEIGHBORING AIRPORTS

ITEM NO.	DATA SUBJECT			
1.	Airport Name	DENVER STAPLETON	ARAPAHOE	JEFFERSON CO.
2.	Dist. From HUB A/P	N/A	10 Miles South	15 Miles North North West
3.	Normal Runway Configuration	2 Parallel 12,000' 11,499' 7,926' 10,010' 6,500' Config B+B	2 Parallel 4,903' 7,001' 5,145' Config A+B	2 Parallel 7,498' 4,000' 3,601' Config A+B
4.	Tower Approach Aid	Yes Precision	Yes Precision	Yes Precision
5.	Public/Private	Public	Public	Public
6.	Air Space Control	TCA Group II	None	None
7.	Aircraft Mix (Traffic)	A - 8% B - 48% C - 10% D&E 34%	D&E - 100%	D&E - 100%
8.	VFR PHOCAP	190	300	275
9.	IFR PHOCAP	84	53	53
10.	PANCAP (000)	500	600	550
11.	Based Aircraft	S.E. - 165 M.E. - 139 Total 304	S.E. - 252 M.E. - 39 Total 291	S.E. - 258 M.E. - 44 Total 302

TABLE A-4 Sheet 1

AD-A125 349 ANALYSIS OF NON-CAPITAL ALTERNATIVES FOR HANDLING GENERAL AVIATION ACTIVITY AT BUSY AIRPORTS(U) SYSCON CORP SAN DIEGO CA B BROWN ET AL. AUG 77 FAA-AVP-77-29 2/2

UNCLASSIFIED DOT-FATQWA-3865 F/G 17/7 NL

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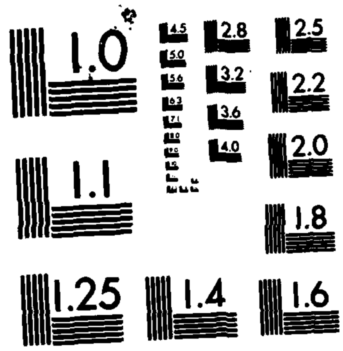

1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6

GENERAL AIRPORT DATA

FOR

DENVER STAPLETON & SELECTED NEIGHBORING AIRPORTS

ITEM NO.	DATA SUBJECT		
1.	Airport Name	SKY RANCH	COLUMBINE
2.	Dist. From HUB A/P	7 Miles East	17 Miles South Southwest
3.	Normal Runway Configuration	3 Intersecting 4,625' 4,850' 5,280' Sod/Gravel	Single Runway 4,000'
		Config M	Config A
4.	Tower Approach Aid	No None	No None
5.	Public/Private	Private	Private
6.	Air Space Control	None	None
7.	Aircraft Mix (Traffic)	D&E - 100%	D&E - 100%
8.	VFR PHOCAP	175	99
9.	IFR PHOCAP	—	—
10.	PANCAP (000)	375	215
11.	Based Aircraft	S.E. - 81 M.E. - 5 Total 86	S.E. - 61 M.E. - 1 Total 62

TABLE A-4 Sheet 2

GENERAL AIRPORT DATA

FOR

FT. LAUDERDALE - HOLLYWOOD & SELECTED NEIGHBORING AIRPORTS

ITEM NO.	DATA SUBJECT			
1.	Airport Name	FT. LAUDERDALE-HOLLYWOOD	FT. LAUDERDALE EXECUTIVE	NORTH PERRY
2.	Dist. From HUB A/P	N/A	8 Miles North	8 Miles Southwest
3.	Normal Runway Configuration	2 Parallel 8,054' 3,201' 6,020' Config P	3 Intersecting 6,000' 4,000' 4,000' Config M	4 Parallel 3,050' 3,003' 3,068' 3,000' Config A + B
4.	Tower Approach Aid	Yes Precision	Yes Non Precision	Yes None
5.	Public/Private	Public	Public	Public
6.	Air Space Control	TRSA Stage III	TRSA Stage I	None
7.	Aircraft Mix (Traffic)	A - 3% B - 15% C - 12% D&E - 70%	C - 10% D&E - 90%	D&E - 100%
8.	VFR PHOCAP	190	175	300
9.	IFR PHOCAP	96	14	—
10.	PANCAP (000)	500	375	600
11.	Based Aircraft	S.E. - 291 M.E. - 154 JET 6 TOTAL 451	S.E. - 158 M.E. - 40 JET 6 TOTAL 204	S.E. - 183 M.E. - 30 TOTAL 213

TABLE A-5 Sheet 1

GENERAL AIRPORT DATA

FOR

FT. LAUDERDALE - HOLLYWOOD & SELECTED NEIGHBORING AIRPORTS

ITEM NO.	DATA SUBJECT		
1.	Airport Name	POMPANO BEACH	OPA LOCKA
2.	Dist. From HUB A/P	12 Miles North	14 Miles South
3.	Normal Runway Configuration	3 Intersecting 4,400' 4,025' 3,500' Config M	5 Parallel 8,000' 3,300' 3,756' Config H 3,500' 3,280' 3,170'
4.	Tower Approach Aid	Yes Non Precision	Yes Non Precision
5.	Public/Private	Public	Public
6.	Air Space Control	TRSA Stage I	TRSA State I
7.	Aircraft Mix (Traffic)	D&E - 100%	C - 10% D&E - 90%
8.	VFR PHOCAP	175	390
9.	IFR PHOCAP	61	61
10.	PANCAP (000)	375	770
11.	Based Aircraft	S.E. - 101 M.E. - 23 TOTAL 125	S.E. - 392 M.E. - 126 JET - 9 TOTAL 527

TABLE A-5 Sheet 2

GENERAL AIRPORT DATA

FOR

DETROIT METRO WAYNE & SELECTED NEIGHBORING AIRPORTS

ITEM NO.	DATA SUBJECT			
1.	Airport Name	DETROIT METRO WAYNE AIRPORT	DETROIT CITY	WILLOW RUN
2.	Dist. From HUB A/P	N/A	22 Miles Northeast	10 Miles West
3.	Normal Runway Configuration	2 Parallel 10,500' 8,500' 8,702' 4,330' Config. D	2 Intersecting 5,091' 4,025' Config. L,	2 Parallel 6,656' 7,520' 6,511' 7,294' 6,914' Config. O,
4.	Tower Approach Aid	Yes Precision	Yes Precision	Yes Precision
5.	Public/Private	Public	Public	Public
6.	Air Space Control	TCA Group II	TRSA Stage 1	TRSA Stage 1
7.	Aircraft Mix (Traffic)	A - 15% B - 50% C - 12% D&E - 23%	C - 20% D&E - 80%	C - 10% D&E - 90%
8.	VFR PHOCAP	108	198	217
9.	IFR PHOCAP	84	53	53
10.	PANCAP (000)	340	400	465
11.	Based Aircraft	S.E. - 86 M.E. - 28 Total 104	S.E. - 200 M.E. - 110 Total 310	S.E. - 72 M.E. -120 Total 192

TABLE A-6 Sheet 1

GENERAL AIRPORT DATA

FOR

DETROIT METRO WAYNE & SELECTED NEIGHBORING AIRPORTS

ITEM NO.	DATA SUBJECT			
1.	Airport Name	GROSS ILE	CUSTER	NATIONAL
2.	Dist. From HUB A/P	12 Miles South East	20 Miles South	8 Miles North North West
3.	Normal Runway Configuration	2 Intersecting 4,980' 4,580' Config. L	Single Runway 3,500' Config A	Single Runway 2,800' Config A
4.	Tower Approach Aid	No None	No None	No None
5.	Public/Private	Public	Private	Private
6.	Air Space Control	None	None	None
7.	Aircraft Mix (Traffic)	D&E - 100%	D&E-100%	D&E - 100%
8.	VFR PHOCAP	175	99	99
9.	IFR PHOCAP	—	—	—
10.	PANCAP (000)	375	215	215
11.	Based Aircraft	S.E. - 136 M.E. - 8 Total 144	S.E. - 40 M.E. - 5 Total 45	S.E. - 120

TABLE A-6 Sheet 2

GENERAL AIRPORT DATA

FOR

DETROIT METRO WAYNE & SELECTED NEIGHBORING AIRPORTS

ITEM NO.	DATA SUBJECT	
1.	Airport Name	TROY
2.	Dist. From HUB A/P	24 Miles North North East
3.	Normal Runway Configuration	Single Runway 3,855' Config A
4.	Tower Approach Aid	No None
5.	Public/Private	Private
6.	Air Space Control	None
7.	Aircraft Mix (Traffic)	D&E - 100%
8.	VFR PHOCAP	99
9.	IFR PHOCAP	—
10.	PANCAP (000)	215
11.	Based Aircraft	S.E. - 68 M.E. - 10 Total 78

TABLE A-6 Sheet 3

GENERAL AIRPORT DATA

FOR

CLEVELAND HOPKINS & SELECTED NEIGHBORING AIRPORTS

ITEM NO.	DATA SUBJECT			
1.	Airport Name	CLEVELAND HOPKINS	CUYAHOGA	BURKE LAKEFRONT
2.	Dist. From HUB A/P	N/A	21 Miles Northeast	11 Miles Northeast
3.	Normal Runway Configuration	2 Close Parallel 6242' 6242' 9000' 6014' 5015' 6411' 2000' - SOD 1750' - SOD Config B	Single Runway 15000 Config A	2 Close Parallel 6200' 5200' Config B
4.	Tower Approach Aid	Yes Precision	Yes Precision	Yes Precision
5.	Public/Private	Public	Public	Public
6.	Air Space Control	TCA Group II	None	None
7.	Aircraft Mix (Traffic)	A - 8% B - 42% C - 13% D&E - 36%	C - 10% D&E - 90%	C - 10% D&E - 90%
8.	VFR PHOCAP	155	99	198
9.	IFR PHOCAP	42	53	64
10.	PANCAP (000)	360	300	385
11.	Based Aircraft	S.E. - 101 M.E. - 60 Jet - 14 TOTAL 182	S.E. - 155 M.E. - 48 TOTAL 203	S.E. - 15 M.E. - 18 TOTAL 33

TABLE A-7 Sheet 1

GENERAL AIRPORT DATA

FOR

CLEVELAND HOPKINS & SELECTED NEIGHBORING AIRPORTS

ITEM NO.	DATA SUBJECT			
1.	Airport Name	STRONGSVILLE	COLUMBIA	BOSWORTH
2.	Dist. From HUB A/P	6 Miles South	8 Miles South West	14 Miles West
3.	Normal Runway Configuration	2 Intersecting (midpoint) 2350' 2985' Config L2	2 Parallel 2000' 3300' Turf 1800' Turf Config B	Single Runway 3090' Turf/ Gravel Config A
4.	Tower Approach Aid	No None	No None	No None
5.	Public/Private	Private	Private	Private
6.	Air Space Control	None	None	None
7.	Aircraft Mix (Traffic)	D&E - 100%	D&E - 100%	D&E - 100%
8.	VFR PHOCAP	99	198	99
9.	IFR PHOCAP	--	---	--
10.	PANCAP (000)	220	300	215
11.	Based Aircraft	S.E. - 62 M.E. - 1 TOTAL 63	Unknown	S.E. - 19 M.E. - 1 TOTAL 20

TABLE A-7 Sheet 2

GENERAL AIRPORT DATA

FOR

MEMPHIS INTERNATIONAL & SELECTED NEIGHBORING AIRPORTS

ITEM NO.	DATA SUBJECT			
1.	Airport Name	MEMPHIS INTERNATIONAL	ARLINGTON MUNICIPAL	GENERAL DEWITT SPAIN
2.	Dist. From HUB A/P	N/A	23 Miles Northeast	11 Miles North Northwest
3.	Normal Runway Configuration	2 Parallel 5,977' 8,926' 4,338' 8,400' 9,320' Config B + L	Single Runway 3,800' Config A	Single Runway 3,800' Config A
4.	Tower Approach Aid	Yes Precision	No None	No None
5.	Public/Private	Public	Public	Public
6.	Air Space Control	TRSA Stage III	None	None
7.	Aircraft Mix (Traffic)	A - 2% B - 35% C - 8% D&E - 55%	D&E - 100%	D&E - 100%
8.	VFR PHOCAP	275	99	99
9.	IFR PHOCAP	115	—	—
10.	PANCAP (CCO)	650	215	215
11.	Based Aircraft	S.E. - 165 M.E. - 175 Total 340	S.E. - 27 M.E. - 8 Total 35	S.E. -16 M.E. - 6 Total 22

TABLE A-8 Sheet 1

GENERAL AIRPORT DATA

FOR

MEMPHIS INTERNATIONAL & SELECTED NEIGHBORING AIRPORTS

ITEM NO.	DATA SUBJECT			
1.	Airport Name	CHARLES BAKER	WILSON	WEST MEMPHIS (ARKANSAS)
2.	Dist. From HUB A/P	15 Miles North	7 Miles East	15 Miles West Northwest
3.	Normal Runway Configuration	2 Intersecting 3,500' 1,000'	2 Parallel 2,450' Turf 1,420' Turf 1,480' Turf	Single Runway 5,000'
		Config K,	Config B	Config A
4.	Tower Approach Aid	No No	No No	Yes Non Precision
5.	Public/Private	Public	Private	Public
6.	Air Space Control	None	None	None
7.	Aircraft Mix (Traffic)	D&E - 100%	D&E - 100%	D&E - 100%
8.	VFR PHOCAP	198	198	99
9.	IFR PHOCAP	—	—	44
10.	PANCAP (000)	420	385	215
11.	Based Aircraft	S.E. - 114 M.E. - 21 Total 135	S.E. - 32	S.E. - 54 M.E. - 19 Total 73

TABLE A-8 Sheet 2

GENERAL AIRPORT DATA

FOR

MEMPHIS INTERNATIONAL & SELECTED NEIGHBORING AIRPORTS

ITEM NO.	DATA SUBJECT		
1.	Airport Name	DESOTO (Mississippi)	OLIVE BRANCH (Mississippi)
2.	Dist. From HUB A/P	5 Miles Southwest	12 Miles Southwest
3.	Normal Runway Configuration	Single Runway 2,600' Config A	Single Runway 4,000' Config A
4.	Tower Approach Aid	No No	No No
5.	Public/Private	Private	Private
6.	Air Space Control	None	None
7.	Aircraft Mix (Traffic)	D&E - 100%	D&E - 100%
8.	VFR PHOCAP	99	99
9.	IFR PHOCAP	—	—
10.	PANCAP (000)	215	215
11.	Based Aircraft	S.E. - 24 M.E. - 4 Total 28	Unknown

TABLE A-8 Sheet 3

GENERAL AIRPORT DATA

FOR

NASHVILLE METROPOLITAN & SELECTED NEIGHBORING AIRPORTS

ITEM NO.	DATA SUBJECT			
1.	Airport Name	NASHVILLE METROPOLITAN	SMYRNA	LEBANON
2.	Dist. From HUB A/P	N/A	12 Miles Southeast	20 Miles East Northeast
3.	Normal Runway Configuration	2 Parallel 7700' 4040' Config B	2 Intersecting 8004' 3389' Config L,	2 Intersecting 3500' 2300' SOD Config L,
4.	Tower Approach Aid	Yes Precision	No Non Precision	No Non Precision
5.	Public/Private	Public	Public	Public
6.	Air Space Control	TRSA Stage III	None	None
7.	Aircraft Mix (Traffic)	B - 25% C - 7% D&E - 68%	D&E - 100%	D&E - 100%
8.	VFR PHOCAP	160	175	175
9.	IFR PHOCAP	63	44	44
10.	PANCAP (000)	360	375	375
11.	Based Aircraft	S.E. - 66 M.E. - 68 TOTAL 134	S.E. - 21 M.E. - 5 TOTAL 26	S.E. - 23 M.E. - 3 TOTAL 26

TABLE A-9 Sheet 1

PHOENIX SKY HARBOR AND LOCAL NEIGHBORING AIRPORTS

AIRCRAFT OPERATIONS DEMAND LEVELS

AIRPORT NAME	ACTUAL LEVELS 1975 OPERATIONS (000)						FORECAST LEVELS 1982 OPERATIONS (000)						FORECAST LEVELS 1987 OPERATIONS (000)					
	TOT	AC	AT	GAL	GAI	MIL	TOT	AC	AT	GAL	GAI	MIL	TOT	AC	AT	GAL	GAI	MIL
PHOENIX SKY HARBOR	434	89	9	92	233	11	701	117	19	169	385	11	783	137	35	99	501	11
LITCHFIELD	129	0	0	91	38	0	185	0	0	128	57	0	221	0	0	139	82	0
FALCON FIELD	126	0	0	71	55	0	218	0	0	129	89	0	297	0	0	180	117	0
DEER VALLEY	164	0	0	87	77	0	221	0	0	130	91	0	280	0	0	182	98	0
SCOTTSDALE	159	0	0	91	68	0	229	0	0	126	103	0	274	0	0	125	149	0
CHANDLER	80	0	0	67	13	0	128	0	0	106	22	0	180	0	0	147	33	0
GLENDALE	92	0	0	73	19	0	148	0	0	115	33	0	207	0	0	159	49	0
TOTAL	1184	89	9	572	503	11	1830	117	19	903	780	11	2242	137	35	1031	1028	11

TOT - Total Aircraft Operations, AC - Air Carrier Operations, AT - Air Taxi Operations
GAL - General Aviation Local Operations, GAI - General Aviation Itinerant Operations
MIL - Military Aircraft Operations

TABLE A-10

SAN DIEGO LINDBERG AND LOCAL NEIGHBORING AIRPORTS

AIRCRAFT OPERATIONS DEMAND LEVELS

AIRPORT NAME	ACTUAL LEVELS 1975 OPERATIONS (000)						FORECAST LEVELS 1982 OPERATIONS (000)						1987 OPERATIONS (000)					
	TOT	AC	AT	GAL	GAI	MIL	TOT	AC	AT	GAL	GAI	MIL	TOT	AC	AT	GAL	GAI	MIL
SAN DIEGO LINDBERG	190	72	9	29	73	7	320	93	23	79	118	7	400	111	45	82	82	7
MONTGOMERY	325	0	1	201	123	0	468	0	1	266	201	0	559	0	1	267	267	0
BROWN	178	0	0	124	50	4	256	0	0	177	75	4	306	0	0	195	195	0
GILLESPIE	246	0	0	131	115	0	354	0	0	181	173	0	423	0	0	173	173	0
TOTAL	939	72	10	485	361	11	1398	93	24	703	567	11	1168	111	46	717	807	7

TOT - Total Aircraft Operations, AC - Air Carrier Operations, AT - Air Taxi Operations
GAL - General Aviation Local Operations, GAI - General Aviation Itinerant Operations
MIL - Military Aircraft Operations

TABLE A-11

SAN JOSE MUNICIPAL AND LOCAL NEIGHBORING AIRPORTS

AIRCRAFT OPERATIONS DEMAND LEVELS

AIRPORT NAME	ACTUAL LEVELS 1975 OPERATIONS (000)						FORECAST LEVELS 1982 OPERATIONS (000)						1987 OPERATIONS (000)					
	TOT	AC	AT	GAL	GAI	MIL	TOT	AC	AT	GAL	GAI	MIL	TOT	AC	AT	GAL	GAI	MIL
SAN JOSE	428	52	8	215	152	1	560	68	12	229	250	1	953	80	18	529	325	1
PALTO ALTO	189	0	0	109	80	0	300	0	0	170	130	0	438	0	0	268	170	0
REID HILLVIEW	304	0	0	180	124	0	437	0	0	251	186	0	522	0	0	253	269	0
FREEMONT	62	0	0	36	26	0	66	0	0	35	31	0	70	0	0	33	37	0
TOTAL	983	52	8	540	382	1	1363	68	12	685	597	1	1983	80	18	1083	801	1

TOT - Total Aircraft Operations, AC - Air Carrier Operations, AT - Air Taxi Operations
GAL - General Aviation Local Operations, GAI - General Aviation Itinerant Operations
MIL - Military Aircraft Operations

TABLE A-12

DENVER STAPLETON AND LOCAL NEIGHBORING AIRPORTS

AIRCRAFT OPERATIONS DEMAND LEVELS

AIRPORT NAME	ACTUAL LEVELS 1975 OPERATIONS (000)						FORECAST LEVELS 1982 OPERATIONS (000)						1987 OPERATIONS (000)					
	TOT	AC	AT	GAL	GAI	MIL	TOT	AC	AT	GAL	GAI	MIL	TOT	AC	AT	GAL	GAI	MIL
DENVER STAPLETON	397	203	20	25	147	2	497	268	44	11	172	2	770	314	77	62	315	2
ARAPAHOE	237	0	0	166	71	0	410	0	0	294	116	0	559	0	0	408	151	0
JEFFERSON CO.	233	0	0	124	108	1	402	0	4	220	177	1	543	0	6	306	230	1
SKY RANCH	119	0	0	110	9	0	247	0	0	228	19	0	416	0	0	385	31	0
COLUMBINE	61	0	0	48	13	0	127	0	0	100	27	0	213	0	0	168	45	0
TOTAL	1047	203	20	473	348	3	1683	268	48	853	511	3	2501	314	83	1329	772	3

TOT - Total Aircraft Operations, AC - Air Carrier Operations, AT - Air Taxi Operations
GAL - General Aviation Local Operations, GAI - General Aviation Itinerant Operations
MIL - Military Aircraft Operations

TABLE A-13

FT. LAUDERDALE - HOLLYWOOD AND NEIGHBORING AIRPORTS

AIRCRAFT OPERATIONS DEMAND LEVELS

AIRPORT NAME	ACTUAL LEVELS 1975 OPERATIONS (000)						FORECAST LEVELS 1982 OPERATIONS (000)						1987 OPERATIONS (000)					
	TOT	AC	AT	GAL	GAI	MIL	TOT	AC	AT	GAL	GAI	MIL	TOT	AC	AT	GAL	GAI	MIL
FT. LAUDERDALE - HOLLYWOOD	331	68	16	85	160	2	540	88	35	141	274	2	700	103	62	176	357	2
FT. LAUDERDALE EXECUTIVE	179	0	0	109	70	0	249	0	0	146	103	0	339	0	0	208	131	0
NORTH PERRY	225	0	0	149	76	0	314	0	0	202	112	0	426	0	0	284	142	0
POMPANO BEACH	157	0	0	93	64	0	217	0	0	123	94	0	297	0	0	178	119	0
OPA LOCKA	429	0	0	217	200	12	700	0	0	357	331	12	774	0	0	329	433	12
TOTAL	1321	68	16	653	570	14	2020	88	35	969	914	14	2536	103	62	1175	1182	14

TOT - Total Aircraft Operations, AC - Air Carrier Operations, AT - Air Taxi Operations
GAL - General Aviation Local Operations, GAI - General Aviation Itinerant Operations
MIL - Military Aircraft Operations

Table A-14

DETROIT METROPOLITAN AND LOCAL NEIGHBORING AIRPORTS

AIRCRAFT OPERATIONS DEMAND LEVELS

AIRPORT NAME	ACTUAL LEVELS 1975 OPERATIONS (000)						FORECAST LEVELS 1982 OPERATIONS (000)						1987 OPERATIONS (000)					
	TOT	AC	AT	GAL	GAI	MIL	TOT	AC	AT	GAL	GAI	MIL	TOT	AC	AT	GAL	GAI	MIL
DETROIT METRO	235	161	13	0	61	0	340	216	20	0	104	0	425	253	29	0	143	0
DETROIT CITY	184	2	11	76	95	0	337	3	24	144	166	0	452	4	33	199	216	0
WILLOW RUN	170	2	12	103	53	0	298	3	33	179	83	0	407	4	47	249	107	0
GROSS ILE	133	0	0	122	11	0	153	0	0	140	13	0	169	0	0	155	14	0
CUSTER	44	0	0	23	21	0	51	0	0	25	26	0	55	0	0	25	30	0
NATIONAL	94	0	0	67	27	0	110	0	0	77	33	0	122	0	0	84	38	0
TROY	43	0	0	26	17	0	51	0	0	30	21	0	56	0	0	32	24	0
TOTAL	903	165	36	417	285	0	1340	222	77	595	446	0	1686	261	109	744	572	0

TOT - Total Aircraft Operations, AC - Air Carrier Operations, AT - Air Taxi Operations
GAL - General Aviation Local Operations, GAI - General Aviation Itinerant Operations
MIL - Military Aircraft Operations

TABLE A-15

CLEVELAND HOPKINS AND LOCAL NEIGHBORING AIRPORTS

AIRCRAFT OPERATIONS DEMAND LEVELS

AIRPORT NAME	ACTUAL LEVELS 1975 OPERATIONS (000)						FORECAST LEVELS 1982 OPERATIONS (000)						1987 OPERATIONS (000)					
	TOT	AC	AT	GAL	GAI	MIL	TOT	AC	AT	GAL	GAI	MIL	TOT	AC	AT	GAL	GAI	MIL
CLEVELAND HOPKINS	233	124	16	27	65	1	336	164	21	27	124	1	424	192	25	27	179	1
CUYAHOGA	121	0	0	55	66	0	205	0	0	98	107	0	300	0	0	160	140	0
BURKE LAKEFRONT	53	3	6	8	35	1	83	3	7	14	57	1	109	4	9	20	75	1
STRONGSVILLE	75	0	0	54	21	0	112	0	0	78	34	0	151	0	0	103	48	0
COLUMBIA	21	0	0	12	9	0	35	0	0	21	14	0	46	0	0	26	20	0
BOSWORTH	49	0	0	16	33	0	74	0	0	21	53	0	99	0	0	25	74	0
TOTAL	552	127	22	172	229	2	845	167	28	259	389	2	1129	196	34	361	536	2

TOT - Total Aircraft Operations, AC - Air Carrier Operations, AT - Air Taxi Operations
GAL - General Aviation Local Operations, GAI - General Aviation Itinerant Operations
MIL - Military Aircraft Operations

TABLE A-16

MEMPHIS INT'L AND SELECTED LOCAL AIRPORTS

AIRCRAFT OPERATIONS DEMAND LEVELS

AIRPORT NAME	ACTUAL LEVELS 1975 OPERATIONS (000)						FORECAST LEVELS 1982 OPERATIONS (000)						1987 OPERATIONS (000)					
	TOT	AC	AT	GAL	GAI	MIL	TOT	AC	AT	GAL	GAI	MIL	TOT	AC	AT	GAL	GAI	MIL
MEMPHIS	292	107	27	12	141	5	432	141	43	23	220	5	553	165	60	33	290	5
ARLINGTON	56	0	0	38	18	0	60	0	0	39	21	0	63	0	0	40	23	0
SPAIN	47	0	0	29	18	0	50	0	0	29	21	0	53	0	0	30	23	0
BAKER	81	0	0	38	43	0	88	0	0	39	49	0	92	0	0	37	55	0
WILSON	53	0	0	35	18	0	57	0	0	36	21	0	60	0	0	37	23	0
WEST MEMPHIS	59	0	0	32	27	0	106	0	0	53	53	0	139	0	0	68	71	0
DESOTO	22	0	0	14	8	0	30	0	0	20	11	0	40	0	0	26	14	0
OLIVE BRANCH	90	0	0	60	30	0	127	0	0	84	43	0	162	0	0	108	54	0
TOTAL	700	107	27	258	303	5	951	141	43	323	439	5	1162	165	60	379	553	5

TOT - Total Aircraft Operations, AC - Air Carrier Operations, AT - Air Taxi Operations
GAL - General Aviation Local Operations, GAI - General Aviation Itinerant Operations
MIL - Military Aircraft Operations

TABLE A-17

NASHVILLE METROPOLITAN AND SELECTED NEIGHBORING AIRPORTS

AIRCRAFT OPERATIONS DEMAND LEVELS

AIRPORT NAME	ACTUAL LEVELS 1975 OPERATIONS (000)						FORECAST LEVELS 1982 OPERATIONS (000)						1987 OPERATIONS (000)					
	TOT	AC	AT	GAL	GAI	MIL	TOT	AC	AT	GAL	GAI	MIL	TOT	AC	AT	GAL	GAI	MIL
NASHVILLE METROPOLITAN	195	54	10	21	102	8	271	71	16	24	152	8	392	83	22	69	210	8
SMYRNA	51	0	0	31	20	0	55	0	0	32	23	0	57	0	0	32	25	0
LEBANON	16	0	0	5	11	0	17	0	0	5	12	0	18	0	0	5	13	0
TOTAL	262	54	10	57	133	8	343	71	16	61	187	8	467	83	22	106	248	8

TOT - Total Aircraft Operations, AC - Air Carrier Operations, AT - Air Taxi Operations
GAL - General Aviation Local Operations, GAI - General Aviation Itinerant Operations
MIL - Military Aircraft Operations

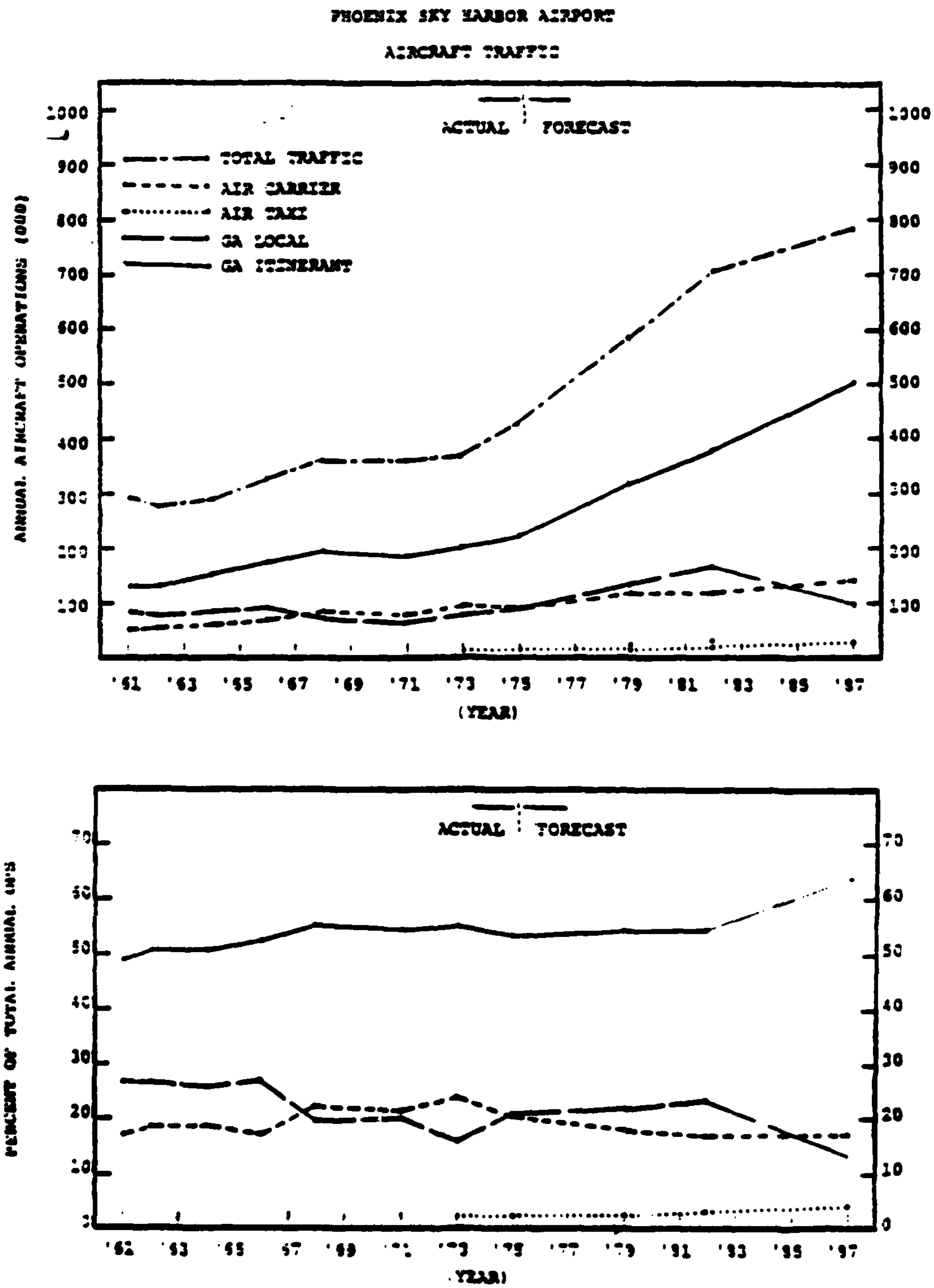
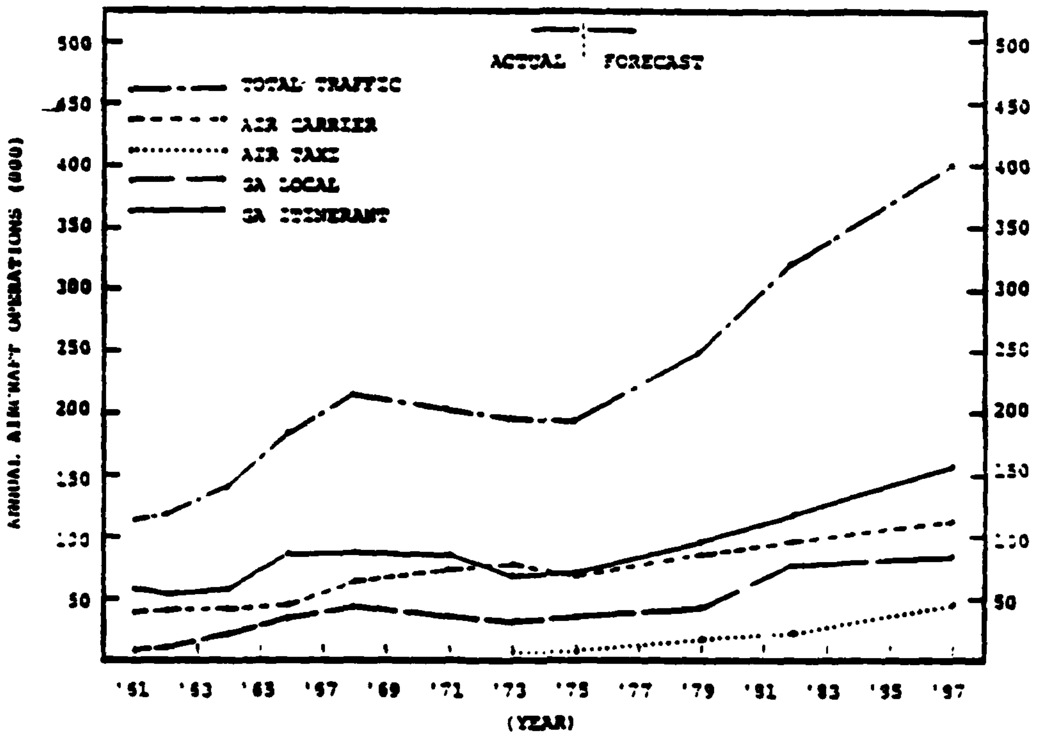

PHOENIX SKY HARBOR AIRPORT
AIRCRAFT TRAFFIC
ACTUAL
FORECAST
TOTAL TRAFFIC
AIR CARRIER
AIR TAXI
GA LOCAL
GA ITINERANT
ANNUAL AIRCRAFT OPERATIONS (000)
(YEAR)
PERCENT OF TOTAL ANNUAL OPS

FIGURE A-1

SAN DIEGO LINDBERG AIRPORT

AIRCRAFT TRAFFIC



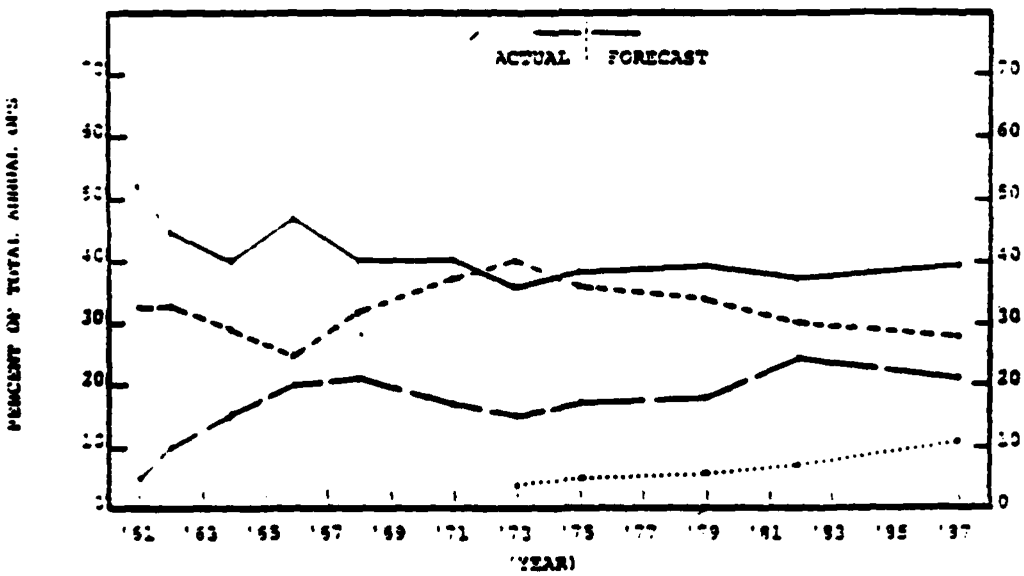


FIGURE A-2

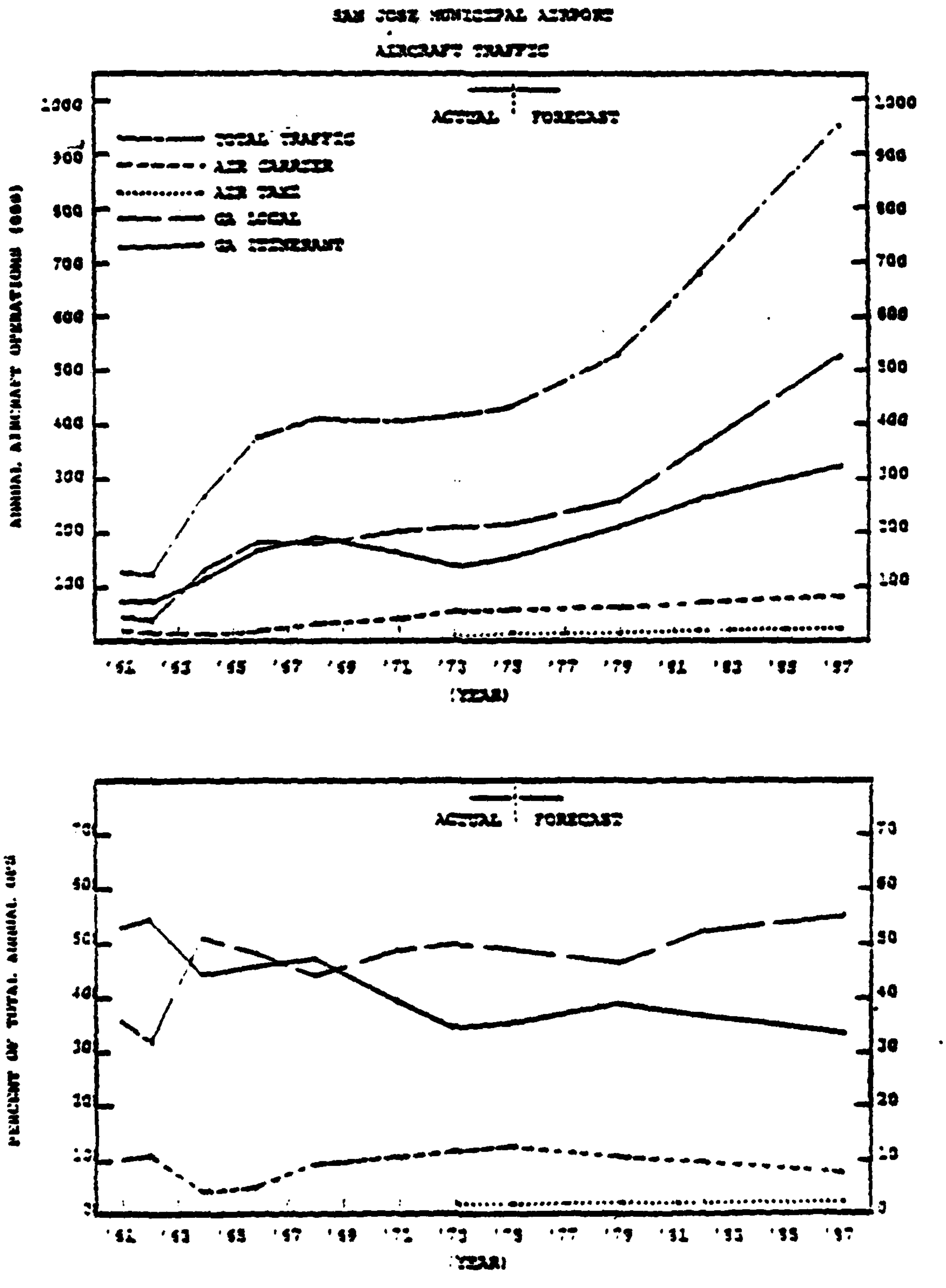


FIGURE A-3

DENVER STAPLETON INTERNATIONAL AIRPORT

AIRCRAFT TRAFFIC

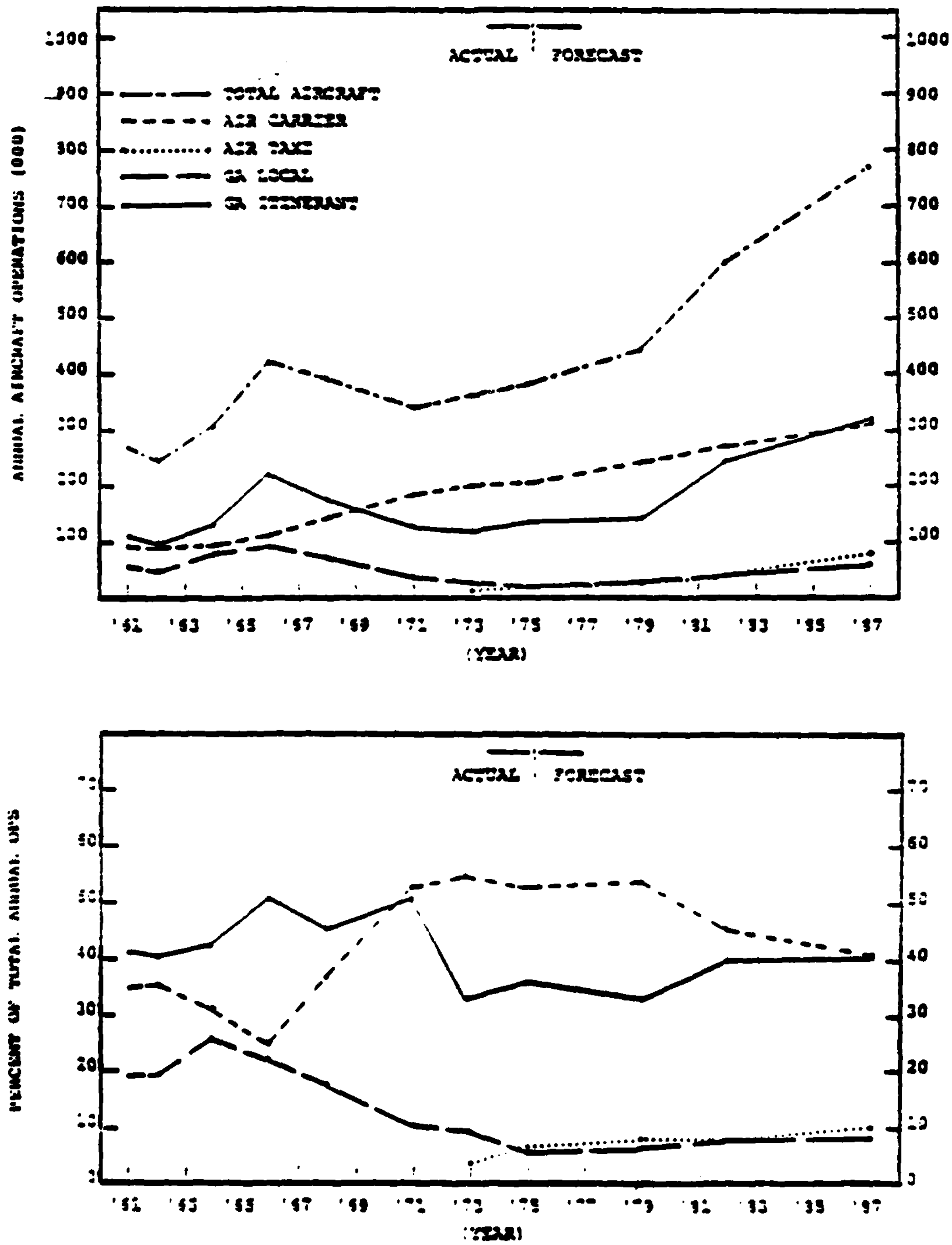


FIGURE A-4

FORT LAUDERDALE-HOLLYWOOD AIRPORT

AIRCRAFT TRAFFIC

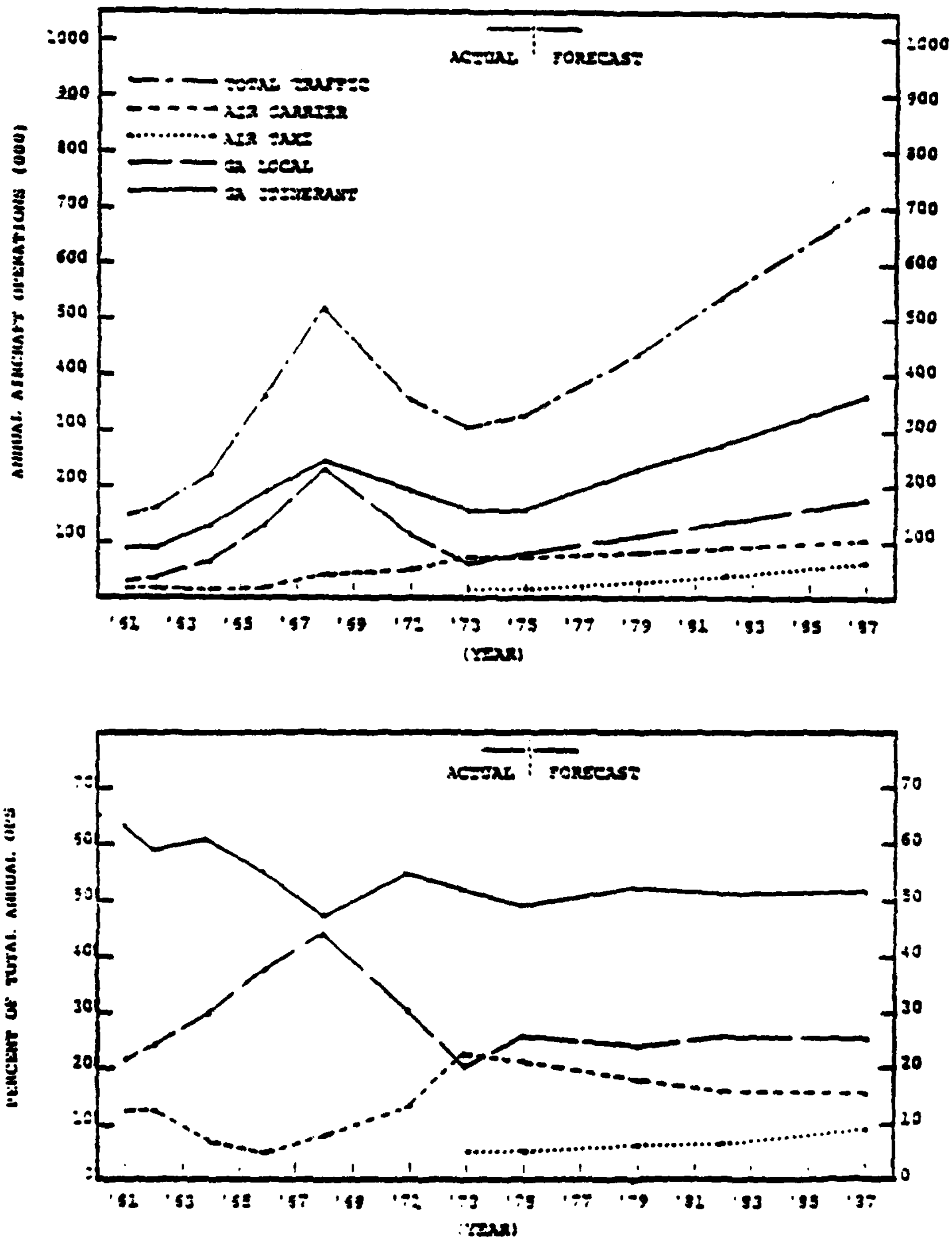


Figure A-5

DETROIT METROPOLITAN WAYNE AIRPORT

AIRCRAFT TRAFFIC

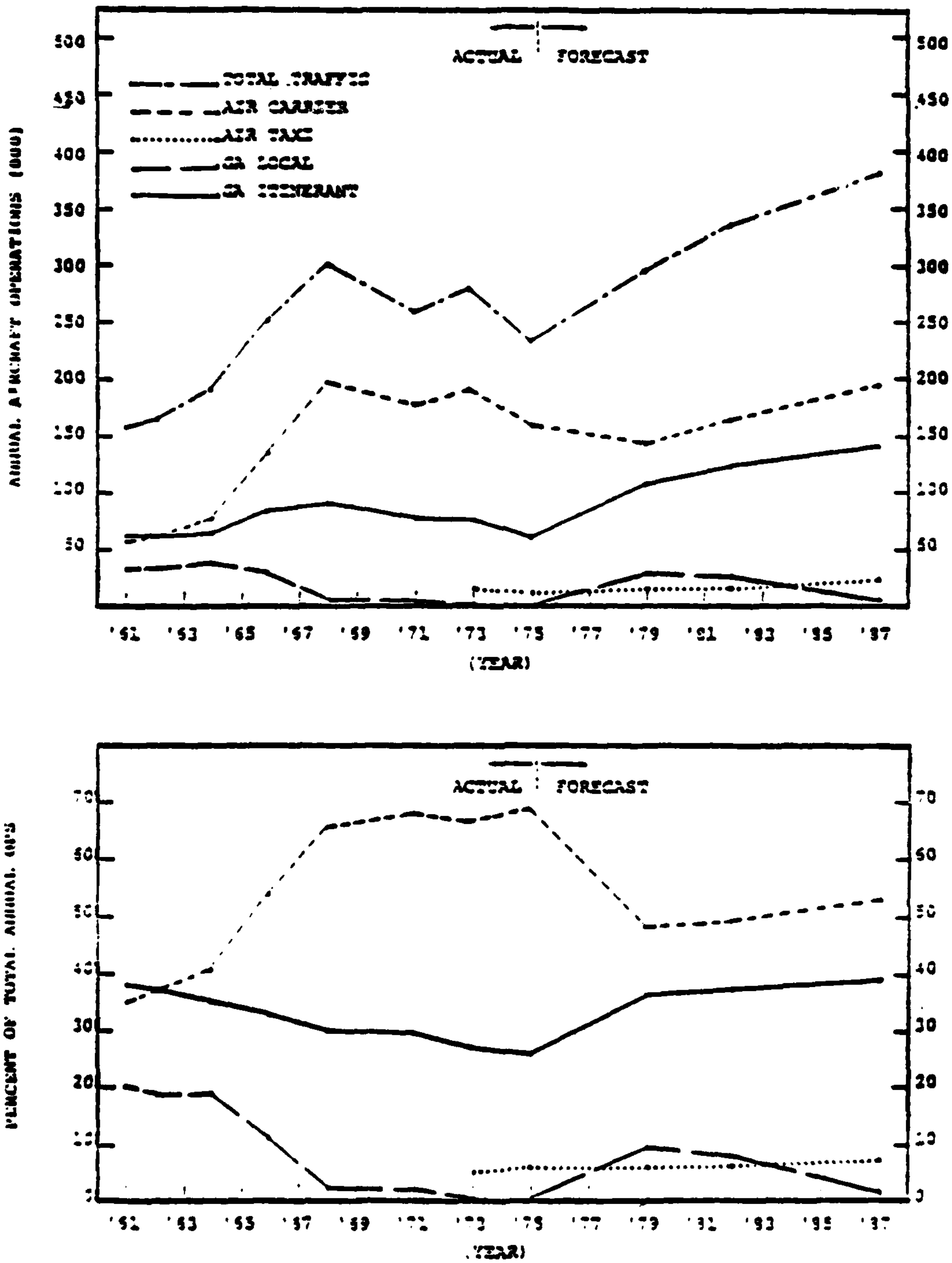


FIGURE A-6

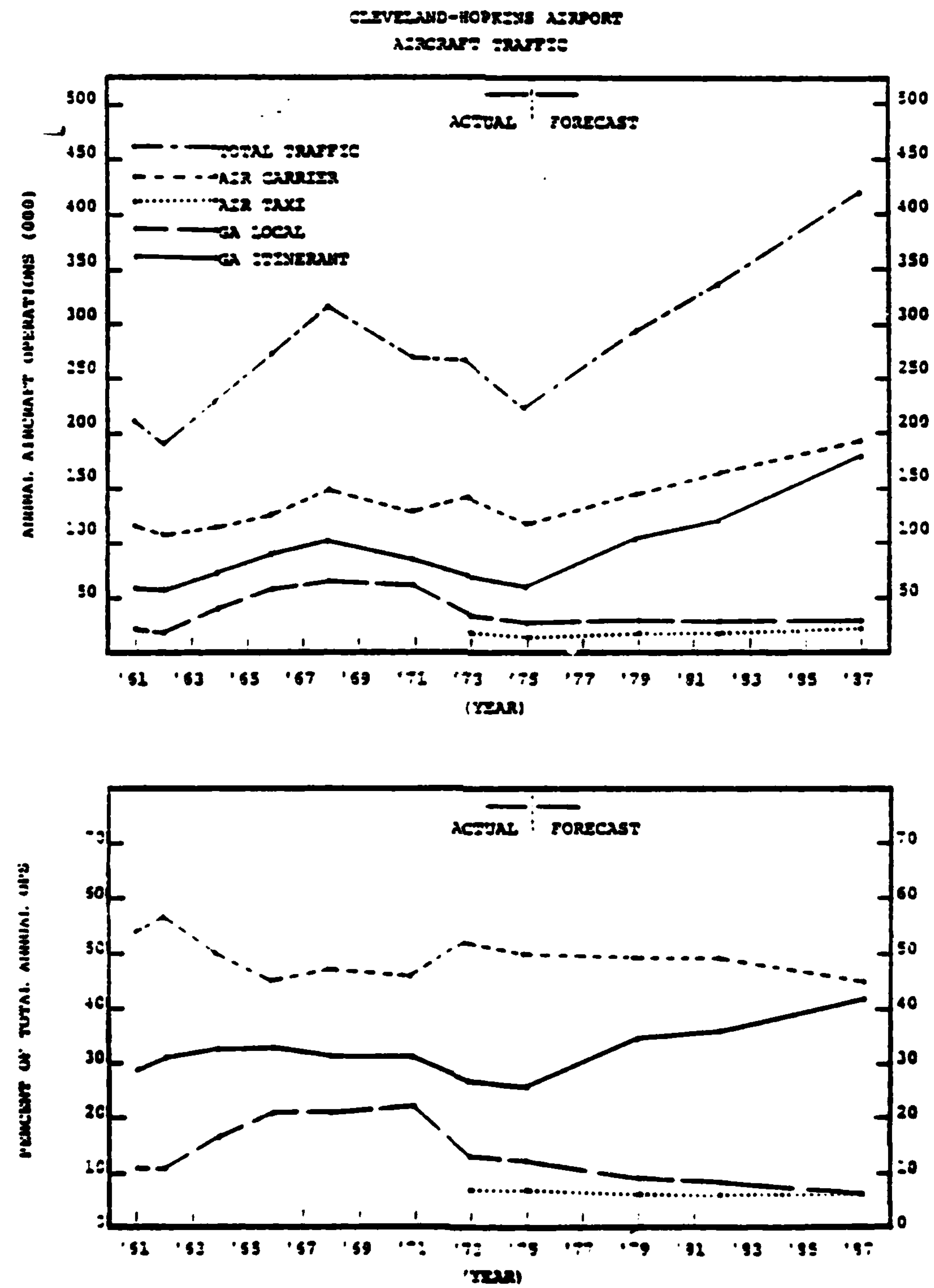

CLEVELAND-HOPKINS AIRPORT
AIRCRAFT TRAFFIC
ACTUAL
FORECAST
TOTAL TRAFFIC
AIR CARRIER
AIR TAXI
GA LOCAL
GA ITINERANT
ANNUAL AIRCRAFT OPERATIONS (000)
PERCENT OF TOTAL ANNUAL OPS
(YEAR)

FIGURE A-7

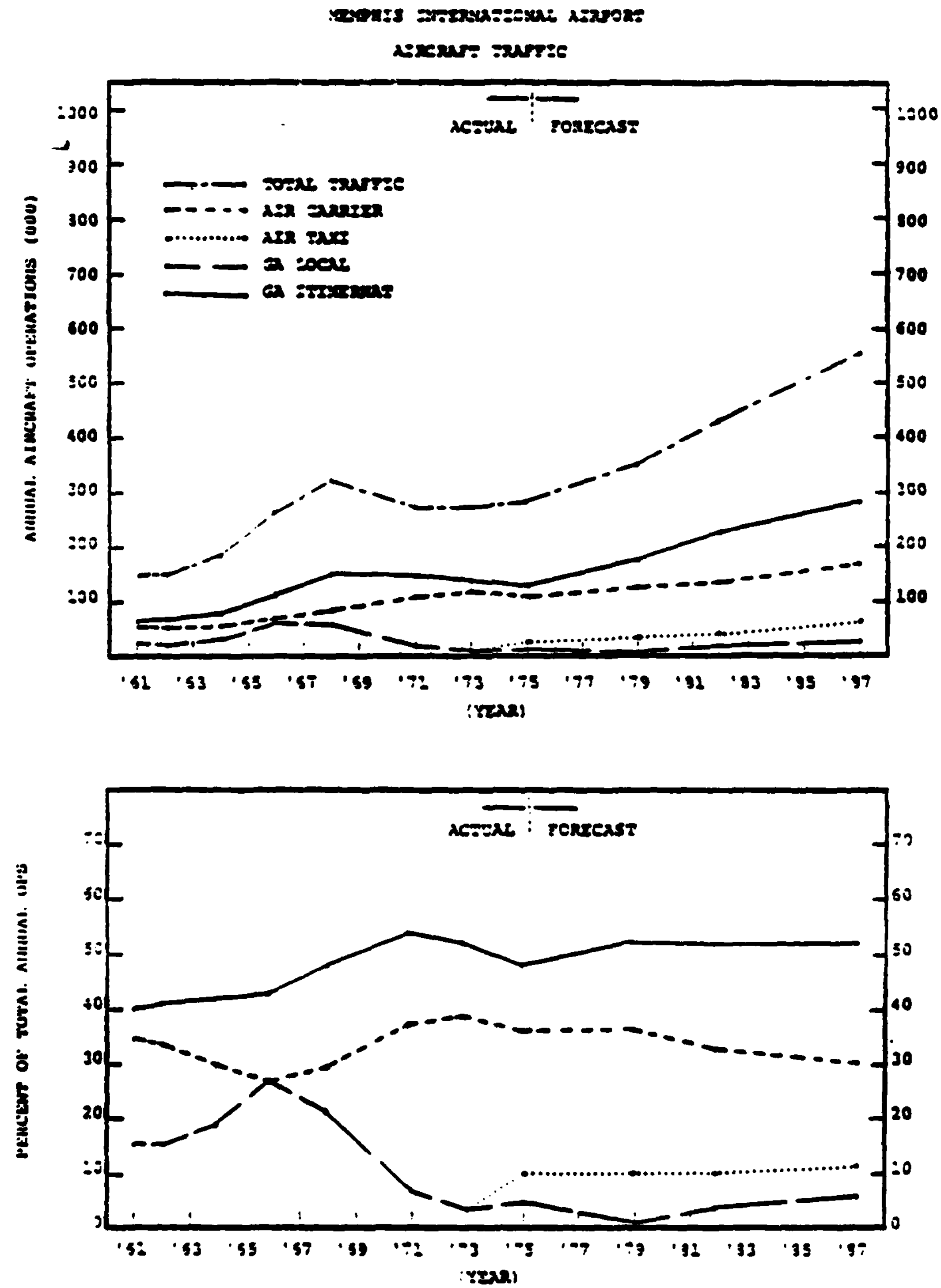

MEMPHIS INTERNATIONAL AIRPORT
AIRCRAFT TRAFFIC
ACTUAL
FORECAST
TOTAL TRAFFIC
AIR CARRIER
AIR TAXI
GA LOCAL
GA ITINERANT
ANNUAL AIRCRAFT OPERATIONS (000)
1000
900
800
700
600
500
400
300
200
100
'61 '63 '65 '67 '69 '71 '73 '75 '77 '79 '81 '83 '85 '87
(YEAR)
ACTUAL
FORECAST
PERCENT OF TOTAL ANNUAL OPS
70
60
50
40
30
20
10
0
'61 '63 '65 '67 '69 '71 '73 '75 '77 '79 '81 '83 '85 '87
(YEAR)

FIGURE A-8

NASHVILLE METROPOLITAN AIRPORT

AIRCRAFT TRAFFIC

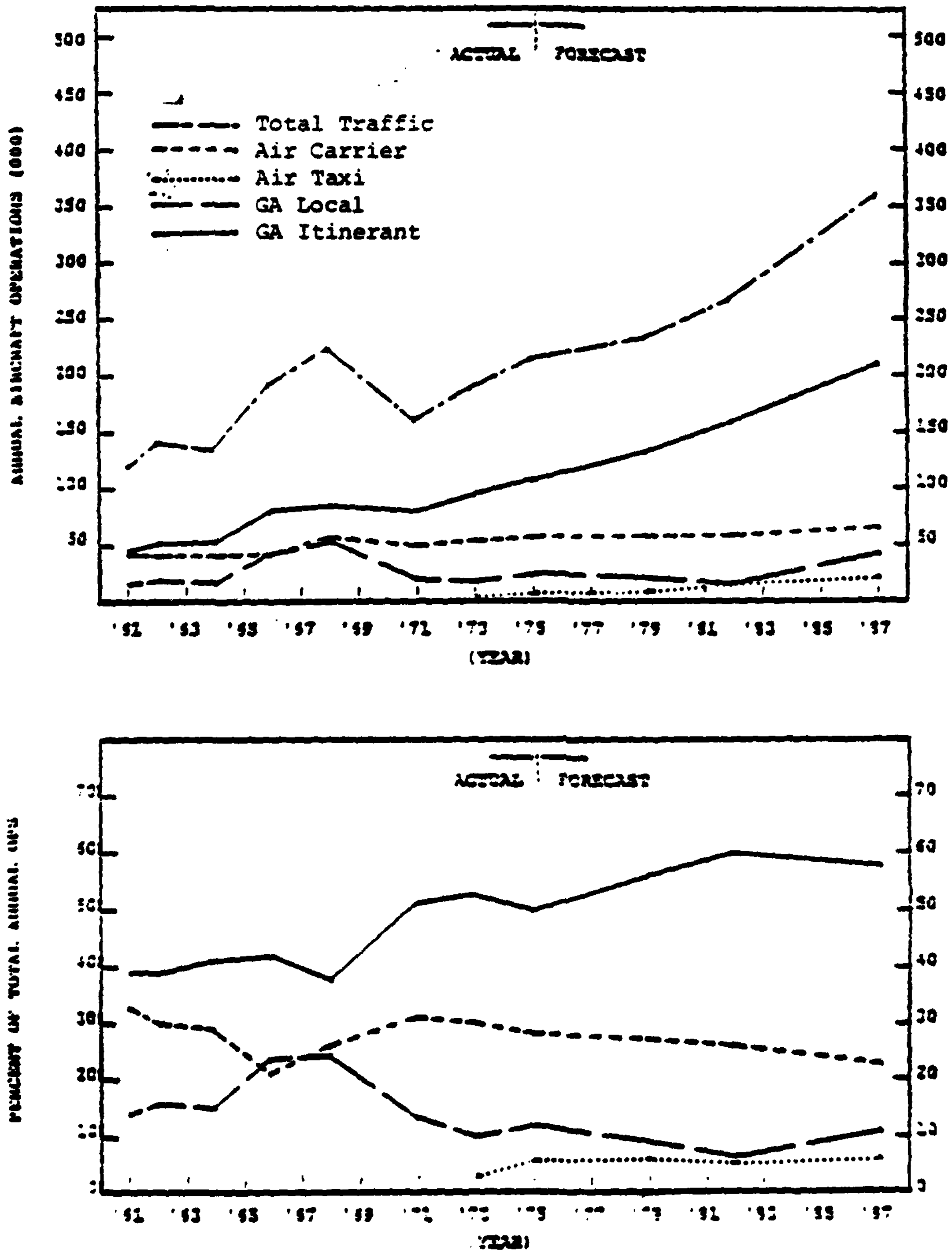


FIGURE A-9

SAMPLE TRAFFIC DISTRIBUTION

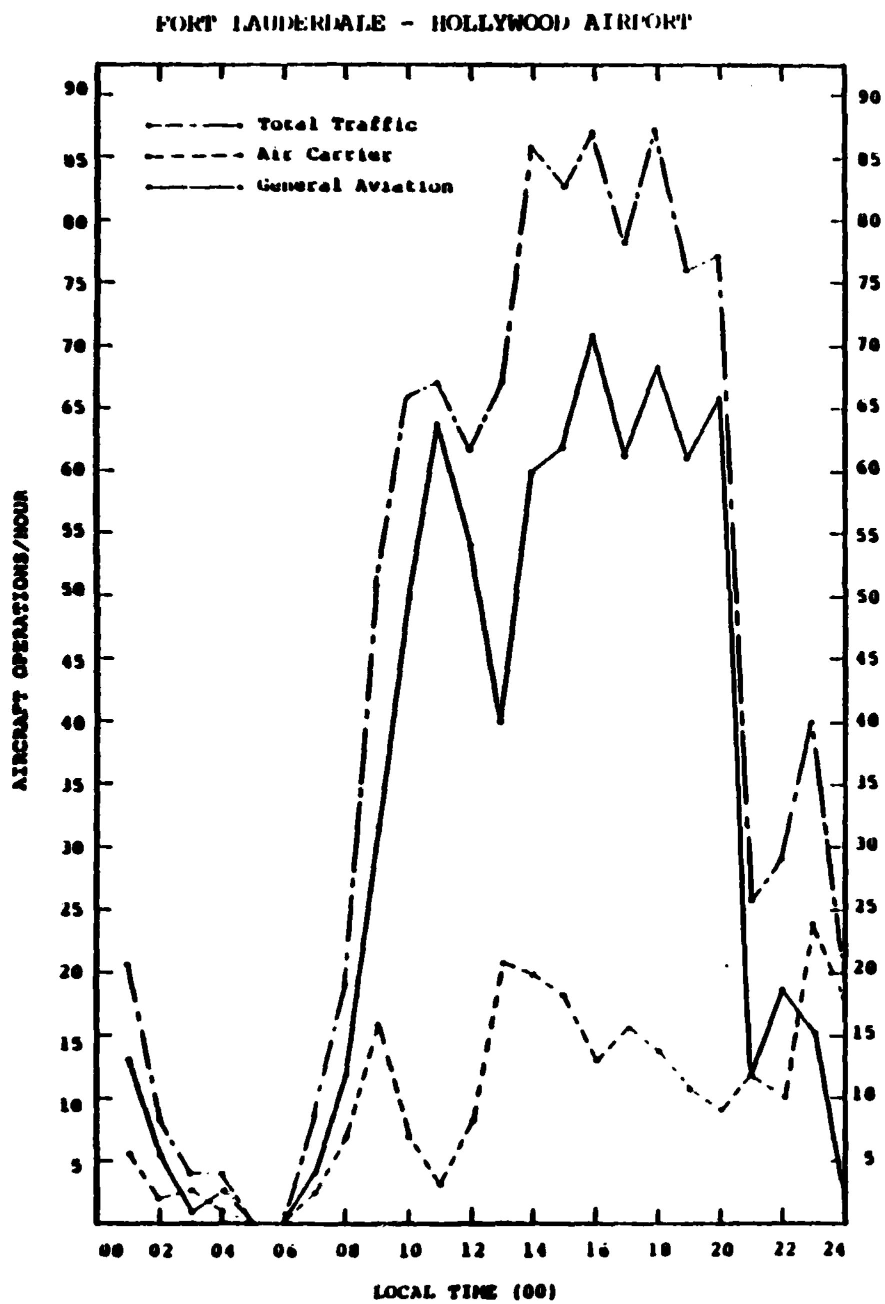


FIGURE A-10

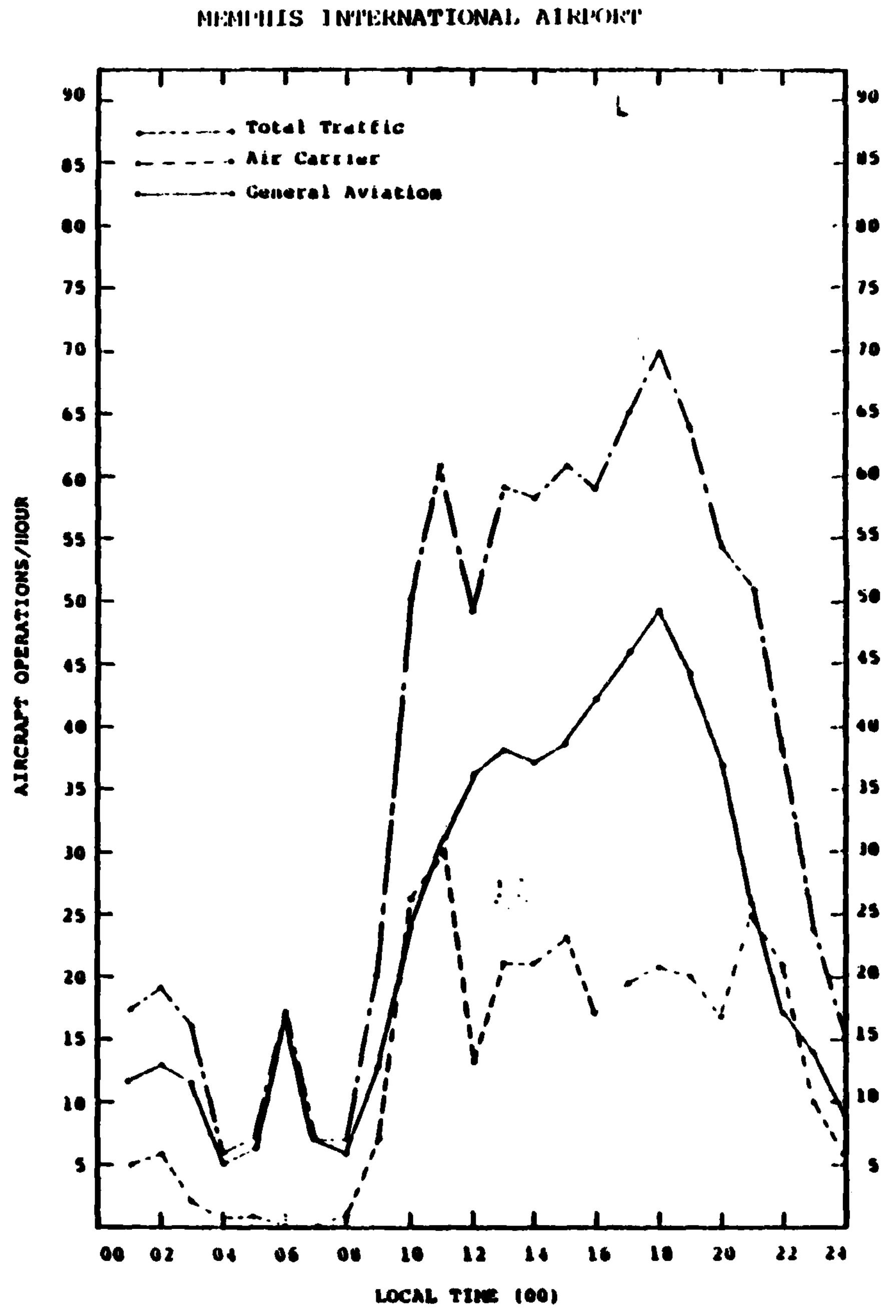


FIGURE A-11

NASHVILLE METROPOLITAN AIRPORT

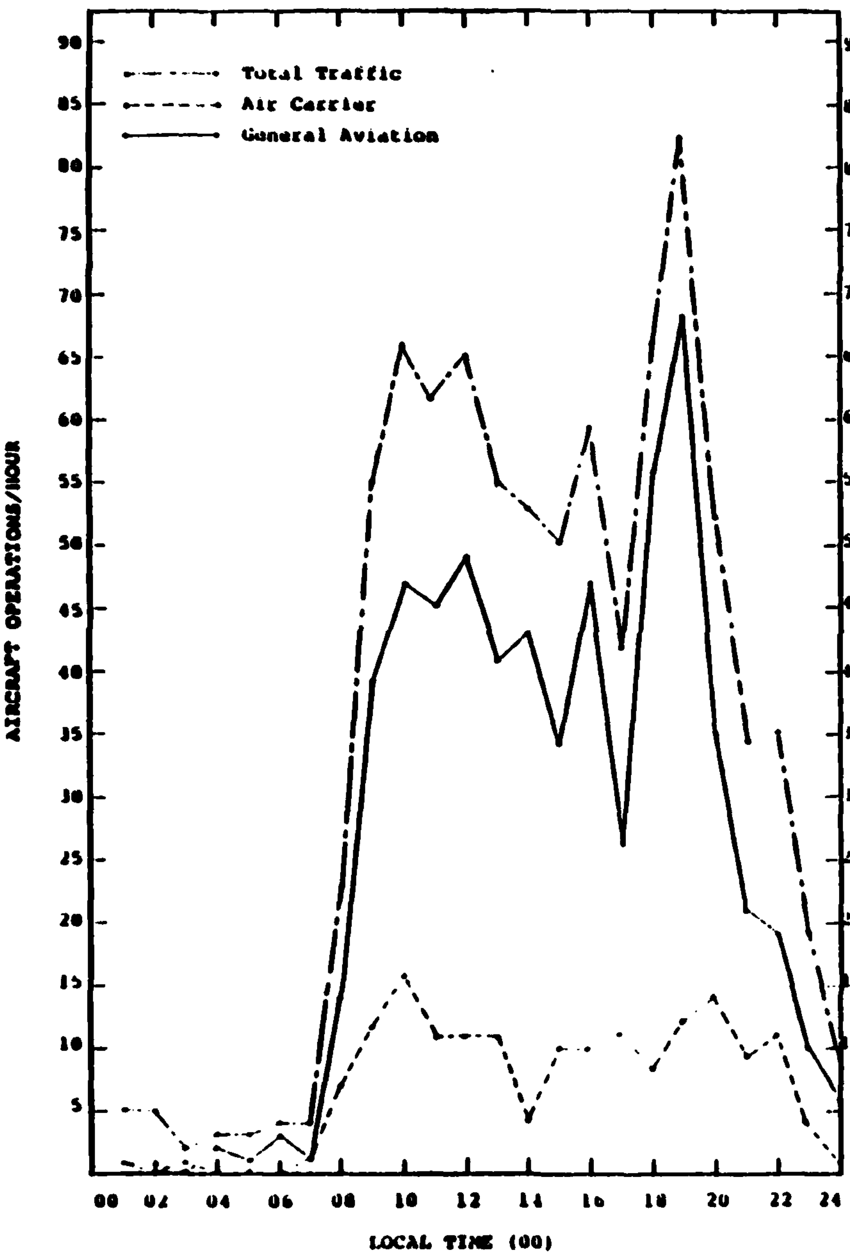


FIGURE A-12

CLEVELAND HOPKINS AIRPORT

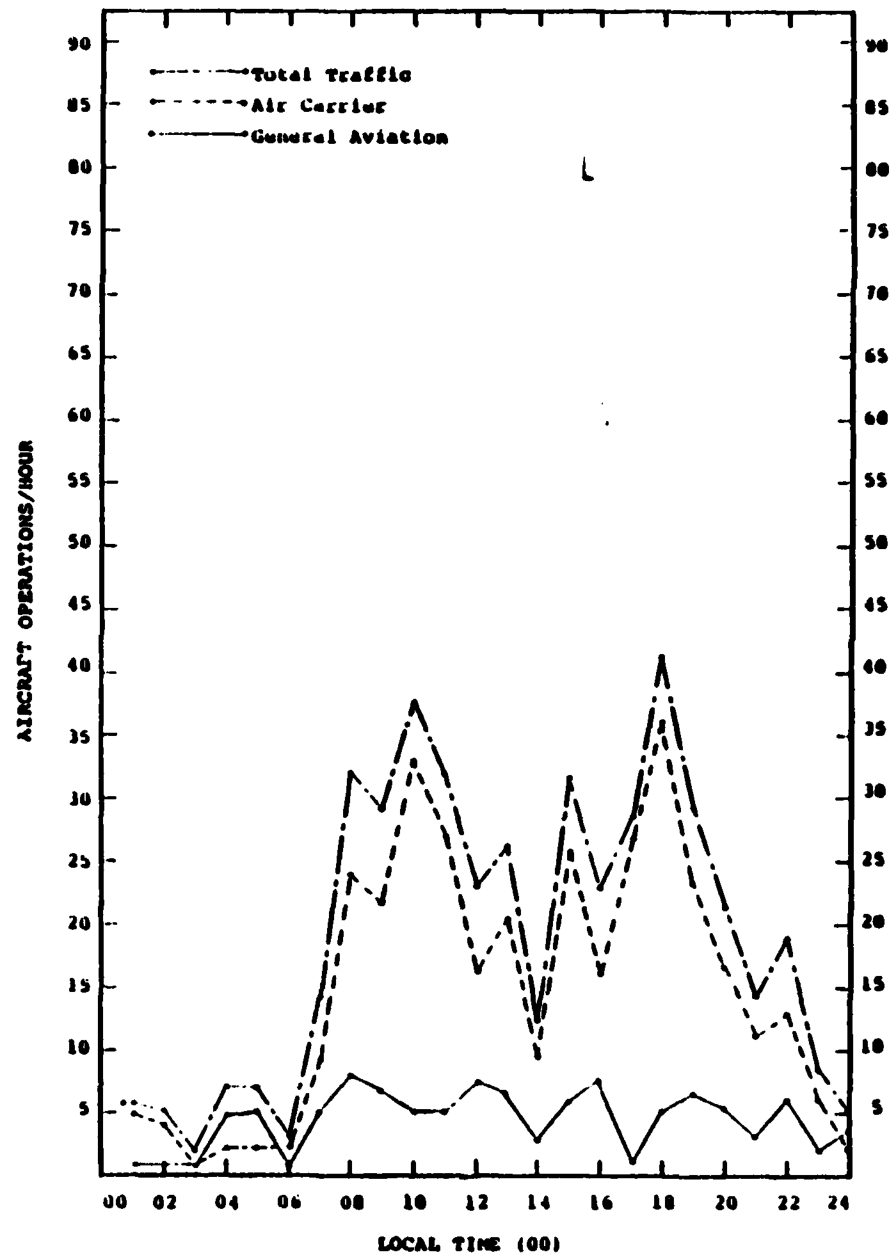


FIGURE A-13

SAMPLE TRAFFIC DISTRIBUTION

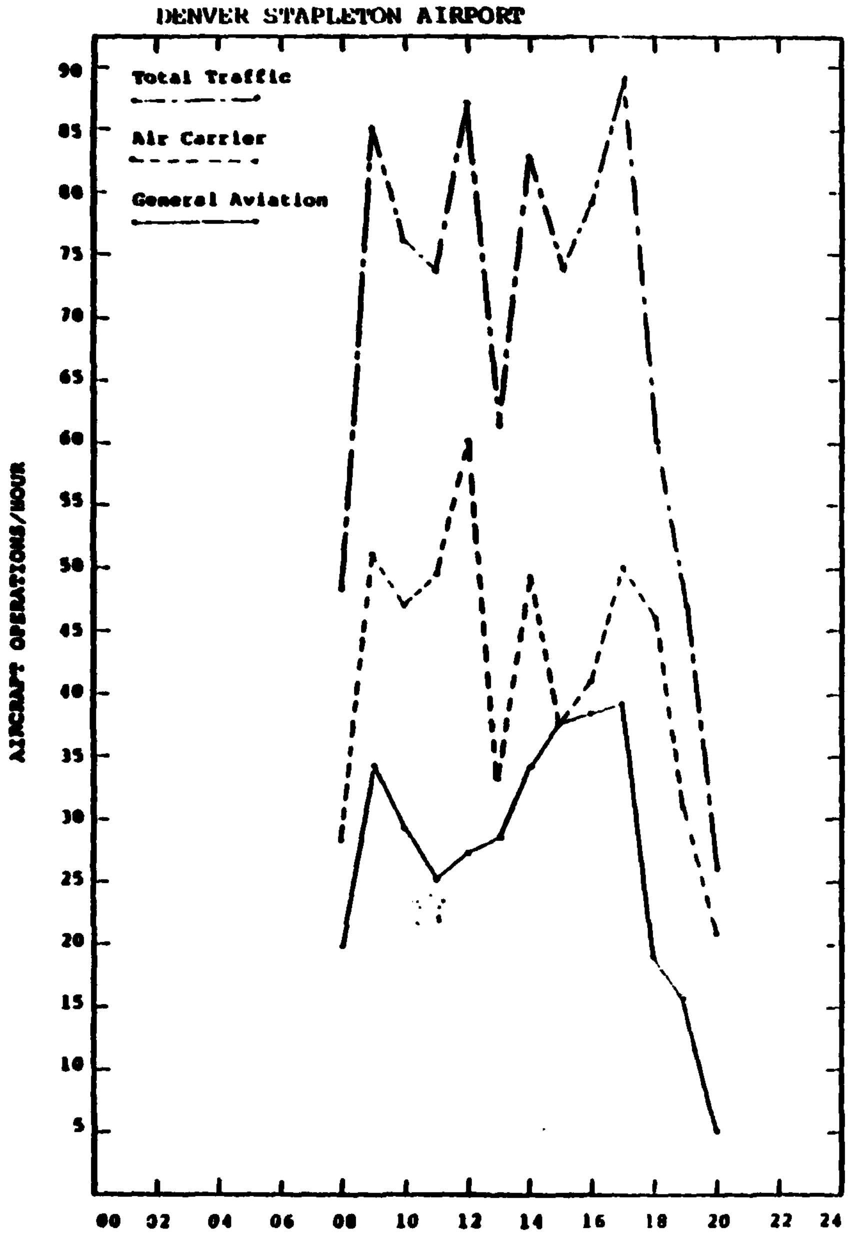


FIGURE A-14

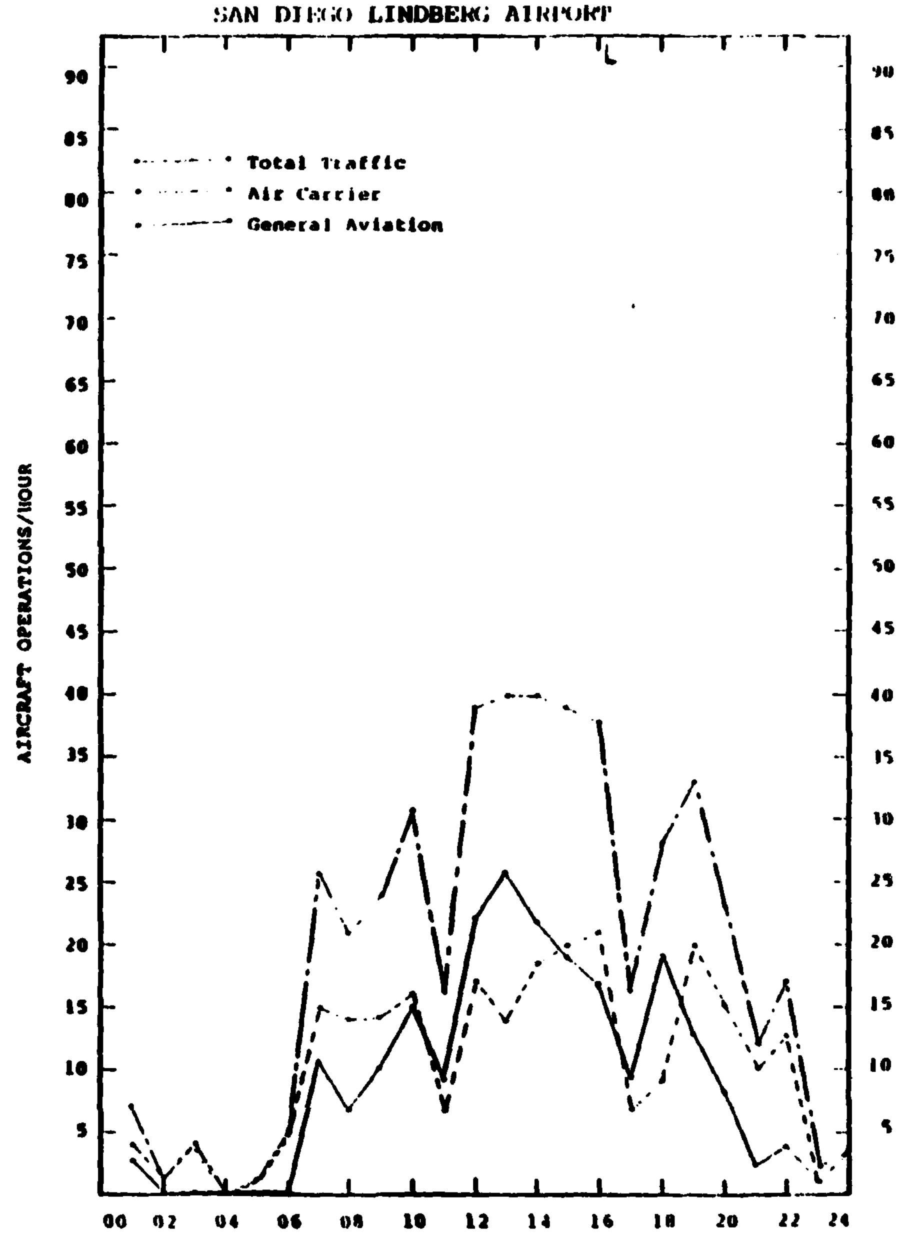


FIGURE A-15

SAMPLE TRAFFIC DISTRIBUTION

DETROIT METROPOLITAN AIRPORT

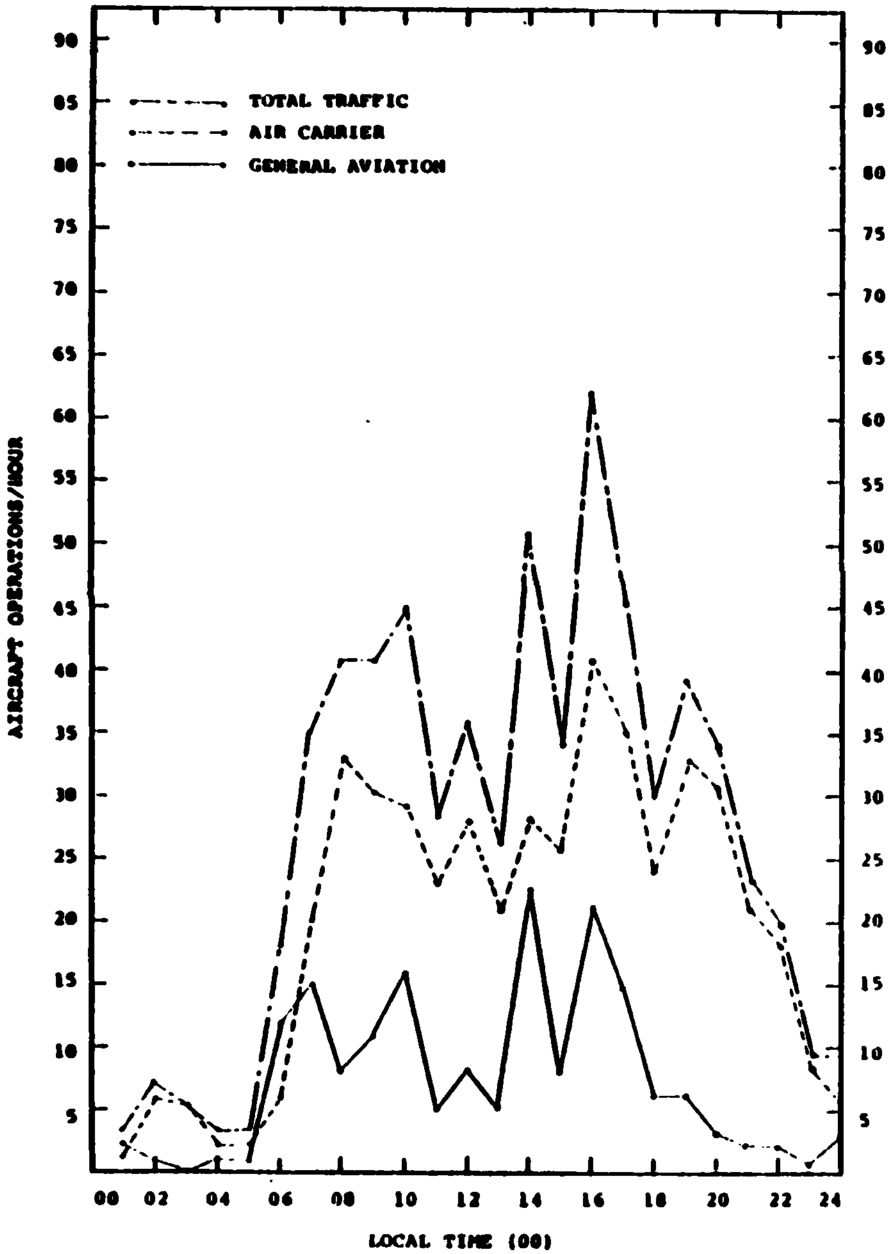


FIGURE A-16

SAN JOSE MUNICIPAL AIRPORT

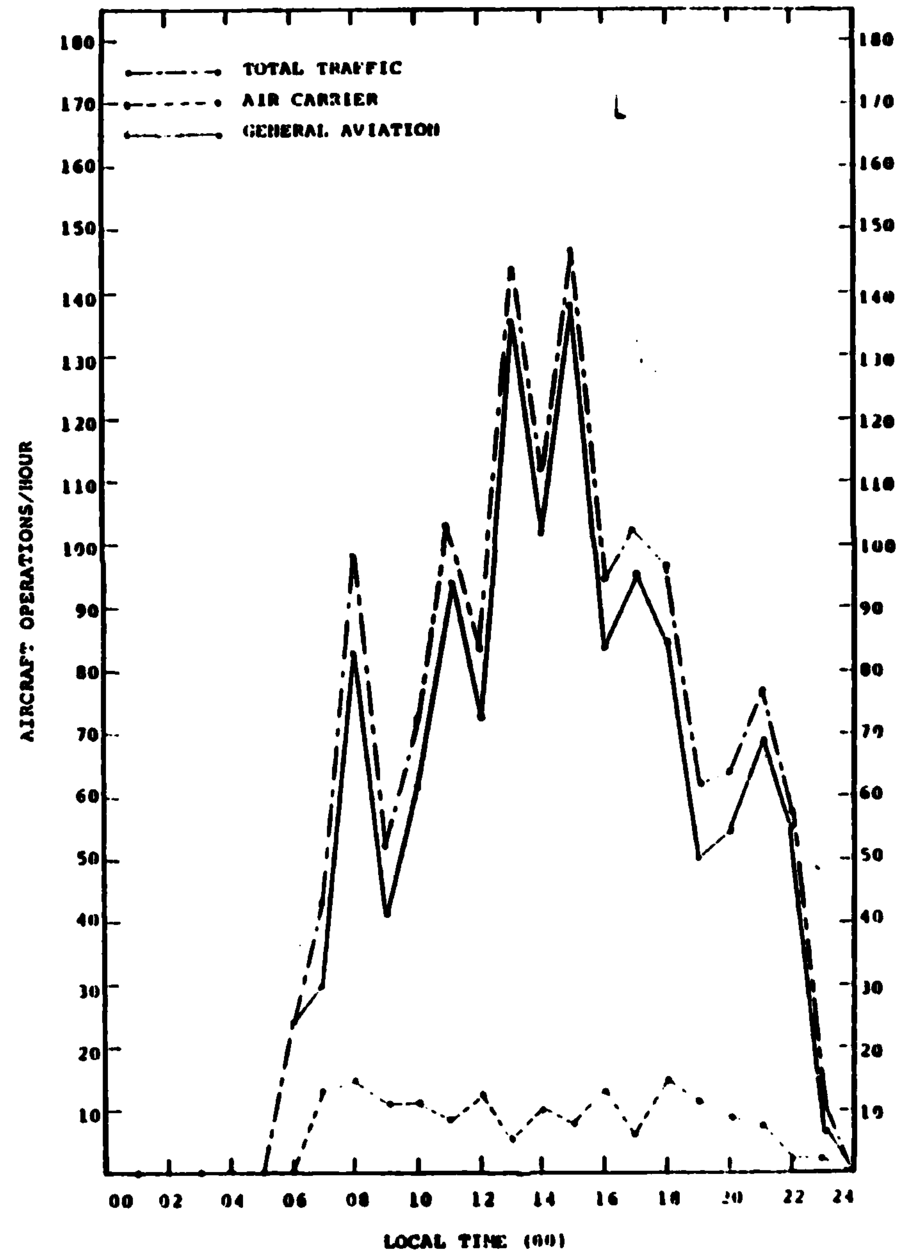


FIGURE A-17

APPENDIX B

SOURCE DOCUMENTS

Extract from Tennessee Airport System Plan, Mid-Cumberland Development District, Nashville Metropolitan Area. dated 1973.

Summary Report, 1990 Master Plan Study, Nashville Metropolitan Airport, Dated Oct. 1973.

"Cleveland Hopkins International EIAR", Draft, June 1976.

Michigan State Airport System Plan, Aug. 1974.

Draft Environmental Impact Statement, Board of County Road Commissioners, Wayne County, Michigan, Apr. 1973.

Florida Aviation System Plan, Southeast Region 1990, (Plan and Executive Summary), Dated March 1976.

East Slope Task Force Interim Study Report, Dated 19 October 1976.

Analyses and Simulation of Terminal/Airport Development Concepts, Phoenix Sky Harbor International Airport, dated March 1971.

Analysis of Airside Operations, Phoenix Sky Harbor International Airport. Dated March 1971.

Analysis of Airside Operations, Phoenix Sky Harbor International Airport, Dated March 1971 .

Phoenix Sky Harbor International Airport, Noise Impact Evaluation, Undated, Time Frame 1971/72.

Phoenix Deer Valley Municipal Airport, Master Plan Report.

Cleveland-Hopkins Demand/Capacity Analysis Report No. 2-3, Dated May 1974.

San Diego Plan for Air Transportation, Interim Report No. 1, Volume 3, Dated February 1972.

Terminal Area Forecast for 1977 - 1987, FAA-AVP-76-5, Dated January 1976.

FAA Air Traffic Activity Report, Calendar years 1961 thru 1975.

APPENDIX B

Airman's Information Manual, September 9, 1976.

Aviation Forecasts For Fiscal Years 1976 - 1987. FAA-AVP-75-7.

Planning the Metropolitan Airport System, FAA AC 150/5070-5, Dated May 1970.

Airport Capacity Criteria, FAA AC 150/5060-3A, Dated December 24, 1969.

Airport Capacity Criteria, FAA AC 150/5060-1A, Dated July 8, 1968.