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AIR TRAFFIC DEMAND ESTIMATES FOR 1995

R. H. Reck
J. B. Hagopian

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16. Abstract

This Department of Transportation report is a projection of 1995 air traffic environment used in connection with the Department's Advanced Air Traffic Management System Study. The forecasts provide a range of reasonable 1995 activity levels for analyzing and comparing cost and performance characteristics of future air traffic management system concept alternatives. High and low estimates of the various demand measures are given, reflecting the uncertainty in any long-term projection. The demand measures are based on FAA ten year projections to 1984 and include the fleet size and number of operations for air carrier, general aviation, and military aircraft, the number of airports and hubs, and the peak number of airborne aircraft in both terminal and en route airspace regions. The results of one analysis on high density airport capacity are included. Data in this report are presented for 1972, 1984, and 1995.

Forecast growth in the demand for air transportation between 1972 and 1995 is predicted to result in fleet of 362,000 aircraft (7,000 air carrier, 335,000 general aviation, and 20,000 military); tripled general aviation operations; an increase in the number of IFR operations by a factor of 13; a 50 percent increase in the number of civil airports; and a 250 percent increase in the number of aircraft airborne at the peak instant of time (about a third of these will be IFR in 1995).

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PREFACE

This report was prepared by the Transportation Systems Center at the request of the Office of the Secretary, Office of the Assistant Secretary for Systems Development and Technology, in partial fulfillment of PPA OS404 - Advanced Air Traffic Management Systems.

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1. SUMMARY

In 1971 the Department of Transportation initiated a multi-year planning study to define advanced air traffic control system concepts that could best meet the needs of the aviation community in the 1990's. In order to do technical and economic analyses during this study, an estimate of the future demand for air transportation was required. This report summarizes the aviation forecasts, and their derivation, used to estimate the 1995 air traffic environment which, in turn, was used in system concept design and research and development planning activities. The demand estimates, or forecasts of air transportation growth, in this study include:

- Public demand for commercial air transportation
- Airfleet size and characteristics
- Peak traffic loading on the ATC system
- Numbers of airports and hubs
- Capacities of future busy airports

The air traffic projections presented here are based on trends forecast by the FAA or found in historical data. Some trends involve such socioeconomic factors as population growth, consumer spending habits, and the gross national product (GNP).(1)* Validity of the forecasted demand is highly dependent on the continuing validity of these trends. While it is too early to assess the long term aviation impact of the Nation's energy balances, it is apparent that changing patterns of fuel availability and consumption will have an impact on aviation traffic levels in the decades ahead. However, this report assumes that an adequate supply of aviation fuel will continue to be available at reasonable prices. Noise or emission control standards may also affect demand forecasts. Lacking definitive information, as in the fuel question, no impact on these forecasts has been determined.

*References are given in Appendix B

The public demand for commercial air transportation is projected on the basis of two related quantities: revenue passenger miles (RPM) and revenue passenger enplanements (RPE). The former is the number of miles per year flown by airline passengers; the latter is the number of paying passengers, annually, who embark on commercial flights. The forecasts for domestic and international flights, shown in Figure 1-1, are made periodically by the FAA, which considers such parameters as the GNP, revenue yield per passenger mile, aircraft and seat availability, fare and route structures, passenger trip lengths, and a number of socioeconomic factors, such as income levels and population distribution.*[2] Between 1972 and 1995 the number of revenue passenger miles and revenue passenger enplanements are expected to increase by factors of about eight and six, respectively. These increases impact on future ATC system concepts in terms of the number and type of aircraft which must be put into operation to meet this demand in an adequate fashion, as well as the number of operations (or aircraft usage) required to service this demand.

The size of the air carrier fleet necessary to meet the forecast RPE's and RPM's can be estimated. The full impact of the demand upon the air traffic management system, however, is only realized when the forecasts for general aviation and military aircraft are included in the analysis. These are considered below.

The FAA ten year forecast of air carrier aircraft is based on the number of each type of aircraft in inventory or on order, data on how the carriers propose to meet their demand requirements, and operating and performance data for each type of aircraft.[2] This Study extended the FAA air carrier forecasts to 1995 by considering the rate of air carrier fleet growth, the trend to an all-jet fleet, and the revenue passenger miles and revenue passenger enplanements that the air carrier fleet will have to accommodate. The air taxi** segment of the fleet was assumed to be integrated with the air

*International flights in this forecast include those made by U.S. certificated air carriers which originate or terminate within the United States.

**Air Taxi aircraft are those used by the holder of an Air Taxi Operating Certificate. They are generally short or ultra-short haul aircraft designed for operation from short runways.

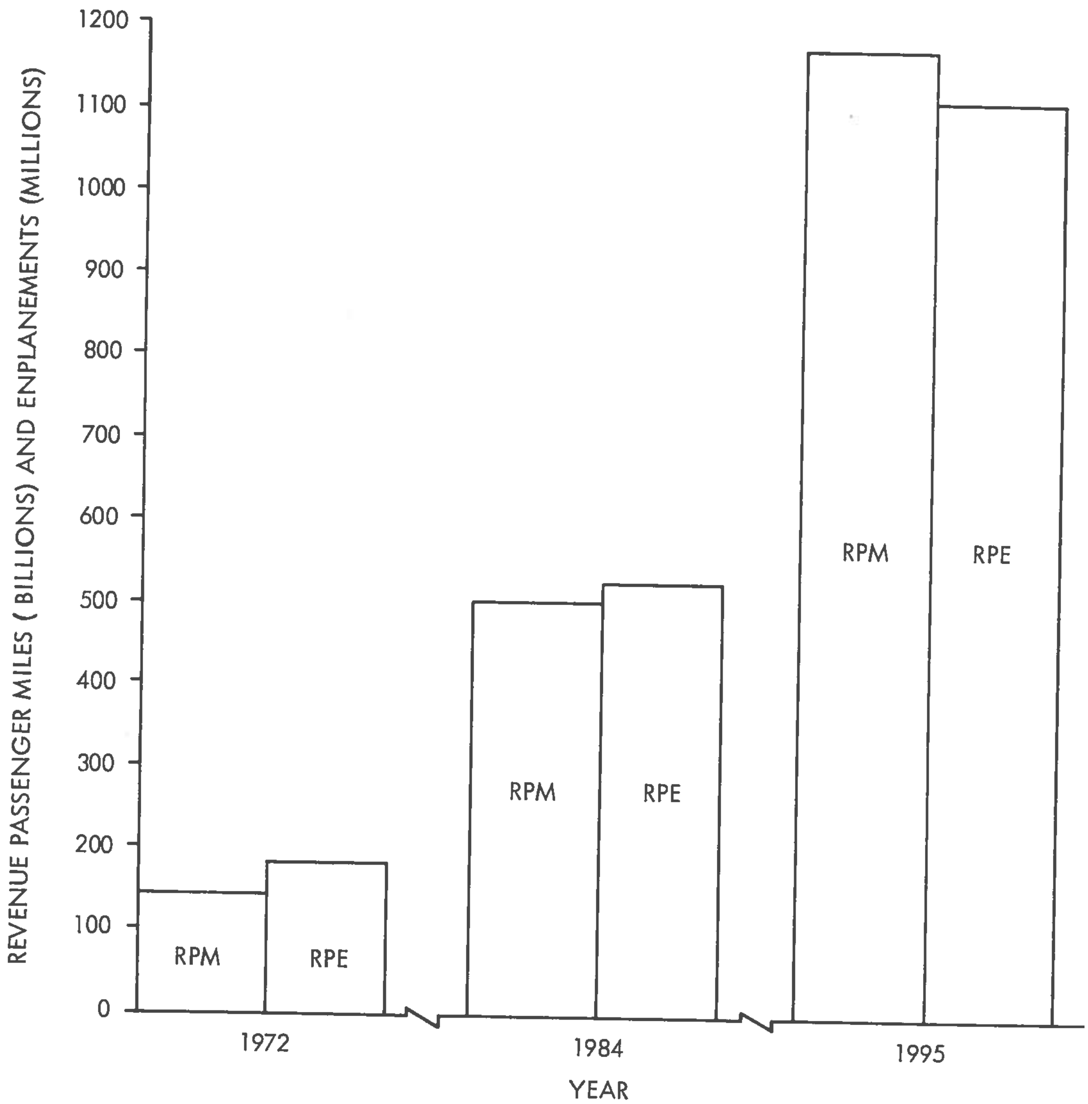

Figure 1-1 Revenue Passenger Miles (RPM) and Enplanements (RPE) By Year

carrier fleet sometime between 1984 and 1995. It is assumed part of the general aviation fleet prior to 1984. The 1995 estimated air carrier operations (takeoffs and landings) were based on estimates of average aircraft utilization and trip length figures and on trends determined from Civil Aeronautics Board data.(3) These results are presented in Table 1-1.

The general aviation fleet size estimate was based on its historically high correlation with the GNP, whose forecast annual growth rate is 3.8 percent from 1984 to 1995, and 4.3 percent from 1973 to 1984.(1) Extending from the 1972 fleet size of 131,000 aircraft, 217,000 aircraft are projected by the FAA for 1984, and 335,000 are projected by this Study for 1995. The forecast number of operations for general aviation aircraft was based on trends in annual utilization, average flight duration, and the distribution of flight time between itinerant and local use. Table 1-1 shows the growth in general aviation operations from 1972 (90 million) to 1995 (253 million).

The military fleet and its activity within CONUS are expected to remain nearly constant over the next two decades.(4) These estimates are also shown in Table 1-1.

The peak instantaneous airborne count (PIAC), for 1995 represents a demand measure crucial to the design of future air traffic management systems. This count represents the number of aircraft that are expected to be airborne over CONUS during the busiest instant of time in any particular year. Consequently this number represents the predicted maximum loading on the system and is representative of the actual number of aircraft the system must be capable of handling at any one time. Peak instantaneous airborne count, (PIAC), estimates for 1995 were made for both terminal and en route airspace considering the major air route structure and expected number of flights on each route, fleet size and characteristics, revenue passenger miles and revenue passenger enplanements, the type of flight (VFR, IFR, itinerant, and local), and various terminal area and airport characteristics.(6,7) The PIAC projections for 1972, 1984 and 1995 are given in Table 1-1. A

TABLE 1-1 FLEET SIZE, ANNUAL OPERATIONS, AND PEAK INSTANTANEOUS AIRBORNE COUNT BY YEAR

	1972	1984	1995
Fleet Size	153,600	240,600	362,000
Air Carrier	2,600	3,600	7,000*
General Aviation	131,000*	217,000*	335,000
Military	20,000	20,000	20,000
Annual Operations (Millions per year)	140	210	327
Air Carrier	10	15	34*
General Aviation	90*	155*	253
Military	40**	40**	40**
Peak Instantaneous Airborne Count	14,890	23,570	37,000
Air Carrier	1,980	2,740	5,350*
General Aviation	12,050*	19,970*	30,800
Military	860	860	860

*Includes air taxi fleet, operations, or count, as appropriate.
**Includes three million operations at civil airports

Source: References 1, 4, 5, 6, and 7.

verifiable rule of thumb, based on study data presented in Section 6, for estimating the overall PIAC is to take 10 percent of the total aircraft fleet; of this overall PIAC, approximately 60 percent represents the count in terminal airspace.

This Study also forecast the number of hubs and airports in 1995. A hub encompasses the airports and terminal and transition airspace associated with a metropolitan area. The number of hubs was forecast based on an analysis of present hubs including their share of the revenue passenger enplanements and their ability to handle the future demand. Table 1-2 presents the hub classification criteria, the number of hubs in 1972, and those forecast for 1984 and 1995. The number of airports was projected to 1995 in accordance with the activity level classification scheme defined by the National Aviation System Policy Report.[7,8] Table 1-3 shows the classification scheme and the number of airports for 1972, 1984 and 1995.

These forecasts are based on the present and forecast number of yearly operations expected for each airport without consideration of any growth limitation factors, as well as on the growth trend in the number of airports, (National Airport System (NAS), non-NAS, and other). There is a trend, evident in Table 1-3 and due to increased numbers of operations and enplanements, towards increasing numbers of primary and high density airports.

The impact of future aviation demand on the air traffic management system has been estimated based on a study of 29 of the busiest hub airports for 1995.[9,13] These hub airports in 1971 accounted for 67, 15, and 13 percent of the nation's terminal area delays incurred by air carrier, general aviation, and military users, respectively. The maximum number of 1995 busy hour operations (takeoffs and landings) handled by each airport, i.e., their saturation capacities, was estimated, assuming modest changes in the present runway configurations, approach

TABLE 1-2 HUB CLASSIFICATION CRITERIA AND NUMBER BY YEAR

Hub Classification Criteria			Number by Year		
Size	Percent of Nation's RPE in Hub	Approximate Number of RPE's in Hub in 1995	1972	1984	1995
Large	More than 1%	10 Million RPE	23	24	25
Medium	1/4% to 1%	2.5 to 10 Million RPE	37	38	39
Small	1/20% to 1/4%	0.5 to 2.5 Million RPE	80	75	70

Source: References 7 and 8.

TABLE 1-3 CIVIL AIRPORT CLASSIFICATION CRITERIA AND NUMBER BY YEAR

Airport Category	Classification Criteria		Number of Airports		
	Annual Passenger Enplanements	Annual Aircraft Operations	1972	1984	1995
Primary	More than 1,000,000		41	81	133
High Density		350,000 or more	9	27	103
Medium Density		250,000 to 350,000	15	27	19
Low Density		Less than 250,000	17	27	11
Secondary	50,000 to 1,000,000		385	601	784
High Density		250,000 or more	27	129	243
Medium Density		100,000 to 250,000	106	287	342
Low Density		Less than 100,000	162	185	199
Feeder	Less than 50,000		2600	3100	4000
High Density		100,000 or more	50	200	400
Medium Density		20,000 to 100,000	750	900	1500
Low Density		Less than 20,000	1800	2000	2100
Total NAS Airports			3026	3782	4917
Other Airports			9000	11000	14000
Total U.S. Airports			12026	14782	18917

Source: References 7 and 8.

control delivery precision, and flight control safety rules, to alleviate congestion problems. The changes included construction of high speed turnoffs, improved taxiways, and both dual-lane and parallel runways. They also included equipment for improving accuracy of threshold delivery times, and for resolving the wake turbulence problem, thereby allowing reduction in the longitudinal spacing between landing aircraft. It has been estimated that these changes can increase individual airport capacity in excess of 165 percent compared to those of the present system.(4) The saturation capacities, derived for the 29 airports based on these assumptions, were compared to the demand estimates for 1995.(10,11,13) The results showed that 12 of the 29 airports will experience busy hour demand* exceeding the projected busy hour saturation capacity even with the above assumed system and airport improvements. Table 1-4 presents the comparison for all 29 airports.

In summary, this Study has forecast a growth in the demand for air transportation between 1972 and 1995, that will result in the following:

- An eight-fold increase in the number of revenue passenger miles
- A doubling of the air carrier fleet
- A 250 percent increase in the size of the general aviation fleet.
- A tripling of the number of general aviation operations
- An increase in the number of IFR operations by a factor of 13
- A 50 percent increase in the number of civil airports
- A 250 percent increase in the number of aircraft airborne at the peak instant of time (about a third of these will be IFR in 1995)

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*The number of aircraft expected to request permission to takeoff or land during the busiest hour of operation at each airport.

TABLE 1-4 1995 DEMAND AND CAPACITY AT THE 29 BUSIEST AIRPORTS

Airport	Busy Hour Capacity (Operations Per Hour)	Busy Hour Demand (Operations Per Hour)
*Atlanta	182	272
*Baltimore	90	112
*Boston	90	166
*Chicago-O'Hare	185	273
*Chicago-Midway	82	84
Cleveland	157	90
Dallas	255	210
Denver	178	143
Detroit	189	108
Honolulu	162	142
Houston	158	102
Kansas City	126	96
Las Vegas	142	112
Los Angeles	255	214
Miami	255	168
Mineapolis	158	95
*Newark	153	155
New Orleans	152	91
New York-J.F. Kennedy	184	178
*New York-LaGuardia	90	159
Oakland	175	142
*Philadelphia	155	170
*Pittsburgh	146	146
St. Louis	156	141
*San Diego	63	112
*San Francisco	156	202
Seattle	156	103
Washington-Dulles	183	85
*Washington-National	90	131

*Airports at which demand is expected to exceed capacity.

Source: References 9 to 13.

2. INTRODUCTION

In 1968, air traffic was in a crisis, evident by the failure of airport and air traffic control system capacity to keep pace with the operational needs of aviation. The crisis made improvements to the system imperative since the phenomenal growth rate of the aviation industry during the 1960's was expected to continue, at least for several decades. The Department of Transportation's Air Traffic Control Advisory Committee explored solutions to the capacity problems, and this resulted in the present efforts to upgrade the Third Generation ATC System for the 1980's and to define a Fourth Generation Air Traffic Management System concept for application in the 1990's.[4] Air traffic forecasts to determine the size, activity, and distribution of the future domestic aviation fleet were part of the studies carried out in connection with the work of the Air Traffic Control Advisory Committee, the Federal Aviation Administration in its definition studies of the Upgraded Third Generation ATC System, and the Department of Transportation in its concept definition study for an air traffic management system for the 1990's. This report documents the work done in connection with the latter study and consequently contains aviation forecasts for 1995.

This demand estimate study was made during late-1972 and 1973, and is based on FAA ten year projections of various air traffic demand parameters. The 1995 forecasts in this report include the fleet size and composition, the activity of the air carrier, general aviation, and military segments of the aviation community, projections of the number of hubs and airports, and the distribution of the estimated instantaneous airborne count. The assumptions and methodology used in deriving each parameter are also presented.

Forecasting activity of any kind twenty years in the future is an uncertain art. Future aviation activity, in particular, will be greatly influenced by factors such as:

1) general level of economic activity

2) the growth of population

3) the availability and cost of fuel

4) the growth in disposable income

5) the availability and characteristic of future competing intercity modes of transportation

6) the regulatory actions of the Civil Aeronautics Board

7) the reallocation of aviation system user taxes and fees

8) the cost of meeting future avionics equipment requirements

9) the importance of aircraft in the future defense structure

Even if reasonable assumptions about the above events were postulated as the basis for forecasting, the forecaster is still faced with deriving from historical data the quantitative relationships which approximate the cause and effect relationships between the activity levels of the many constituents of aviation and each of the events assumed in the forecasting scenario. Although such historical data can probably be found for military and commercial aviation, similar information for the various components of general aviation is generally lacking.

The forecasts required as part of the AATMS study are intended to provide a range of reasonable 1995 activity levels for comparing the cost and performance characteristics of the future air traffic management system concept alternatives. As a result, precise forecasting of the expected level of activity is not as important as providing reasonable bounds.

In view of the above considerations, it was decided to base the 1995 activity forecast on the existing 1984 forecasts available from the FAA[(2)] with extrapolation to 1995 based on judgement applied to trend data found in other sources. The use of more powerful econometric techniques as a basis of such forecasts was considered inappropriate from the standpoint of their intended use, the time and resource priorities of the study and the lack of some critical data elements on which to base these techniques. The results of the AATMS studies will provide important clues concerning the critical elements in the activity forecast which have the greatest influence on R&D decisions and which, therefore should receive the greatest emphasis in the next cycle of improvement of these forecasts.

The remainder of this report describes how the various activity forecasts were derived.

3. AIR CARRIER DEMAND

3.1 REVENUE PASSENGER MILES AND ENPLANEMENTS

Two measures of air carrier demand are the number of revenue passenger miles (RPM) and revenue passenger enplanements (RPE). The former is the number of miles flown by commercial airline passengers; the latter is the number of paying passengers, annually, who embark on commercial flights. These measures are generally computed for domestic flights and then factored to additionally provide the United States international RPM's and RPE's.* The FAA's Aviation Forecast Division has been forecasting these parameters ahead 10 to 12 years.(2) The forecast in this study uses the present FAA forecast and methodology to project the number of RPM's and RPE's for 1995.

The present FAA forecast of total U.S. domestic revenue passenger miles was derived based on a methodology which relates total passenger revenue, gross national product, (GNP), and the overall yield per passenger mile.(2) This methodology, which was adopted after extensive review of methodologies used throughout the air transportation industry, is similar in many respects to those used by some of the major airlines. A long term annual average GNP growth rate, in constant 1958 dollars, is used. This rate was decided upon after a review of various GNP forecasts made by non-government organizations such as banks, insurance companies and economic research firms, and also after discussions with certain economists within the Federal Government.

The FAA methodology also requires a separate forecast of passenger mile revenue yields. To obtain this forecast a detailed examination was made by the FAA of the history of the domestic fare

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* International flights in this forecast include those made by U.S. certificated air carriers and which originate or terminate within the United States.

structure considering such influences as the shift in demand from first class to coach services, the changes in aircraft cost and performance characteristics over time, and the profit position of the carriers. Since there is no known equation which will forecast the passenger-mile yield and account specifically for the influences that significant factors have on the yield, this yield forecast had to rely heavily on judgement. The yields adopted considered projected future fleet composition, its characteristics and its changes with time. The present cost and profit position of the carriers was also considered, as well as the projected future carrier investment requirements.

The number of passenger enplanements was developed in the FAA methodology by dividing the forecast passenger miles by the projected average passenger trip length. The latter was based on a review and extension of past trends.

The forecast of U.S. international revenue passenger miles was made after the forecast of U.S. domestic traffic and is related to it. There has been a very close relationship between the domestic and international passenger revenue amounts received by the U.S. domestic carriers. The forecast assumes this relationship will continue. Passenger miles were determined by dividing the revenue by a forecast of passenger mile yield. The number of passengers enplaned was derived by dividing the total estimated number of passenger miles by an estimated average passenger trip length. As with the domestic trip length, the latter was estimated based on a review and extension of the past trend.

Annual growth rates in domestic RPM and RPE are forecast by the FAA to average 11 percent and 9 percent respectively from 1972 to 1984, reaching 378 billion RPM's and 461 billion RPE's at the end of that period. The assumptions underlying these growth rates are derived in large part from a report of the Aviation Advisory Commission and are as follows:[1]

a. The GNP annual growth rate will be 4.3 percent for the forecast period (1972-1984).

b. Domestic revenue per passenger mile will increase at the rate of 2 percent per year.

c. Domestic fares will increase at a rate of 1 percent per year.

d. The portion of GNP spent on transportation will increase from 0.7 percent in 1972 to 1.1 percent in 1984.

e. Domestic passenger trip length will increase from 683 miles in 1972 to 820 miles in 1984.

This Study used a recent long term forecast as the basis for extending these projections to 1995.(4) This forecast projected the annual rate of growth in the number of RPM's and RPE's from 1984 through 1995, as 7.5 percent for a nominal level of demand, and 6.5 and 9.0 percent for low and high levels of demand, respectively. At these rates, domestic RPM's will increase from 378 billion in 1984 to approximately 850 billion in 1995 for the nominal growth level, 750 billion for the low, and one trillion for the high. The methodology employed in the long term forecast is based on a number of socioeconomic assumptions, the more important being:

a. Population growth will be 1 percent per year.

b. Population over 18 years of age will grow at twice the rate as that under 18.

c. Annual individual income will be exceeding $25,000 for approximately 25 percent of the population in the year 2000.

d. Passenger cost of air travel will decrease at the rate of 1 percent per year

e. Passenger trip length will increase at the rate of approximately 1 percent per year.

f. Average number of seats per aircraft will increase at the rate 5 percent per year.

g. Annual rate of growth of the GNP is expected to be 3.8 percent per year, with low and high estimates of 2.9 and 4.8 percent respectively.

The RPM's and RPE's reported in 1972, their FAA forecast for 1984, and this projection for 1995 are presented in Table 3-1. The ratio between the totals in each year and the domestic RPM's or RPE's changes slightly over the time period covered in the forecast because of data incorporated in the FAA forecasting technique which projects an increasing percentage of international RPM's and RPE's. The trend shows the domestic RPM's becoming a lesser percentage of the total RPM, decreasing from 78 percent in 1972 to 73 percent in 1995. A commensurate decrease is evident for the ratio of domestic RPE's to total RPE's.

3.2 AIR CARRIER FLEET SIZE AND COMPOSITION

Another measure of air carrier demand is the projected composition and size of the commercial aircraft fleet. The forecasts made in this study for 1995 are based on the 1972-1984 forecasts made by the FAA's Aviation Forecast Division.[2]

The FAA forecast of the U.S. air carrier fleet is a summary of individual forecasts prepared by the FAA for each air carrier. The base for the forecast is the number of aircraft, by type, each carrier has on hand and on order. The order data is compiled from public announcements and is time-phased by month and year of delivery. A carrier-by-carrier review is made by the FAA of the entire fleet and additional aircraft are assigned to certain carriers if their future fleets, as tallied, are deemed inadequate to handle projected RPM and RPE growth, provide for retirement of some aircraft types, and maintain a competitive position with other airlines. The individual carrier fleets, by aircraft types, are projected beyond the years for which aircraft order information is available, based on historic trends.

After the fleet size and type estimates are prepared, the FAA estimates the total number of available seat-miles of the fleet to determine its consistency with the forecast of the revenue passenger-miles. A separate productivity determination is made for each type of aircraft, by carrier group, based on average annual utilization, speed, and number of passenger seats. The FAA

TABLE 3-1 REVENUE PASSENGER MILES AND ENPLANEMENTS FORECAST: 1972-1995

Year	1972	1984	1995 Low	1995 Nominal	1995 High
Fleet Size (Air Carriers)	2,630	3,600	5,000	7,000	9,500
Revenue Passenger Miles					
Total (Billions)	144.2	500.5	1030	1165	1370
Domestic (Billions)	112.3	378.0	750	850	1000
Domestic (Percent of Total)	78.	75.5	73.	73.	73.
Revenue Passenger Enplanements					
Total (Billions)	189.2	524.0	980	1105	1280
Domestic (Billions)	164.5	461.0	850	950	1100
Domestic (Percent of Total)	90.	88.	86.	86.	86.

Source: References 1, 2, 7, and 14.

procedure provides estimates, for each year, of total hours and aircraft miles flown and of total available seat miles. The seat-mile estimates are compared to the passenger-mile estimates previously prepared, and tested for reasonableness on the basis of appropriate load factors. If the correlation is not reasonable, the fleet size and composition estimates are adjusted. On the basis of this procedure, the air carrier fleet is forecast by the FAA to total 3600 aircraft by 1984, indicating an annual growth rate of approximately 3 percent for the 12 years after 1972.

This Study estimated the 1995 air carrier fleet size and its composition based on the FAA methodology which also reflected the anticipated annual growth of the fleet, the trend to wide-body jets. The estimates were also based on the following assumptions:

a. The fleet will maintain an annual nominal growth rate of approximately 3 percent between 1972 and 1995.

b. The fleet will be comprised of only jet aircraft in 1995, and a one-for-one replacement of jet for prop or piston aircraft will take place to effect this transition.

c. The four basic air transportation markets will continue to be:

Long Haul	1500 nmi and over
Medium Haul	700 - 1500 nmi
Short Haul	200 - 700 nmi
Ultra-Short Haul	0 - 200 nmi

d. The air carrier fleet will include air taxi aircraft (ultra-short haul) in 1995.

e. The air taxi fleet (approximately 900 aircraft in 1972) will nominally maintain an annual growth rate of 3 percent between 1972 and 1995, meeting a 15 percent per year growth in air taxi enplanements by using larger capacity aircraft.[3]

Thus, the 1995 air carrier fleet is expected to number 7,000 aircraft; 5,000 long/medium/short haul types and 2,000 ultra-short haul aircraft. Low and high 1995 fleet size estimates of 5,000 and 9,500 respectively, were derived in this Study by assuming variances of approximately 1-1/2 percent on either side of the 1972 nominal growth rate of 3 percent.

The reported size and composition of the 1972 air carrier fleet, the FAA projection of that fleet in 1984, and this Study's estimates (low, nominal, and high) of the 1995 fleet are given in Table 3-2. Included in the Table are both air carrier and air taxi estimates, as well as the seating capacity for each of the aircraft in the four market categories. The anticipated market growth, or demand, for air carrier services is satisfied by increased aircraft sizes (seating capacities) and only a modest growth in the number of aircraft.

3.3 AIR CARRIER ANNUAL OPERATIONS

A traffic activity parameter of particular interest in analyzing future airport and air traffic control systems is the number of operations that each segment of the flying community performs. An operation is considered to be a takeoff or a landing. In the case of commercial aviation or air carriers nearly all of their operations are conducted at airports with FAA air traffic control towers under an IFR flight plan and ATC clearance. Air carrier operations are also primarily itinerant in nature (local flights are defined in Section 4). The FAA Aviation Forecast Division has forecast air carrier operations through the year 1984, and this forecast forms the basis for the 1995 projections made by this study.[2] The FAA forecast was obtained by doubling the number of projected annual departures. The number of departures was determined by dividing, for each aircraft type in the air carrier fleet, the estimated total miles flown by the average nonstop flight distance or stage length. The number of miles flown is based on the average annual usage of each aircraft type (the number of hours each aircraft is in service) and the average speed between destination and departure points.

TABLE 3-2 AIR CARRIER FLEET COMPOSITION

		1972		1984		1995 (Nominal)	
Market Category	Aircraft Type	No. of Aircraft	Seats Per Aircraft	No. of Aircraft	Seats per Aircraft	No. of Aircraft	Seats Per Aircraft
Long Haul	SST			75	120	100	200
1500 nmi and up	4 engine jumbo	107	324	324	359	400	600
Medium Haul	4 engine stretch	133	175	128	175	500	300
700 - 1500 nmi	4 engine stand.	640	114	109	114		
	3 engine jumbo	13	215	1008	269	1500	400
Short Haul	3 engine stretch	250	125	356	125	500	250
200 - 700 nmi	3 engine stand.	415	96	130	96		
	2 engine jumbo			844	200	1100	200
	2 engine stretch	388	91	499	92	600	120
	2 engine stand.	167	69	9	205	300*	80
Ultra Short Haul	Turbo Prop.	353	48	50	41		
0 - 200 nmi	Piston	148	31	43	13		
	Air Taxi jumbo					900	100
	Air Taxi stretch					600	60
	Air Taxi Stand.	900	15	1406	30	500	30
TOTAL AIR CARRIER		2600		3600		7000**	
TOTAL AIR TAXI		900		1400			

*New Aircraft
**Includes 2,000 Air Taxi

Source: References 2 and 14

These parameters are based on past trends, which are modified by the FAA to reflect expected changes in the future use of particular aircraft types. This methodology was used in this report to forecast the 1995 annual operations for the total air carrier fleet including both U.S. domestic air carriers and U.S. air carriers on international flights to or from domestic airports. The results are presented in Table 3-3.

The estimates for the number of aircraft in Table 3-3 are taken, for the appropriate year, from Table 3-2. The annual usage (average annual flight hours per aircraft) was taken from FAA forecast data (see Appendix A). The product of these two figures, number of aircraft and annual usage, gives the annual fleet flying hours. Utilization figures for 1995 long/medium/short haul aircraft were determined from FAA data by assuming a constant growth in utilization from year to year (about 0.5 percent per year). The utilization figure for each year for ultra-short haul aircraft (air taxi) was determined to be 1800 hours per aircraft per year based on data from the Civil Aeronautics Board for present air taxi operations.(3) This figure was kept constant over this forecast period since the available trend data indicated little historical change. The average flight duration in hours for 1972 and 1984 long/medium/short haul carriers was determined from FAA forecast data for those years (averaged across all aircraft types) for average passenger lengths and speed. These figures were exponentially extrapolated to 1995 in order to determine the average flight duration for that year (this extrapolation was based on the apparent exponential growth in the FAA 1972-1984 forecast data). The average flight duration for air taxi aircraft was determined, based on Civil Aeronautics Board data, to be about two-thirds of an hour (average stage length of 100 nautical miles at an average speed of 150 knots). The average duration for each fleet type was divided into the number of flying hours to determine the number of flights (or departures), and this in turn was doubled to obtain the number of operations. Each flight was assumed to make one takeoff and one landing operation. Low and high operations counts for 1995 reflect only differences in the fleet size, and not differences in other parameters used in the derivation.

TABLE 3-3 TOTAL AIR CARRIER ACTIVITY FOR SELECTED YEARS

Year And Estimate	Air Carrier Fleet Type	No. of Aircraft	Annual Utilization (Hours/AC)	Annual Fleet Flying Hours (Millions)	Average Flight Duration (Hours)	Annual Flights (Millions)	Annual Operations (Millions)
1972	Long/Medium/Short-haul	2600	2575	6.7	1.17	5.7	11.4
	Ultra-Short Haul	900	1800	1.6	.67	2.4	4.8
	TOTAL	3500	-	8.3	-	8.1	16.2
1984	Long/Medium/Short-haul	3600	2865	10.3	1.25	8.3	16.5
	Ultra-Short Haul	1400	1800	2.5	.67	3.8	7.5
	TOTAL	5000	-	12.8	-	12.1	24.0
1995-Low	Long/Medium/Short-haul	3570	3160	11.3	1.33	8.5	17.0
	Ultra-Short Haul	1430	1800	2.6	.67	3.8	7.7
	TOTAL	5000	-	13.9	-	12.3	24.7
1995-Nominal	Long/Medium/Short-haul	5000	3160	15.8	1.33	11.9	23.8
	Ultra-Short Haul	2000	1800	3.6	.67	5.4	10.7
	TOTAL	7000	-	19.4	-	17.3	34.5
1995-High	Long/Medium/Short-haul	6785	3160	21.4	1.33	16.1	32.2
	Ultra-Short Haul	2715	1800	4.9	.67	7.3	14.6
	TOTAL	9500	-	26.3	-	23.4	46.8

Source: References 2,7, and 14.

To determine the consistency of the above forecast, the number of available seat miles was compared with the forecast number of RPM's, and the load factor was computed. These calculations were made for 1972, 1984, and 1995, and only air carrier long/medium/short haul figures were considered. The average aircraft speed and average number of seats per aircraft for 1972 and 1984 came from FAA forecast data (see Appendix A). An exponential extrapolation of the trend determined from 1972 to 1984 FAA forecast data. The load factors were determined by dividing the RPM by the number of available seat miles. The details falling out of this procedure are given in Table 3-4. The trend to larger load factors is noteworthy, and consistent with FAA expectations.

TABLE 3-4 LOAD FACTOR DETERMINATION FOR SELECTED YEARS

Year	Annual Flying Hours (Millions)	Average No. Of Seats Per Aircraft	Average Speed (Knots)	Average Seat-Miles (Billions)	Revenue Passenger Miles (Billions)	Load Factor
1972	6.7	117	415	325.3	144.2	.44
1984	10.3	207	459	978.6	500.5	.51
1995 (Nominal)	15.8	290	500	2290.	1165.	.51

4. GENERAL AVIATION

4.1 FLEET SIZE AND COMPOSITION

The forecast of General Aviation (GA) fleet size presented in this report is based on the relationship between fleet size and the rate of growth of the U.S. gross national product (GNP).[14] If the historically recorded growth rate of 3.5 percent for the GNP in the 1950-1970 period is used as the GA fleet growth rate between 1968 and 1972, the fleet size determined is 131,149 aircraft, a figure nearly identical to that reported by the FAA for 1972. Furthermore, if the forecast 4.3 percent GNP annual growth rate for the 1972-1984 period is used as the growth rate for the GA fleet during that period, a GA fleet of 217,000 aircraft is estimated.

In extending the fleet size forecast beyond 1984 to 1995, the forecast (nominal) GNP growth rate of 3.8 percent was used, resulting in a fleet size projection of 335,000 aircraft. This analysis did not use the low (2.9 percent) or the high (4.8 percent) GNP growth rate forecasts to project 1995 GA fleet size limits because the spread was inconsequential. It was felt wise, however, to set some significant spread, even if arbitrary, to reflect a more stringent requirement into later ATC design considerations. Therefore, an arbitrary but considered annual growth rate of 1-1/2 percent was assumed, producing, for 1995, a low GA fleet size estimate of 250,000 aircraft. This was doubled to obtain the high GA fleet size estimate of 500,000 aircraft.

The general aviation fleet composition data reported by the FAA for 1972, and forecast for 1984, were used as a basis for projecting the composition of the 1995 fleet shown in Table 4-1. Single-engine piston aircraft are expected to continue to comprise the largest share of the fleet in 1995, although their relative importance continued to decline in a linear fashion (based on FAA 1972-1984 projections)--83 percent of the fleet in 1972, 79 percent in 1984, and 75 percent in 1995. The largest growth within the GA fleet will continue to be demonstrated by turbine-powered

TABLE 4-1 GENERAL AVIATION FLEET COMPOSITION FOR SELECTED YEARS

Aircraft Category	Year and Forecast Estimate				
	1972	1984	1995 Low	1995 Nominal	1995 High
Piston (Fleet Size)	124,629	201,000	224,000	300,000	447,700
Single-Engine (Fleet Size)	109,000	170,600	186,600	250,000	373,100
Single-Engine (Percent of Fleet)	83	79	-	75	-
Multi-Engine (Fleet Size)	15,529	30,400	37,400	50,000	74,600
Multi-Engine (Percent of Fleet)	12	14	-	15	-
Turbine (Fleet Size)	2,483	8,200	15,000	20,000	29,900
Turbine (Percent of Fleet)	2	4	-	6	-
Other (Fleet Size)	4,037	7,800	11,000	15,000	22,400
Other (Precent of Fleet)	3	3	-	4	-
TOTAL (FLEET SIZE)	131,149	217,000	250,000	335,000	500,000

Source: References 2, 7, and 16.

aircraft which increase by a factor of eight from 1972 to 1995, although in 1995 they will represent only six percent of the total GA fleet.

4.2 GENERAL AVIATION OPERATIONS

The number, type, and location of operations expected to be performed by general aviation are of special interest in considering requirements for future airports and for the ATC system itself, since it is this segment of the aviation community that is expected to undergo the most significant growth. Based on several different, but consistent methodologies the FAA's Aviation Forecast Division projects the following items for general aviation activity through 1984.[2]

a. Active aircraft by type of aircraft by year

b. Active aircraft by FAA region

c. Estimated hours flown by type of aircraft

d. Itinerant aircraft operations at airports with FAA traffic control service

e. Local aircraft operations at airports with FAA traffic control service

f. Instrument operations at airports with FAA traffic control service

Employing these FAA projections similar projections have been made for 1995. Another recent study has made forecasts to 1995 of these parameters, producing similar results.[7]

General aviation is defined as all civil flying not classified as air carrier. Consequently it contains many different user categories as well as many different types of aircraft. In this Study, general aviation was segmented into aircraft types according to the classifications presented in Section 4.1 and, subsequently, the numbers of both itinerant and local flights were determined. An aircraft operation is defined as a takeoff or landing. A local operation is one performed by an aircraft that operates in the traffic pattern of, or within sight of an airport; operates at an airport to depart to or arrive from a local flight practice area; or executes simulated instrument approaches or low passes at that airport. All general aircraft arrivals and departures other than local operations, as defined, are classified as itinerant.

Forecasts of the total number of operations at all domestic airports have been made based on the following assumptions.

a. Average annual utilization for each aircraft type (with the exception of the "Other" category which includes rotorcraft, gliders, balloons, etc.), based on historical trends, changes linearly from 1972 to 1995, as shown in Table 4-2.(14)

b. Average flight duration by aircraft type changes little from 1972 to 1995 as projected by the Air Traffic Control Advisory Committee and shown in Table 4-3.(4)

c. There are two operations per itinerant flight and six operations per local flight.(4,14)

d. The itinerant portion of total flying hours by aircraft type will be 80 percent for single engine piston aircraft, 90 percent for multi-engine piston aircraft, 95 percent for turbine aircraft, and 55 percent for "Other" category aircraft, based on an extrapolation of data from the Report of the Aviation Advisory Committee.(4) These figures reflect a shift towards more itinerant aircraft usage.

To calculate the total number of operations generated by the general aviation fleet, the total number of flying hours is derived for each aircraft type by multiplying the fleet size for each aircraft type (Table 4-1) by its projected utilization (Table 4-2). This figure, the total number of flying hours, is separated into itinerant and local hours based on the above tabulated assumptions. The numbers of itinerant and local flights are obtained from this data based on the projected flight duration by each aircraft type (Table 4-3). Using the numbers of operations per itinerant and per local flight mentioned in the assumptions, the total number of

TABLE 4-2 AVERAGE ANNUAL UTILIZATION BY GENERAL AVIATION AIRCRAFT TYPE BY YEAR

Year	Average Annual Utilization (Hours/Aircraft)			
	Piston Aircraft		Turbine	Other
	Single Engine	Multi-Engine		
1972*	180	275	600	275
1984*	190	255	560	250
1995	200	235	520	315

*Computed from FAA figures on fleet size and flying hours.[2]

TABLE 4-3 AVERAGE FLIGHT DURATION ESTIMATES FOR GENERAL AVIATION AIRCRAFT IN 1995

Aircraft Type	Itinerant Flight Duration (Hours)*	Local Flight Duration (Hours)*
Piston		
Single-Engine	1.0	0.8
Multi-Engine	1.3	0.6
Turbine	1.2	0.7
Other (Ballons, Helicopters)	0.7	0.3

*These estimates also apply to 1972 and 1984 with the exception of "Other" (helicopter, balloon, etc.) local flights which are 0.8 instead of 0.3 hours.

operations is generated. The high and low operations forecast estimates are obtained by using the high and low fleet size forecasts of Table 4-1. Tables 4-4 to 4-8 contain the data used in making the forecasts for 1972, 1984, and 1995. For 1972 and 1984, however, itinerant flying represents only 70 percent of the total flight hours for single-engine piston aircraft. This reflects the expectation that increased power, speed, and range of future single-engine piston aircraft will promote itinerant usage. These forecasts apply to the general aviation fleet at all domestic airports and therefore differ significantly from FAA forecasts which only project the operations at airports with FAA control towers.

Another recent forecast of general aviation operations presented estimates that in 1995 about 89 percent of all operations would take place at the busiest 1200 airports; about 55 percent of these would be local operations and 45 percent itinerant, and the projected 1995 FAA controlled airports would have about 80 percent of the total general aviation operations.(7) While differing in some minor aspects, the results of this forecast were nearly identical with the AATMS Demand Study results.

The FAA also forecasts the number of instrument operations performed by general aviation aircraft at FAA control towers, and the number of IFR aircraft handled by Air Route Traffic Control Centers, assuming the continuation of present terminal procedures.*(15,16) The forecast number of IFR aircraft handled by Air Route Traffic Control Centers (ARTCC) includes some of the instrument operations performed by general aviation aircraft at FAA control towers and consists of twice the number of IFR departures (for each departure there is an assumed landing) plus the number of "over-flights" for which the ARTCC is responsible. An over-flight is one that originates and terminates outside the region for which the ARTCC is responsible. The number of IFR activities is always expected to be larger than the number of operations at FAA control towers since many general aviation flights originate and terminate at uncontrolled

*An arrival or departure on an IFR flight plan or provision of IFR separation service to other aircraft by that facility.

TABLE 4-4 GENERAL AVIATION FLEET ACTIVITY FOR 1972

Aircraft Type	No. of Air-craft	Annual Utilization (Hours)	Annual Flying Hours (Millions)			Flight Duration (Hours)		Annual Flights (Millions)			Annual Operations (Millions)		
			Total	Itin	Local	Itin	Local	Total	Itin	Local	Total	Itin	Local
Piston													
Single Engine	109,000	180	19.5	13.7	5.8	1.0	0.8	20.9	13.7	7.2	68.8	27.4	43.2
Multi Engine	15,529	275	4.3	3.9	0.4	1.3	0.6	3.6	3.0	0.6	9.6	6.0	3.6
Turbine	2,483	600	1.5	1.4	.1	1.2	0.7	1.2	1.1	0.1	2.8	2.2	0.6
Other	4,037	275	1.1	0.6	0.5	0.7	0.8	1.4	0.8	0.6	5.2	1.6	3.6
Totals	131,149		26.4	20.4	6.0			27.1	18.6	8.5	88.2	37.2	51.0

TABLE 4-5 GENERAL AVIATION FLEET ACTIVITY FOR 1984

Aircraft Type	No. of Air-craft	Annual Utilization (Hours)	Annual Flying Hours (Millions)			Flight Duration (Hours)		Annual Flights (Millions)			Annual Operations (Millions)		
			Total	Itin	Local	Itin	Local	Total	Itin	Local	Total	Itin	Local
Piston													
Single Engine	170,600	190	32.3	22.6	9.7	1.0	0.8	34.7	22.6	12.1	117.4	45.2	72.2
Multi Engine	30,400	255	7.8	7.0	0.8	1.3	0.6	6.7	5.4	1.3	18.6	10.8	7.8
Turbine	8,200	560	4.6	4.4	.2	1.2	0.7	4.0	3.7	0.3	9.2	7.4	1.8
Other	7,800	250	1.9	1.1	0.8	0.7	0.8	2.5	1.5	1.0	9.0	3.0	6.0
Totals	217,000		46.6	36.8	9.8			47.9	33.2	14.7	154.2	66.4	87.8

TABLE 4-6 GENERAL AVIATION FLEET ACTIVITY FOR 1995 (LOW ESTIMATE)

Aircraft Type	No. of Air-craft	Annual Utilization (Hours)	Annual Flying Hours (Millions)			Flight Duration (Hours)		Annual Flights (Millions)			Annual Operations (Millions)		
			Total	Itin	Local	Itin	Local	Total	Itin	Local	Total	Itin	Local
Piston													
Single Engine	186,600	200	37.3	29.8	7.5	1.0	0.8	39.2	29.8	9.4	116.0	59.6	56.4
Multi Engine	37,400	235	8.8	7.9	0.9	1.3	0.6	7.5	6.0	1.5	21.0	12.0	9.0
Turbine	15,000	520	7.8	7.4	0.4	1.2	0.7	6.8	6.2	0.6	16.0	12.4	3.6
Other	11,000	315	3.5	1.9	1.6	0.7	0.3	11.6	6.3	5.3	44.4	12.6	31.8
Totals	250,000		57.4	47.0	10.4			65.1	48.3	16.8	197.4	96.6	100.8

TABLE 4-7 GENERAL AVIATION FLEET ACTIVITY FOR 1995 (NOMINAL ESTIMATE)

Aircraft Type	No. of Air-craft	Annual Utilization (Hours)	Annual Flying Hours (Millions)			Flight Duration (Hours)		Annual Flights (Millions)			Annual Operations (Millions)		
			Total	Itin	Local	Itin	Local	Total	Itin	Local	Total	Itin	Local
Piston													
Single Engine	250,000	200	50.0	40.0	10.0	1.0	0.8	42.5	40.0	12.5	155.0	80.0	75.0
Multi Engine	50,000	235	11.7	10.5	1.2	1.3	0.6	10.0	8.0	2.0	28.0	16.0	12.0
Turbine	20,000	520	10.4	9.9	0.5	1.2	0.7	8.9	8.2	0.7	20.6	16.4	4.2
Other	15.000	3.5	4.7	2.6	2.1	0.7	0.3	10.7	3.7	7.0	49.4	7.4	42.0
Totals	335,000		76.8	63.0	13.8			82.1	59.9	22.2	253.0	119.8	133.2

TABLE 4-8 GENERAL AVIATION FLEET ACTIVITY FOR 1995 (HIGH ESTIMATE)

Aircraft Type	No. of Air-craft	Annual Utilization (Hours)	Annual Flying Hours (Millions)			Flight Duration (Hours)		Annual Flights (Millions)			Annual Operations (Millions)		
			Total	Itin	Local	Itin	Local	Total	Itin	Local	Total	Itin	Local
Piston													
Single Engine	373,100	200	74.6	59.7	14.9	1.0	0.8	78.3	59.7	18.6	231.0	119.4	111.6
Multi Engine	74,600	235	17.5	15.7	1.8	1.3	0.6	15.1	12.1	3.0	42.2	24.2	18.0
Turbine	29,900	520	15.5	14.7	0.8	1.2	0.7	13.3	12.2	1.1	31.0	24.4	6.6
Other	22,400	3.5	7.1	3.9	3.2	0.7	0.3	6.6	5.5	1.1	17.6	11.0	6.6
Totals	500,000		114.7	94.0	20.7			113.3	89.5	23.8	321.8	179.0	142.8

TABLE 4-9 GENERAL AVIATION INSTRUMENT OPERATIONS FOR SELECTED YEARS

Demand Parameter	Forecast Year		
	1972	1974	1995 (Nominal)
Fleet Size	131,150	217,000	335,000
Total General Aviation Operations (Millions)	88.2	154.2	253.0
Instrument Operations at Airports with FAA Towers (Millions)	5.9	16.8	44.0
IFR Departures Handled by ARTCC's (Millions)	2.1	8.1	28.0
IFR "Overs" Handled by ARTCC's (Millions)	.6	2.5	9.0
IFR Aircraft Handled by ARTCC's (Millions)	4.8	18.7	65.0

Source: References 2,7, and 16.

airfields. The 1972 to 1984 FAA forecasts of these parameters for general aviation are presented in Table 4-9 and in this Study these have been exponentially extended to 1995 based on the exponential trend shown in the FAA forecast data. The significant increase in general aviation IFR activity is seen as due to increased automation of the control system, new procedures, new definitions of what an IFR operation means, and a lowering of the positive control airspace floor to 14,500 feet.

5. MILITARY AVIATION

The United States Department of Defense currently operates about 10 times more aircraft than the civil air carriers, an amount equivalent to about one-fifth of the general aviation fleet.[17] IFR departures of these aircraft from domestic civil airports having FAA control towers approximate nearly one-half those of air carriers. Recent forecasts of military activity reflect a continuing down-trend, begun in 1969, and the probable reduction in active, regular force aircraft, or else assume a nearly constant, no growth, situation during the next 25 years.[4] Present forecasts have been hampered by a scarcity of information on military fleet size, and its overall activities. Most of the present forecasts are based on the no-growth model due to this lack of information.

5.1 MILITARY FLEET SIZE AND COMPOSITION

The performance of military aircraft has changed appreciably in two directions during the past decade.[17] One trend is toward higher performance (speed, climb rates, etc.), larger size, and greater weight (requiring longer runways). The second is more or less opposite, in the direction of special mission aircraft, as exemplified by those associated with the Southeast Asia operations. Older, more conventional, aircraft tend to remain in service between these two extremes so that the spread of military aircraft performance has increased substantially, a trend that is likely to continue. Included in the performance spread is the increasing use of vertical takeoff or landing aircraft, i.e., helicopters. The long range projection of unique trends in military type aircraft is beyond the scope of this analysis. Nevertheless, the need to consider and provide for coordinated control and air traffic management services for military aircraft operations in the domestic airspace is recognized.

Most present estimates of military fleet size, including those of the FAA, assume that there are 20,000 aircraft in CONUS.[2,4,14] One-half of these are purported to be fixed-wing jet and piston powered aircraft, and the remainder are special purpose aircraft, such as helicopters. This study assumes that this fleet population and distribution will continue until 1995. It is of interest that another recent study on Air Force aircraft operations and air traffic control did, however, estimate that the present inventory of military aircraft within CONUS was about 28,000 aircraft.(17) This divergence from the earlier referenced 20,000 aircraft estimate illustrates the questionable validity of information on the subject. The same study did forecast, based on the downward trend begun in 1969, that by 1980 the (nominal) military fleet size would be 20,000 aircraft and that the fleet would stabilize at this size until at least 1995. Allowing for uncertainties in their 1995 forecast, high and low fleet size estimates of 25,000 and 15,000 aircraft, respectively, were made, and these were used in this AATMS Demand Study.

5.2 MILITARY AVIATION ACTIVITY

The forecast of military aviation activity presented in this report is based on estimates in the Report of the Air Traffic Control Advisory Committee (ATCAC); high and low activity estimates for 1995 were based on data from a Rand Corporation Study on Influences and Implications of Changing Air Traffic Control on World-wide USAF Operations.(4,17) Table 5-1 summarizes the derived data based on these reports. The 1968, 1980, and nominal 1995 estimates were taken from the ATCAC Report. Based on the data presented therein, the average flight duration and average operations per flight, for itinerant and local flights, were derived. The forecasts for 1972 and 1984 were based on interpolations of the ATCAC source data. The high and low activity estimates for 1995 were based on ATCAC utilization numbers with due consideration for the fleet size uncertainties given in the Rand report. The results show that in 1995, about 40 million operations may be expected, due to military aircraft, at <u>all</u> bases, both civil and military.

In 1969, the Rand Study on USAF aircraft operations reports that the CONUS military contingent performed 1.6 million itinerant operations at airports with FAA control towers, and 1.8 million

TABLE 5-1 MILITARY AVIATION ACTIVITY FORECASTS FOR SELECTED YEARS

Activity Element	Forecast Year and Source						
	1968 (ATCAC)	1972 (*)	1980 (ATCAC)	1984 (**)	1995 Low Est. (***)	1995 Nominal (ATCAC)	1995 High Est. (***)
Fleet Size	20,000	20,000	20,000	20,000	15,000	20,000	25,000
Avg. Annual Utilization (Hours)	470	455	430	440	450	450	450
Annual Flying Hours (Millions)							
Itenerant	4.5	4.1	3.4	3.2	2.2	2.9	3.6
Local	4.9	5.0	5.2	5.6	4.6	6.1	7.7
Total	9.4	9.1	8.6	8.8	6.8	9.0	11.3
Annual Flights (Millions)							
Itinerant	2.2	2.0	1.7	1.7	1.1	1.5	1.8
Local	3.3	3.4	3.5	3.7	3.1	4.1	5.1
Total	5.5	5.4	5.2	5.4	4.2	5.6	6.9
Annual Operations (Millions)							
Itinerant	4.5	4.1	3.5	3.2	2.2	3.0	3.6
Local	28.2	29.2	31.0	33.3	28.1	37.4	46.7
Total	32.7	33.3	34.5	36.5	30.3	40.4	50.3
Avg. Flight Duration (Hours)							
Itinerant	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Local	1.5	1.5	1.5	1.5	1.5	1.5	1.5
(Flying Hrs./Flights)							
Operations Per Flight							
Itinerant	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Local	8.5	8.6	8.9	9.0	9.1	9.1	9.1

* Interpolated from ATCAC 1968 and 1980 data
** Interpolated from ATCAC 1980 and 1995 data
*** Fleet size from Rand USAF Study - Other data from ATCAC

Source: References 4 and 17.

local operations at those same airports. About 4.8 million itinerant IFR operations were made by military aircraft (departures, arrivals, and ARTCC handles), and about 1.6 million IFR military departures were made through FAA facilities. The Rand report points out that these activity numbers will tend to remain constant through 1995 due to the countering trends of decreasing fleet sizes, fewer military bases, and an increased use of IFR services due to automated procedures and the lowering of the positive control airspace floor to 14,500 feet. The Rand study points out that, by 1995, uncertainties in their estimates of these numbers (i.e, no change from present estimates) will be as great as their present fleet size estimates.

6. INSTANTANEOUS AIRBORNE COUNTS

One measure of air traffic activity or demand is the peak instantaneous airborne count, (PIAC); the number of aircraft expected to be airborne at the busiest instant of time during the year. This measure of activity is based on the fleet size and national activity forecasts for each category of airspace user as discussed in the preceding sections. Accordingly, it does not account for any deficiencies in the future ATC system to handle the forecast traffic. This activity measure is described as "unconstrained," since it does not make allowances for variations in the capacity of individual system elements. The PIAC represents the maximum load the air traffic control system must handle, and is generally expressed in terms of the number of aircraft and their distribution (geographic, altitude, user/class, flight type, etc.). The PIAC is an important parameter for use in ATC system and subsystem design since it influences the size of the control work force, the size and extent of ATC automation, and the number and location of enroute control centers, towers, and airports. In addition, it determines requirements for such factors as the accuracies, data rates, and channel loading of surveillance, navigation and communication sensors. The relationship between safety and capacity, and the PIAC may also be investigated, resulting, for instance, in assessments of airport saturation and traffic delays. The following parts of this section describe the models and techniques for estimating the instantaneous airborne counts for the en route and terminal regions within CONUS.

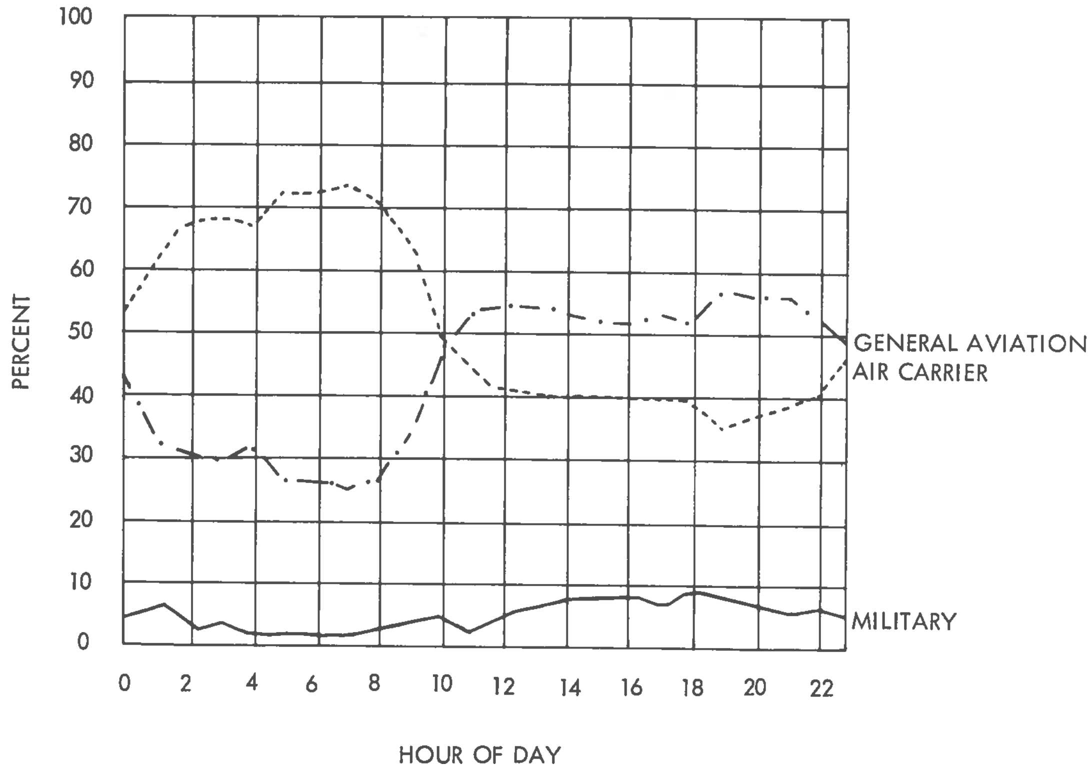
6.1 EN ROUTE ACTIVITY

The peak instantaneous airborne count for 1995 over CONUS has been estimated in terms of flight type (VFR, IFR), geographic distribution of air traffic, altitude distribution, user class (air carrier, general aviation, military), and aircraft type. The determination of the PIAC for the en route airspace is based on the sequential application of two models of air traffic activity. The first is an IFR en route demand model created in 1970 by R. Dixon Speas Associates.[18] It estimates the traffic count along each of 905 city-pair routes. This data was used to determine the peak instantaneous airborne count in a procedure devised by North American Rockwell, Autonetics Division.[6] These procedures are discussed below.

<u>City-Pair IFR Traffic Demand Model</u>[18]

In order to estimate air traffic activity for 1995 in connection with the Civil Aviation Research and Development (CARD) Policy Study, R. Dixon Speas Associates developed a model that determined the density of air carrier, general aviation and military air traffic on the busiest routes between major cities.[18, 19,20] This study was based on forecast IFR en route activity which estimated three-times as many air carrier operations in 1995 as in 1969, the base year for this study, and six-times as many general aviation operations. Critical city-pairs were identified by an analysis of the Official Airline Guide.[21] Origin and destination pairs for non-stop flights were selected if at least five daily flights were exchanged over that route. This information, coupled with a projection of the percentage of IFR departures represented by each user class at the busy hour was used to derive the busy hour activity on each of the city-pair routes.

Based on the anticipated growth in the number of air carrier, general aviation, and military operations, the diurnal distribution of IFR departures for each user category was determined. This information is presented in Figure 6-1. The busy hour is about 1800 hours, and the relative percentages of IFR traffic departures are air carrier - 40 percent, general aviation - 52 percent, and military - 8 percent. The analysis of the Official Airline Guide determined that there were 905 city-pair routes that exchanged five or more daily air carrier flights between 389 cities.[18] In making the 1995 activity projections, it was assumed that the same relative percentage of flights on each route would be maintained.



Source: Reference 18

NOTE: Details based upon 1969 hourly distribution of departures and forecast activity increases of three times for air carrier activity and six times for general aviation activity.

Figure 6-1 IFR Departures Distribution by User and Time of Day: 1995

The number of air carrier IFR flights during the busy hour on these routes was estimated by multiplying the number of daily weekday flights, determined from the Airline Guide, by three (to account for the anticipated increase in the number of IFR departures), and by one-tenth (to account for the busy hour activity relative to the average daily activity). More elaborate steps were required to estimate the IFR general aviation load on these routes. The city-pair distance was determined and the average flight distance capabilities of general aviation aircraft were considered (based on data such as hours flown, number of operations, and speeds), to obtain average trip lengths for each type of aircraft. The results determined that the average trip lengths for three major categories of general aviation aircraft were:

Single-Engine Reciprocal	100 Miles
Multi-Engine Reciprocal	200 Miles
Turbo-Jet	400 Miles

Distance correction factors generated from these average trip lengths were used to modify estimates of the number and type of general aviation aircraft along each city-pair route as a function of route length. The number of general aviation aircraft along each route was estimated from the busy hour ratio of air carrier and general aviation departures (52/40) onto a route, as shown in Figure 6-1, and this distance or trip length correction factor.

Once the total number of general aviation aircraft along a particular route at the busy hour had been estimated, the distribution of the aircraft according to aircraft type and altitude was made. In the R. Dixon Speas Study this was performed guided by the fact that historically the ratio of single-engine to multi-engine aircraft IFR departures has been 1 to 1.9, and that the ratio of multi-engine to turbo-jet aircraft IFR departures has been 1.9 to 1.2. Since the total of all aircraft is known, the aircraft distribution could be derived. The altitude assignments were broadly based on aircraft type and flight characteristics.

En Route Instantaneous Airborne Count Model[6]

For the Advanced Air Traffic Management System Study the R. Dixon Speas Aviation Activity Model was updated to reflect recent forecast changes, and used to generate more detailed analyses of the total (both VFR and IFR) busy hour demand on the same city-pair routes. This revision was done by Autonetics Division of Rockwell International.[6] They updated the Speas data, distributed the flights according to altitude, determined the number of flights by aircraft type, altitude, and route distance, and then estimated the number of aircraft in one-degree longitude and latitude squares or blocks over the contiguous United States. FAA altitude distribution data, Figure 6-2, was used in this part of their procedure to assign flight altitudes uniformly as a function of aircraft type.[22] The expected number of flights along each route during the busy hour was thus obtained. It was assumed in both studies that the total en route itinerant traffic was represented by the traffic on the 905 city-pair routes considered in this analysis. The 1995 busy hour aircraft counts for the twenty busiest city-pair routes is shown in Table 6-1.

The geographic distribution of the en route traffic was determined using a one-degree square longitude and latitude grid over the contiguous United States and determining the traffic within each square or block of that grid. (Other distributions of traffic have been made in other studies.[5,6,7,18,20]) The traffic counts above were assumed to be uniformly distributed over each city-pair route. It was also assumed that there was sufficient airspace capacity to handle the resulting traffic load between any pair of cities. Each route was investigated to see which blocks on the geographic grid that route penetrated, and what proportion of the route length lay within each of those blocks. The traffic was apportioned to each block on the basis of the number of aircraft on the route and the proportion of the route that lay within each block. The total national en route instantaneous airborne count of 15,500 aircraft is the sum of the number of aircraft in each grid block.

PEAK DAY IFR FLIGHTS FROM CENTERS BY ALTITUDE AND TYPE OF AIRCRAFT

FISCAL YEAR 1971

ALTITUDE ASSIGNED IN FEET	TOTAL	SINGLE ENGINE: 1 TO 3 PLACES	SINGLE ENGINE: 4 OR MORE PLACES	MULTI ENGINE: UNDER 12,500 POUNDS	MULTI ENGINE: OVER 12,500 POUNDS	TURBINE ENGINE: TURBO PROP	TURBINE ENGINE: TURBO JET	ROTOR CRAFT	UN KNOWN
TOTAL FLIGHTS	32024	249	1692	5373	1660	4837	18131	78	4
UP TO 1,999	4	1	2	0	0	0	1	0	0
2,000 - 2,999	55	0	11	[illegible]	5	26	1	0	0
3,000 - 3,999	382	7	93	114	40	103	13	12	0
4,000 - 4,999	964	11	222	358	124	210	31	7	1
5,000 - 5,999	1943	23	523	704	235	331	116	11	0
6,000 - 6,999	2260	31	328	904	274	552	156	15	0
7,000 - 7,999	2045	25	245	856	247	474	161	14	1
8,000 - 8,999	1476	24	170	664	185	323	102	4	0
9,000 - 9,999	1134	11	129	511	126	297	58	2	0
10,000 - 10,999	1693	16	48	320	137	384	786	2	0
11,000 - 11,999	981	10	26	167	61	288	406	3	0
12,000 - 12,999	692	6	15	164	53	184	270	0	0
13,000 - 13,999	655	10	22	117	38	175	293	0	0
14,000 - 14,999	734	12	4	105	33	189	391	0	0
15,000 - 15,999	722	10	2	91	19	164	436	0	0
16,000 - 16,999	825	13	1	57	16	113	624	1	0
17,000 - 17,999	661	7	1	53	14	73	513	0	0
18,000 - 18,999	364	3	2	26	7	56	270	0	0
19,000 - 19,999	665	0	1	44	14	104	516	0	0
20,000 - 20,999	867	3	2	21	6	111	724	0	0
21,000 - 21,999	612	2	1	25	2	56	526	0	0
22,000 - 22,999	762	0	0	4	0	33	724	1	0
23,000 - 23,999	1511	0	0	4	3	62	1442	0	0
24,000 - 24,999	1362	0	0	0	3	47	1312	0	0
25,000 - 25,999	750	1	1	0	1	22	724	0	1
26,000 - 26,999	734	0	0	1	0	15	718	0	0
27,000 - 27,999	440	0	0	0	1	10	427	1	1
28,000 - 28,999	752	0	0	0	0	33	719	0	0
29,000 - 29,999	1018	0	0	0	2	11	1005	0	0
30,000 - 30,999	10	0	0	0	0	1	9	0	0
31,000 - 31,999	1156	2	0	1	0	26	1127	0	0
32,000 - 32,999	2	0	0	0	0	0	2	0	0
33,000 - 33,999	1253	0	0	0	0	43	1210	0	0
34,000 - 34,999	0	0	0	0	0	0	0	0	0
35,000 AND OVER	2091	3	0	0	1	78	2009	0	0
ON TOP	428	12	35	35	15	43	286	2	0
UNKNOWN	3	0	2	0	0	0	1	0	0

Source: Reference 22

Figure 6-2 1971 Peak Day IFR Flights from Centers by Altitude and Type of Aircraft

TABLE 6-1 1995 BUSY HOUR AIRCRAFT COUNTS FOR TWENTY BUSIEST CITY-PAIR ROUTES

City-Pair	Air Carrier	General Aviation	Military	Total
Los Angeles/San Francisco	99	219	11	329
Boston/New York	64	251	7	322
New York/Washington	74	213	8	295
Los Angeles/San Diego	48	208	5	261
Los Angeles/Las Vegas	39	147	4	190
Portland/Seattle	34	138	4	176
Chicago/Detroit	35	132	4	171
Philadelphia/Washington	32	136	3	171
Miami/Tampa	26	100	3	129
Miami/Orlando	25	96	3	124
New York/Philadelphia	20	86	2	108
Chicago/Minneapolis	28	85	3	106
Dallas/Houston	22	79	2	103
Phoenix/Tuscon	19	82	2	103
Chicago/St. Louis	22	76	2	100
Chicago/Milwaukee	18	78	2	98
New York/Pittsburgh	23	71	2	96
Miami/Nassau	18	69	2	89
San Francisco/Sacramento	16	69	2	87
Atlanta/Birmingham	16	67	2	85

Source: Reference 5.

It was estimated that at the busiest instant of time in 1995 there would be 3,880 air carrier aircraft airborne together with 11,000 general aviation and 560 military aircraft. About 30 percent of the general aviation and military aircraft are expected to be IFR. Figure 6-3 shows the geographic distribution of aircraft over CONUS as determined by the above procedure. The above methodology was also applied for the high and low estimates of fleet activity, and the results of these analyses, and the one above, are given in Table 6-2.

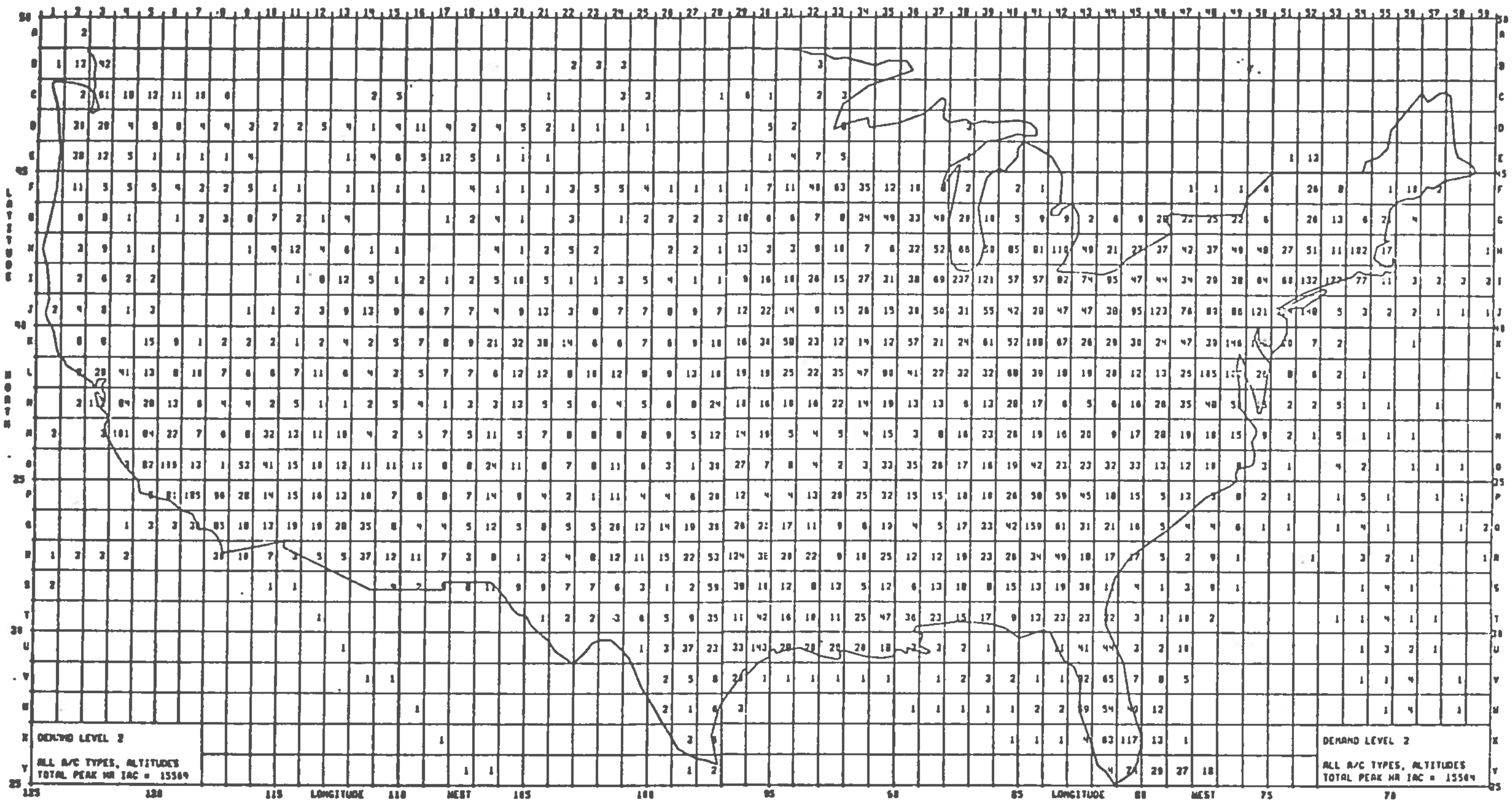
TABLE 6-2 EN ROUTE INSTANTANEOUS AIRBORNE COUNT FOR 1995 BY USER CLASS AND ESTIMATE

User Category	Demand Level and Estimate					
	Low		Nominal		High	
	Fleet	PIAC	Fleet	PIAC	Fleet	PIAC
Air Carrier	5,000	2,800	7,000	3,900	9,500	5,350
General Aviation	250,000	8,200	335,000	11,000	500,000	16,450
Military	15,000	400	20,000	550	25,000	700
Totals	270,000	11,400	362,000	15,450	534,500	22,500

Source: Reference 7.

6.2 TERMINAL ACTIVITY

The terminal area instantaneous airborne count and its geographical distribution used in the AATMS Study is based on recent studies by the Mitre Corporation.[7] This measure of future aircraft activity within the United States is based on present FAA forecasts of terminal area activity in 1984 for the busiest 1200 airports, and on the conversion of the anticipated number of annual operations at each of these airports into busy hour operations, and subsequently into an instantaneous airborne count which may be distributed geographically.[7]



Source: Reference 7

Figure 6-3 1995 En Route Peak Instantaneous Airborne Count Geographic Distribution (Nominal Demand Level)

Figure 6-4 illustrates the methodology used in determining the terminal area instantaneous airborne count and its geographic distribution. The FAA forecasts for the top 1200 airports were extended from 1984 to 1995. Included in this extension of the FAA forecast was a breakdown of the operations into air carrier and general aviation enplanements, and air carrier, general aviation, and military operations, both itinerant and local. Based on the airport projections, projections of hub activity were made. The hub and airport operations data was then converted to busy hour operations at each airport, and then to the instantaneous airborne count associated with each hub or terminal. The geographic distribution of this count was determined based on hub size and location, and on airport location.

Airport Activity Forecasts

The FAA recently projected certain key measures of aviation activity for 1200 selected airports meeting at least one of the following criteria.

Has an existing control tower

Is a candidate for a control tower

Has 50 or more based aircraft

Receives certificated route air carrier service

Has 20,000 or more general aviation itinerant operations

The data reported for these "busiest" airports includes the number of enplaned passengers for air carrier and air taxi flights; the number of air carrier, total itinerant, total, and instrument operations; and the number of instrument approaches. The forecast is extended trend data that takes into account near-term plans at these airports for new equipment and facilities. The 1984 operations figures for these 1200 airports were extended to 1995 based on the projected national demand, and the assumption that each airport would maintain its present proportional share of national operations between 1984 and 1995. Specifically, the 1995 projections were based on the following equation:[7]

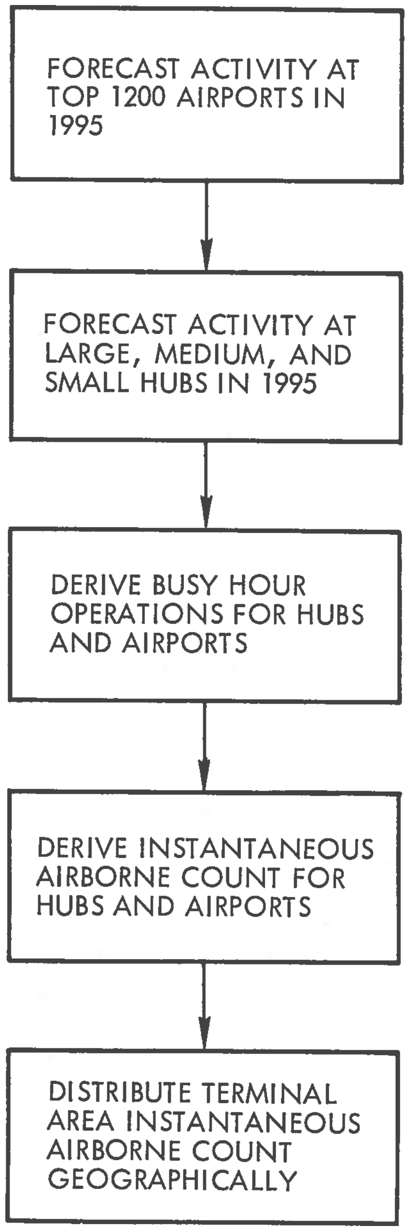


Figure 6-4 Methodology Used to Determine Terminal Area Instantaneous Airborne Count and Geographic Distribution

$$D_a\,(1995) = D_a\,(1984)\left[\frac{D_{national}(1995)}{D_{national}\,(1984)}\right]$$

where, for air carrier or general aviation operations,

D_a (1995) is the forecast demand parameter at airport "a" in 1995,

D_a (1984) is the forecast demand parameter at airport "a" in 1984,

$D_{national}$ (1984) is the forecast national demand for the parameter of interest in 1984.

These growth estimates ignore variations in individual airport growth. The forecasts produced by this technique are accordingly called "unconstrained" demand estimates. In developing the 1995 forecasts for the 1200 airports the following assumptions were also made:

1. The total itinerant traffic at the 1200 airports is assumed to include <u>all</u> itinerant activity for 1972, 1984, and 1995.
2. All general aviation itinerant activity is concentrated at the top 1200 airports.
3. Total GA itinerant activity at FAA-serviced towers, relative to that at the top 1200 airports, increases from 66 to 81 percent from 1972 to 1984. Thus, as the number of controlled airports increases from 350 to 550 to 800 (towers and remote controlled airports) in 1972 to 1984 to 1995, the fraction of total GA itinerant activity at FAA-serviced airports increases to 95 percent of that at the top 1200 airports.
4. GA itinerant and local traffic activity at airports with FAA control towers (or remote controlled airports) has been and will continue to be 55 and 45 percent, respectively, of the total activity at these airports.

From these assumptions and the information derived in Section 4.2 of this report, the 1995 activity for general aviation at the 800 controlled airports and 1200 top airports was derived as follows:

1. In 1995, there will be about 120 million GA itinerant operations (From Section 4.2), and by the second assumption above, all this activity will be at the 1200 top airports.

2. The total GA local activity at all airports will be the difference between the number of itinerant operations and the total number of operations (253 million in 1995 from Section 4.2), or 133 million operations.

3. GA itinerant operations at airports with FAA control towers will be 95 percent of the total itinerant operations, or 115 million.

4. By the fourth assumption, 55 percent of the total GA traffic at FAA-serviced airports will be itinerant; thus a total of 210 million operations (115 million divided by .55) will take place at these airports.

5. The local activity at airports with FAA control towers will be 45 percent of the total GA activity or 95 million operations (.45 times 210 million).

6. Local operations at airports without FAA control towers will amount to 38 million operations, (133 less 95 million) or an average of six daily operations at each of these airports.

Military operations are assumed to remain unchanged from the present. Figure 6-5 shows the data derived by the above technique for the 36 airports with the largest projected number of annual operations. The 133 primary airports are expected, in 1995, to account for 94 percent of the air carrier activity (operations) and 37 percent of the total itinerant traffic.[7]

AIRPORT ACTIVITY PROJECTIONS BASED ON THE TERMINAL AREA FORECAST * * PRIMARY HIGH DENSITY AIRPORTS

CODE	STATE	A-C ENPS	G-A ENPS	A-C OPNS	G-A OPS ITN	G-A OPS LCL	MILOPS ITN	MILOPS LC	G-A OPS	MIL OPS	ITN OPS	LCL OPS	TTL OPS	HUB	LOCATION DESCRIPTION AIRPORT	LOCATION DESCRIPTION COMMUNITY
ATL	GA.	55048	363	986	242	15	1	0	257	1	1229	15	1244	ATL	ATLANTA	WBHARTSFD
ORD	ILL.	57401	231	1061	154	0	3	0	154	3	1218	0	1218	CHI	CHICAGO	O'HARE
OPF	FLA.	0	1014	0	676	487	8	7	1163	15	664	494	1178	MIA	MIAMI	OPA LOCKA
SNA	CAL.	4220	820	125	547	481	1	1	1028	2	674	492	1156	LAX	SANTA A	ORANGE CO
LGB	CAL.	498	897	31	578	463	8	29	1061	37	637	492	1129	LAX	LONG BE	LONG BECH
DFW	TEX.	41267	400	713	267	3	0	0	270	0	980	3	983	DFW	DALLAS/	REG ARPT
LAX	CAL.	47395	279	778	186	0	8	0	186	8	972	0	972	LAX	LOSANGE	INTERNATIONAL
SJC	CAL.	6202	597	200	398	362	1	1	760	2	599	363	962	SJC	SAN JOS	MUNICIPAL
SJU	P.R.	12790	661	466	441	43	6	4	484	10	913	47	960	SJU	SAN JUA	INTERNATIONAL
SFO	CAL.	36902	90	821	60	0	6	0	60	6	887	0	887	SFO	SAN FRA	INTERNATIONAL
FLL	FLA.	6035	777	176	518	182	1	3	700	4	695	185	880	MIA	FT LAUD	HOLLYWOOD
BUR	CAL.	6936	684	114	456	274	2	1	730	3	572	275	847	LAX	BURBANK	HOLLYWOOD
PHX	ARIZ	10012	706	212	471	135	6	4	606	10	689	139	828	PHX	PHOENIX	SKYHARBOR
HOU	TEX.	641	925	30	617	171	0	4	788	4	647	175	822	IAH	HOUSTON	W P HOBBY
PHL	PA.	21798	430	525	237	0	2	1	267	3	814	1	815	PHL	PHILE	INTERNATIONAL
JFK	N.Y.	43060	228	655	152	0	1	0	152	1	808	0	808	NYC	NEW YOR	KENNEDY
BOS	MASS	28572	304	566	203	7	0	0	210	0	769	7	776	BOS	BOSTON	LOGAN INT
MIA	FLA.	28673	231	594	154	0	1	9	154	10	749	9	758	MIA	MIAMI	INTERNATIONAL
OAK	CAL.	10396	534	240	356	151	2	2	507	4	598	153	751	SFO	OAKLAND	INTERNATIONAL
ANC	ALAS	3256	579	140	386	212	2	2	598	4	528	214	742	ANC	ANCHORA	INTERNATIONAL
LGA	N.Y.	30764	268	553	179	0	1	0	179	1	733	0	733	NYC	NEW YOR	LAGUARDIA
ORL	FLA.	213	835	23	557	150	1	1	707	2	581	151	732	ORL	ORLANDO	HERNDON
EWR	N.J.	28901	258	540	172	6	0	0	178	0	712	6	718	EWR	NEWARK	NEWARK
PBI	FLA.	3125	628	117	419	171	1	1	590	2	537	172	709	PBI	WPALMBE	PALMBEACH
HNL	HAW.	24255	379	382	253	3	52	15	256	67	687	18	705	HNL	HONOLUL	INTERNATIONAL
PIT	PA.	17674	357	451	225	4	11	11	229	22	667	15	702	PIT	PITTSBR	GREATER
STL	MO.	19251	310	445	207	3	16	1	210	17	668	4	672	STL	ST LOUI	INTERNATIONAL
MEM	TENN	7604	642	222	428	13	3	1	441	4	653	14	667	MEM	MEMPHIS	INTERNATIONAL
DEN	COL.	31385	178	528	119	0	1	0	119	1	646	0	646	DEN	DENVER	STAPLETON
SLC	UTAH	6902	493	165	329	110	10	14	439	24	504	124	628	SLC	SALT LK	INTERNATIONAL
DCA	D.C.	19529	316	413	211	0	1	2	211	3	625	2	627	WAS	WASHING	NATIONAL
BAL	MD.	11170	592	197	395	3	2	2	398	4	594	5	599	BAL	BALTIMO	FRIENDSHP
SBA	CAL.	740	496	28	331	236	1	1	567	2	360	237	597	SBA	ST BARB	MUNICIPAL
SAN	CAL.	10919	396	235	264	70	6	8	334	14	505	78	583	SAN	SAN DIE	INTERNATIONAL
ICT	KAN.	2164	604	73	403	95	3	0	498	3	479	95	574	ICT	WICHITA	MUNICIPAL
AUS	TEX.	1552	459	69	306	177	7	10	483	17	382	187	569	AUS	AUSTIN	MUELLER

Legend

A-C = Air Carrier
G-A = General Aviation
MIL = Military
ENPS= Enplanements per year(thousands)
OPS = Operations per year (thousands)
ITN = Itinerant
LCL = Local
TTL = Total

Source: Reference 7.

Figure 6-5 1995 Operations at Major Airports

The National Airport System Plan has established a classification scheme for airports according to the number of air carrier enplanements, an estimated general aviation enplanement factor, and the number of annual operations recorded.[8] Table 6-3 shows the classification criteria, the number of airports in 1972 and those projected for 1984 and 1995. The projected distribution of airports shifts appreciably upward as the operations at all airports increase. The estimated number of feeder and independent airports is somewhat arbitrary since reliable data on these facilities is unavailable.

Hub Activity Forecasts

Certain metropolitan areas within the United States are designated airport hub areas based on the number of enplanements and operations at all airports within the area. The geographic area associated with a hub varies with the boundaries associated with the urban area, and thus the number of airports included varies from hub to hub. Table 6-4 shows the hub classification criteria currently used by the FAA, the number of high, medium, and low density hubs in 1972, and the number projected for 1984 and 1995[8] The 1995 projections of hub air traffic activity have been adjusted to include some airports outside present hub boundaries, but near a metropolitan area and most likely associated with the 1995 hub. The individual hub activity projections were obtained by adding the activity estimates for each hub airport, based on the preceding Airport Activity Forecasts. Table 6-5 lists the high and medium density hubs for 1995 and their associated activity parameters. These figures are integrally connected with the derivation of the terminal area instantaneous airborne count.

Instantaneous Airborne Count for Terminal Areas in 1995

The determination of the terminal area instantaneous airborne count depends on the estimation of the busy hour operations at the airports and hubs considered in this Study. The FAA has determined that two factors may be used to relate annual operations to busy hour operations.[23] The busy hour air carrier operations

TABLE 6-3 CIVIL AIRPORT CLASSIFICATION CRITERIA AND NUMBER BY YEAR

Airport Category	Classification Criteria		Number of Airports		
	Annual Passenger Enplanements	Annual Aircraft Operations	1972	1984	1995
Primary	More than 1,000,000		41	81	133
High Density		350,000 or more	9	27	103
Medium Density		250,000 to 350,000	15	27	19
Low Density		less than 250,000	17	27	11
Secondary	50,000 to 1,000,000		385	601	784
High Density		250,000 or more	27	129	243
Medium Density		100,000 to 250,000	106	287	342
Low Density		less than 100,000	162	185	199
Feeder	Less than 50,000		2600	3100	4000
High Density		100,000 or more	50	200	400
Medium Density		20,000 to 100,000	750	900	1500
Low Density		less than 20,000	1800	2000	2100
Total NAS Airports			3026	3782	4917
Other Airports			9000	11000	14000
Total U.S. Airports			12026	14782	18917

Source: References 7 and 8.

TABLE 6-4 HUB CLASSIFICATION CRITERIA AND NUMBER BY YEAR

Hub Classification Criteria			Number by Year		
Size	Percent of Nation's RPE in Hub	Approximate Number of RPE's in Hub in 1995	1972	1984	1995
Large	More than 1%	10 million RPE	23	24	25
Medium	1/4% to 1%	2.5 to 10 million RPE	37	38	39
Small	1/20% to 1/4%	0.5 to 2.5 million RPE	80	75	70

Source: References 7 and 8.

TABLE 6-5 PROJECTED 1995 LARGE AND MEDIUM HUB ACTIVITY

HUB NAME	CODE	NO. A/C AIRPORTS	NO. G/A AIRPORTS	A/C ENPLANES	G/A ENPLANES	A/C OPNS	G/A ITN OPNS	G/A LC OPNS	MIL OPNS	TOTAL OPNS
NEW YORK CITY	NYC	5	3	74517	2793	1264	1863	1459	11	4597
LOS ANGELES	LAX	5	9	69582	7405	1194	4939	3893	112	10138
CHICAGO	CHI	3	13	69280	3281	1331	2190	2693	27	6241
ATLANTA	ATL	2	3	55069	1516	989	1011	851	16	2867
SAN FRANCISCO	SFO	3	8	47325	3061	1064	2042	2094	16	5216
DALLAS	DFW	2	7	41303	2785	717	1858	1713	16	4304
MIAMI	MIA	3	4	34754	3359	775	2240	2361	34	5410
DENVER	DEN	1	5	31385	784	526	524	955	1	2006
WASHINGTON	WAS	4	5	28941	1463	613	977	1736	246	3572
NEWARK	EWR	2	3	28933	2107	547	1405	1025	1	2978
BOSTON	BOS	2	3	28595	1311	569	875	1042	13	2499
HONOLULU	HNL	1	0	24255	379	382	253	3	67	705
PHILADELPHIA	PHL	2	4	21948	1159	542	774	698	5	2019
ST. LOUIS	STL	2	2	19293	874	446	584	569	29	1628
PITTSBURGH	PIT	3	4	17954	1248	460	834	714	25	2033
MINNEAPOLIS	MSP	1	7	17144	1923	252	1283	1714	44	3293
DETROIT	DET	3	8	16657	2266	349	1512	1609	4	3474
HOUSTON	IAH	2	9	16520	2031	354	1356	1088	4	2802
LAS VEGAS	LAS	1	1	16164	593	280	396	264	15	955
SEATTLE	SEA	2	7	16122	1863	242	1244	1155	4	2645
NEW ORLEANS	MSY	2	0	13412	783	293	522	452	10	1277
SAN JUAN	SJU	1	0	12790	661	466	441	43	10	960
KANSAS CITY	MKC	2	5	12693	1292	282	863	868	1	2014
BALTIMORE	BAL	1	0	11170	592	197	395	3	4	599
CLEVELAND	CLE	3	8	11162	1280	246	855	781	3	1885

TABLE 6-5 PROJECTED 1995 LARGE AND MEDIUM HUB ACTIVITY (CONTINUED)

HUB NAME	CODE	NO. A/C AIRPORTS	NO. G/A AIRPORTS	A/C ENPLANES	G/A ENPLANES	A/C OPNS	G/A ITN OPNS	G/A LC OPNS	MIL OPNS	TOTAL OPNS
SAN DIEGO	SAN	1	6	10919	1939	235	1294	1629	14	3172
PHOENIX	PHX	1	3	10012	1260	212	841	518	10	1581
TAMPA	TPA	1	5	9799	1137	221	759	747	14	1741
RIVERSIDE	RIV	4	4	9037	1451	194	969	753	14	1930
PORTLAND	PDX	1	5	8631	1106	215	738	867	23	1843
MEMPHIS	MEM	1	2	7604	1072	222	715	304	4	1245
SALT LAKE CITY	SLC	1	0	6902	493	165	329	110	24	628
SAN JOSE	SJC	1	1	6202	1180	200	787	889	2	1878
SAN ANTONIO	SAT	1	1	5947	557	125	372	215	75	787
BUFFALO	BUF	1	2	5668	652	143	435	486	47	1111
CINCINNATI	CIN	1	3	5086	804	166	537	464	1	1168
COLUMBUS	CMH	1	4	4861	981	111	655	579	18	1363
ORLANDO	ORL	2	0	4802	835	140	557	150	2	849
SACRAMENTO	SAC	1	4	4587	1127	116	752	512	11	1391
HARTFORD	BDL	2	2	4462	904	157	604	342	18	1121
NORFOLK	ORF	1	1	4439	472	108	315	177	9	609
OKLAHOMA CITY	OKC	2	4	4331	1669	107	1113	936	9	2165
LOUISVILLE	LOU	1	1	4319	804	120	536	659	13	1328
INDIANAPOLIS	IND	1	10	4281	989	161	662	965	3	1791
CHARLOTTE	CLT	1	0	4243	400	117	267	13	15	403
ALBUQUERQUE	ABQ	1	2	4188	589	145	393	402	62	1002
JACKSONVILLE	JAX	1	2	4085	601	111	401	400	17	929
NASHVILLE	BNA	1	0	3912	385	95	257	40	8	400
OMAHA	OMA	1	4	3823	766	101	511	419	2	1033
MILWAUKEE	MKE	1	5	3789	977	149	652	722	12	1535
ROCHESTER	ROC	1	0	3671	304	104	203	218	2	527
KAHULUI	OGG	1	0	3545	166	99	111	4	19	233

TABLE 6-5 PROJECTED 1995 LARGE AND MEDIUM HUB ACTIVITY (CONTINUED)

HUB NAME	CODE	NO. A/C AIRPORTS	NO. G/A AIRPORTS	A/C ENPLANES	G/A ENPLANES	A/C OPNS	G/A ITN OPNS	G/A LC OPNS	MIL OPNS	TOTAL OPNS
TUCSON	TUS	1	2	3494	419	69	280	415	23	787
SYRACUSE	SYR	1	0	3471	286	105	191	92	17	405
LIHUE	LIH	1	0	3347	76	75	51	18	2	146
RALEIGH	RDU	1	0	3281	348	85	232	30	15	362
ANCHORAGE	ANC	1	0	3256	579	140	386	212	4	742
TULSA	TUL	2	3	3227	1757	97	1172	630	13	1912
HILO	ITO	1	0	3182	172	63	115	46	7	231
EL PASO	ELP	1	0	3129	321	67	214	154	27	462
WEST PALM BEACH	PBI	1	0	3125	628	117	419	171	2	709
SPOKANE	GEG	1	2	3089	491	78	328	245	5	656
DAYTON	DAY	1	3	2965	624	108	417	209	0	734
RICHMOND	RIC	1	0	2959	361	87	241	92	48	468
RENO	RNO	1	1	2952	379	65	253	98	8	424
GREENSBORO	GSO	2	0	2820	638	99	426	240	3	768

are obtained by multiplying the annual air carrier operations by .07/300. This factor recognizes that minimum air carrier activity occurs on weekends, and that air carrier activity is especially concentrated during about 14 hours of the day. A similar factor for general aviation is .1/270. This recognizes that much general aviation activity occurs on weekends, and that this activity has its diurnal peak during a 10 hour midday period. These figures have been verified through an analysis of annual operations and busy hour operations for 1971.[23] Since non-hub airports account for only five percent of the air carrier activities, the second factor has been used at these airports since peaking effects there are minimal.[7]

Busy hour operations were converted into an instantaneous airborne count by a factor, determined to be about 4, based on each aircraft spending an average of 30 minutes within a terminal area (between the edge of a hub and the destination or origin airport), and also on the fact that for each takeoff there is also a landing.[7] The factors converting annual operations to busy hour operations, and busy hour operations to terminal area instantaneous airborne count have been applied to the hubs and to the airports in this Study and the results summed to arrive at the nominal demand level terminal area instantaneous airborne count of 21,550. Table 6-6 shows the detailed breakdown of the count for the large hubs.

Table 6-7 shows the terminal area peak instantaneous airborne for the low, nominal, and high demand levels. The estimates of this parameter were only determined at the nominal demand level. The low and high estimates in the Table were obtained by scaling based on the size of each segment of the aviation fleet.

The concluding step in analyzing the terminal area instantaneous count was the determination of the geographic distribution of this activity. The contiguous United States was divided into a grid of one-degree square longitude and latitude blocks in order to provide a basis (identical to that used in the en route analysis) for distributing the terminal traffic. The airport and hub traffic was assigned to this grid as a function of the type of airport or hub.

TABLE 6-6 INSTANTANEOUS AIRBORNE COUNT BREAKDOWN FOR LARGE HUBS IN 1995

Hub Name (City)	No. of Air Carrier Airports in Hub	No. of General Aviation Airports in Hub	Peak Instantaneous Airborne Count						
			Air Carrier	Gen. Av. Itinerant	Gen. Av. Local	Mil	IFR	VFR	Total
New York	5	3	74	172	135	1	127	255	382
Los Angeles	5	9	70	457	361	10	217	681	898
Chicago	3	13	78	203	249	2	141	391	532
Atlanta	2	3	58	94	79	1	87	145	232
San Francisco	3	8	62	189	194	2	121	291	412
Dallas/Ft. Worth	2	7	42	172	159	1	95	279	374
Miami	3	4	45	207	219	3	110	364	474
Denver	1	5	31	49	88	0	46	122	168
Washington	4	5	36	90	161	23	86	224	310
Newark	2	3	32	130	95	0	71	186	257
Boston	2	3	33	81	97	1	58	154	212
Philadelphia	2	4	32	72	65	0	54	115	169
St. Louis	2	2	26	54	53	3	45	91	136
Pittsburgh	3	4	27	77	66	2	42	120	162
Minneapolis	1	7	15	119	159	3	54	242	296
Detroit	3	8	20	140	149	0	62	247	209
Houston	2	9	21	126	101	0	59	189	248
Las Vegas	1	1	16	37	24	1	28	187	215
Seattle	2	7	14	115	107	0	49	187	236
New Orleans	2	0	17	48	42	1	32	76	108
Kansas City	2	5	16	80	80	0	40	136	176
Baltimore	1	0	12	37	0	0	33	26	59
Cleveland	3	8	14	79	72	0	38	126	164

Source: Reference 7.

TABLE 6-7 TERMINAL AREA PEAK INSTANTANEOUS AIRBORNE COUNTS FOR 1995

User Category	Demand Level					
	Low		Nominal		High	
	Fleet	PIAC	Fleet	PIAC	Fleet	PIAC
Air Carrier	5,000	1,000	7,000	1,450	9,500	1,900
General Aviation	250,000	14,800	335,000	19,800	500,000	29,500
Military	15,000	200	20,000	300	25,000	400
Totals	270,000	16,000	362,000	21,550	534,500	31,800

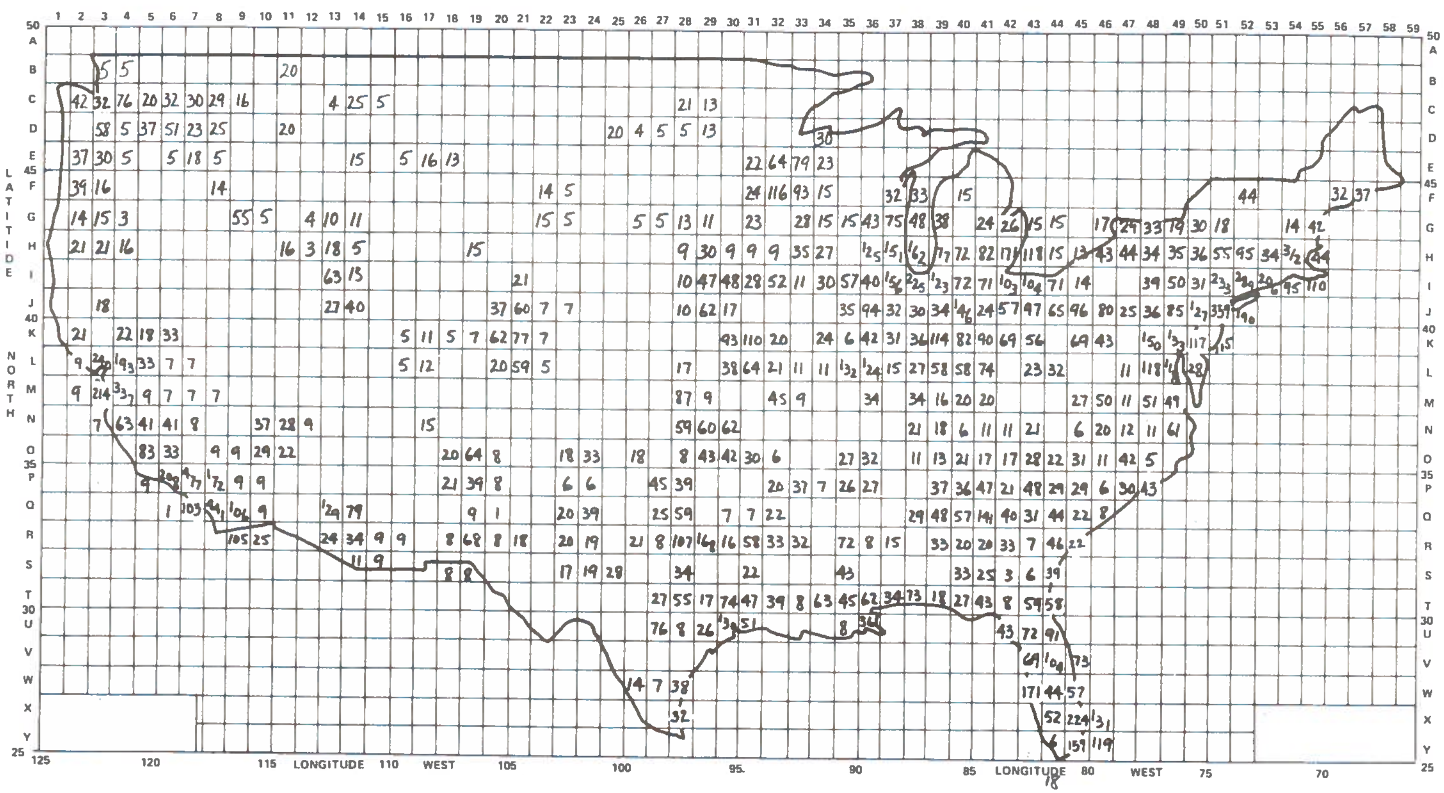
a. Hubs were assigned a radius depending on their size and character. Large hubs had a radius of about 50 miles. Medium and small hubs had radii of 35 and 20 miles, respectively. These assignments recognize the radius of activity associated with each hub.

b. The instantaneous airborne count determined for each hub is distributed uniformly over the hub area, and the proportion of that area within each one-degree square block was used to allocate the hub traffic to each block.

c. Non-hub airports with more than 150,000 operations annually were assumed to have their associated instantaneous airborne counts concentrated at their geographic locations, and hence within a particular one-degree square block.

d. All other airports were assumed to have their total traffic spread uniformly throughout their associated FAA region.

Figure 6-6 shows the geographic distribution of the total terminal area instantaneous airborne count of 21,550 aircraft. Combined with Figure 6-3 the total aircraft (both en route and terminal) within any block may be determined.



Source: Reference 7.

Figure 6-6 Terminal Area Peak Instantaneous Airborne Count Geographic Distribution: 1995

6.3 CONUS ACTIVITY

The national peak instantaneous airborne count estimated on the basis of nominal 1995 demand projections may be obtained by adding the corresponding parameters from the en route and terminal studies. The techniques used under both procedures gave estimates of the number of VFR and IFR aircraft by user class, and these are indicated in Table 6-8. A further category of users has been included in the Table to further segregate general aviation VFR users into those in mixed airspace under separation assurance techniques such as the intermittent positive control (IPC) concept, and those outside that airspace. IPC is a separation assurance concept expected to materially aid in reducing midair collisions or conflicts.[4] In the IPC concept, properly equipped aircraft are given ground-based computer-derived instructions (based on ground system knowledge of aircraft position through surveillance) to avoid flight hazards arising from other aircraft, weather, airspace boundary conditions, and surface obstacles. The number of aircraft estimated to require this type of service is a function of altitude and proximity to major terminal or hub areas. (Mixed airspace is a block of airspace in which both IFR and VFR flights take place, and in 1995 may include the airspace between 6000 feet and the floor of positive control airspace, or up to about 14,5000 feet.)

Considering CONUS peak instantaneous activity for 1995, the Mitre Corporation estimated that IPC service would be required by 75 percent of en route itinerant and terminal local traffic and 85 percent of terminal area itinerant traffic.[7,24] The remainder of the VFR general aviation fleet would be in mixed airspace. In further assessing the distribution of traffic, all air carrier and military traffic was assumed to be IFR itinerant and 30 percent of the general aviation itinerant flights was assumed to be IFR. Table 6-8 contains this summary.

A less precise procedure to estimate the instantaneous airborne count may also be used as a check on the above procedures. In applying this technique, the Study first estimated the average instantaneous airborne count by the following steps:

TABLE 6-8 DISTRIBUTION OF THE 1995 PEAK INSTANTANEOUS AIRBORNE COUNT

Fleet Component	En Route				Terminal			
	IFR	IPC	VFR	Total	IFR	IPC	VFR	Total
Air Carrier	3,900	-	-	3,900	1,450	-	-	1,450
General Aviation								
Itinerant	3,100	5,950	1,950	11,000	3,050	6,075	1,075	10,200
Local	-	*	*	-	-	7,200*	2,400*	9,600*
Military	500	-	-	550	300	-	-	300
Totals	7,550	5,950	1,950	15,450	4,800	13,275	3,475	21,550
Total National Peak Instantaneous Airborne Count = 37,000 Aircraft								

* No estimate was made of local traffic outside the 1,200 busiest airports.

a. Assume the average flying day for the air carrier fleet to be 16 hours, and for the general aviation and military fleet 8 hours.

b. Divide the annual flying hours for each fleet type by 365 to obtain the average fleet flying hours per day.

c. Divide the average fleet flying hours per day by the operating hours per day of that fleet type to obtain the average number of fleet flying hours per hour.

d. Divide the fleet flying hours per hour by the average flight duration of that fleet type to obtain the average number of instantaneous airborne aircraft.

Table 6-9 contains this derivation. The result is an average 1995 instantaneous airborne count of 33,640 aircraft. An estimate of the peak instantaneous airborne count was made from this average estimate by using the peaking factors found in the Air Traffic Control Advisory Committee report.(4) These factors considered that the traffic peaked above its average level as follows: air carrier - 20 percent; general aviation itinerant - 10 percent; general aviation - 30 percent; military itinerant - 30 percent; and military local - 40 percent. A peak instantaneous airborne count, for 1995, of 42,100 aircraft was produced by applying these factors to the count derivation of this section. This peak instantaneous airborne count is 13 percent higher than that estimated by the more rigorous techniques described earlier. The total national peak instantaneous airborne count is about 10 percent of the fleet size, and of this amount, nearly 60 percent is expected to be in the terminal areas.

TABLE 6-9 NATIONAL IAC - 1995 NOMINAL AIR FLEET

	Aircraft Type	No. of Aircraft	Annual Utilization	Flying Hours Per Year (Millions) I	Flying Hours Per Year (Millions) L	Flying Hours Per Day (Thousands) I	Flying Hours Per Day (Thousands) L	Hours Of Operation	Flying Hours Per Hour (Thousands) I	Flying Hours Per Hour (Thousands) L	Flight Duration (Hours) I	Flight Duration (Hours) L	Instantaneous Airborne Count (IAC) I	Instantaneous Airborne Count (IAC) L
Air Carrier	Long/Medium/Short Haul	5,000	3160	15.8	-	43.3	-	16	2.7	-	1.3	-	2,034	-
	Ultra-Short Haul	2,000	1800	3.6	-	9.8	-	16	0.6	-	0.67	-	900	-
	Totals	7,000		19.4	-	53.1	-	-	3.3	-	-	-	2,934	-
General Aviation	Single Eng. Piston	250,000	200	40.0	10.0	109.5	27.4	8	13.7	3.4	1.0	0.8	13,700	4,250
	Multi-Eng. Piston	50,000	235	10.5	1.2	28.7	3.3	8	3.6	0.4	1.3	0.6	2,770	667
	Turbine	20,000	520	9.9	0.5	27.1	1.4	8	3.4	0.2	1.2	0.7	2,833	285
	Other	15,000	315	2.6	2.1	7.1	5.7	8	0.9	0.7	0.7	0.3	1,285	2,333
Military Aviation													20,588	7,535
	General	20,000	450	2.9	6.1	7.9	16.7	8	1.0	2.1	1.2	1.2	833	1,750
	Total Average IAC												24,355	9,285
													33,640	
	Total Peak IAC (Above average with peaking factors applied - see text)												42,100	

7. CONSTRAINED AIRPORT ANALYSIS

The preceding analyses of air traffic activity and fleet size have been made on the basis of "unconstrained" projections of traffic growth. Each activity parameter was projected to 1995, using 1972 FAA projections of activity in 1984, without considering whether or not the future air traffic control or airport systems could handle this demand. A recent study, done by the Mitre Corporation and described here, assessed the ability of 29 of the busiest high density primary airports to handle the forecast 1995 demand, and determined that thirteen of these airports would be unable to do so; that is they would be saturated.[10] Airport saturation occurs when the unconstrained projection of the number of operations during the busy hour (busy hour demand) exceeds the number of busy hour operations the airport can handle under IFR conditions (busy hour capacity).

The constrained airport analysis was based on the unconstrained airport projections described in Section 6.2. This information provided estimates on the number of busy hour operations each major airport might expect to handle if its present growth pattern were to continue into 1995. A separate estimate was made of the maximum IFR capacity of each of 29 top airports in 1995, and by comparing the two results each airport was classified as saturated (demand exceeds capacity) or unsaturated (capacity exceeds demand).

The busy hour capacity of each of the 29 airports was determined using a mathematical model that considered the major parameters relating to airport capacity.[10] A mix of aircraft was assumed at each airport for 1995, after assessing the trend to wide body jets and more sophisticated general aviation aircraft. The mix of landing aircraft was assumed to be different for long and short runways. Some airport improvements were assumed implemented prior to 1995, namely special runways for short-haul traffic, as well as new cross and parallel runways where existing real estate permits. A highly automated control concept was assumed, characterized by accurate metering and spacing, and four dimensional area navigation. A microwave landing system was also assumed. Two control schemes were considered, both taking the wake vortex problem into account. In the first scheme present spacing criteria would continue (two to five mile spacing between aircraft depending on aircraft type, size, and weight). In the second scheme, a consistent two mile spacing between aircraft was assumed, permissible because of changes in improved aircraft aerodynamics or wake turbulence ground warning systems. Independent IFR operations on parallel runways were assumed.

The results are summarized in Table 7-1. With the best of the future improvements indicated above at each of the twenty nine airports, twelve would still be saturated in 1995. If a solution to the wake turbulence problem does not materialize by 1995, two to five mile interaircraft spacing will continue, and eighteen of the top twenty nine airports are expected to be saturated. Techniques for relieving saturation at these airports include expanding the airports so that new runways and facilities may be constructed, shifting the demand for primary airport operations to other nearby airports, restricting the busy hour usage of the airport by techniques such as a reservation system, or spreading the total traffic load at an airport throughout the day to avoid usage peaks.

TABLE 7-1 1995 DEMAND AND CAPACITY AT 29 OF THE BUSIEST AIRPORTS

Airport	Busy Hour Capacity (Operations Per Hour)	Busy Hour Demand (Operations Per Hour)
*Atlanta	182	272
*Baltimore	90	112
*Boston	90	166
*Chicago-O'Hare	185	273
*Chicago-Midway	82	84
Cleveland	157	90
Dallas	255	210
Denver	178	143
Detroit	189	108
Honolulu	162	142
Houston	158	102
Kansas City	126	96
Las Vegas	142	112
Los Angeles	255	214
Miami	255	168
Mineapolis	158	95
*Newark	153	155
New Orleans	152	91
*New York-J.F. Kennedy	184	178
*New York-LaGuardia	90	159
Oakland	175	142
*Philadelphia	155	170
*Pittsburgh	146	146
St. Louis	156	141
*San Diego	63	112
*San Francisco	156	202
Seattle	156	103
Washington-Dulles	183	85
*Washington-National	90	131

*Airports at which demand is expected to exceed capacity.

Source: References 9 to 13.

APPENDIX A

AVIATION FORECAST DATA: 1972-1984

The following pages represent computer generated forecast data made and used by the FAA Office of Aviation Economics in preparing their ten year forecasts.

NUMBER OF AIRCRAFT　　　UNITED STATES TOTAL / AVERAGE　　　PAGE 23

A/C TYPE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
ALL A/C	2628.	2560.	2572.	2609.	2663.	2774.	2869.	2965.	3054.	3172.	3302.	3474.	3599.
FIXED WING	2614.	2546.	2557.	2595.	2645.	2754.	2847.	2942.	3090.	3148.	3278.	3450.	3575.
JET	2113.	2097.	2140.	2227.	2311.	2454.	2580.	2709.	2834.	2984.	3141.	3338.	3482.
2-3 ENGINE	1233.	1307.	1389.	1482.	1577.	1737.	1882.	2017.	2152.	2310.	2481.	2685.	2846.
2 ENGINE	555.	550.	554.	565.	586.	679.	776.	872.	959.	1051.	1149.	1259.	1352.
2 ENG STD	167.	148.	131.	115.	94.	83.	71.	66.	56.	42.	27.	19.	9.
2 ENG STR	388.	402.	423.	450.	470.	491.	500.	505.	511.	514.	510.	506.	499.
2 ENG JUM	0.	0.	0.	0.	22.	105.	205.	301.	392.	495.	612.	734.	844.
3 ENGINE	678.	757.	835.	917.	991.	1058.	1106.	1145.	1193.	1259.	1332.	1426.	1494.
3 ENG STD	415.	414.	397.	377.	347.	313.	275.	238.	210.	185.	169.	152.	130.
3 ENG STR	250.	259.	290.	309.	332.	341.	343.	344.	346.	348.	348.	352.	356.
3 ENG JUM	13.	84.	148.	231.	312.	404.	488.	563.	637.	726.	815.	922.	1008.
4 ENGINE	880.	790.	748.	721.	698.	678.	657.	646.	630.	617.	595.	584.	561.
4 ENG STD	640.	546.	482.	438.	384.	331.	290.	261.	228.	200.	163.	140.	109.
4 ENG STR	133.	129.	130.	135.	142.	146.	149.	149.	149.	147.	143.	137.	128.
4 ENG JUM	107.	115.	136.	148.	172.	201.	218.	236.	253.	270.	289.	307.	324.
SST	0.	0.	3.	24.	36.	39.	41.	46.	52.	57.	65.	69.	75.
CONCORDE	0.	0.	3.	24.	36.	39.	41.	46.	52.	57.	65.	69.	75.
	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TURBOPROP	353.	308.	298.	270.	246.	221.	197.	171.	141.	111.	86.	65.	50.
1-2 ENGINE	264.	236.	231.	213.	200.	181.	160.	138.	112.	87.	67.	51.	37.
1 ENGINE	4.	4.	4.	4.	4.	3.	2.	1.	0.	0.	0.	0.	0.
2 ENGINE	260.	232.	227.	209.	196.	178.	158.	137.	112.	87.	67.	51.	37.
4 ENGINE	89.	72.	67.	57.	46.	40.	37.	33.	29.	24.	19.	14.	13.
PISTON	148.	141.	119.	98.	88.	79.	70.	62.	55.	53.	51.	47.	43.
1-2 ENGINE	117.	110.	92.	75.	68.	64.	60.	57.	55.	53.	51.	47.	43.
1ENGINE	13.	13.	11.	10.	8.	5.	2.	0.	0.	0.	0.	0.	0.
2ENGINE	104.	97.	81.	65.	60.	59.	58.	57.	55.	53.	51.	47.	43.
4 ENGINE	31.	31.	27.	23.	20.	15.	10.	5.	0.	0.	0.	0.	0.
ROTARY WING	14.	14.	15.	14.	18.	20.	22.	23.	24.	24.	24.	24.	24.
TURBINE	11.	11.	14.	14.	18.	20.	22.	23.	24.	24.	24.	24.	24.
PISTON	3.	3.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

A/C TYPE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
ALL A/C	2572.	2592.	2620.	2667.	2708.	2741.	2774.	2799.	2818.	2834.	2848.	2857.	2865.
FIXED WING	2579.	2599.	2628.	2674.	2717.	2751.	2785.	2810.	2829.	2845.	2859.	2867.	2875.
JET	2828.	2831.	2837.	2854.	2877.	2890.	2907.	2915.	2917.	2919.	2922.	2918.	2918.
2-3 ENGINE	2579.	2596.	2621.	2661.	2684.	2705.	2740.	2758.	2769.	2778.	2786.	2789.	2794.
2 ENGINE	2444.	2451.	2461.	2478.	2472.	2514.	2571.	2593.	2607.	2612.	2621.	2624.	2623.
2 ENG STD	2364.	2362.	2359.	2364.	2389.	2407.	2433.	2456.	2489.	2530.	2603.	2689.	3011.
2 ENG STR	2478.	2484.	2493.	2507.	2511.	2517.	2499.	2487.	2474.	2459.	2458.	2457.	2453.
2 ENG JUM	-0.	-0.	-0.	-0.	2000.	2582.	2792.	2799.	2796.	2777.	2758.	2736.	2719.
3 ENGINE	2690.	2700.	2728.	2773.	2609.	2628.	2859.	2885.	2900.	2917.	2928.	2935.	2949.
3 ENG STD	2662.	2626.	2592.	2561.	2537.	2506.	2473.	2485.	2489.	2504.	2518.	2531.	2526.
3 ENG STR	2751.	2730.	2707.	2688.	2670.	2668.	2668.	2667.	2666.	2663.	2661.	2657.	2653.
3 ENG JUM	2400.	2978.	3132.	3234.	3260.	3214.	3210.	3187.	3162.	3144.	3128.	3108.	3108.
4 ENGINE	3177.	3219.	3239.	3260.	3283.	3316.	3337.	3347.	3358.	3375.	3400.	3416.	3439.
4 ENG STD	3079.	3092.	3081.	3093.	3114.	3125.	3115.	3113.	3114.	3121.	3129.	3129.	3130.
4 ENG STR	3416.	3420.	3436.	3443.	3442.	3457.	3469.	3469.	3469.	3463.	3471.	3473.	3482.
4 ENG JUM	3462.	3600.	3611.	3585.	3527.	3529.	3542.	3528.	3513.	3514.	3518.	3522.	3525.
SST	0.	0.	2400.	2600.	3494.	3717.	3717.	3717.	3715.	3715.	3713.	3713.	3714.
CONCORDE	0.	0.	2400.	2600.	3494.	3717.	3717.	3717.	3715.	3715.	3713.	3713.	3714.
	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TURBOPROP	1846.	1874.	1892.	1928.	1949.	1956.	1944.	1942.	1933.	1918.	1905.	1900.	1848.
1-2 ENGINE	2046.	2059.	2062.	2080.	2081.	2088.	2088.	2088.	2086.	2067.	2043.	2009.	1956.
1 ENGINE	800.	800.	800.	800.	800.	800.	800.	800.	0.	0.	0.	0.	0.
2 ENGINE	2065.	2081.	2084.	2104.	2107.	2109.	2104.	2097.	2086.	2067.	2043.	2009.	1956.
4 ENGINE	1254.	1267.	1305.	1359.	1375.	1362.	1324.	1333.	1344.	1375.	1421.	1500.	1538.
PISTON	771.	746.	710.	647.	647.	640.	632.	616.	586.	589.	593.	601.	610.
1-2 ENGINE	702.	665.	614.	535.	544.	556.	570.	583.	586.	589.	593.	601.	610.
1ENGINE	350.	350.	350.	350.	350.	350.	350.	0.	0.	0.	0.	0.	0.
2ENGINE	747.	708.	650.	564.	570.	573.	578.	583.	586.	589.	593.	601.	610.
4 ENGINE	1032.	1032.	1037.	1010.	1000.	1000.	1000.	1000.	-0.	-0.	-0.	-0.	-0.
ROTARY WING	1196.	1196.	1329.	1389.	1383.	1385.	1386.	1386.	1387.	1387.	1387.	1387.	1387.
TURBINE	1386.	1386.	1309.	1389.	1383.	1385.	1386.	1386.	1387.	1387.	1367.	1387.	1387.
PISTON	500.	500.	500.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

A/C TYPE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
ALL A/C	6759.	6636.	6741.	6960.	7212.	7605.	7960.	8301.	8607.	8990.	9406.	9927.	10313.
FIXED WING	6742.	6619.	6721.	6941.	7187.	7577.	7930.	8269.	8574.	8957.	9373.	9894.	10280.
JET	5976.	5937.	6072.	6357.	6651.	7094.	7502.	7898.	8269.	8713.	9179.	9742.	10162.
2-3 ENGINE	3181.	3393.	3642.	3944.	4233.	4700.	5157.	5565.	5960.	6418.	6914.	7491.	7953.
2 ENGINE	1356.	1349.	1364.	1400.	1449.	1707.	1995.	2261.	2500.	2745.	3013.	3305.	3547.
2 ENG STD	395.	350.	309.	272.	225.	200.	173.	162.	139.	106.	70.	51.	27.
2 ENG STR	962.	999.	1055.	1128.	1180.	1235.	1250.	1256.	1265.	1264.	1254.	1243.	1224.
2 ENG JUM	0.	0.	0.	0.	44.	271.	573.	843.	1096.	1375.	1689.	2010.	2295.
3 ENGINE	1824.	2045.	2278.	2543.	2784.	2993.	3162.	3304.	3460.	3673.	3901.	4186.	4407.
3 ENG STD	1105.	1087.	1029.	966.	880.	784.	680.	592.	523.	463.	426.	385.	329.
3 ENG STR	686.	707.	785.	831.	887.	910.	915.	918.	923.	927.	926.	936.	945.
3 ENG JUM	31.	250.	464.	747.	1017.	1299.	1567.	1795.	2015.	2283.	2549.	2866.	3134.
4 ENGINE	2796.	2544.	2423.	2351.	2292.	2249.	2193.	2162.	2116.	2082.	2023.	1995.	1929.
4 ENG STD	1971.	1688.	1485.	1355.	1196.	1035.	903.	813.	710.	624.	510.	438.	341.
4 ENG STR	454.	441.	447.	465.	489.	505.	517.	517.	517.	509.	496.	476.	446.
4 ENG JUM	371.	414.	491.	531.	607.	709.	772.	833.	889.	949.	1017.	1081.	1142.
SST	0.	0.	7.	62.	126.	145.	152.	171.	193.	212.	241.	256.	279.
CONCORDE	0.	0.	7.	62.	126.	145.	152.	171.	193.	212.	241.	256.	279.
	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TURBOPROP	652.	577.	564.	521.	480.	432.	383.	332.	273.	213.	164.	124.	92.
1-2 ENGINE	540.	486.	476.	443.	416.	378.	334.	288.	234.	180.	137.	103.	72.
1 ENGINE	3.	3.	3.	3.	3.	2.	2.	1.	0.	0.	0.	0.	0.
2 ENGINE	537.	483.	473.	440.	413.	376.	333.	287.	234.	180.	137.	103.	72.
4 ENGINE	112.	91.	88.	78.	63.	55.	49.	44.	39.	33.	27.	21.	20.
PISTON	114.	105.	85.	63.	57.	51.	44.	38.	32.	31.	30.	28.	26.
1-2 ENGINE	82.	73.	57.	40.	37.	36.	34.	33.	32.	31.	30.	28.	26.
1ENGINE	5.	5.	4.	4.	3.	2.	1.	0.	0.	0.	0.	0.	0.
2ENGINE	78.	69.	53.	37.	34.	34.	34.	33.	32.	31.	30.	28.	26.
4 ENGINE	32.	32.	28.	23.	20.	15.	10.	5.	0.	0.	0.	0.	0.
ROTARY WING	17.	17.	20.	19.	25.	28.	31.	32.	33.	33.	33.	33.	33.
TURBINE	15.	15.	19.	19.	25.	28.	31.	32.	33.	33.	33.	33.	33.
PISTON	2.	2.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

AVG. AIR SPEED PER HOUR — UNITED STATES TOTAL / AVERAGE

A/C TYPE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
ALL A/C	415.	417.	420.	428.	437.	441.	444.	447.	450.	453.	456.	457.	459.
FIXED WING	416.	418.	421.	429.	438.	442.	445.	448.	451.	454.	457.	458.	460.
JET	441.	441.	442.	448.	456.	458.	458.	459.	460.	461.	462.	462.	463.
2-3 ENGINE	402.	407.	411.	415.	419.	422.	425.	426.	428.	429.	430.	431.	432.
2 ENGINE	361.	360.	358.	356.	357.	366.	374.	379.	382.	386.	389.	391.	392.
2 ENG STD	355.	351.	348.	344.	338.	334.	329.	326.	322.	322.	323.	325.	336.
2 ENG STR	364.	363.	361.	359.	357.	356.	354.	353.	352.	350.	349.	348.	347.
2 ENG JUM	-0.	-0.	-0.	-0.	442.	437.	431.	428.	425.	423.	421.	419.	416.
3 ENGINE	433.	439.	443.	447.	451.	454.	457.	459.	460.	462.	463.	464.	464.
3 ENG STD	435.	434.	433.	432.	431.	430.	429.	428.	427.	427.	427.	426.	425.
3 ENG STR	427.	425.	424.	423.	422.	421.	420.	418.	417.	416.	415.	415.	414.
3 ENG JUM	500.	500.	497.	494.	493.	492.	491.	490.	488.	487.	486.	484.	483.
4 ENGINE	485.	486.	486.	487.	488.	490.	491.	492.	493.	494.	496.	497.	498.
4 ENG STD	481.	481.	480.	481.	481.	482.	482.	482.	483.	484.	484.	485.	485.
4 ENG STR	485.	485.	484.	484.	484.	483.	483.	483.	482.	482.	482.	481.	481.
4 ENG JUM	507.	507.	507.	507.	507.	507.	507.	508.	508.	508.	508.	508.	508.
SST	0.	0.	1100.	1100.	1100.	1100.	1100.	1100.	1100.	1100.	1100.	1100.	1100.
CONCORDE	0.	0.	1100.	1100.	1100.	1100.	1100.	1100.	1100.	1100.	1100.	1100.	1100.
	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TURBOPROP	229.	227.	227.	227.	225.	225.	224.	224.	224.	223.	221.	218.	217.
1-2 ENGINE	217.	215.	215.	215.	215.	215.	215.	214.	213.	211.	209.	205.	199.
1 ENGINE	120.	120.	120.	120.	120.	120.	120.	120.	0.	0.	0.	0.	0.
2 ENGINE	217.	216.	216.	216.	216.	216.	215.	214.	213.	211.	209.	205.	199.
4 ENGINE	289.	288.	290.	291.	292.	291.	290.	289.	288.	287.	285.	283.	284.
PISTON	189.	191.	192.	194.	194.	191.	186.	179.	168.	168.	167.	166.	165.
1-2 ENGINE	169.	169.	167.	164.	164.	166.	167.	168.	168.	168.	167.	166.	165.
1ENGINE	100.	100.	100.	100.	100.	100.	100.	0.	0.	0.	0.	0.	0.
2ENGINE	173.	173.	172.	170.	169.	169.	169.	168.	168.	168.	167.	166.	165.
4 ENGINE	242.	242.	243.	245.	250.	250.	250.	250.	-0.	-0.	-0.	-0.	-0.
ROTARY WING	107.	107.	109.	110.	110.	110.	110.	110.	110.	110.	110.	110.	110.
TURBINE	110.	110.	110.	110.	110.	110.	110.	110.	110.	110.	110.	110.	110.
PISTON	80.	80.	80.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

A/C TYPE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
ALL A/C	117.	124.	133.	142.	152.	164.	175.	182.	188.	194.	199.	204.	207.
FIXED WING	117.	124.	133.	143.	152.	164.	176.	182.	188.	194.	199.	204.	208.
JET	122.	129.	138.	147.	157.	169.	180.	186.	191.	197.	201.	205.	208.
2-3 ENGINE	100.	111.	121.	132.	143.	157.	169.	176.	182.	187.	192.	197.	201.
2 ENGINE	85.	86.	87.	88.	93.	111.	126.	136.	144.	150.	157.	162.	166.
2 ENG STD	69.	71.	71.	71.	72.	72.	73.	73.	73.	73.	73.	73.	73.
2 ENG STR	91.	91.	92.	92.	92.	92.	92.	92.	92.	92.	92.	92.	92.
2 ENG JUM	-0.	-0.	-0.	-0.	200.	200.	199.	199.	199.	199.	199.	199.	200.
3 ENGINE	109.	124.	138.	153.	166.	181.	194.	202.	207.	213.	218.	223.	227.
3 ENG STD	96.	95.	96.	95.	96.	95.	96.	96.	96.	96.	96.	96.	96.
3 ENG STR	125.	125.	125.	125.	125.	125.	125.	125.	125.	125.	125.	125.	125.
3 ENG JUM	215.	219.	230.	240.	249.	259.	269.	269.	269.	269.	269.	269.	269.
4 ENGINE	155.	163.	177.	189.	205.	224.	241.	253.	266.	278.	294.	305.	316.
4 ENG STD	114.	114.	114.	114.	114.	114.	114.	114.	114.	114.	114.	115.	114.
4 ENG STR	175.	174.	174.	174.	175.	175.	175.	175.	175.	175.	175.	175.	175.
4 ENG JUM	324.	325.	334.	344.	349.	354.	360.	359.	359.	360.	359.	360.	359.
SST	0.	0.	0.	120.	120.	120.	120.	120.	120.	120.	120.	120.	120.
CONCORDE	-0.	-0.	-0.	120.	120.	120.	120.	120.	120.	120.	170.	120.	120.
	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TURBOPROP	48.	47.	47.	47.	46.	46.	46.	46.	46.	45.	45.	43.	41.
1-2 ENGINE	46.	46.	46.	46.	46.	46.	46.	46.	46.	45.	45.	43.	41.
1 ENGINE	4.	4.	4.	4.	4.	4.	4.	4.	0.	0.	0.	0.	0.
2 ENGINE	47.	47.	47.	47.	47.	46.	46.	46.	46.	45.	45.	43.	41.
4 ENGINE	85.	85.	85.	85.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.
PISTON	31.	30.	26.	14.	12.	12.	12.	13.	13.	13.	13.	13.	13.
1-2 ENGINE	31.	30.	25.	12.	12.	12.	12.	13.	13.	13.	13.	13.	13.
1ENGINE	8.	8.	8.	8.	8.	8.	8.	0.	0.	0.	0.	0.	0.
2ENGINE	33.	31.	27.	13.	13.	13.	13.	13.	13.	13.	13.	13.	13.
4 ENGINE	32.	32.	32.	32.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ROTARY WING	20.	20.	22.	22.	21.	22.	22.	22.	22.	22.	22.	22.	22.
TURBINE	22.	22.	22.	22.	21.	22.	22.	22.	22.	22.	22.	22.	22.
PISTON	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

AVAILABLE SEAT MILES — UNITED STATES TOTAL / AVERAGE

A/C TYPE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	198
ALL A/C	330644.	339394.	369004.	411924.	460124.	521684.	581415.	632268.	682217.	739060.	802020.	871183.	930402
FIXED WING	330607.	339356.	368955.	411876.	460063.	521616.	581340.	632189.	682135.	738977.	801937.	871100.	930319
JET	322812.	332510.	362451.	406026.	454693.	516802.	577085.	628553.	679210.	736720.	800235.	869867.	929435
2-3 ENGINE	127351.	151894.	179905.	216869.	257511.	315373.	373643.	420494.	466235.	518349.	574286.	637371.	691259
2 ENGINE	42823.	42992.	43759.	45237.	49562.	70595.	96101.	118621.	139645.	161817.	186422.	211846.	233488
2 ENG STD	9956.	8907.	7838.	6852.	5611.	4965.	4268.	3972.	3398.	2607.	1766.	1319.	770
2 ENG STR	32867.	34086.	35921.	38385.	40062.	41864.	42149.	42245.	42375.	42204.	41721.	41248.	40483
2 ENG JUM	0.	0.	0.	0.	3890.	23767.	49685.	72606.	93873.	117007.	142936.	169280.	192236
3 ENGINE	84529.	108902.	136147.	171633.	207950.	244779.	277543.	301673.	326590.	356533.	387855.	425525.	457771
3 ENG STD	43869.	42971.	40174.	37154.	33218.	29268.	25146.	21544.	19040.	16545.	14852.	13167.	11489
3 ENG STR	37307.	38357.	42560.	44979.	47952.	49176.	49339.	49339.	49500.	49655.	49524.	49938.	50341
3 ENG JUM	3355.	27575.	53414.	89501.	126782.	165336.	203059.	230791.	258052.	290334.	323489.	362422.	395942
4 ENGINE	195461.	180617.	181596.	180920.	180577.	182289.	183326.	185488.	187473.	190414.	194084.	198678.	201401
4 ENG STD	102258.	82646.	69656.	60231.	50208.	41346.	35048.	30637.	26489.	22375.	17300.	14465.	10541
4 ENG STR	31031.	28411.	27346.	27987.	28691.	30328.	31577.	31548.	31518.	31488.	30406.	29329.	27466
4 ENG JUM	62163.	69560.	84596.	92703.	101679.	110617.	116701.	123105.	129467.	136551.	146380.	154884.	163393
SST	0.	0.	951.	8237.	16606.	19141.	20117.	22573.	25503.	27958.	31865.	33819.	36776
CONCORDE	0.	0.	951.	8237.	16606.	19141.	20117.	22573.	25503.	27958.	31865.	33819.	36776
	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0
TURBOPROP	6975.	6084.	5903.	5410.	4977.	4489.	3997.	3445.	2802.	2140.	1590.	1132.	794
1-2 ENGINE	5511.	4909.	4807.	4488.	4209.	3817.	3362.	2885.	2317.	1749.	1295.	932.	614
1 ENGINE	2.	2.	2.	2.	2.	2.	1.	1.	0.	0.	0.	0.	0
2 ENGINE	5509.	4907.	4805.	4486.	4208.	3815.	3361.	2885.	2317.	1749.	1295.	932.	614
4 ENGINE	1465.	1176.	1096.	923.	768.	673.	636.	561.	486.	391.	296.	201.	181
PISTON	821.	763.	602.	441.	395.	326.	259.	192.	124.	118.	113.	102.	91
1-2 ENGINE	434.	376.	268.	159.	145.	139.	134.	129.	124.	118.	113.	102.	91
1ENGINE	4.	4.	4.	3.	3.	2.	1.	0.	0.	0.	0.	0.	0
2ENGINE	430.	372.	265.	156.	142.	137.	133.	129.	124.	118.	113.	102.	91
4 ENGINE	387.	387.	335.	283.	251.	188.	126.	63.	0.	0.	0.	0.	0
ROTARY WING	38.	38.	49.	49.	61.	68.	76.	79.	83.	83.	83.	83.	83
TURBINE	38.	38.	49.	49.	61.	68.	76.	79.	83.	83.	83.	83.	83
PISTON	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0

A/C TYPE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
ALL A/C	486.	491.	495.	514.	531.	546.	556.	565.	572.	581.	585.	581.	576.
FIXED WING	493.	499.	504.	523.	543.	559.	571.	580.	587.	595.	599.	594.	589.
JET	599.	595.	595.	606.	622.	629.	631.	630.	627.	626.	622.	610.	600.
2-3 ENGINE	379.	396.	410.	424.	439.	457.	471.	478.	482.	487.	490.	487.	483.
2 ENGINE	256.	250.	245.	239.	240.	262.	284.	296.	303.	308.	311.	308.	300.
2 ENG STD	244.	233.	226.	217.	204.	197.	188.	182.	176.	175.	177.	180.	205.
2 ENG STR	281.	256.	251.	245.	240.	236.	231.	227.	223.	219.	214.	210.	206.
2 ENG JUM	-0.	-0.	-0.	-0.	750.	669.	599.	553.	515.	480.	447.	413.	378.
3 ENGINE	542.	579.	607.	639.	665.	692.	713.	733.	748.	765.	779.	792.	826.
3 ENG STD	552.	547.	541.	536.	531.	524.	519.	515.	510.	508.	506.	503.	493.
3 ENG STR	508.	500.	496.	490.	483.	479.	472.	467.	462.	457.	454.	450.	446.
3 ENG JUM	1500.	1461.	1378.	1295.	1258.	1228.	1183.	1165.	1148.	1130.	1117.	1100.	1151.
4 ENGINE	1325.	1357.	1379.	1404.	1438.	1470.	1492.	1503.	1515.	1534.	1562.	1584.	1603.
4 ENG STD	1212.	1227.	1226.	1240.	1260.	1282.	1296.	1311.	1327.	1349.	1363.	1379.	1363.
4 ENG STR	1465.	1454.	1448.	1454.	1456.	1467.	1474.	1472.	1470.	1462.	1469.	1472.	1484.
4 ENG JUM	2069.	2055.	2024.	19d5.	1931.	1850.	1812.	1766.	1730.	1726.	1733.	1738.	1741.
SST	0.	0.	2400.	2400.	2400.	2400.	2400.	2400.	2400.	2400.	2400.	2400.	2400.
CONCORDE	-0.	-0.	2400.	2400.	2400.	2400.	2400.	2400.	2400.	2400.	2400.	2400.	2400.
	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TURBOPROP	134.	133.	133.	133.	130.	129.	129.	130.	131.	133.	134.	134.	142.
1-2 ENGINE	114.	114.	114.	114.	114.	114.	114.	115.	115.	115.	115.	115.	116.
1 ENGINE	60.	60.	60.	60.	60.	60.	60.	60.	0.	0.	0.	0.	0.
2 ENGINE	114.	115.	115.	115.	115.	115.	115.	115.	115.	115.	115.	115.	116.
4 ENGINE	378.	372.	387.	399.	405.	397.	380.	370.	357.	349.	338.	321.	331.
PISTON	117.	119.	118.	116.	115.	111.	105.	98.	88.	87.	87.	86.	85.
1-2 ENGINE	93.	93.	91.	85.	85.	86.	87.	88.	88.	87.	87.	86.	85.
1ENGINE	45.	45.	45.	45.	45.	45.	45.	0.	0.	0.	0.	0.	0.
2ENGINE	97.	97.	95.	90.	89.	89.	89.	88.	88.	87.	87.	86.	85.
4 ENGINE	213.	213.	206.	200.	200.	200.	200.	200.	0.	0.	0.	0.	0.
ROTARY WING	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.
TURBINE	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.
PISTON	20.	20.	20.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.

NUMBER OF DEPARTURES UNITED STATES TOTAL / AVERAGE

A/C TYPE	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
ALL A/C	5783.	5639.	5718.	5807.	5932.	6147.	6354.	6566.	6771.	7016.	7339.	7816.	8208.
FIXED WING	5594.	5551.	5510.	5701.	5798.	5997.	6189.	6393.	6590.	6836.	7159.	7636.	8028.
JET	4400.	4399.	4514.	4706.	4874.	5162.	5449.	5752.	6065.	6419.	6830.	7381.	7836.
2-3 ENGINE	3376.	3488.	3656.	3862.	4038.	4345.	4657.	4966.	5287.	5651.	6077.	6637.	7108.
2 ENGINE	1918.	1938.	1993.	2081.	2150.	2381.	2631.	2897.	3158.	3433.	3759.	4186.	4632.
2 ENG STD	575.	526.	476.	431.	371.	339.	303.	290.	255.	195.	128.	92.	44.
2 ENG STR	1343.	1413.	1517.	1650.	1754.	1865.	1916.	1954.	1997.	2026.	2041.	2057.	2059.
2 ENG JUM	0.	0.	0.	0.	26.	177.	413.	652.	906.	1212.	1590.	2036.	2529.
3 ENGINE	1458.	1549.	1663.	1781.	1887.	1964.	2026.	2069.	2129.	2218.	2318.	2452.	2476.
3 ENG STD	870.	863.	824.	778.	715.	643.	562.	492.	438.	390.	359.	326.	283.
3 ENG STR	578.	601.	672.	717.	774.	800.	813.	822.	834.	844.	848.	863.	877.
3 ENG JUM	10.	86.	167.	285.	399.	521.	651.	755.	857.	984.	1110.	1263.	1316.
4 ENGINE	1024.	911.	855.	816.	779.	750.	722.	708.	689.	671.	642.	625.	600.
4 ENG STD	782.	662.	582.	526.	457.	389.	336.	299.	259.	224.	181.	154.	122.
4 ENG STR	151.	147.	150.	155.	163.	166.	169.	170.	170.	168.	163.	156.	145.
4 ENG JUM	91.	102.	123.	136.	159.	195.	216.	239.	261.	279.	298.	316.	334.
SST	0.	0.	3.	29.	58.	66.	70.	78.	89.	97.	111.	117.	128.
CONCORDE	0.	0.	3.	29.	58.	66.	70.	78.	89.	97.	111.	117.	128.
	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TURBOPROP	1109.	983.	959.	889.	828.	749.	662.	571.	464.	357.	270.	200.	141.
1-2 ENGINE	1024.	912.	894.	833.	782.	709.	625.	537.	433.	330.	248.	182.	124.
1 ENGINE	6.	6.	6.	6.	6.	5.	3.	2.	0.	0.	0.	0.	0.
2 ENGINE	1018.	906.	887.	826.	775.	704.	622.	535.	433.	330.	248.	182.	124.
4 ENGINE	85.	71.	66.	57.	46.	40.	37.	34.	31.	27.	23.	19.	17.
PISTON	185.	169.	137.	106.	96.	87.	78.	70.	62.	60.	58.	54.	51.
1-2 ENGINE	149.	132.	104.	77.	71.	68.	65.	63.	62.	60.	58.	54.	51.
1ENGINE	10.	10.	9.	8.	6.	4.	2.	0.	0.	0.	0.	0.	0.
2ENGINE	139.	122.	95.	69.	65.	64.	64.	63.	62.	60.	58.	54.	51.
4 ENGINE	36.	36.	33.	29.	25.	19.	13.	6.	0.	0.	0.	0.	0.
ROTARY WING	88.	88.	108.	106.	134.	150.	165.	173.	180.	180.	180.	180.	180.
TURBINE	83.	83.	106.	106.	134.	150.	165.	173.	180.	180.	180.	180.	180.
PISTON	6.	6.	2.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

APPENDIX B

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