PORT OF SEATTLE

MEMORANDUM

DATE February 11, 1982

TO Dawson Alexander (POS), Bill Hamilton (WSDOT), George Saito (FAA), Joe Sims (POS) and Don Smith (King County)

FROM Jody Yamanaka, Planner II JY

SUBJECT Forecast of Aviation Demand for King County International Airport (Boeing Field) and Sea-Tac International Airport (Sea-Tac) Airspace Study

This memo is to solicite your comments on the draft working paper, "Forecast of Aviation Demand." The draft working paper presents the forecasts of annual and peak hour operations for both Boeing Field and Sea-Tac. A copy of this draft working paper is attached.

The forecasts of annual operations for Boeing Field and Sea-Tac have already gone through a review process and comments have been incorporated into the working paper. The Boeing Field forecast of annual operations was initially presented in the memo dated 12/23/81. Comments were received from the Federal Aviation Administration, King County, Washington State Department of Transportation and three members of the Advisory Committee. The Sea-Tac forecasts of annual operations were taken from the Sea-Tac Noise Exposure Update (revised forecast, February 1982).

Please transmit your comments to me no later than the next Advisory Committee meeting, February 24, 1982. At this meeting, the forecasts will be summarized and any questions or comments will be taken.

D/66
Attachment

cc: Advisory Committee/W Attachments--Ault, Day, Jhaveri, Kos, Kronshage, McKenna, Patterson, Pihlman, Rotter, Secrist, Sweet, Wood, Woosley, Zeutschel

Ahn--King County w/attachment
Maddison--PMM w/attachment
Crum, Orr--FAA w/attachment
Dunham--Port of Seattle w/attachment
Whitehead--United

CHAPTER 3

DRAFT
FORECAST OF AVIATION DEMAND

Forecasts of aircraft operations at Sea-Tac International Airport (Sea-Tac) and King County International Airport (Boeing Field) are required in order to estimate future levels of airfield and airspace capacities and to estimate delays to aircraft due to demands beyond airfield and airspace capacities. [Aircraft operations (i.e, the number of aircraft take-offs and landings) are expressed on an annual basis and as the number of aircraft operations during the peak hour of the average day of the peak month of the year.] Summaries of the Sea-Tac and Boeing Field forecasts used in this study are presented in Tables 1 and 2, respectively. Projections represent demand unconstrained by airfield and airspace capacities for the years 1985, 1990, and 2000.

METHODOLOGY

The forecasts of aviation demand for Sea-Tac and Boeing Field were conducted in two steps: first, annual operations were forecast for the four aircraft categories of air carrier/air taxi, local general aviation, intinerant general aviation, and military; and second, peak hour operations were forecast based on the average day of the peak month (ADPM) by aircraft classification (i.e., aircraft type) within the four aircraft categories for both Instrument Flight Rules (IFR) and Visual Flight Rules (VFR) weather conditions.

For annual operations, forecasts of the four aircraft categories were developed from historical trends and previously prepared forecasts when available. The air carrier/air taxi category includes the operations of airlines certificated by the Civil Aeronautics Board (CAB) to offer scheduled air service within the United States and its territories and air taxi operators registered with the CAB. Air taxis operate small aircraft of 18,000 lbs. or less (except under special exemption) or having a maximum seating capacity of 60 seats or less and carry passengers, mail, and cargo for revenue. Commuter airlines are a subclass of air taxis. General aviation includes all civil aircraft and operations which are not classified as air carrier or air taxi. Local operations of the general aviation category are the training and practice flights of general aviation aircraft. Itinerant operations of the general aviation category are all general aviation operations other than local. The military category includes the operations of active U.S. military aircraft.

For peak hour operations of the ADPM, forecasts were based on the forecasts of annual operations, historical trends, current airport operating procedures, surveys and samples of aircraft operations, projections of aircraft fleet mix, pilot population, and avionics equipage from preexistent studies. This peak period represents a "typical peak hour." Rather than plan for the rare occurrence, the peak hour used in this study is the peak hour of the average day of the peak month.

(avionics equipage influences forecasts in this study)

Table 1

SUMMARY OF FORECAST OF AVIATION DEMAND
SEA-TAC INTERNATIONAL AIRPORT: 1980-2000

	Actual 1980	Forecast 1985	Forecast 1990	Forecast 2000
Annual Aircraft Operations				
Air Carrier/Air Taxi	183,698	174,430	185,210	219,880
General Aviation - Itinerant	27,693	29,300	32,600	40,200
General Aviation - Local	1,662	1,500	1,400	1,200
Military	551	550	550	550
Total Operations	213,604	205,780	219,760	261,830

	Estimate 1980	Forecast 1985	Forecast 1990	Forecast 2000
Peak Hour Operations[1]				
Aircraft Operations: VFR				
Air Carrier/Air Taxi	47	47	48	51
General Aviation - Itinerant	7	7	7	8
General Aviation - Local	0	0	0	0
Military	0	0	0	0
Total Operations	54	54	55	59
Aircraft Operations: IFR				
Air Carrier/Air Taxi	47	47	48	51
General Aviation - Itinerant	5	5	5	6
General Aviation - Local	0	0	0	0
Military	0	0	0	0
Total Operations	52	52	53	57

[1]Peak hour of the average day of the peak month

Source: The Port of Seattle

Table 2

SUMMARY OF FORECAST OF AVIATION DEMAND
KING COUNTY INTERNATIONAL AIRPORT: 1980-2000

	Actual 1980	Forecast 1985	Forecast 1990	Forecast 2000
Annual Aircraft Operations				
Air Carrier/Air Taxi	15,999	17,000	20,000	26,000
General Aviation - Itinerant	247,342	262,500	284,500	329,000
General Aviation - Local	145,055	142,000	138,000	131,000
Military	2,457	2,500	2,500	2,500
Total Operations	410,853	424,000	445,000	488,500
	Estimate 1980	**Forecast 1985**	**Forecast 1990**	**Forecast 2000**
Peak Hour Operations[1]				
Aircraft Operations: VFR				
Air Carrier/Air Taxi	2	2	3	6
General Aviation - Itinerant	105	111	121	136
General Aviation - Local	90	89	88	84
Military	1	1	1	1
Total Operations	198	203	213	227
Aircraft Operations: IFR				
Air Carrier/Air Taxi	2	2	3	6
General Aviation - Itinerant	71	76	84	97
General Aviation - Local	0	0	0	0
Military	0	0	0	0
Total Operations	73	78	87	103

[1]Peak hour of the average day of the peak month

Source: The Port of Seattle

WA. St. Airports Systems

Exhibit 1

AIRCRAFT CLASSIFICATIONS

Aircraft Classification	Types of Aircraft[1]
Class A	Small single-engine aircraft weighing 12,500 lb[2] or less (e.g., Cessna 152; Piper 28; Beech A36; etc.)
Class B	Small twin-engine aircraft weighing 12,500 lb or less (e.g., Cessna 402; Piper 31; Beech 55; etc.)
Class C	Large aircraft weighing more than 12,500 lb and up to 300,000 lb (e.g., DC-9; Boeing 737; Boeing 727; Sabreliner 65; Learjet 35, etc.)
Class D	Heavy aircraft[3] weighing more than 300,000 lb (e.g., L1011; DC-10; Boeing 747; Airbus A300; etc.)
Rotocraft	Helicopters (e.g., Bell 412; Agusta A109A)

---

[1] For aircraft type designators, see FAA Handbook No. 7340.1E with changes.

[2] Weights refer to maximum certificated take-off weight.

[3] Heavy aircraft are capable of takeoff weights of 300,000 lb or more whether or not they are operating at this weight during a particular phase of flight. (Reference FAA Handbook 7110.65 with changes.)

The procedure used to develop the peak hour forecasts follows three major steps: first, annual operations were converted to VFR peak hour operations and VFR peak hour operations allocated between aircraft categories; second, IFR peak hour operations were allocated between aircraft categories; and third, traffic mix was projected for each aircraft category in both VFR and IFR peak hours.[1/] Traffic mix is expressed in this study as classes of aircraft differentiated by maximum take-off weights and performance characteristics. Exhibit 1 identifies each of the five classes of aircraft and representative aircraft within the classes.

Forecasts of annual operations by aircraft classification within the four categories are not needed as input for either the calculation of airfield or airspace capacity. However, for general reference, these projections are made. For Boeing Field, they are based on the assumptions that the VFR peak hour fleet mix represents the fleet mix during the proportion of the year VFR weather conditions occur (90.6% of the year) and that the IFR peak hour fleet mix represents the fleet mix during the proportion of the year that IFR weather conditions occur (9.4% of the year).[2/] See Table 20, For Sea-Tac, they are based on projections included in the Sea-Tac Noise Exposure Update (draft forecast), February, 1982) and information from Sea-Tac Air Traffic Control Tower personnel. See Table 28,

ANNUAL OPERATIONS FOR KING COUNTY INTERNATIONAL AIRPORT

The five-, ten-, and twenty-year forecast of annual operations for King County International Airport (Boeing Field) is based on the Washington State Airport System Plan (October 1980) prepared by the Washington State Department of Transportation (WSDOT). This forecast was selected because of corresponding forecast years and reasonableness of growth rates. The WSDOT forecast projected annual operations through the year 2000 from a 1977 base year. The forecast is presented in Table 3.

Table 3
WASHINGTON STATE DEPARTMENT OF TRANSPORTATION
FORECAST OF BOEING FIELD
ANNUAL OPERATIONS

		Forecast		
	Actual 1977	1985	1990	2000
	424,028	507,000	532,400	584,600
Growth rate in % per year		2.3%	1.0%	0.9%

Source: Washington State Department of Transportation, Washington State Airport System Plan, (October 1980).

Between 1977 and 1980, operations decreased at Boeing Field from 424,028 to 410,853. The first seven months of 1981, however, showed a 6% increase in operations over the same seven-month period 1980. A return to the growth projected by the WSDOT was indicated until the initiation of the air traffic controllers' strike on August 3, 1981.

The controllers' strike has been largely responsible for the decrease in aircraft operations at Boeing Field since the beginning of August.[3/] The Boeing Field Air Traffic Control tower has been handling close to 100% of demand. However, demand has been down due to closure of the tower between 0000 and 0600 and to other factors in the system, such as the newly implemented General Aviation Reservation (GAR) plan and the closure of other Air Traffic Control towers (e.g., Olympia). As a result, Boeing Field operations for 1981 were reported as 410,073, 780 operations less than 1980.

Boeing Field operations are expected to return to 1977/1978 levels in 1985 based primarily on two factors: recovery from the air traffic controllers' strike and a projected upturn in the economy.

The Air Traffic Division of the Federal Aviation Administration (FAA) has predicted that in the Seattle area, operations will be back to about 95% of prestrike levels within a year to a year and a half. During 1983, operations are expected to be back to 100% of prestrike levels. These projections are further strengthened by the anticipated upturn in the economy during 1983. As indicated by historical trends, upturns in the economy have been accompanied by an increase in the number of operations at Boeing Field. This relationship is expected to continue.

The Airspace Study forecast for Boeing Field will use the base year level of annual operations (i.e., 424,028 operations in 1977) from the WSDOT forecast for 1985 and apply the appropriate rates of growth to total operations for the

remainder of the forecast years. The rate of growth used to project total operations between 1985 and 1990 in the WSDOT forecast (0.98% per year) will be used to project total operations in this study for 1990. The rate of growth used to project total operations between 1990 and 2000 in the WSDOT forecast (0.94% per year) will be used to project total operations in this study for 2000. The Airspace Study forecast of annual operations and associated rates of growth at Boeing Field are presented in Table 4.

Table 4
AIRSPACE STUDY
FORECAST OF BOEING FIELD
ANNUAL OPERATIONS AND GROWTH RATES

Categories	Actual 1980	Forecast 1985	Forecast 1990	Forecast 2000
Air Carrier/Air Taxi	15,999	17,000	20,000	26,000
(Growth rate in % per year)		(1.2%)	(3.3%)	(2.7%)
General Aviation - Itinerant	247,342	262,500	284,500	329,000
(Growth rate in % per year)		(1.2%)	(1.6%)	(1.5%)
General Aviation - Local	145,055	142,000	138,000	131,000
(Growth rate in % per year)		(-0.4%)	(-0.6%)	(-0.5%)
Military	2,457	2,500	2,500	2,500
(Growth rate in % per year)		(0.0%)	(0.0%)	(0.0%)
Total Operations	410,853	424,000	445,000	488,500
(Growth rate in % per year)		(0.6%)	(1.0%)	(0.9%)

Source: The Port of Seattle and King County

The proportion of operations by category is presented in Table 5.

Table 5
AIRSPACE STUDY
FORECAST OF BOEING FIELD
PERCENT OF ANNUAL OPERATIONS

Categories	Actual 1980	Forecast 1985	Forecast 1990	Forecast 2000
Air Carrier/Air Taxi	3.9%	4.0%	4.5%	5.3%
General Aviation - Itinerant	60.2%	61.9%	63.9%	67.4%
General Aviation - Local	35.3%	33.5%	31.0%	26.8%
Military	0.6%	0.6%	0.6%	0.5%
Total Operations	100.0%	100.0%	100.0%	100.0%

Source: The Port of Seattle and King County

Air Carrier/Air Taxi Category

Air carrier/air taxi operations are expected to increase through the forecast period as a proportion of total aircraft operations and in the number of operations. This trend has been projected by the FAA in the FAA Aviation Forecast--Seattle-Tacoma (December 1979). The proportion of this category which includes weather-related aircraft diversions, primarily from Sea-Tac, and operations of supplemental (i.e., charter) airlines is not expected to increase. Weather-related diversions may even decrease due to the installation of a Category III Instrument Landing System at Sea-Tac which will allow aircraft to land under lower-ceiling and less-visibility conditions than currently exist. The number of operations of supplemental airlines has not significantly changed in the last five years. Operations have increased from 417 in 1975 to 446 in 1980. On the other hand, the proportion of this category which includes the operations of scheduled air carrier and commuter airlines and other "for hire" air taxi operators, is expected to increase. Presently, no scheduled passenger air carrier or commuter airlines serve Boeing Field, but the Washington State Department of Transportation expects "Boeing Field will receive commuter airline service in the near future. Service ... would be tailored to meet the business market between Northwest cities rather than the airline feeder market available for long-haul trips from Sea-Tac."[4/] Operations of scheduled all-cargo air carrier/ commuter airlines (e.g., Federal Express, AirPac Airlines, etc.) comprise the largest proportion of this category, and continued growth is projected on the basis of steady growth over the past five years.

Table 6 presents the historical record of the level of annual operations in the air carrier/air taxi category. A comparison with total aircraft operations illustrates the growing number and proportion of total operations of this category.

Table 6
AIR CARRIER/AIR TAXI ANNUAL OPERATIONS
BOEING FIELD: 1975-1980

	1975	1976	1977	1978	1979	1980
Air Carrier/Air Taxi	5,267	8,321	9,615	13,078	14,510	15,999
Total Operations	354,838	377,563	424,028	424,811	416,004	410,853
Air Carrier/Air Taxi as a % of Total Operations	1.5%	2.2%	2.3%	3.1%	3.5%	3.9%

Source: The Port of Seattle, King County and Federal Aviation Administration

General Aviation Categories

The number of general aviation operations is expected to increase through the forecast period although the proportion in relation to total aircraft operations should decrease slightly. It is projected that itinerant general aviation operations will increasingly outnumber local general aviation operations. This trend has been forecasted by the FAA in the FAA Aviation Forecast--Seattle-Tacoma (December 1979). The increase in the number of itinerant to local general aviation operations is shown in Table 7. The percent of itinerant general aviation operations compared to total general aviation operations is also shown in Table 7.

Table 7
GENERAL AVIATION ANNUAL OPERATIONS BY TYPE
BOEING FIELD: 1975-1980

	1975	1976	1977	1978	1979	1980
Itinerant	190,842	212,659	248,016	242,664	251,490	247,342
Local	155,450	153,631	163,881	166,390	147,395	145,055
Total General Aviation	346,292	366,290	411,897	409,054	398,885	392,397
Itinerant as a % of Total General Aviation	55.1%	58.1%	60.2%	59.3%	63.0%	63.0%

Source: The Port of Seattle, King County and Federal Aviation Administration

Local general aviation operations are performed for instruction and proficiency. This type of flying has been decreasing, particularly over the past few years, due to a number of factors, including the end of the student pilot program of the U.S. Veterans' Administration, the growth of flying instruction services at other airports, the increases in operating costs of a highly discretionary trip (i.e., elastic demand relative to itinerant flying), and growing congestion in the Seattle Terminal Control Area (TCA).

Itinerant general aviation operations are comprised of the following: executive use (i.e., use of an aircraft by a corporation, company or other organization for the purpose of transporting its employees and/or property not for compensation or hire and employing professional pilots for the operation of the aircraft); business use (i.e., use of an aircraft not for compensation or hire by an individual for the purpose of transportation required by a business in which he is engaged); aerial application (i.e., use of an aircraft in agriculture consisting of those activities that involve the discharge of materials from aircraft in flight); industrial/special use (i.e., use of an aircraft for specialized work allied with industrial activity except transportation and aerial application, such as pipeline patrol, survey, advertising, and photography); personal use (i.e., use of an aircraft by a private individual for non-business trips); and some instruction and proficiency use. These types of flying have been increasing at Boeing Field in both numbers and as a proportion of total general aviation operations due to a number of factors which have included the cost advantage of general aviation relative to the automobile or air carrier for certain travel distances, changing air carrier/commuter route structures, and business dispersion and centralized management.

Military Category

The proportion of military operations is expected to decrease through the forecast years, but the number of operations is expected to remain relatively constant. This trend has been projected by the FAA in the FAA Aviation Forecast--Seattle-Tacoma (December 1979). Military operations have been decreasing in number over the last five years, as shown in Table 8, but are expected to level off at a number of operations comparable to the period prior to the Vietnam conflict buildup of the early 1970's.

Table 8
MILITARY ANNUAL OPERATIONS
BOEING FIELD: 1975-1980

	1975	1976	1977	1978	1979	1980
Military	3,279	2,955	2,536	2,679	2,609	2,457

Source: The Port of Seattle, King County and Federal Aviation Administration

Comparison of Forecasts of Annual Operations

Exhibit 2 presents the Airspace Study forecast along with the three most recently prepared forecasts of annual operations at King County International Airport (Boeing Field). The Washington State Department of Transportation (WSDOT) forecast was prepared for the Washington State Airport System Plan (October 1980) and used as a basis for the Airspace Study forecast. The Federal Aviation Administration (FAA) forecast was prepared for the FAA Aviation Forecast--Seattle-Tacoma (December 1979). Both the WSDOT and FAA forecasts were prepared during a period of high and increasing levels of aircraft operations. Projections of high levels of aircraft operations resulted. The Puget Sound Council of Governments (PSCOG) forecast was prepared for the Draft Regional Airport System Plan 1980-2000 Central Puget Sound Region (November 1980). This forecast was prepared in the period after the level of operations at Boeing Field had begun to decline. Projections of lower levels of aircraft operations resulted.

ANNUAL OPERATIONS FOR SEA-TAC INTERNATIONAL AIRPORT

The five-, ten-, and twenty-year forecast of annual operations for Sea-Tac International Airport (Sea-Tac) is based on the forecast of aviation demand presented in the Sea-Tac International Noise Exposure Update (revised forecast, February 1982). This forecast was selected because of the corresponding forecast years and its recent completion. The Airspace Study forecasts of annual operations and associated rates of growth at Sea-Tac are presented in Table 9.

Table 9
FORECAST OF SEA-TAC
ANNUAL OPERATIONS AND GROWTH RATES

		Forecast		
	Actual 1980	1985	1990	2000
Air Carrier/Air Taxi	183,698	174,430	185,210	219,880
(Growth rate in % per year)		(-1.0%)	(1.2%)	(1.7%)
General Aviation - Itinerant	27,693	29,300	32,600	40,200
(Growth rate in % per year)		(1.1%)	(2.2%)	(2.1%)
General Aviation - Local	1,662	1,500	1,400	1,200
(Growth rate in % per year)		(-2.0%)	(-1.4%)	(-1.5%)
Military	551	550	550	550
(Growth rate in % per year)		(0.0%)	(0.0%)	(0.0%)
Total Operations	213,604	205,780	219,760	261,830
(Growth rate in % per year)		(-0.7%)	(1.3%)	(1.8%)

Source: The Port of Seattle

(Note: Total 1980 general aviation operations and military operations identified in Table 9 are from Federal Aviation Administration Air Traffic Records. Total 1980 general aviation operations and military operations used in the Sea-Tac Noise Exposure Update are from Sea-Tac Operations and Traffic Reports.)

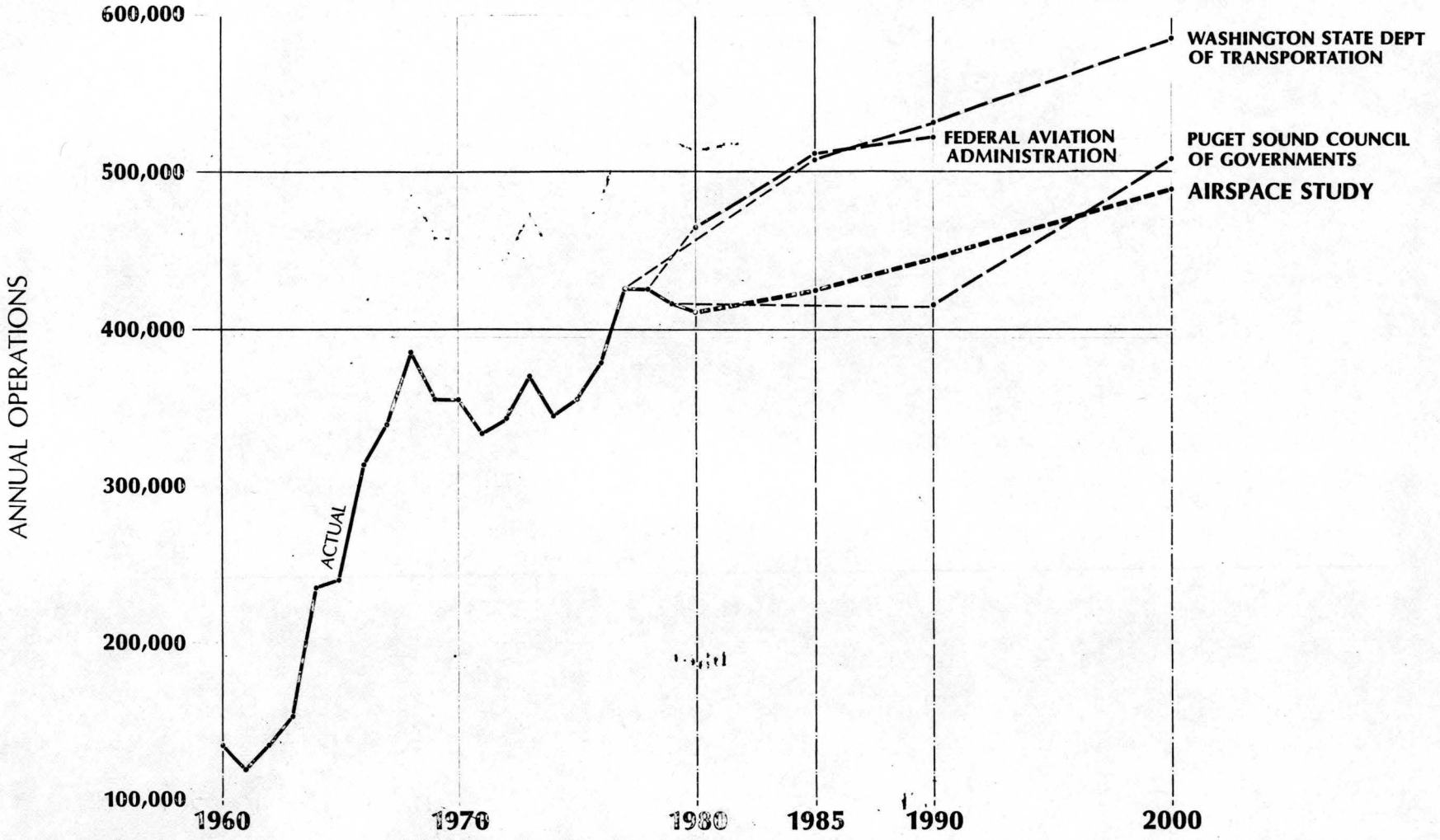


Exhibit 2
AIRSPACE STUDY

FORECAST COMPARISON

KING COUNTY INTERNATIONAL AIRPORT

The proportion of operations by category is presented in Table 10.

Table 10
FORECAST OF SEA-TAC
PERCENT OF ANNUAL OPERATIONS

Categories	Actual 1980	Forecast 1985	Forecast 1990	Forecast 2000
Air Carrier/Air Taxi	86.0 %	84.8 %	84.3 %	84.0 %
General Aviation - Itinerant	13.0 %	14.2 %	14.8 %	15.3 %
General Aviation - Local	0.8 %	0.7 %	0.6 %	0.5 %
Military	0.2 %	0.3 %	0.3 %	0.2 %
Total Operations	100.0 %	100.0 %	100.0 %	100.0 %

Source: The Port of Seattle

Air Carrier/Air Taxi Category

For the air carrier/air taxi category, separate projections are made for the operations of commercial passenger aircraft (including commuter airlines), all-cargo aircraft, and air taxi operators (excluding commuter airlines).

Commercial Passenger Aircraft Operations

Commercial passenger aircraft operations are derived from projected passenger levels developed from the methodology and approach presented by the Puget Sound Council of Governments in Air Carrier Demand Forecasts: Central Puget Sound Region (October 1980).

Projections of passengers begin with projections of passenger originations (i.e., passengers commencing transport by air at Sea-Tac). Originations are based on the historical relationship between passenger originations, regional personal income per capita, and average revenue per passenger mile. Historical data are presented in Table 11. The equation derived from this historical data is as follows:

$$Orig = -15.8 + 1.35\ (I) - 1.54\ (R)$$

where Orig = natural logarithm of annual adjusted originations per capita
I = natural logarithm of regional personal income per capita in 1967 dollars
R = natural logarithm of average revenue per passenger miles in 1967 dollars

Table 11
HISTORICAL DATA
PASSENGER FORECAST

Year	Originations (000)	Origination Adjustments (000) Deduction	Origination Adjustments (000) Addition	Adjusted Originations Per Capita	Regional Population (000) 1/	Regional Personal Income (1967$ Mill) 2/	Personal Income Per Capita (1967$)	Average Passenger Revenue Per Revenue Passenger Mile (Current 3/)	Average Passenger Revenue Per Revenue Passenger Mile (1967$)
1954	501.8	---	---	0.38	1330.2	3534.0	2656	.0566	.0720
1955	573.1	---	---	0.42	1361.9	3763.2	2763	.0560	.0709
1956	618.8	---	---	0.44	1393.7	3943.1	2823	.0558	.0698
1957	683.8	---	---	0.48	1425.3	4079.8	2862	.0554	.0664
1958	695.5	---	---	0.48	1457.1	4204.3	2885	.0580	.0681
1959	771.3	---	---	0.52	1488.1	4426.9	2974	.0596	.0687
1960	686.3	---	---	0.45	1513.0	4451.5	2942	.0614	.0699
1961	721.4	---	---	0.47	1546.8	4677.6	3024	.0624	.0699
1962	911.4	150.1	---	0.48	1584.0	5070.3	3201	.0631	.0696
1963	765.9	---	---	0.48	1609.8	5076.0	3153	.0609	.0661
1964	898.2	---	---	0.55	1640.5	5207.2	3175	.0595	.0637
1965	1079.7	---	---	0.64	1685.1	5561.4	3301	.0587	.0621
1966	1291.6	80.0	110.0	0.76	1730.0	6291.9	3636	.5067	.0584
1967	1659.1	200.0	---	0.81	1810.8	6820.0	3766	.0549	.0549
1968	1932.7	220.0	---	0.90	1893.3	7347.9	3881	.0546	.0524
1969	2095.7	200.0	---	0.98	1943.0	7428.5	3823	.0568	.0520
1970	2014.9	140.0	50.0	0.99	1938.7	7288.9	3760	.0579	.0508
1971	1980.5	90.0	---	0.98	1936.4	7282.7	3761	.0606	.0521
1972	1908.0	---	55.0	1.02	1916.4	7528.0	3927	.0608	.0508
1973	2082.3	---	---	1.09	1915.1	7855.2	4102	.0634	.0497
1974	2303.3	---	---	1.19	1935.5	7995.1	4131	.0729	.0515
1975	2359.4	---	---	1.21	1955.1	8285.8	4238	.0759	.0515
1976	2609.9	---	---	1.32	1974.4	8720.1	4416	.0797	.0484
1977	2817.2	---	---	1.41	2001.2	8981.6	4488	.0842	.0474
1978	3221.9	---	150.0	1.64	2051.2	9585.3	4673	.0830	.0427
1979	3663.0	---	150.0	1.74	2187.8	10433.05	4600	.0101	.0404
1980	3296.5	---	---	1.47	2247.0	11280.8	4800	.1163	.0465

1/ State of Washington Office of Financial Management, revised 1976, 1979.
2/ U.S. Dept. of Commerce, Bureau of Economic Analysis, 1979, adjusted to 1967 dollars by Consumer Price Index (Seattle-Everett), U.S. Dept. of Labor, Bureau of Labor Statistics.
3/ CAB, Handbook of Airline Statistics, 1973, supp. 1975, CAB, Air Carrier Traffic Statistics, monthly; Air Carrier Financial Statistics, quarterly; adjusted by CPI (Seattle-Everett).

Source: Port of Seattle and Puget Sound Council of Governments

The primary assumptions used in this forecast of originations include:

- o The relationship between air passenger demand and local population growth, local per capita income, and average air fare will remain the same throughout the forecast period.
- o Unforeseen technological changes will not significantly change the need for air travel or materially affect the inflation-adjusted costs of flying. Adjusted prices will continue to rise in 1981.
- o Airline and terminal capacity, as well as the supporting infrastructure, will continue to be sufficient to accommodate air travel demands.

Table 12 indicates the projections of population, regional income, and average revenue per passenger mile used in the calculations of passenger originations.

Table 12
PROJECTIONS OF INDEPENDENT VARIABLES
FOR PASSENGER FORECAST

Year	Regional Population[1/]	Regional Personal Income (1967) [2/]	Average Passenger Revenue Per Revenue Passenger Mile (1967 $)[2/]
1985	2,424,700	$5,640,000,000	.054
1990	2,633,700	6,304,000,000	.057
2000	3,077,600	7,713,000,000	.063

1/ Puget Sound Council of Governments, revised January 1981.

2/ Port of Seattle forecast, March 1981. These projections are based on a forecast of fuel costs rising at 3% annually.

Source: The Port of Seattle

Connecting passengers were forecast at a constant 26% of originating passengers based on conclusions from the previously cited Air Carrier Demand Forecast study. The sum of connecting passengers and originations represents enplanements. Enplanements can be assumed to equal deplanements. Therefore, a doubling of enplanements represents total passengers. The forecast of total passengers at Sea-Tac is presented in Table 13.

Table 13
TOTAL PASSENGER FORECAST
SEA-TAC INTERNATIONAL AIRPORT

Year	Total	Annual Growth
1980 Actual	9,156,800	
1985	10,083,700	2.3%
1990	11,687,600	3.0%
2000	15,247,400	2.7%

Source: The Port of Seattle

The formula used for converting passenger numbers to aircraft operations was developed for the special purpose requirements of the Sea-Tac Noise Exposure Update. As input for the noise prediction computer model, each aircraft operation was identified by representative aircraft type, geographic sector of the origin/destination of the flight, and stage length of departure (i.e., the distance in nautical miles to the first stop of a flight leaving Sea-Tac). The formula was as follows:

$$O_l = \sum_{i=1}^{N} \frac{\frac{P \times S_l}{L} \times A_{il}}{B}$$

Where A_{il} is derived from the 1980 fleet mix by section "l" and adjusted by the forecasted aggregate fleet mix and where

O_l = operations for sector/stage length "l"
P = annual passengers (enplanements and deplanements)
S_l = passenger ratio for sector/state length "l" (1980)
L = average boarding load factor
A_{il} = predicted fleet mix ratio for aircraft type "i" for sector/stage length "l" of total operations
B = average seats for aircraft type "i"
N = number of aircraft types

In order to complete the forecast calculation, projections were made for sector/stage length ratios, load factors, and fleet mix ratios.

The passenger ratios for sectors and stage lengths are based on the distribution of passengers among sectors/stage lengths in 1980 presented in Table 14. This relationship is assumed to remain constant through the forecast period. Sectors were identified by seven "directions" (southbound/West Coast, Southeast, East, Alaska/Canada, Hawaii, Far East, and Europe) and four stage lengths (0-500 nautical miles, 500-1,000 nautical miles, 1,000-1,500 nautical miles, and over 1,500 nautical miles).

Table 14
1980
PASSENGER DISTRIBUTION
BY SECTOR/STAGE LENGTH
SEA-TAC INTERNATIONAL AIRPORT

Stage Length	Hawaii	Far East	Alaska/ Canada	West Coast	South-east	East	Europe	Total
Less than 500 miles	-	-	2%	13%*	1%	10%	-	26%
500-1,000 miles	-	-	3%	21%	8%	**	-	32%
1,000-1,500 miles	-	-	10%	**	3%	12%	-	25%
Over 1,500 miles	4%	3%	-	-	4%	4%	2%	17%
Total	4%	3%	15%	34%	16%	26%	2%	100%

*Northwest Puget Sound commuter traffic comprises 6% of this 13%.
**Less than 0.5%.

Source: Civil Aeronautics Board Service Segment Data (1980) and Port of Seattle

The concept of "load factor" represents the percent of seats occupied by passengers. In 1980, the boarding load factor (i.e., the percent of seats occupied by enplaning/deplaning passengers) was estimated at 50%. This load factor is projected to increase to 52% in 1985, to 55% in 1990 and to 57% in year 2000. In addition, a 6% "thru" load factor is projected for Sea-Tac through the forecast period. The "thru" load factor represents the percent of seats occupied by passengers who arrive but do not deplane on stop-over flights.

Fleet mix ratios are developed for each sector/stage length and are based on the distribution of operations in 1980 presented in Table 15. In the forecast years, this distribution of operations was adjusted by applying the following assumptions:

Table 15
1980 AIR CARRIER/COMMUTER FLEET MIX - ALL SECTORS
(Annual Operations)

Stage Length	Sectors: FAR EAST	HAWAII	ALASKA	West	Southeast	East	Europe
0-500 nautical miles			2EN - 4,819 3EN - 1,338	2EN - 2,889 2EW - 403 3EN - 17,292 STP - 9,170 4EN - 505 3EW - 3,019 4EW - 11 Puget Sound (N&W) STP - 24,224	2EN - 4,466 3EN - 748 STP - 2,333	3EN - 3,206 4EW - 9 3EW - 2,302 STP - 10,884	
500-1000 nautical miles			2EN - 3,139 3EN - 1,049	3EN - 25,241 4EW - 191 4EN - 59 2EN - 4,152 3EW - 2,571	2EN - 203 3EN - 7,417 4EN - 1,262 4EW - 2 3EW - 1,488	3EN - 293 3EW - 2	
1000-1500 nautical miles			2EN - 1,258 3EN - 7,410 4EN - 11 4EW - 794 3EW - 2,555	3EN - 1,110	3EN - 5,533 3EW - 2	3EN - 3,890 4EW - 535 4EN - 1,913 3EW - 5,731	
Over 1500 nautical miles	4EW - 3,460	4EW - 1,547 3EW - 212			3EN - 1,486 3EW - 1,688 2EW - 414	3EN - 187 4EW - 619 4EN - 234 3EW - 1,658	4EW - 2,393
Subtotal	3,460	1,759	22,373	90,837	27,042	31,463	2,393

Total = 179,327

Abbreviations:

2EW = 2-engine, wide-body
2EN = 2-engine, narrow-body
3EW = 3-engine, wide-body
3EN = 3-engine, narrow-body
4EW = 4-engine, wide-body
4EN = 4-engine, narrow-body
STP = small turboprop/piston

Source: Civil Aeronautics Board Service Segment Data, International Edition of the Official Airline Guide and Port of Seattle.

Note: This table includes the operations of all-cargo aircraft.

- Between 1980 and 1985 -

    1. decrease in share of four-engine, narrow-body seats allocated to two-engine, wide-body
    2. decrease in share of three-engine, wide-body seats allocated to two-engine, wide-body
    3. decrease in share of three-engine, narrow-body seats allocated to two-engine, wide-body, two-engine, narrow-body, and medium prop

- Between 1985 and 1990 -

    1. decrease in share of two-engine, narrow-body seats allocated to two-engine, wide-body
    2. decrease in share of three-engine, narrow-body seats allocated to two-engine, narrow-body and medium prop
    3. decrease in share of small prop seats allocated to medium prop

- Between 1990 and 2000 -

    1. decrease in share of three-engine, narrow-body seats allocated to two-engine, narrow-body, two-engine, wide-body, and medium prop
    2. decrease in share of small prop seats allocated to medium prop

Application of the operations' formula resulted in projections of annual operations by aircraft category (i.e., groups of aircraft identified by number of engines and width of fuselage) and by sector/stage length. A summary of the forecasted operations is presented in Table 16. Appendix B of the Sea-Tac Noise Exposure Update presents the results for the forecast years of 1985, 1990, and 2000 in their entirety.

Table 16
FORECAST OF SEA-TAC
PASSENGER AIRCRAFT ANNUAL OPERATIONS

		Forecast		
	Actual 1980	1985	1990	2000
Air Carrier Airlines	130,298	129,860	134,380	160,180
Commuter Airlines	46,095	36,060	41,670	49,090
Total Operations	176,393	165,920	176,050	209,270

Source: The Port of Seattle

All-Cargo Aircraft Operations

Growth of air cargo at Sea-Tac has been essentially static since 1976. Because of the 20-year span of this forecast, however, some estimate of increased operations must be planned in order to accommodate expanded population and associated commercial trade. Therefore, a token 0.5% per year was used to forecast all-cargo operations. Changes in fleet mix through the forecast were based on the same assumptions used in the forecast of passenger aircraft operations. The forecast of all-cargo operations is presented in Table 17.

Table 17
FORECAST OF SEA-TAC
ALL-CARGO AIRCRAFT ANNUAL OPERATIONS

		Forecast		
	Actual 1980	1985	1990	2000
All-Cargo	2,934	3,010	3,080	3,160

Source: The Port of Seattle

Air Taxi Operations

Air taxi operations (excluding commuter airline operations) are projected to increase at 2% per year over the forecast period. This modest rate of growth reflects the general growth in the economy. The air taxi operations forecast at Sea-Tac are presented in Table 18.

Table 18
FORECAST OF SEA-TAC
AIR TAXI ANNUAL OPERATIONS

		Forecast		
	Actual 1980	1985	1990	2000
Air Taxi	5,000	5,500	6,080	7,450

Source: The Port of Seattle

General Aviation Categories

General aviation operations for Sea-Tac are projected to increase at 2% per year over the forecast period. Despite an annual growth rate of over 11% between 1975 and 1979, general aviation operations declined by 22% between 1979 and 1980. The FAA report Aviation Forecasts: FY 1981-1992 (September 1980) has forecasted a 3.1% growth rate nationally between 1980 and 1992 for general aviation operations at towered airports. The less optimistic forecast of 2% per year is based on the recent downturn in the economy, the decreasing purchases of general aviation aircraft, and the decreasing enrollment of student pilots. As at Boeing Field, itinerant general aviation operations are projected to increasingly outnumber local general aviation operations. This trend has been forecasted by the FAA in the FAA Aviation Forecast--Seattle-Tacoma (December 1979). The increase in the number of itinerant to local general aviation operations is shown in Table 19. Table 19 also compares the percent of itinerant general aviation operations in relation to total general aviation operations.

Table 19
GENERAL AVIATION ANNUAL OPERATIONS BY TYPE
SEA-TAC: 1975-1980

	1975	1976	1977	1978	1979	1980
Itinerant	19,028	23,946	27,267	29,606	31,247	27,693
Local	3,033	5,515	3,568	3,181	2,741	1,662
Total General Aviation	22,061	29,461	30,835	32,787	33,988	29,355
Itinerant as a percent of General Aviation Operations	86.3%	81.3%	88.4%	90.3%	91.9%	94.3%

Source: The Port of Seattle and Federal Aviation Administration

Military Category

Military operations have been steadily decreasing at Sea-Tac since 1973. In 1980, 551 military aircraft operations were reported. Annual operations are forecast to remain at approximately 550. This trend has been projected by the FAA in the FAA Aviation Forecast--Seattle-Tacoma (December 1979).

Comparison of Forecasts of Annual Operations

Exhibit 3 presents the Airspace Study forecast along with the three most recently prepared forecasts of annual operations at Sea-Tac. The Washington State Department of Transportation (WSDOT) forecast was prepared for the Washington State Airport System Plan (October 1980). The Federal Aviation Administration (FAA) forecast was prepared for the FAA Aviation Forecast--Seattle-Tacoma (December

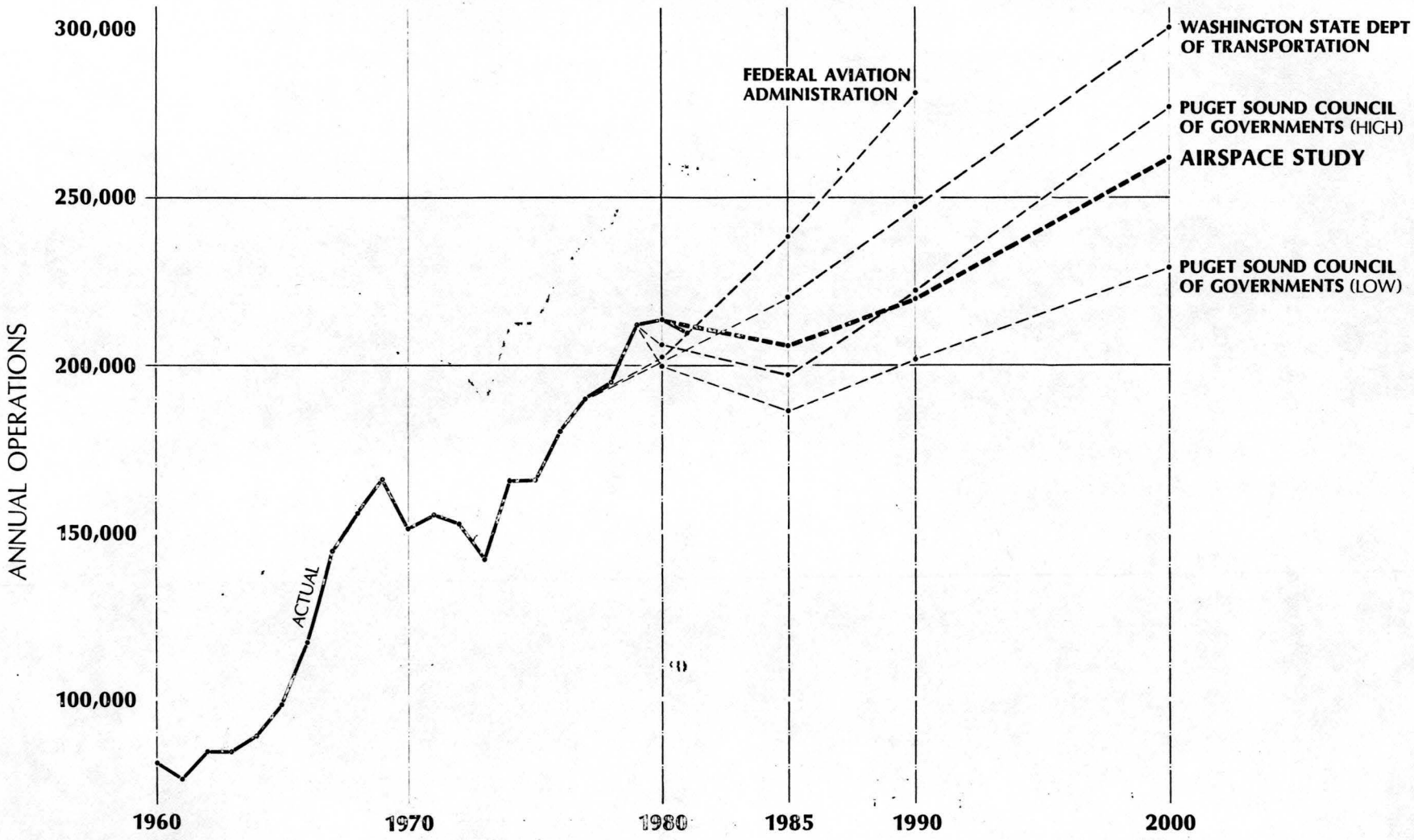


Exhibit 3
AIRSPACE STUDY

FORECAST COMPARISON

SEA-TAC INTERNATIONAL AIRPORT

1979). Both the WSDOT and FAA Forecasts were prepared prior to airline deregulation and were not able to predict the new competitiveness which arose from the open-market environment of deregulation or to predict the current general downturn in the economy. Increases in commercial airline operations following deregulation exceeded the projections of both the WSDOT and FAA. Continued growth rates forecasted by WSDOT and FAA are probably overly optimistic when viewed against the general downturn in the economy, air traffic controllers' strike, increasing aircraft operating costs, and the continuation of post-deregulation market establishment (e.g., decrease in new market airline entrants, airline mergers, development of more profitable and energy-efficient airline route systems, introduction of large commuter-size aircraft into the Sea-Tac market, etc.). In contrast, the forecast prepared by the Puget Sound Council of Governments in the Air Carrier Demand Forecasts: Central Puget Sound Region (October 1980) projects future levels of operations lower than the Airspace Study forecast.[5/] The lower projections of aircraft operations of the PSCOG and Airspace Study forecasts reflect such factors as lower projections of airline passengers, higher average seats per air carrier aircraft operation, shift in composition of commuter airline fleet mix to larger commuter-sized aircraft, and lower forecasts of general aviation operations.

PEAK HOUR OPERATIONS FOR KING COUNTY INTERNATIONAL AIRPORT

The five-, ten-, and twenty-year forecasts of peak hour operations for King County International Airport are presented in Table 20. The peak hour forecasts represent the number of aircraft operations (i.e., aircraft take-offs and landings) projected to take place during a "typical busy hour" (i.e., the peak hour of the average day of the peak month of the year) under both Visual Flight Rule (VFR) and Instrument Flight Rule (IFR) weather conditions and by aircraft classification (i.e., aircraft type) within the four aircraft categories of air carrier/air taxi, itinerant general aviation, local general aviation, and military. Total peak hour operations are forecast to increase from 198 in 1980 to 227 in the year 2000 for VFR demand and from 73 in 1980 to 103 in the year 2000 for IFR demand.

The procedure used to develop the Boeing Field peak hour forecasts follows three major steps: first, annual operations are converted to VFR peak hour operations and VFR peak hour operations allocated between aircraft categories; second, IFR peak hour operations are allocated between aircraft categories; and third, traffic mix is projected for each aircraft category in both VFR and IFR peak hours.

VFR Peak Hour Operations

Peak hour demand under VFR weather conditions is based on monthly, daily, and hourly distributions of aircraft operations reported by Federal Aviation Administration records. The following methodology was used to determine the VFR peak hour demand:

Yamanaka 060 Tbl draft 02/10/82

Table 20

FORECASTS OF PEAK HOUR AND ANNUAL AIRCRAFT OPERATIONS BY AIRCRAFT CLASSIFICATION
KING COUNTY INTERNATIONAL AIRPORT: 1980-2000

Aircraft Classifications	Peak hour, average day, peak month								Annual operations			
	VFR operations				IFR conditions							
	1980**	1985	1990	2000	1980**	1985	1990	2000	1980**	1985	1990	2000
Air Carrier/Air Taxi												
Class* A	-	-	1	1	-	-	1	1	3,680	3,570	3,800	4,680
B	1	1	1	3	1	1	1	3	8,159	8,500	9,600	12,480
C	1	1	1	2	1	1	1	2	4,160	4,930	6,600	8,840
D	-	-	-	-	-	-	-	-	-	-	-	-
Total	2	2	3	6	2	2	3	6	15,999	17,000	20,000	26,000
General Aviation-Itinerant												
Class* A	85	88	94	101	27	28	30	31	189,569	197,250	208,950	230,100
B	14	16	19	25	29	32	37	46	39,453	45,280	53,060	70,250
C	5	6	7	9	13	14	15	18	15,992	17,500	19,820	25,550
D	1	1	1	1	2	2	2	2	2,034	2,150	2,330	2,710
Rotorcraft	-	-	-	-	-	-	-	-	294	320	340	390
Total	105	111	121	136	71	76	84	97	247,342	262,500	284,500	329,000
General Aviation-Local												
Class* A	85	85	84	80	-	-	-	-	137,802	134,900	131,100	124,450
B	5	4	4	4	-	-	-	-	7,253	7,100	6,900	6,500
C	-	-	-	-	-	-	-	-	-	-	-	-
D	-	-	-	-	-	-	-	-	-	-	-	-
Total	90	89	88	84	0	0	0	0	145,055	142,000	138,000	131,000
Military												
Class* A	-	-	-	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-	-	-	-
C	1	1	1	1	-	-	-	-	1,646	1,670	1,670	1,670
D	-	-	-	-	-	-	-	-	811	830	830	830
Rotorcraft	-	-	-	-	-	-	-	-	-	-	-	-
Total	1	1	1	1	0	0	0	0	2,457	2,500	2,500	2,500
Total	198	203	213	227	73	78	87	103	410,853	424,000	445,000	488,500

*Aircraft classifications defined in Exhibit 1.
**1980 estimates of distribution between aircraft classifications within aircraft categories

Source: The Port of Seattle and King County

D/060/25C - 02/10/82

Operations of the average day of the peak month were obtained by multiplying the annual operations by a ratio of peak month to annual operations and dividing the peak month by the average days in the peak month. Peak hour operations were then obtained by multiplying the average day of the peak month operations by a ratio of peak hour to daily operations.

The ratio of peak month to annual operations and the number of days in the peak month were calculated from monthly traffic counts between 1970 and 1980. Historical data and the derived peak month ratio are presented in Table 21. For this forecast, the ratio and the average days in the peak month are assumed to continue in the future.

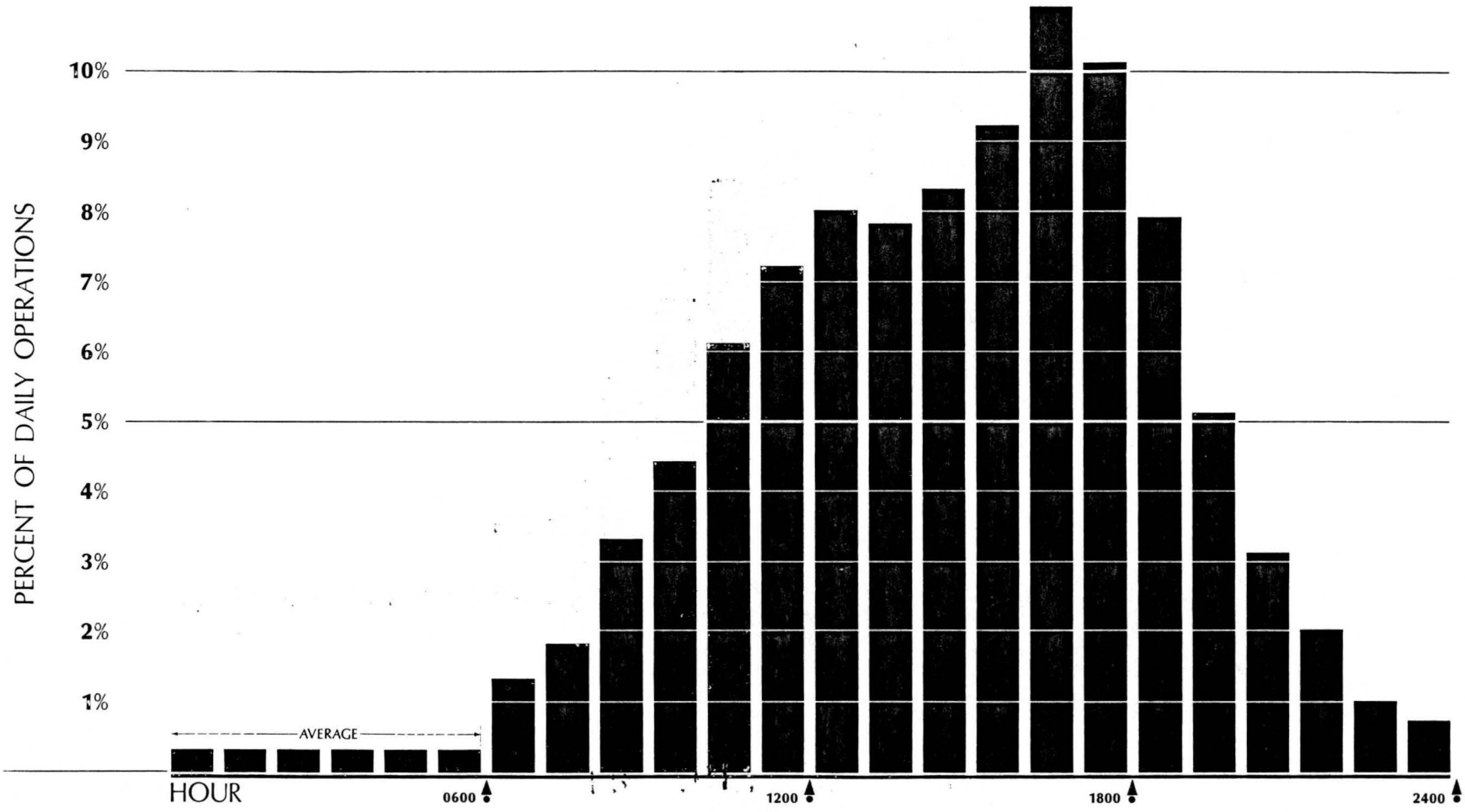
Table 21
PEAK MONTH OPERATIONS
BOEING FIELD: 1970-1980

Year	Peak Month	Days in Peak Month	Monthly Operations	Annual Operations
1970	June	30	37,478	354,997
1971	August	31	39,478	333,425
1972	May	31	37,711	343,109
1973	May	31	38,884	370,439
1974	July	31	35,702	344,115
1975	September	30	40,238	354,838
1976	July	31	41,114	377,563
1977	August	31	45,733	424,028
1978	June	30	45,634	424,811
1979	March	31	42,098	416,004
1980	July	31	45,063	410,853
		ave. = 30.7	ave. = 40,830	ave. = 377,653

Ratio of peak month to annual operations over this period was 10.8%. Average days in the peak month over this period was 30.7.

Source: The Port of Seattle and Federal Aviation Administration.

The ratio of peak hour to daily operations was developed from hourly operations counts taken during May and June 1980 and October 1981 by Boeing Field FAA Air Traffic Control Tower personnel. Over these two periods, the ratio of peak hour to daily operations was determined to be 13.6%. The peak hour occurred anywhere between the hours of 9 a.m. and 8 p.m., but most often in the early evening hours. This peaking characteristic is illustrated in Exhibit 4 which presents



PERIOD OF OBSERVATIONS: MAY 16 - JUNE 5, 1980
OCTOBER 1 - OCTOBER 31, 1981

Exhibit 4
AIRSPACE STUDY

HOURLY DISTRIBUTION OF OPERATIONS

KING COUNTY INTERNATIONAL AIRPORT

the percent of average daily operations by hour of the day during the May/June 1980 and October 1981 counts. For this forecast, this hourly distribution and the ratio of peak hour to daily operations are assumed to continue through 1990. Increases in operations will spread equally through the day. However, by the year 2000, increases in operations are expected to occur more during non-peak periods than to the peak hour. Growing congestion on the ground and in the air will influence some aircraft operators to fly at less busy times of the day. Therefore, in the year 2000, a peak hour ratio of 13.6% will be applied to operations of the average day of the peak month up to 1990 daily levels and a peak hour ratio of 8.9% for operations of the average day of the peak month beyond 1990 daily operations.

The distribution of VFR peak hour demand by the aircraft categories of air carrier/air taxi, itinerant general aviation, local general aviation, and military was based on hourly operations counts taken during October 1981 by Boeing Field FAA Air Traffic Control Tower personnel. Proportions of peak hour operations by each category were derived from only the peak hours in VFR weather conditions. These assumed proportions were to represent the 1980 VFR peak hour. Changes in the distribution of VFR peak hour operations through the forecast years are expected to follow the changes in the distribution between aircraft categories in the forecasts of annual operations. Table 22 presents the distribution of VFR peak hour operations between aircraft categories as a percentage of total VFR peak hour demand through the forecast period. Table 23 presents the number of VFR peak hour operations by aircraft category projected through the forecast period.

Table 22
FORECAST OF BOEING FIELD VFR PEAK HOUR OPERATIONS
BY AIRCRAFT CATEGORY
PERCENT OF VFR PEAK HOUR OPERATIONS

	Estimate	Forecast		
	1980	1985	1990	2000
Air Carrier/Air Taxi	1.1%	1.2%	1.7%	2.5%
General Aviation - Itinerant	53.0%	54.7%	56.7%	60.2%
General Aviation - Local	45.6%	43.8%	41.3%	37.1%
Military	0.3%	0.3	0.3	0.2
Total	100.0%	100.0%	100.0%	100.0%

Source: The Port of Seattle and King County

Table 23
FOREACAST OF BOEING FIELD VFR PEAK HOUR OPERATIONS
BY AIRCRAFT CATEGORY

	Estimate	Forecast		
	1980	1985	1990	2000
Air Carrier/Air Taxi	2	2	3	6
General Aviation -Itinerant	105	111	121	136
General Aviation - Local	90	89	88	84
Military	1	1	1	1
Total	198	203	213	227

Source: The Port of Seattle and King County

IFR Peak Hour Operations

Peak hour demand under IFR weather conditions is expected to be less in the aggregate than under VFR weather conditions. Aircraft operation during IFR weather conditions require more sophisticated avionics for aircraft and an instrument rating for pilots, thereby reducing the number of aircraft and pilots which will fly. The following assumptions are applied to each aircraft category:

* Air Carrier/Air Taxi - IFR peak hour demand will remain at the same level as VFR peak hour demand through the forecast period. As revenue generating operations, the air carrier and air taxi operators are expected to be equipped to fly under both visual and instrument flight rules. Air carrier and commuter operators are expected to meet published schedules and unscheduled air taxis are expected to be able to respond to demand at any opportunity.

* Itinerant General Aviation - In 1980, IFR peak hour demand was approximately 68% of the VFR peak hour demand. This difference will become less through the forecast period as the number of instrument rated pilots increase[6] and as the number of aircraft equipped with avionics which are used to land under instrument flight rules also increases.[7] The IFR demand as a percentage of VFR demand is forecast to increase to 71% by the year 2000. This change is based on projected increases in Washington State's fleet mix of turboprop and jet aircraft.[8]

* Local General Aviation - No local operations will take place during the IFR peak hour. Under current airport operating conditions, local operations do not occur in the IFR peak hours and this situation is expected to continue.

* Military - No military operations will take place during the IFR peak hour. Under current airport operating conditions, military operations do not occur in the IFR peak hours and this situation is expected to continue.

Table 24 presents the number of IFR peak hour operations by aircraft category projected through the forecast period.

Table 24
FORECAST OF BOEING FIELD IFR PEAK HOUR OPERATIONS
BY AIRCRAFT CATEGORY

	Estimate	Forecast		
	1980	1985	1990	2000
Air Carrier/Air Taxi	2	2	3	6
General Aviation - Itinerant	71	76	84	97
General Aviation - Local	0	0	0	0
Military	0	0	0	0
Total	73	78	87	103

Source: The Port of Seattle and King County

Traffic Mix

With forecast of peak hour operations for the four aircraft categories in both VFR and IFR weather conditions, projections were next made for the mix of aircraft traffic by aircraft classification. Aircraft classifications used in this study define classes of aircraft by maximum take-off weights and performance characteristics. Exhibit 1 identifies each of the five classes of aircraft and representative aircraft within the classes.

VFR and IFR traffic mixes are forecasted independently as are the traffic mixes of each of the four categories. VFR traffic mix for 1980 is based on survey data collected at Boeing Field during a week in October 1981. IFR traffic mix for 1980 is based on FAA Air Traffic Control Tower records and the October 1981 tower survey. Projections of future traffic mix are based on the following assumptions:

* Air carrier traffic mix component of the air carrier/air taxi category will remain the same through the forecast period.

* Air taxi traffic mix component of the air carrier/air taxi category and itinerant and local general aviation traffic mix will change at the same rate forecast for Washington State general aviation aircraft in the Washington State Airport System Plan (October 1980).

* Military traffic mix will remain the same thorugh the forecast period.

* Rotorcraft operations include only take-offs and landings from the active runways. Operations from the ramp are not included.

Table 25 presents the forecast of Boeing Field VFR peak hour traffic mix by aircraft category as a percentage of total peak hour operations in each aircraft category. Table 26 presents the number of Boeing Field VFR peak hour operations for each aircraft classification in each aircraft category projected through the forecast period.

Table 27 presents the forecast of Boeing Field IFR peak hour traffic mix by aircraft category as a percentage of total peak hour operations in each aircraft category and as the number of peak hour operations.

PEAK HOUR OPERATIONS FOR SEA-TAC INTERNATIONAL AIRPORT

The five-, ten-, and twenty-year forecasts of peak hour operations for Sea-Tac International Airport are presented in Table 28. The peak hour forecasts represent the number of aircraft operations (i.e. aircraft take-off and landings) projected to take place during a "typical busy hour" (i.e., the peak hour of the average day of the peak month of the year) under both Visual Flight Rule (VFR) and Instrument Flight Rule (IFR) weather conditions and by aircraft classification (i.e., aircraft type) within the four aircraft categories of air carrier/air taxi, itinerant general aviation, local general aviation, and military. Total peak hour operations are forecast to increase from 54 in 1980 to 59 in the year 2000 for VFR demand and from 52 in 1980 to 57 in the year 2000 for IFR demand.

The procedure used to develop the Sea-Tac peak hour forecasts follows three major steps: first, annual operations are converted to VFR peak hour operations and VFR peak hour operations allocated between aircraft categories; second, IFR peak hour operations are allocated between aircraft categories; and third, traffic mix is projected for each aircraft category in both VFR and IFR peak hours.

VFR Peak Hour Operations

Peak hour demand under VFR weather conditions are based on monthly, daily, and hourly distributions of aircraft operations reported by Federal Aviation Administration records. The following methodology was used to determine the VFR peak demand:

> Operations of the average day of the peak month were obtained by multiplying the annual operations by a ratio of peak month to annual operations and dividing the peak month by the average days in the peak month. Peak hour operations were then obtained by multiplying the average day of the peak month operations by a ratio of peak hour to daily operations.

The ratio of peak month to annual operations and the number of days in the peak month were calculated from monthly traffic counts between 1970 and 1980. Historical data and the derived peak month ratio is presented in Table 29. For this forecast, the ratio and the average days in the peak month are assumed to continue in the future.

Table 25
FORECAST OF BOEING FIELD TRAFFIC MIX
PERCENT OF VFR PEAK HOUR OPERATIONS BY AIRCRAFT CATEGORY

Aircraft Category	Estimate 1980	Forecast 1985	1990	2000
Air Carrier/Air Taxi				
Class A	23%	21%	19%	18%
Class B	51%	50%	48%	48%
Class C	26%	29%	33%	34%
Class D	-	-	-	-
Total	100%	100%	100%	100%
General Aviation - Itinerant				
Class A	81%	79%	77%	74%
Class B	13%	15%	16%	19%
Class C	5%	5%	6%	6%
Class D	1%	1%	1%	1%
Rotorcraft	*	*	*	*
Total	100%	100%	100%	100%
General Aviation - Local				
Class A	95%	95%	95%	95%
Class B	5%	5%	5%	5%
Class C	-	-	-	-
Class D	-	-	-	-
Total	100%	100%	100%	100%
Military				
Class A	-	-	-	-
Class B	-	-	-	-
Class C	67%	67%	67%	67%
Class D	-	-	-	-
Rotorcraft	33%	33%	33%	33%
Total	100%	100%	100%	100%

*Note: less than 0.5%

Source: The Port of Seattle and King County.

Table 26
FORECAST OF BOEING FIELD TRAFFIC MIX
VFR PEAK HOUR OPERATIONS BY AIRCRAFT CATEGORY

Aircraft Category	Estimate 1980	Forecast 1985	1990	2000
Air Carrier/Air Taxi				
Class A	-	-	1	1
Class B	1	1	1	3
Class C	1	1	1	2
Class D	-	-	-	-
Total	2	2	3	6
General Aviation - Itinerant				
Class A	85	88	94	101
Class B	14	16	19	25
Class C	5	6	7	9
Class D	1	1	1	1
Rotorcraft	-	-	-	-
Total	105	111	121	136
General Aviation - Local				
Class A	85	85	84	80
Class B	5	4	4	4
Class C	-	-	-	-
Class D	-	-	-	-
Total	90	89	88	84
Military				
Class A	-	-	-	-
Class B	-	-	-	-
Class C	1	1	1	1
Class D	-	-	-	-
Rotorcraft	-	-	-	-
Total	1	1	1	1

Source: The Port of Seattle and King County

Table 27
FORECAST OF BOEING FIELD TRAFFIC MIX
PERCENT AND NUMBER OF IFR PEAK HOUR OPERATIONS BY AIRCRAFT CATEGORY

Percent of IFR Peak Hour Operations Aircraft Category	Estimate 1980	Forecast 1985	 1990	 2000
Air Carrier/Air Taxi				
Class A	23%	21%	19%	18%
Class B	51%	50%	48%	48%
Class C	26%	29%	33%	34%
Class D	-	-	-	-
Total	100%	100%	100%	100%
General Aviation - Itinerant				
Class A	39%	37%	35%	32%
Class B	41%	43%	45%	47%
Class C	18%	18%	18%	19%
Class D	2%	2%	2%	2%
Rotorcraft	*	*	*	*
Total	100%	100%	100%	100%

Number of IFR Peak Hour Operations Aircraft Category	Estimate 1980	Forecast 1985	 1990	 2000
Air Carrier/Air Taxi				
Class A	-	-	1	1
Class B	1	1	1	3
Class C	1	1	1	2
Class D	-	-	-	-
Total	2	2	3	6
General Aviation - Itinerant				
Class A	27	28	30	31
Class B	29	32	37	46
Class C	13	14	15	18
Class D	2	2	2	2
Rotorcraft	-	-	-	-
Total	71	76	84	97

*Note: less than 0.5%

Source: The Port of Seattle and King County

Table 28

FORECASTS OF PEAK HOUR AND ANNUAL AIRCRAFT OPERATIONS BY AIRCRAFT CLASSIFICATION
SEA-TAC INTERNATIONAL AIRPORT: 1980-2000

Aircraft Classifications	Peak hour, average day, peak month								Annual operations			
	VFR operations				IFR conditions							
	1980**	1985	1990	2000	1980**	1985	1990	2000	1980**	1985	1990	2000
Air Carrier/Air Taxi												
Class* A	-	-	-	-	-	-	-	-	-	-	-	-
B	13	11	12	13	13	11	12	13	51,611	42,090	48,290	57,090
C	26	23	21	18	26	23	21	18	100,472	85,210	79,470	77,630
D	8	13	15	20	8	13	15	20	31,615	47,130	57,450	85,160
Total	47	47	48	51	47	47	48	51	183,698	174,430	185,210	219,880
General Aviation-Itinerant												
Class* A	2	2	2	2	2	1	1	2	9,139	9,370	10,270	10,850
B	4	4	4	5	3	3	3	3	14,400	15,240	17,110	21,710
C	1	1	1	1	-	1	1	1	3,323	3,810	4,240	6,430
D	-	-	-	-	-	-	-	-	-	-	-	-
Rotorcraft	-	-	-	-	-	-	-	-	831	880	980	1,210
Total	7	7	7	8	5	5	5	6	27,693	29,300	32,600	40,200
General Aviation-Local												
Class* A	-	-	-	-	-	-	-	-	166	150	140	120
B	-	-	-	-	-	-	-	-	420	330	330	280
C	-	-	-	-	-	-	-	-	818	660	540	380
D	-	-	-	-	-	-	-	-	258	360	390	420
Total	0	0	0	0	0	0	0	0	1,662	1,500	1,400	1,200
Military												
Class* A	-	-	-	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-	-	-	-
C	-	-	-	-	-	-	-	-	551	550	550	550
D	-	-	-	-	-	-	-	-	-	-	-	-
Total	0	0	0	0	0	0	0	0	551	550	550	550
Total	54	54	55	59	52	52	53	57	213,604	205,780	219,760	261,830

*Aircraft classifications defined in Exhibit 1.
**1980 estimates of distribution between aircraft classifications within aircraft categories

Source: The Port of Seattle

D/060/25C - 02/11/82

Table 29
PEAK MONTH OPERATIONS
SEA-TAC: 1970-1980

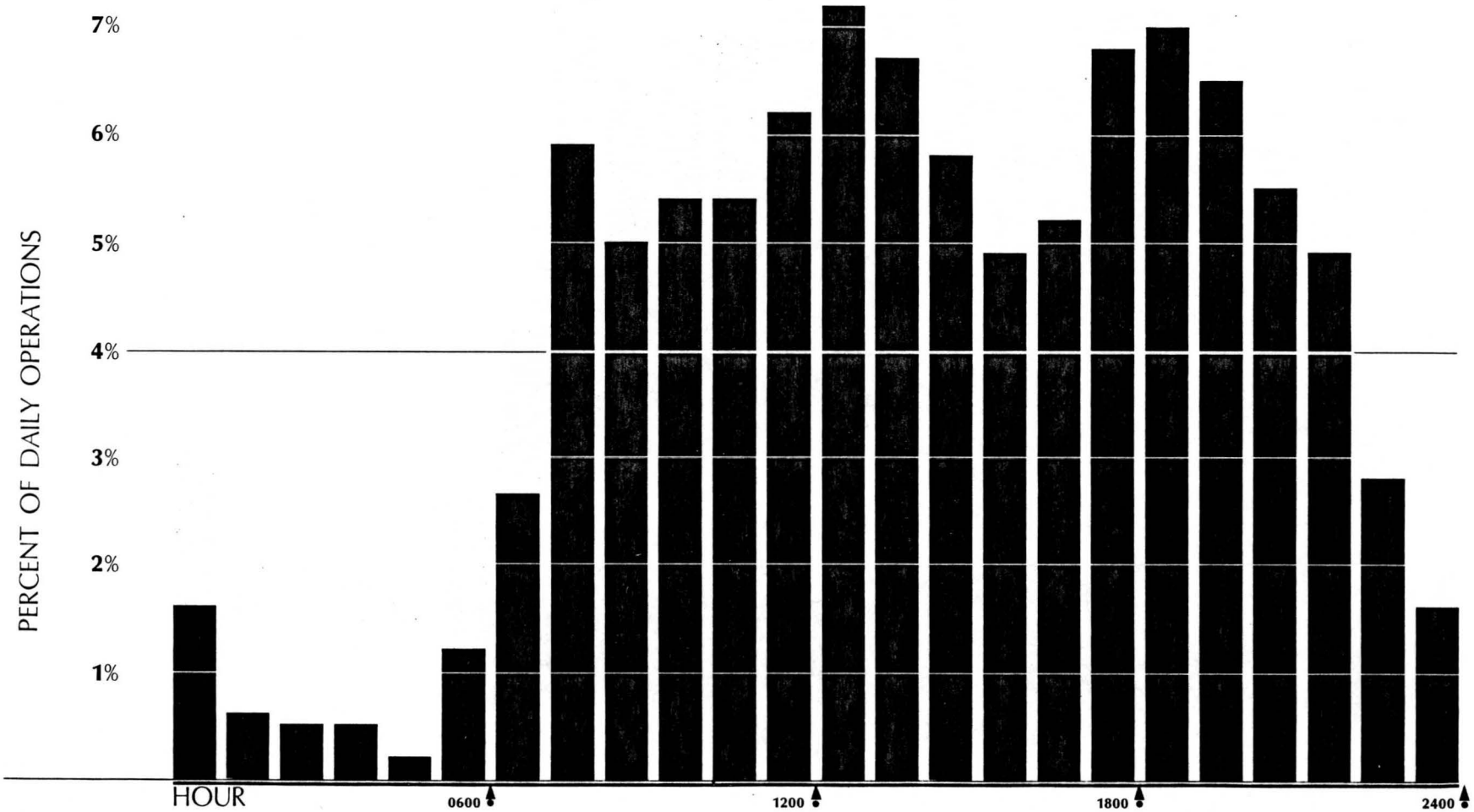
Year	Peak Month	Days in Peak Month	Monthly Operations	Annual Operations
1970	June	30	14,200	150,676
1971	July	31	15,635	155,144
1972	June	30	14,864	152,344
1973	August	31	15,287	158,131
1974	August	31	16,068	160,916
1975	July	31	15,393	163,759
1976	July	31	17,090	173,525
1977	August	31	18,647	190,026
1978	August	31	22,079	211,942
1979	August	31	19,137	194,991
1980	August	31	21,539	213,604
		ave. = 30.8	ave. = 17,267	ave.= 175,005

Ratio of peak month to annual operations over this period was 9.9%. Average days in the peak month over this period was 30.8.

Source: The Port of Seattle and Federal Aviation Administration

The ratio of peak hour to daily operations was developed from hourly operations counts taken during August/September 1981 by Sea-Tac FAA Air Traffic Control Tower personnel. Over this period, the ratio of peak hour to daily operations was determined to be 7.8%. The peak hour occurred most often mid-day and in the early evening hours. This peaking characteristic is illustrated in Exhibit 5 which presents the percent of average daily operations by hour of the day during the August/September 1981 counts. For this forecast, the early morning, midday, and early evening peaks are expected to continue through the forecast period in response to the preferred arrival and departure times of passengers. Therefore any decreases in daily operations will be distributed over non-peak periods. On the other hand, increases in daily operations will be spread over all the hours of the day. The demand during the peak hour will, however, increase less than non-peak hours. Off-peak periods will grow increasingly more attractive as airlines increase the utilization of their aircraft and terminal facilities.

As a result, the peak hour ratio is expected to decrease through the forecast period. In 1985, daily operations should decrease so the peak hour demand will remain at the 1980 level. In 1990, a peak hour ratio of 5.0% will be applied to the operations of the average day of the peak month above 1980 daily levels and



PERIOD OF OBSERVATIONS: AUGUST 6 - SEPTEMBER 15, 1981

Exhibit 5
AIRSPACE STUDY

HOURLY DISTRIBUTION OF OPERATIONS

SEA-TAC INTERNATIONAL AIRPORT

added to the 1985 peak hour demand. In the year 2000, a peak hour ratio of 3.3% will be applied to the operations of the average day of the peak month beyond 1990 levels and added to the 1990 peak hour demand.

The distribution of VFR peak hour demand by the aircraft categories of air carrier/air taxi, itinerant general aviation, local general aviation, and military was based on Sea-Tac Air Traffic Control Tower (ATCT) operating procedures and the distribution of annual operations by aircraft categories. An ATC restriction limits local operations to non-peak periods at Sea-Tac. ATC personnel also reported that military operations rarely take place in peak periods, consequently, no local and military operations were forecasted in either the VFR or IFR peak hours. Air carrier/air taxi and itinerant general aviation demand during the VFR peak hour was assumed to be in the same proportion as the 1980 annual operations by aircraft category. The air carrier/air taxi category was 87% and the itinerant general aviation category was 13% of the combined category annual operations. Through the forecast period, the itinerant general aviation proportion of annual operations increases while the air carrier/air taxi proportion decreases. However, the air carrier/air taxi proportion of peak hour demand is expected to continue at 1980 levels.

Table 30 presents the number of VFR peak hour operations by aircraft category projected through the forecast period.

Table 30
FORECAST OF SEA-TAC VFR PEAK HOUR OPERATIONS
BY AIRCRAFT CATEGORY

	Estimate	Forecast		
	1980	1985	1990	2000
Air Carrier/Air Taxi	47	47	48	51
General Aviation - Itinerant	7	7	7	8
General Aviation - Local	0	0	0	0
Military	0	0	0	0
Total	54	54	55	59

Source: The Port of Seattle

IFR Peak Hour Operations

Peak hour demand under IFR weather conditions is expected to be only slightly less than under VFR weather conditions due to the large proportion of air carrier/air taxi demand in the peak hour. The following assumptions are applied to each aircraft category:

* Air Carrier/Air Taxi - IFR peak hour demand will remain at the same level as VFR peak hour demand through the forecast period. As revenue generators, air carrier and air taxi operators are expected to be equipped to fly under both visual and instrument flight rules. Air carrier and commuter operators are expected to meet published schedules and unscheduled air taxis are expected to be able to respond to demand at any opportunity.

* Itinerant General Aviation - In 1980, IFR peak hour demand was estimated to be approximately 72% of the VFR peak hour demand. This difference will become less through the forecast period as the number of instrument rated pilots increase[6] and as the number of aircraft equipped with avionics which are used to land under instrument flight rules also increases.[7] The IFR demand as a percentage of VFR demand is forecast to increase to 75% by the year 2000. This percentage is based on projected increases in Washington State's fleet mix of turboprop and jet aircraft.[8]
* Local General Aviation and Military - As in the VFR peak hour, no local general aviation or military operations are expected to occur in the IFR peak hour.

Table 31 presents the number of IFR peak hour operations by aircraft category through the forecast period.

Table 31
FORECAST OF SEA-TAC IFR PEAK HOUR OPERATIONS
BY AIRCRAFT CATEGORY

	Estimate	Forecast		
	1980	1985	1990	2000
Air Carrier/Air Taxi	47	47	48	51
General Aviation - Itinerant	5	5	5	6
General Aviation - Local	0	0	0	0
Military	0	0	0	0
Total	52	52	53	57

Source: The Port of Seattle

Traffic Mix

With forecasts of peak hour operations for the four aircraft categories in both VFR and IFR weather conditions, projections were next made for the mix of aircraft traffic by aircraft classification. Aircraft classifications used in this study define classes of aircraft by maximum take-off weights and performance characteristics. Exhibit 1 identifies each of the five classes of aircraft and representative aircraft within the classes.

VFR and IFR traffic mixes are based on the Sea-Tac fleet mix projects presented in the Sea-Tac Noise Exposure Update (revised forecast, February 1982). The distribution between aircraft classifications within categories is expected to be the same in both VFR and IFR peak hours. The following assumptions were incorporated into the traffic mix forecasts:

* Air carrier traffic mix component of the air carrier/air taxi category will have an increasing proportion of large aircraft (class D) as new technology aircraft now under production are introduced into the Sea-Tac fleet mix and smaller two and three-engine, narrow body aircraft are retired and replaced.

* Air taxi traffic mix component of the air carrier/air taxi category will continue to consist of Class B aircraft.

* Itinerant general aviation traffic mix will continue to have a high proportion of twin-engine piston (Class B) and turbojet aircraft (Class C) at Sea-Tac as compared to the U.S. general aviation fleet.

Table 32 presents the forecast of Sea-Tac VFR and IFR traffic mix by aircraft category as a percentage of total peak hour operations in the air carrier/air taxi and itinerant general aviation categories. Table 33 presents the number of Sea-Tac VFR and IFR peak hour operations for each aircraft classification in the air carrier/air taxi and itinerant general aviation categories projected through the forecast period.

Table 32
FORECAST OF SEA-TAC TRAFFIC MIX
PERCENT OF VFR AND IFR PEAK HOUR OPERATIONS BY AIRCRAFT CATEGORY

Aircraft Category	Estimate 1980	Forecast 1985	1990	2000
Air Carrier/Air Taxi				
Class A	-	-	-	-
Class B	27%	24%	25%	25%
Class C	55%	48%	44%	35%
Class D	18%	28%	31%	40%
Total	100%	100%	1005	100%
General Aviation - Itinerant				
Class A	33%	32%	31%	27%
Class B	52%	52%	53%	54%
Class C	12%	13%	13%	16%
Class D	-	-	-	-
Rotorcraft	3%	3%	3%	3%
Total	100%	100%	100%	100%

Source: The Port of Seattle

Table 33
FORECAST OF SEA-TAC TRAFFIC MIX
VFR AND IFR PEAK HOUR OPERATIONS BY AIRCRAFT CATEGORY

Aircraft Category	Estimate 1980	Forecast 1985	1990	2000
Air Carrier/Air Taxi (VFR and IFR)				
Class A	-	-	-	-
Class B	13	11	12	13
Class C	26	23	21	18
Class D	8	13	15	20
Total	47	47	48	51
General Aviation - Itinerant (VFR)				
Class A	2	2	2	2
Class B	4	4	4	5
Class C	1	1	1	1
Class D	-	-	-	-
Rotorcraft	-	-	-	-
Total	7	7	7	8
General Aviation Itinerant (IFR)				
Class A	2	1	1	2
Class B	3	3	3	3
Class C	-	1	1	1
Class D	-	-	-	-
Rotorcraft	-	-	-	-
Total	5	5	5	6

Source: The Port of Seattle

1/ VFR weather conditions occur when the ceiling is greater than 1,000 feet and/or visibility is greater than 3 miles. IFR weather conditions occur when the ceiling is less than 1,000 feet and/or visibility is less than 3 miles.

2 National Oceanic and Atmospheric Administration, Seattle-Tacoma Airport, Period of Record: 1965-1974.

3/ Unseasonal, inclement weather was reported by King County International Airport staff to have also contributed to the decrease in operations through this period.

4/ Washington State Airport System Plan (October 1980), 11-28.

5/ The PSCOG forecast includes only operations of passenger and all-cargo air carrier operations. Operations of commuter, air taxi, military, and general aviation from the Airspace Study were added for purposes of comparison.

6/ FAA, FAA Aviation Forecasts: Fiscal Years 1981-1992 (Sept. 1980).

7/ FAA, General Aviation: Hours Flown and Avionics Purchase Decisions, FAA - AVP - 78 - 9 (May 1978).

8/ WSDOE, Washington State Airport System Plan (October 1980), p. 5-16. According to the document referenced in footnote 7, aircraft with ILS capabilities are directly related to aircraft type. Higher performance aircraft (turboprops and turbojets) are more likely to be ILS-equipped than smaller piston aircraft.