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A Concept for New Establishment Criteria for Airport Surveillance Radar

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U. S. DEPARTMENT OF COMMERCE, Frederick B. Dent, Secretary
NATIONAL BUREAU OF STANDARDS, Richard W. Roberts, Director

A Concept For New

Establishment Criteria for ASR/ATCRBS/BDS

1. Purpose

The purpose of this study is to define the role of the Airport Surveillance Radar, Air Traffic Radar Beacon System, Radar Bright Display (ASR/ATCRBS/BDS), to ascertain the benefits it provides, to present a benefit/cost concept for new establishment criteria for ASR, and to identify factors relevant to that concept.

2.0 Background

2.1 An ASR/ATCRBS/BDS is the hardware which upgrades a manual approach control terminal facility to a radar approach control terminal facility. It consists of an ASR, the primary airport surveillance radar which provides aircraft target display information on the arrival and departure controllers' radar display scopes; an ATCRBS, a cooperative secondary radar system which enhances or augments the reliability and facilitates identification of the targets by interrogating transponder equipped aircraft; and a BDS, a remote bright display radar scope located in the tower cab to provide the local controller with an overview of the traffic situation. For convenience, this system will hereinafter be referred to as ASR in this report.

2.2 The existing establishment criteria for ASR contained in FAA Airway Planning Standard No. 1 (APS-1) are as follows:

2.2.1 Establishment. An FAA approach control tower which records 50,000 or more annual itinerant operations of which 10,000 or more are scheduled air carrier operations (for three consecutive FAA annual counts), is a candidate for ASR/ATCRBS/BDS.

2.3 In addition to the above establishment criteria, APS-1 also contains criteria for decommissioning and improving an ASR. While these criteria must be considered in any study of the establishment criteria, this consideration is of secondary importance because any changes in them must directly reflect changes that are ultimately made in the establishment criteria.

2.4 The need for reviewing and updating the FAA's present establishment criteria for terminal facilities and services has been stimulated by a number of events. Prominent among these is the rapidly escalating costs of establishing, operating, and maintaining FAA facilities and services. In addition, there is the threat that these costs may eventually be borne entirely by the direct aviation users of the facilities and services. As a result the aviation users, particularly the general aviation segment, are taking a much harder look at the justification of new terminal facilities being established by the FAA. On the other hand, the air carrier segment of the aviation community has expressed the feeling that every airport with scheduled air service should have as a minimum, air traffic control service, approach control service (radar at locations having 7500 or more annual air carrier operations), and an instrument landing system (ILS). Consequently, the different viewpoints of the general aviation and air carrier segments of the aviation community must be recognized in the development of new or modified ASR establishment criteria.

2.5 A problem with the current ASR establishment criteria is that they are based on the volume of annual activity. The more critical, shorter term operational requirements for terminal radar service are not reflected in the criteria. For example, it is presently possible for a location with a less critical operational requirement to be provided terminal radar service before another location with a more critical operational requirement because the first generates a higher annual count.

3.0 Functions of the ASR

3.1 The establishment of an ASR at an FAA approach control tower provides the controllers with a visual presentation of their traffic. It permits the use of reduced separation standards and provides the controllers with the capability of vectoring arrival and departure traffic which reduces the need for holding and procedural approaches thereby increasing the utilization of the terminal airspace and expediting the flow of traffic. Therefore, the primary function of an ASR is to achieve a more efficient utilization of the terminal airspace and thus expedite the flow of IFR traffic under actual instrument conditions by providing radar approach and departure service.

3.2 Secondary functions provided by ASR include VFR radar advisory service and radar navigation assistance. VFR radar advisory service consists of advising VFR pilots of separation between a VFR aircraft and other observed aircraft, advisories to identified aircraft when a situation appears to constitute a potential traffic hazard, weather and chart information, and radar navigation assistance to avoid areas of bird activity or other local obstructions. VFR radar advisory service is offered only when permitted by the controller's workload. Radar navigation assistance is the provision of navigation assistance to lost or disoriented pilots or in other emergency situations. There is often a tendency to include many of the individual secondary functions of ASR as primary functions; such as vectoring a VFR pilot in when he finds himself caught on top of cloud cover, low on fuel, lost, or with equipment malfunctioning. However, these services can only be provided by an ASR if one is present. If an ASR is not present, the pilot can still resort to other FAA provided means of assistance such as DF and other emergency services offered through FSS, ARTCC and tower facilities. The ASR can be classified as a limited means of offering navigation assistance to pilots in the immediate area of the airport.

4.0 Discussion of Functions of ASR

4.1 The primary function of an ASR becomes an operational requirement at a manual approach control facility when the traffic situation at the airport, under IFR conditions, is such that manual approach separation standards and procedures result in significant delay to the arriving and departing aircraft. This is the fundamental reason for adding an airport surveillance radar capability to a manual approach facility and should, therefore, be the dominant element in establishment criteria for ASR. The problem is to define the level of delay which is significant in the sense that its cost to the aviation users begins to justify the high cost of the radar system. This involves consideration of a number of factors, all of which vary from one airport to another.

4.2 The first consideration is the volume of traffic at the airport. However, since the primary function of the ASR is to expedite arrival and departure traffic under IFR conditions, the interest logically focuses on the traffic situation during these conditions. Peak day, busy hour, and average hour traffic activity data presently are available for all FAA tower airports. However, the peak day and busy hour data are too gross for the purposes of this study, and the average hour data are not operationally meaningful. Technically, the actual number of operations that occur during each hour an airport is operating under IFR conditions would be required to precisely compute the total aircraft delay. These data are not currently published but are available from existing flight strip information at all manual approach facilities. However, to decipher the required information from these strips and to compute the total delay for each hour an airport is operating under IFR conditions would require a prohibitive amount of effort. A review of actual hourly traffic at airports with a level of activity at which ASR might be justified, indicated that a more practical approach to the problem is to obtain approximations of the delay and the number of hours during the year an ASR would be helpful in reducing the delay. The review also indicated that traffic levels below 10 operations per hour appear to be too low to justify an ASR unless unusual operational considerations exist. An analysis was made of the data obtained from a limited field survey[1/] and of the data from the FAA computer program listing the actual scheduled air carrier activity at the airports included in the survey. It was found that a factor of 75% could be applied to the reported number of operations during the most active hour of the week under IFR conditions to obtain an approximation of the number of hours during the year an ASR would be beneficial. In this report, a busy IFR hour is defined as an hour in which the number of operations at a specific airport is equal to or exceeds 75% of the number of operations during the most active IFR hour of the week. The factor of 75% should be further confirmed by field testing under IFR operating conditions at airports within the range of interest.

4.3 The next factors to consider are: the number of times during the year that the local busy IFR hour occurs, and the mix of aircraft types involved. These data are necessary to determine the cost of delay during the busy IFR hours of a year.

[1/] See Section 5.5 and Appendix A of this report for details of this survey.

4.4 The principal user benefit provided by the primary function of the ASR is reduction of delay. The value of the delay saved should be the principal factor in justifying the cost of the facility.

4.5 It is the opinion of the authors of this report that the VFR radar advisory service and the navigation assistance service functions would never either individually or in combination, by themselves, provide sufficient justification for the establishment of an ASR. However, if an impact analysis of the concept presented in this report indicates marginal results, the additional benefits provided by the secondary functions might be considered to justify the establishment of an ASR at an airport with unusual operational requirements.

4.6 It is not possible to consider the benefits of an ASR system without some discussion of safety. While there is no doubt that a radar approach control environment in which the controllers have a visual presentation of their traffic should provide some safety advantages over a manual approach environment, the FAA's concept has always been to design its air traffic control techniques and procedures to provide equivalent safety under all conditions of facility capabilities and control environments. Time and resources allocated for this particular study did not permit an analysis of the safety aspects of radar versus manual approach environment, but a brief review of a previous analysis[1/] of this problem did not produce any conclusive evidence that one environment is safer than the other. Of the relatively few total accidents that occur within the NAS, usually only a very small fraction of them can be directly related to a specific control environment. The number of such accidents is far too small to develop valid accident statistics comparing one control environment with another. This tends to lend support to the validity of the FAA's concept that all control environments can be made equally safe by proper control techniques and operating procedures. On this basis, the authors of this report feel that safety, per se, should not be a relevant factor in establishment criteria for ASR.

4.6 In summary, the function and benefit related factors at a specific airport that are relevant to establishment criteria for the ASR system are as follows:

4.6.1 No. of operations during a busy IFR hr.

4.6.2 No. of times a year that a busy IFR hr. occurs.

4.6.3 The difference in delay generated during a busy IFR hour between a radar and a non-radar approach control environment.

4.6.4 The categories of aircraft and number of passengers delayed and the cost of that delay.

4.6.5 A quantifiable measurement of the benefits derived from the secondary functions of the ASR.

[1/] Special Study, ASR Program Effectiveness and Establsihment Criteria, FAA, SRDS, August, 1973.

5.0 Approach to Criteria Development

5.1 The proposed benefit/cost concept for new establishment criteria for ASR is represented by the following formula:

$$\frac{C_{AC} + V_P + B_O}{AOC_{ASR}} \geq 1, \text{ where:}$$

C_{AC} = Total operating cost of all aircraft which would be saved by converting from a manual approach control facility to a radar approach facility. These costs may be estimated by using the operating cost per hour data shown in Table 5.1.

V_P = Total value of the passengers' and occupants' time in the above aircraft. The data shown in Table 5.1, in the columns, Number of Passengers, and Value of Passengers' Time are used for computing these values.

B_O = Value of secondary benefits provided by ASR. (Time did not permit the development of this factor. (See paragraph 7.1.1).

AOC_{ASR} = The Annual Operating Cost of an ASR/ATCRBS/BDS which is $663,000. This figure was derived from current ASR cost data provided by FAA/AFS as shown in Appendix A.

Table 5.1 shows the factors that have been used in other FAA analyses for aircraft operating costs, passenger and occupant load factors, and the value of passengers' and occupants' time.

TABLE 5.1

FACTORS USED FOR ESTIMATING DELAY COST

USER CATEGORY	AIRCRAFT OPERATING COST/HR $	NUMBER OF PASSENGERS OR OCCUPANTS	VALUE PASSENGERS' TIME $/HOUR	TOTAL AIRCRAFT DELAY COST/HR $
AC	800	36	15	1340
AT	250	10	15	400
GA_{IT}	100	2.5	21.75	143.50
GA_{LOC}	50	2	15	80
MIL_{HV}	800	20	15	1100
MIL_{MED}	250	10	15	400
MIL_{LT}	100	2.5	15	137.50

NOTE:

Because of the small difference between the total delay cost/hr for GA_{IT} and MIL_{LT}, a cost of $140/hr was used for both categories for plotting the curve in Fig. 6.1.

5.2 An analysis was made of the traffic characteristics and the present ASR establishment criteria at 20 randomly selected FAA tower airports with total annual operations in the range of 50,000 to 250,000. These airports and their activity during FY73 are shown in Table 5.2. Of the 20 FAA towers on these airports, 5 are VFR, 9 are manual approach control and 6 are radar approach control.

5.3 Figures 5.1,5.2, and 5.3 show the distribution of traffic by user category at the 20 airports.

5.3.1 Figure 5.1 indicates that at all but 8 of the airports, itinerant operations were in the range of 50 to 60% of total operations. The airport with the highest percent of itinerant operations to total operations has a VFR tower and approximately 100,000 annual total operations. The airport with the lowest percentage of itinerant to total operations has a manual approach control tower and approximately 226,000 total operations. All 20 airports have air carrier operations, which, except for three airports, are in the range of about 4 to 16% of the total operations. The airport with the highest percentage (about 28%) of air carrier operations has a VFR tower and about 125,000 annual total operations. Air taxi operations constitute about 6 percent or less of the total traffic at all but 2 of the 20 airports. The airport with the highest percentage (approximately 12%) of air taxi operations has a manual approach control tower and approximately 104,000 annual total operations.

5.3.2 Figure 5.2 shows that at all but one airport, total general aviation operations constitute greater than 50% of the total operations. At 5 airports where total general aviation operations are more than 90% of the total operations, one has a radar approach control tower, 2 have manual approach control towers, and 2 have VFR towers. At most of the 20 airports, general aviation itinerant operations are in the range of 25 to 50% of total operations with general aviation local operations in the same range. At 3 airports where general aviation itinerant operations represent about 60% of the total activity, one has a manual approach control tower, one has a radar approach tower, and one has a VFR tower. One airport where general aviation local operations are in excess of 60% of the total operations has a manual approach control tower.

5.3.3 Figure 5.3 shows that at 7 of the 20 airports, military operations generate about 14 to 30% of the total operations. At those 7 airports, there are 2 radar approach control towers, 4 manual approach control towers, and one VFR tower. At those same 7 airports, military local operations range from 10 to 22% of the total operations.

5.4 The above analysis indicates the wide range of different traffic characteristics at the 20 randomly selected airports. It also gives an indication of how the current ASR establishment criteria are being implemented. Only 2 of the 6 airports with radar approach control towers meet the current establishment criteria of 50,000 or more annual itinerant operations, of which 10,000 or more are scheduled air carrier operations. The 2 airports meeting these criteria have but 50,629 and 59,796 itinerant

TABLE 5.2 AIRPORT ACTIVITY - FY 1973

Airport (Ident.)	Total Opers.	Itin. Opers.	Air Carrier	Air Taxi	General Aviation			Military		
					Total	Itin.	Local	Total	Itin.	Local
Ft. Smith, Ark. (FSM)	89,525	52,977	13,377	1,389	48,928	29,478	19,450	25,831	8,733	17,098
Monterey, Ca. (MRY)	101,357	72,415	9,440	1,650	85,435	59,270	26,165	4,832	2,055	2,777
Palm Springs, Ca. (PSP)	93,273	71,681	11,171	2,642	77,724	56,882	20,842	1,736	986	750
Sacramento, Ca. (SMF)	124,311	66,733	35,322	4,886	65,062	22,547	42,515	19,041	3,978	15,063
Santa Barbara, Ca. (SBA)	181,860	106,114	6,154	7,160	166,963	91,573	75,390	1,583	1,227	356
Grand Junction, Co. (GJT)	56,045	39,497	9,230	3,280	43,069	26,589	16,480	466	398	68
New Haven, Conn. (TWD)	129,368	76,663	5,332	10,356	112,055	59,647	52,408	1.625	1,328	297
Wilmington, Del. (ILM)	164,324	84,111	6,351	5,686	124,647	62,514	62,133	27,640	9,560	18,080
Fort Meyers, Fa. (FMY)	93,054	66,974	5,168	7,133	80,223	54,377	25,846	530	296	234
Melbourne, Fa. (MLB)	176,276	75,652	8,996	177	165,995	65,746	100,249	1,108	733	375
Pensacola, Fa. (PNS)	117,414	59,796	11,315	1,288	83,017	39,876	43,141	21,794	7,317	14,477
Augusta, Ga. (AGS)	87,200	46,314	18,513	55	58,554	21,065	37,489	10,078	6,681	3,397
Champaign, Ill. (CMI)	226,659	78,133	10,704	2,443	211,897	63,633	148,264	1,615	1,353	262
Banquor, Me. (BGR)	90,138	53,033	9,473	5,820	50,978	26,536	24,442	23,867	11,204	12,663
Flint, Mi. (FNT)	149,897	74,824	9,336	3,087	136,933	62,097	74,836	541	304	237
Islip, N.Y. (ISP)	243,543	123,283	11,937	296	230,082	110,081	120,001	1,228	969	259
Youngstown, Oh. (YNG)	107,904	56,430	9,529	371	83,182	42,329	40,853	14,822	4,201	10,621
Erie, Pa. (ERI)	88,340	50,629	12,614	1,158	73,771	36,424	37,347	797	433	364
Middletown, Pa. (MDT)	103,691	50,872	14,326	12,678	48,058	17,297	30,761	28,629	6,571	22,058
Yakima, Wa. (YKM)	116,390	64,221	9,738	5,593	92,955	44,809	48,146	8,104	4,081	4,023

TABLE 5.2 AIRPORT ACTIVITY - FY 1973 (Continued)

Airport (Ident.)	Instrument Operations Total	A/C	A/T	G/A	Mil.	Instrument Approaches Total	A/C	A/T	G/A	Mil.	Peak Day	Busy Hour
Ft. Smith, Ark. (FSM)	20,685	7,461	695	7,302	5,227	2,034	996	54	677	307	594	82
Monterey, Ca. (MRY)	28,966	8,980	420	14,308	5,258	3,641	1,374	116	1,819	332	694	80
Palm Springs, Ca. (PSP)	12,367	8,420	57	3,561	329	65	32	1	32	-	572	92
Sacramento, Ca. (SMF)	64,398	35,931	1,730	19,207	7,530	5,298	2,476	344	1,648	830	768	133
Santa Barbara, Ca. (SBA)	20,603	5,153	2,041	13,010	399	3,171	577	394	2,146	54	1,186	122
Grand Junction, Co. (GJT)	7,949	5,354	104	1,874	117	762	486	72	199	5	275	71
New Haven, Conn. (TWD)	13,112	3,921	1,796	7,208	187	2,179	512	590	1,061	16	907	125
Wilmington, Del. (ILM)	32,280	6,481	2,087	18,810	4,902	3,571	703	377	2,088	403	590	110
Fort Meyers, Fa. (FMY)	20,229	6,248	2,433	10,558	990	343	103	65	168	7	438	70
Melbourne, Fa. (MLB)	19,383	8,991	22	9,846	524	642	232	1	384	25	1,126	128
Pensacola, Fa. (PNS)	121,587	12,703	1,354	15,123	92,407	2,470	899	152	970	449	751	151
Augusta, Ga. (AGS)	40,872	18,429	129	17,890	4,424	3,895	2,105	6	1,562	222	528	66
Champaign, Ill. (CMI)	28,983	10,167	1,401	16,436	979	3,774	1,470	256	1,924	124	1,931	196
Banquor, Me. (BGR)	28,579	9,486	3,635	7,949	7,509	4,047	1,412	702	1,280	653	794	111
Flint, Mi. (FNT)	30,518	7,684	2,110	20,312	412	3,881	1,216	368	2,282	15	844	135
Islip, N.Y. (ISP)	19,540	8,929	47	10,310	254	8,355	4,537	18	3,725	105	1,817	243
Youngstown, Oh. (YNG)	46,247	9,403	3,740	28,058	5,046	5,751	1,697	27	3,100	927	669	86
Erie, Pa. (ERI)	45,696	18,190	1,980	25,045	481	5,423	2,720	321	2,350	32	973	68
Middletown, Pa. (MDT)	26,536	13,161	4,719	5,859	2,797	6,993	2,682	1,655	1,954	702	586	59
Yakima, Wa. (YKM)	19,373	8,991	4,093	5,145	1,144	2,173	878	482	642	171	975	110

FIGURE 5.1

AIRPORT ACTIVITY FY 1973

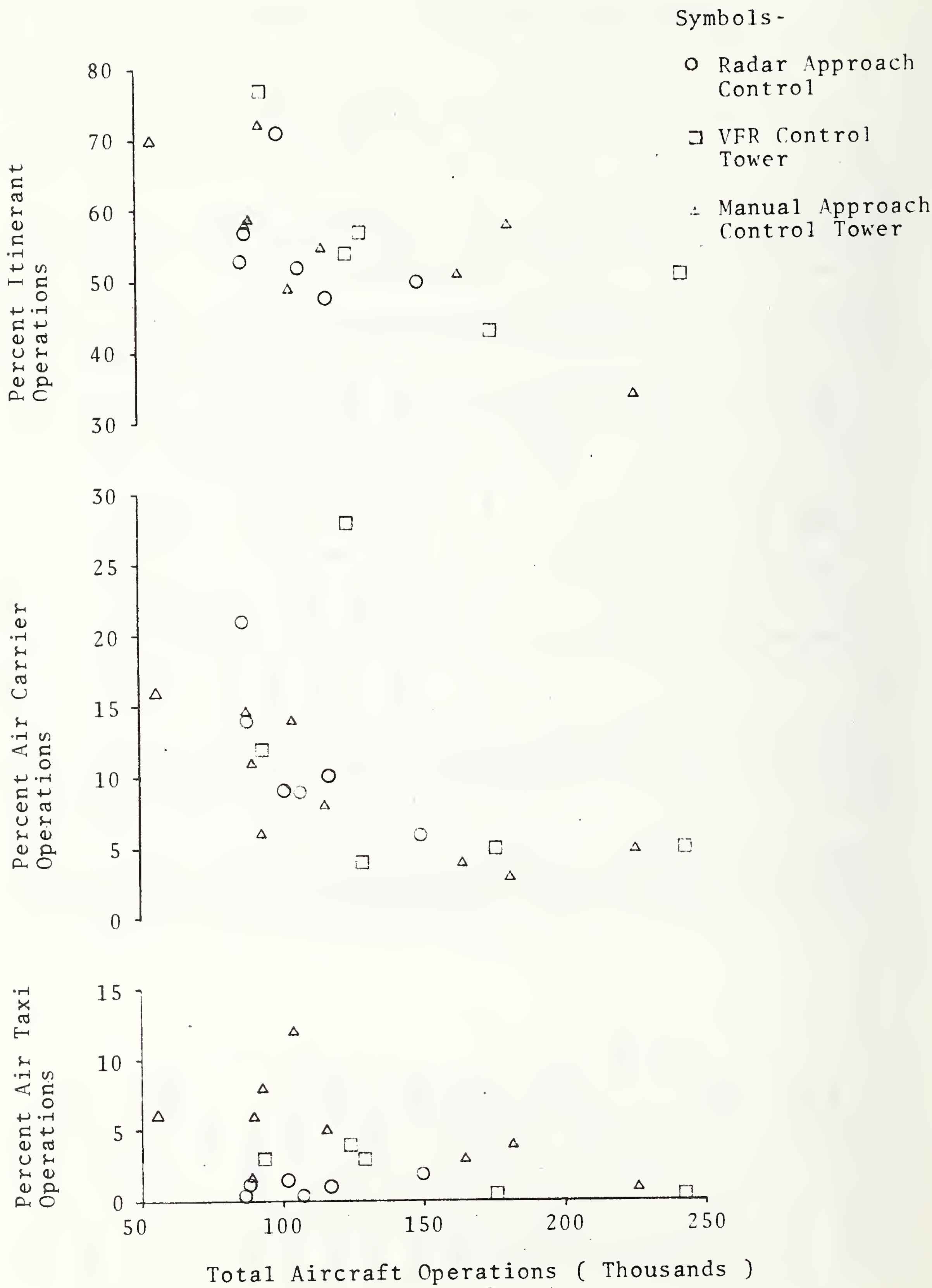


FIGURE 5.2

AIRPORT ACTIVITY FY 1973

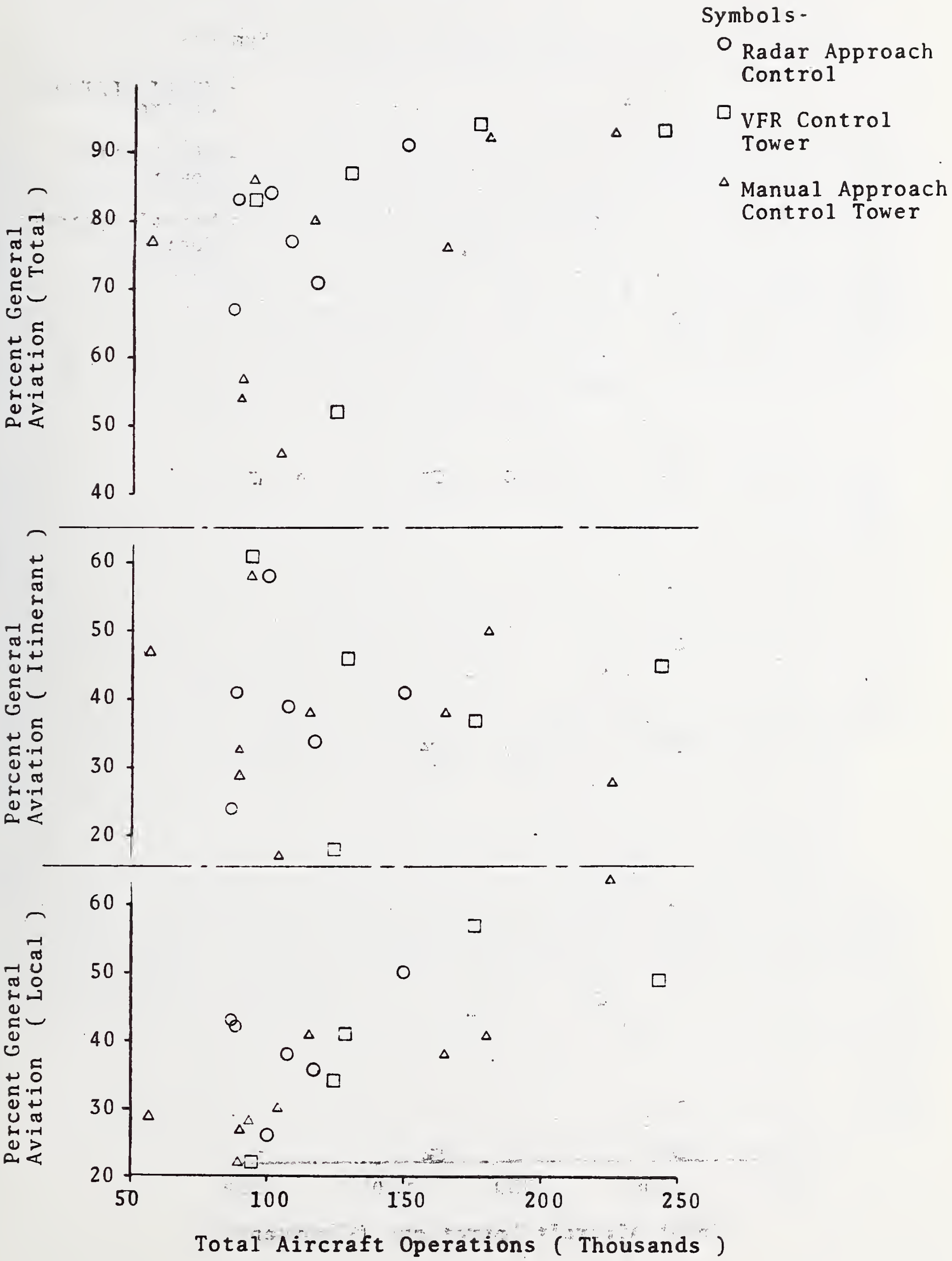
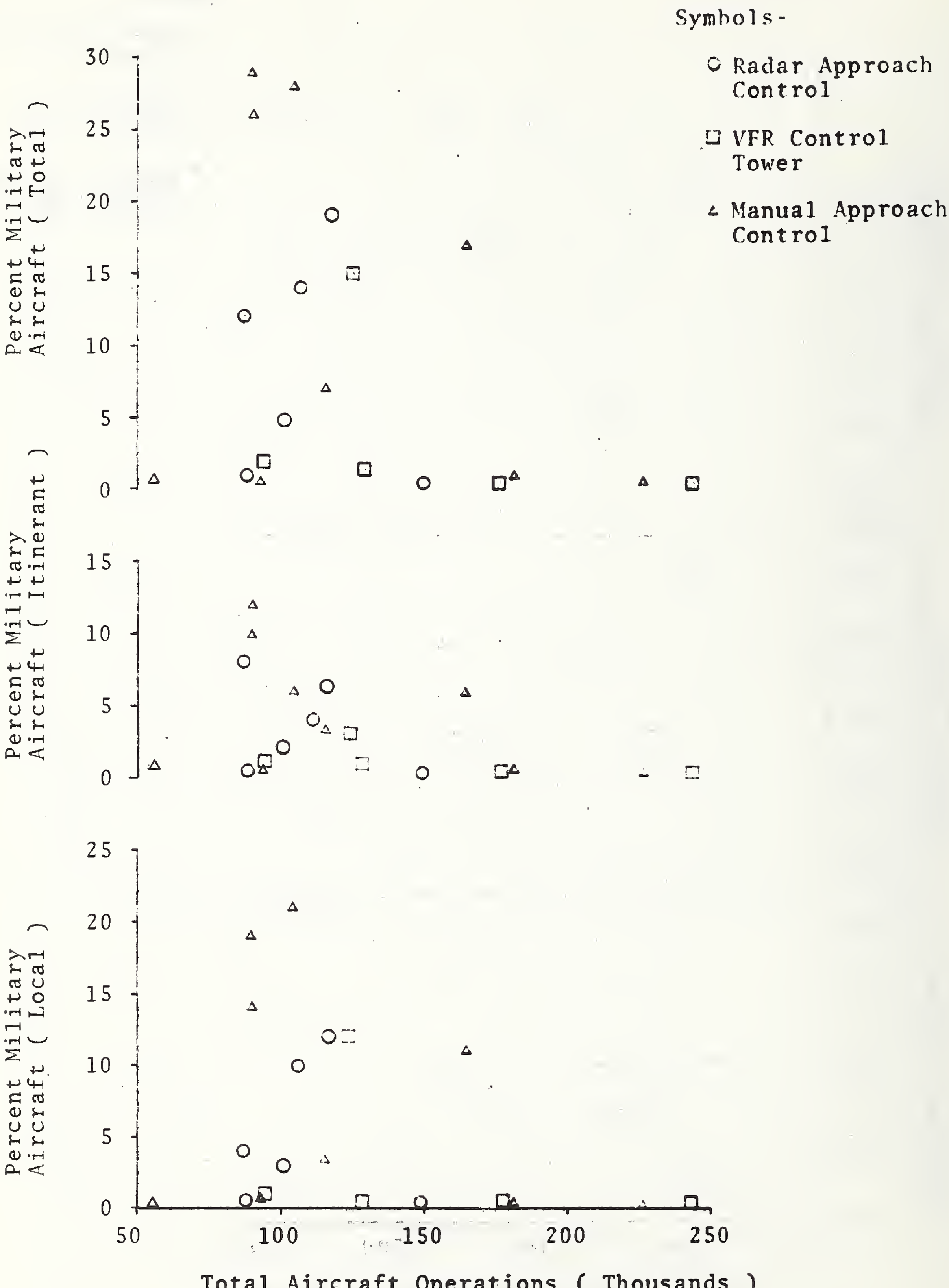


FIGURE 5.3

AIRPORT ACTIVITY FY 1973



operations with 12,614 and 11,315 scheduled air carrier operations respectively. Six of the 14 airports without radar control towers meet the present ASR establishment criteria. Three of these 6 airports have manual approach control and the remaining 3 have VFR control towers. The annual itinerant operations for the airports without ASR range from 50,872 to over 123,000. The annual air carrier operations for these airports range from 5,168 to over 35,000.

5.4.1 Also of interest, is the distribution in the total annual instrument operations which also reflect the need for ASR. The instrument operations for 5 of the 6 airports with radar approach towers range from 28,966 to 46,247 while the instrument operations for the remaining 14 airports without ASR vary from 7,949 to over 64,000. Another contrast of direct interest to ASR is found in the instrument approaches which range from 3641 to 5751 for the airports with ASR and from 65 to over 8,000 for the airports without ASR. Moreover, when the air taxi operations are added to the air carrier operations, the implementation and deficiencies of the present ASR establishment criteria become more apparent. The sums of these two categories of operations range from 9,900 to over 18,500 for the 6 airports with ASR and from 9,175 to over 40,000 for the remaining 14 airports without ASR.

5.5 Additional data, not available from currently reported FAA activity statistics, were required to pursue the establishment criteria concept being investigated in this report. A survey form was designed to obtain estimates of the current activities under typical hourly conditions at an airport. The main objectives of the survey were; first, to obtain data concerning those operating conditions of an airport directly related to the primary function of an ASR; and, second, to determine the characteristics of heavy and normal activity patterns not reflected by the reported "busy hour", "peak day", "average hour", data. In the interest of time, a limited survey was made at 10 of the 20 airports previously listed.

The survey form which was designed and used in obtaining estimates from the ten tower chiefs is shown in Figure 5.4. Table 5.3 lists these airports with a summary of the relevant data regarding the primary function of the ASR. The forms were completed by telephone conversations with those tower chiefs having the data readily available. The balance of the forms were forwarded by mail.

The factor of 75% of the operations during the "Most Active Hour of a Week" was used to obtain an approximation of the number of operations during the busy IFR hour. The tower chiefs submitted their estimate of the total number of times that the busy hour occurred during the year. Copies of the completed forms from the 10 airports are included in Appendix B. Because of the hasty manner in which the survey was conducted and the possibility of misunderstandings by the tower chiefs involved, a more comprehensive effort to verify these data is suggested.

FIGURE 5.4

Survey Form Sample

Airport: ____________________

Location: ____________________

Category of Operation	Number of Operations During the Most Active Hour of a Week[1]		Number of Operations on A Normal Traffic Activity Day[2]	
	Under VFR Conditions	Under IFR Conditions	Under VFR Conditions	Under IFR Conditions
Itinerant				
Local				
Total	(A)			
Instrument		(B)		

[1]Please estimate the respective number of operations per hour during heavy traffic activity day(s) under VFR and IFR weather conditions. The estimates should reflect typical heavy traffic activity and not necessarily the "busy hour" or "peak day" of the year.

[2]Please estimate the respective number of daily operations during a normal traffic activity day under VFR and IFR weather conditions. The estimates should reflect a normal or average activity day and not the heavy or light activity days.

Estimate the number of hours per year, the total operations shown in blocks A and B above, equal or exceed 75% of the counts noted:

75% of A _____.

Hours per year total operations equal or exceed this value under VFR conditions: _____hours

75% of B _____.

Hours per year total operations equal or exceed this value under IFR conditions: _____hours

Please give a brief description of the pattern of heavy traffic (hours of day, days of week, months of year, etc.) if a pattern can be determined.

Estimate of number of days per year total operations equal or exceeds (see note)

_______days.

Additional comments;

Note: The number inserted in this space represents 75% of the "Peak Day" traffic reported for FY 1973.

Table 5.3

IFR Operations
(Results of Survey Conducted June, 1974)

Airport Name Location	No. of Operations Most Active Hour of Week IFR Conditions[1/]	No. of Times Per Year the Busy IFR[2/] Hour Occurs	Type of Facility[3/]
Monterey Peninsula (MRY) Monterey, Ca.	21	1196	RAC
Palm Springs Municipal Palm Springs, Ca.	14	600	VFR
Grand Junction-Walker Field (GJT) Grand Junction, Co.	5	560	MAC
Tweed-New Haven (TWD) New Haven, Conn.	15	9	VFR
Pensacola Regional-Hagler (PNS) Pensacola, Fa.	45	104	RAC
Bangor Int'l. (BGR) Bangor, Me.	30	25	MAC
Flint-Bishop (FNT) Flint, Mich.	60	900	RAC
Youngstown Municipal (YNG) Youngstown, Ohio	29	52	RAC
Harrisburg Int'l. (MDT) Middletown, Pa.	13	416	MAC
Yakima Municipal (YKM) Yakima, Wa.	12	108	MAC

[1/] See survey form - Figure 5.4

[2/] The busy IFR Hour is defined as an hour at a specific airport in which the total IFR instrument operations equals or exceeds 75% of the most active IFR hour of a week.

[3/] MAC - Manual Approach Control
RAC - Radar Approach Control
VFR - VFR Tower

5.5.1 An analysis of the data obtained in the survey indicates a wide range in the relevant parameters of the need for an ASR at the 10 airports. The number of operations during the most active hour of the week, under IFR conditions, vary from a low of 5 at GJT to a high of 60 at FNT. The number of times per year that the busy IFR hour occurs ranges from a low of 9 at TWD to a high of 1196 at MRY. However, in the proposed establishment criteria concept, neither of these two parameters by themselves are significant, but the proper combination of the two determine the candidacy of a location for ASR.

5.6 The DELCAP simulation model[1/] was used to obtain estimates of delay with and without ASR available. Since the primary benefit from ASR is obtained under IFR conditions, IFR separation rules are used. It was assumed that ASR would permit minimum spacing (in this case 3 miles[2/] since heavy aircraft would not use this category of airports) to be maintained at high levels of traffic, while without ASR various manual procedures would result in average spacings of 7.5, 10, and 15 miles at the same traffic levels. It was further assumed that the airports in question would be operating as a single runway configuration when IFR conditions prevailed.

Two aircraft types, whose pertinent flight characteristics are given below, are used in the simulation runs.

Aircraft Description

	SPEEDS (KNOTS)		RUNWAY OCCUPANCY (SECONDS)	
TYPE	LANDING	LIFTOFF	LANDING	TAKEOFF
G/A	90	90	35	25
A/C	125	120	34	32

Four ratios of these two aircraft types were run; 10% G/A - 90% A/C, 20% G/A - 80% A/C, 40% G/A - 60% A/C, and 80% G/A - 20% A/C. Five traffic activity levels were simulated; 10,15,20,25, and 30 operations per hour. The distribution of the number of arriving aircraft is assumed to be Poisson. In each case, it is assumed that half of the operations are landings and half are takeoffs.

[1/] Judith Gilsinn, E.H. Short, W.A. Steele, and D. Klavan, A Simulation Model for Estimating Airport Terminal Area Throughputs and Delays, National Bureau of Standards Report Number 10592, Washington, D.C. 20234, May 1971.

[2/] Nautical miles in this report are expressed as miles.

Delay is calculated for each aircraft, takeoff and landing, as the difference of the flight time actually required from that which would have occurred had no other aircraft been present. The calculations of the delays in landings plus the dalays in takeoffs are shown in Table 5.4. The values listed in Table 5.4 are the average of the results obtained from twenty simulation runs utilizing different strings of random numbers for generating the arrivals. Figures 5.5, 5.6, 5.7, and 5.8 are plots of the total delay per hour of operations of aircraft landing and taking off for each of the four mixes of aircraft for airports operating in four different approach environments; i.e., 3, 7.5, 10, and 15 mile separation of aircraft. Figures 6.2, 6.3, and 6.4, which are used in the application of the criteria described in the next section of this report, are plots of the differences, or time saved per hour by operating in an ASR environment using a three mile separation from the time required using 7.5, 10 and 15 mile separations. Plots of the time saved for the four mixes of aircraft are shown for each of the three separation distances.

The plots shown in Figures 5.5, 5.6, 5.7, and 5.8, and Figures 6.2, 6.3, and 6.4 terminate at the "ultimate capacity" values shown in Table 5.4. These capacity values were calculated as twice the landing capacity with no takeoffs present. The term "ultimate" is used to infer that the actual capacity is likely to be somewhat less.

The ultimate capacities listed in Table 5.4 were calculated as shown in the following example. At the 10 mile separation, the average time between the touch down of one aircraft and the touch down of a following G/A aircraft is;

$$\frac{10 \text{ miles}}{90 \text{ knots}} = 0.11 \text{ hours},$$

and, the average time between the touch down of one aircraft and the touch down of a following A/C aircraft is;

$$\frac{10 \text{ miles}}{125 \text{ knots}} = 0.08 \text{ hours}.$$

At the 20% G/A traffic mix, the probability of the landing aircraft being G/A is 0.20, and the probability of the landing aircraft being A/C is 0.80.

Total Minutes of Aircraft Delay Per Hour of Operation

Operations per Hour	10% G/A	20% G/A	40% G/A	80% G/A
		3 Mile Separation		
10	8.7	10.6	11.6	18.8
15	15.7	22.3	31.6	34.1
20	32.5	41.5	52.7	54.4
25	56.7	68.1	86.2	79.0
30	83.8	95.1	111.8	102.8
		7.5 Mile Separation		
10	14.7	16.9	21.2	29.9
15	30.0	39.8	49.1	68.2
20	81.5	106.3	185.3	194.8
25	283.6	472.2	1061.2	1,701
30	744.0	1,549	2,620	O/C
Ultimate Capacity (opers./hr.)	(32)	(31)	(30)	(26)
		10 Mile Separation		
10	21.9	28.1	33.5	43.2
15	48.6	51.5	82.6	119.9
20	299.1	444.4	889.4	O/C
Ultimate Capacity (opers./hr.)	(24)	(23)	(22)	(19)
		15 Mile Separation		
10	57.0	65.3	79.4	129.5
15	153.8	171.1	O/C	O/C
Ultimate Capacity (opers./hr.)	(16)	(15)	(14)	(12)

O/C = over capacity

Table 5.4

FIGURE 5.5

Delay @ 10% G/A - 90% A/C Mix

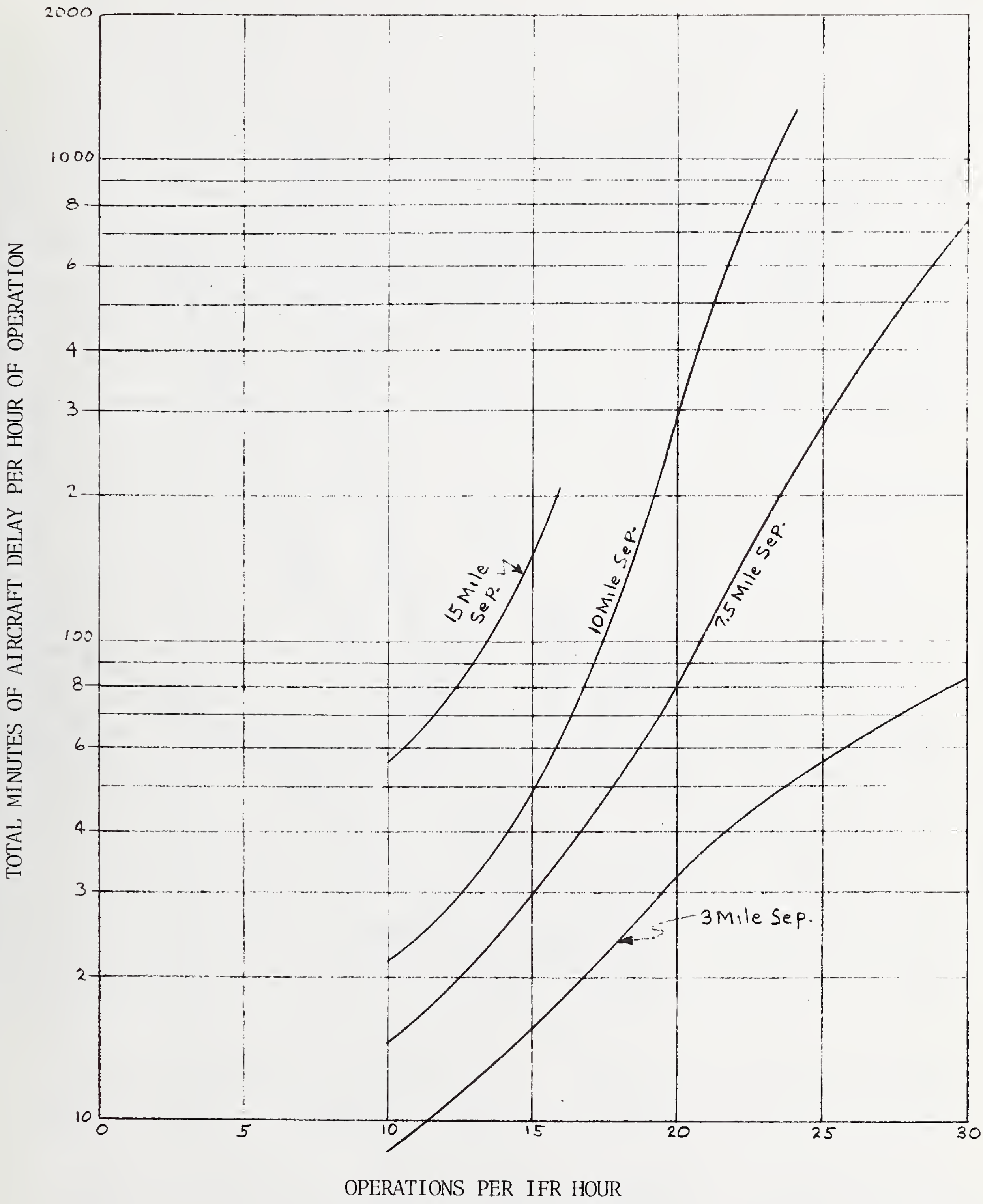


FIGURE 5.6

Delay @ 20% G/A - 80% A/C Mix

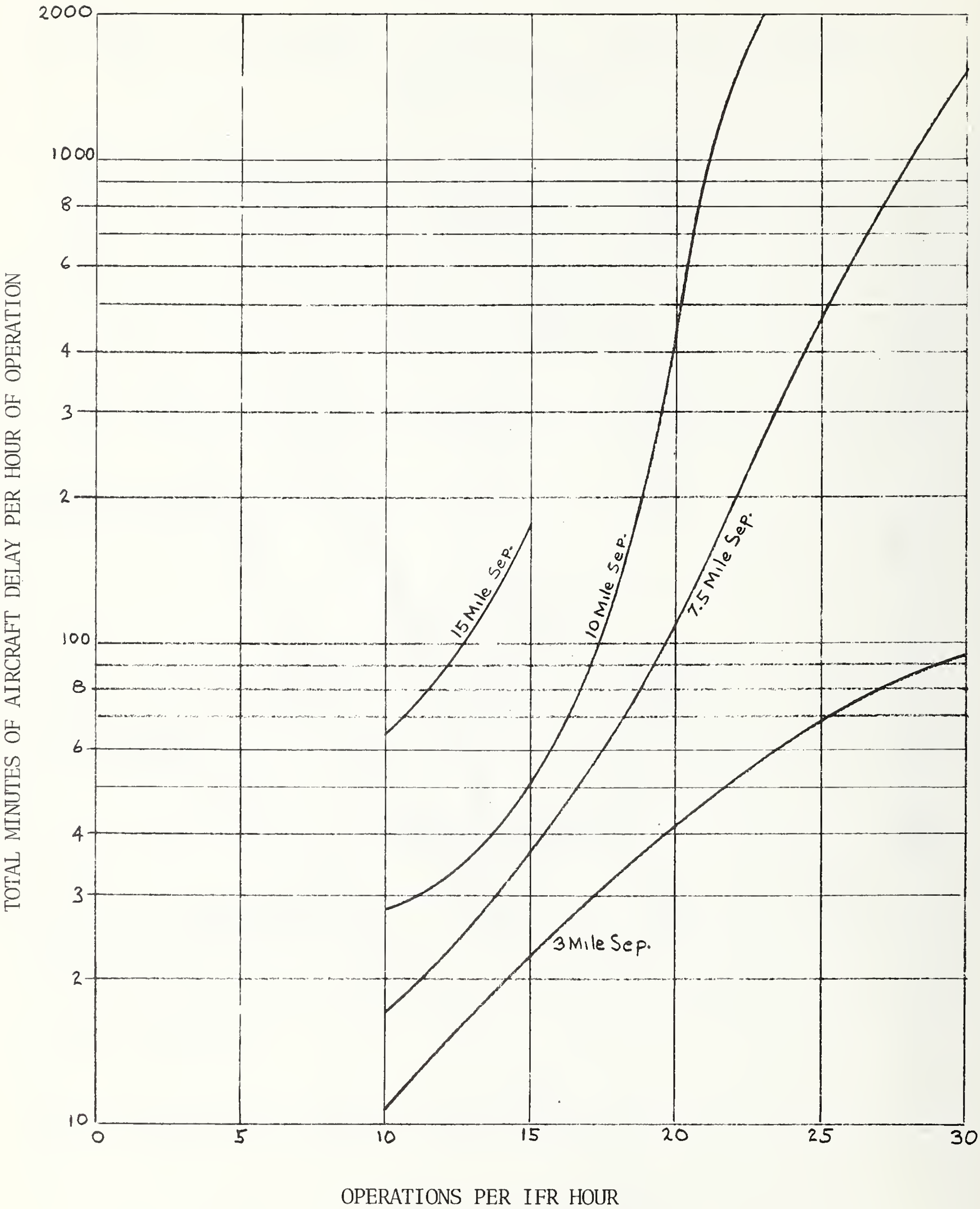


FIGURE 5.7

Delay @ 40% G/A - 60% A/C Mix

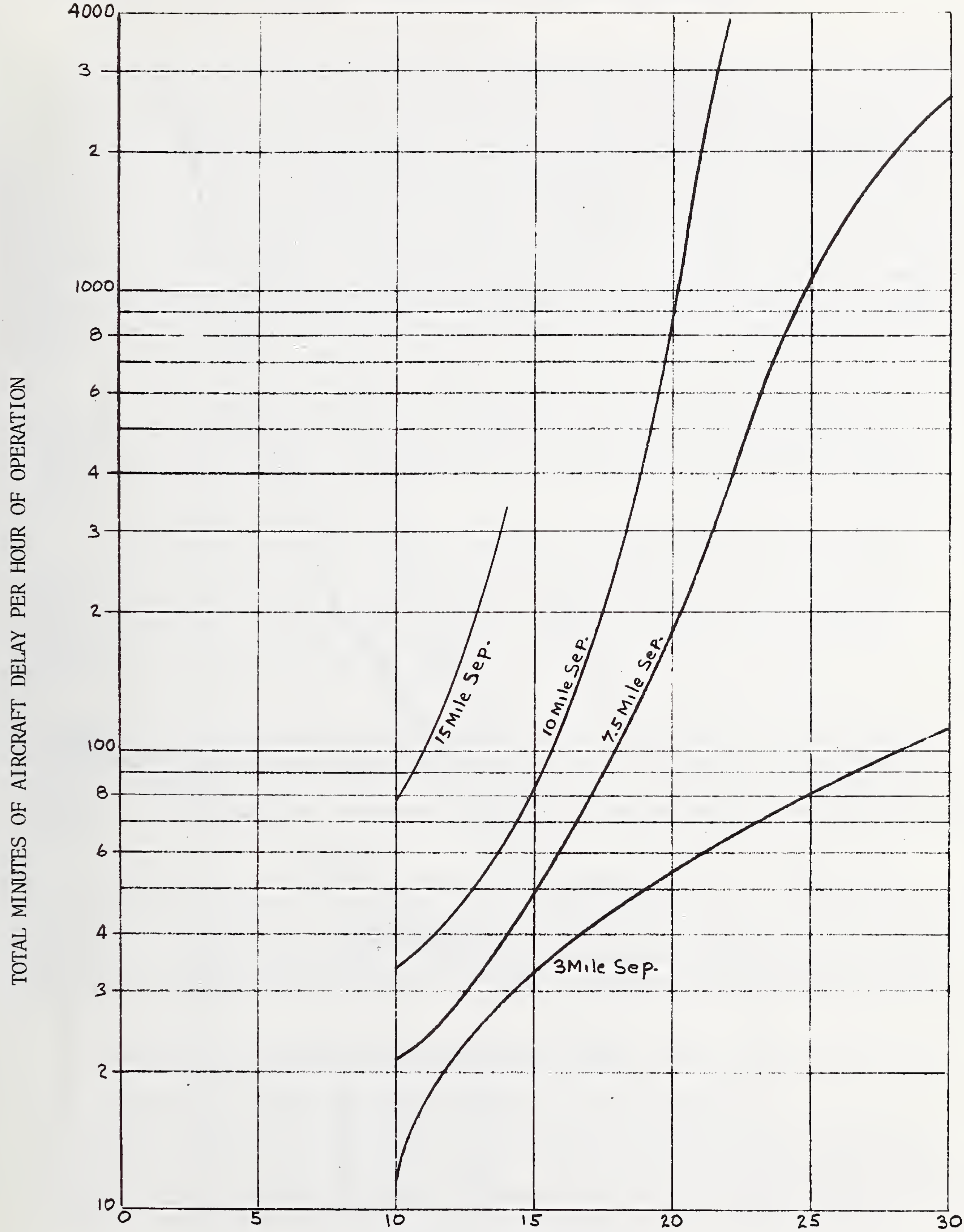
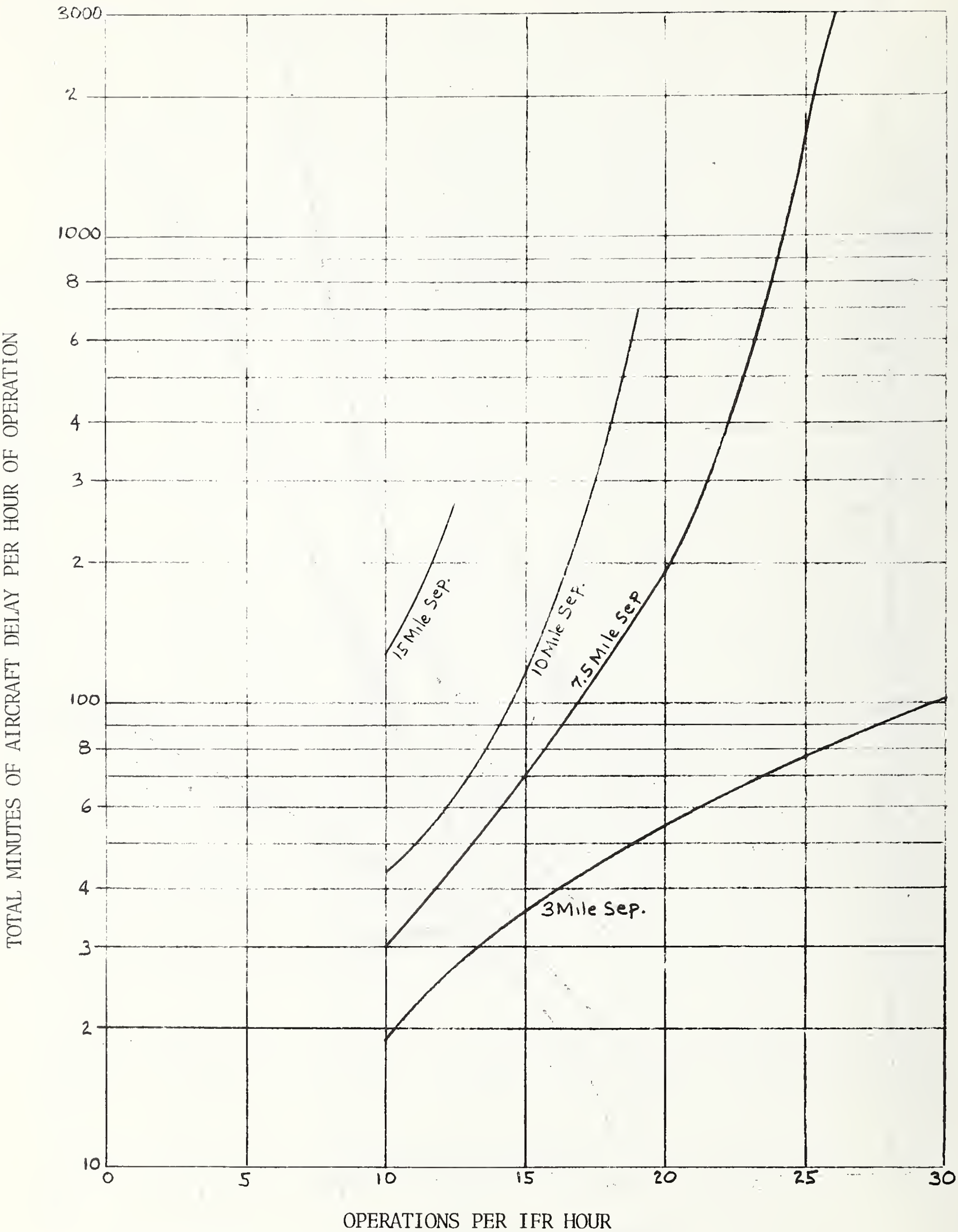


FIGURE 5.8

Delay @ 80% G/A - 20% A/C Mix



Therefore, the average time required per landing aircraft is;

$$.11 \times .20 + .08 \times .80 = .086 \text{ hours},$$

which yields an average rate of 11.6 landing aircraft per hour with no takeoffs. In this example, i.e., 10 miles separation, the separation between landing aircraft is great enough to permit takeoffs without affecting the sequence of landings. Therefore, since half of the operations would be landings and half takeoffs, the total potential operations per hour is 23 under the conditions stated. Since these conditions can be considered as "ideal" relative to the actual conditions under which an airport is forced to operate, the capacities computed in this manner are considered "ultimate". A slower aircraft landing ahead a faster aircraft will generate a delay. This factor becomes evident when the plots of the total delay for a 40% G/A mix are compared with higher and lower percentages of G/A aircraft. The most critical condition would appear in a 50% G/A mix.

In general, at the lower levels of operations per hour, the delay for takeoffs is greater than that for landings since the landing aircraft always have priority. However, as the ultimate capacities are approached, the simulation model permits landing delays to exceed delays in takeoff to avoid an excessive departure queue.

Additional simulation runs were made at the three mile and 7.5 mile separations increasing the runway occupancy for landing A/C aircraft from 34 seconds to 60 seconds. No significant differences in the total delays were apparent for this increase. However, the data suggest that runway occupancy periods of over 60 seconds can become critical when computing delays for a 3 mile separation distance.

During the survey, one of the ten tower chiefs reported that the ILS runway had but one taxiway turn-off which was at the center of the runway. A condition such as this would increase the runway occupancy time of A/C and G/A aircraft in both takeoff and landing. It is therefore suggested that delays be determined by using longer runway occupancy periods in the simulation model.

Several of the tower chiefs with ASR commented on the substantial utilization of their facilities for instrument approaches to satellite airports. A review of the FAA air traffic activity publications suggests the need for further investigation of a means for computing delays at primary and secondary airports. The existing DELCAP model may be capable of doing this with minor modification.

6.0 Statement of Criteria and Sample Application

6.1 Statement of Suggested Establishment Criteria for ASR:

The primary purpose for converting an FAA manual approach control facility to a radar approach control facility is to expedite the flow of arrival and departure aircraft under IFR conditions. An FAA manual approach control facility is a candidate for ASR/ATCRBS/BDS when the number of operations during the busy IFR hour, and the number of busy IFR hours during the year are such that:

the cost of the aircraft delay estimated to be saved by the addition of the ASR; plus

the value of the time of the passengers in the above aircraft; plus

the value of other benefits provided by the ASR

is equal to or exceeds the annual operating cost of the ASR. Aircraft using satellite airports under the jurisdiction of the ASR may be included in the busy IFR hour count. A busy IFR hour is defined as an hour in which the total number of operations is equal to or exceeds 75% of the most active hour of the week under IFR conditions. (An example of this condition is when the number of operations during the busy IFR hours is 17, of which 80% or more are air carrier or heavy military operations, and the busy IFR hour occurs 100 or more times per year.)

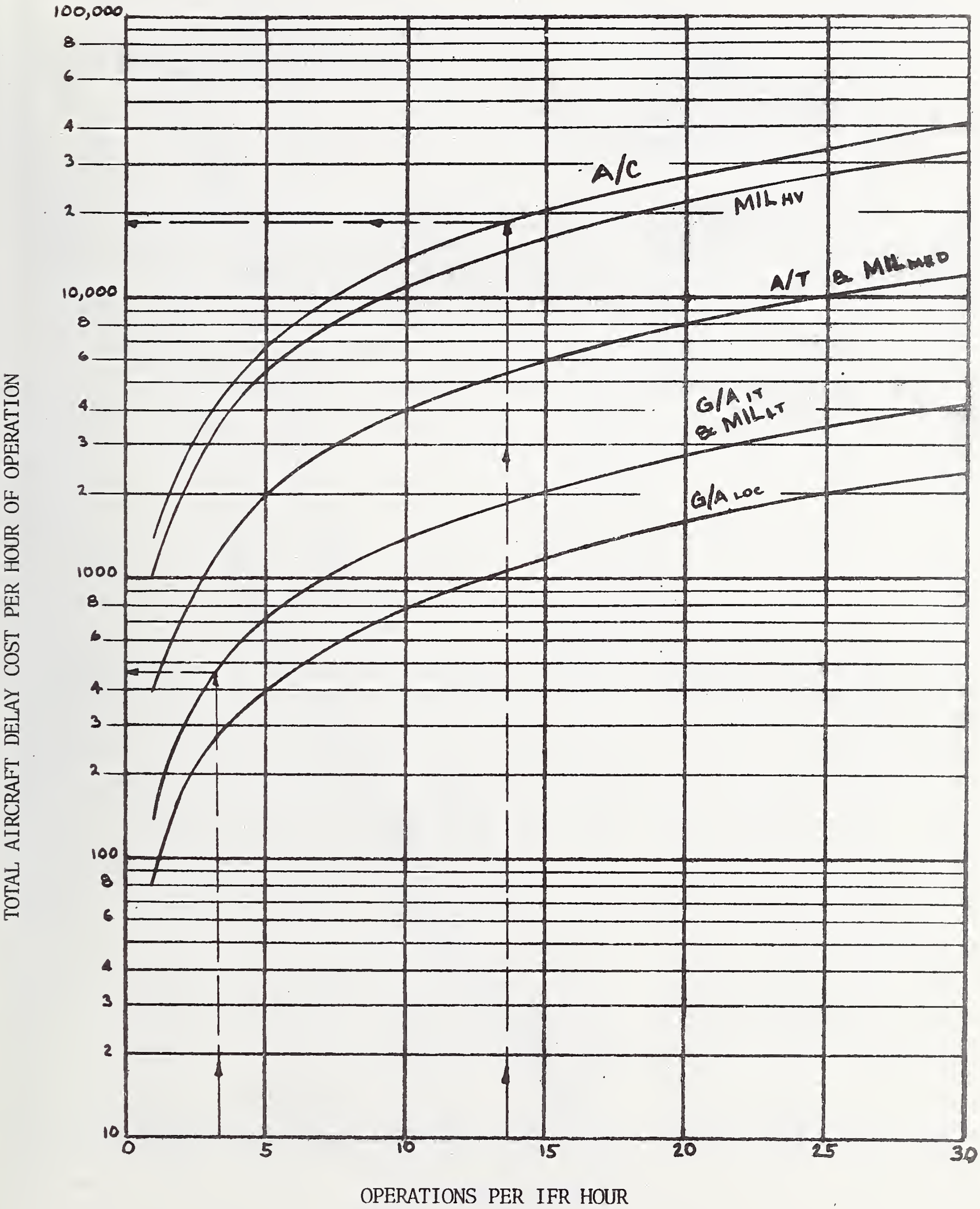
6.2 Sample Application

Assume that an FAA manual approach control facility, operating with a 7.5 miles separation distance, has 17 operations/hour during a busy IFR hour, and that 20% or about 3.4 of the 17 operations are itinerant general aviation and the remaining 13.6 operations are air carrier. The busy IFR hour occurs 100 times a year. To determine whether the location is a candidate for ASR the following procedure is used: Figure 6.1 is used to estimate the delay cost/hour for the specified traffic mix. (The curves in this figure are based on generally accepted FAA factors for aircraft operating costs, passenger load factors, and value of passengers' time as shown in Table 5.1). The air carrier curve is entered at 13.6 operations/hour and the itinerant general aviation curve at 3.4 operations/hour. From the curves, the delay cost/hour for the air carrier operations is $18,500 and the cost/hour for the general aviation operations is $460 for a total cost of $18,960/hour for that mix of traffic. In order to obtain the expected cost of each plane in the mix, divide the total cost by the number of operations during the busy IFR hour, which yields $1115/hour for each operation in this example.

Next, since the separation is 7.5 miles, Figure 6.2 is used to estimate the time saved/hour of operation, if the location had an ASR. The curves in Figures 6.2, 6.3 and 6.4 were derived from the delay estimates discussed in paragraph 5.6. Entering the curve at 17 operations/hour for a mix of 20% general aviation, the total aircraft delay saved is 0.48 hours/hour of operation. To determine the dollar savings/hour of operation, the $1115 is multiplied by 0.48, which is $532/hour. The $532 is next entered into the curve in Figure 6.5 and extended out to 100, the number of busy IFR hours/year. In this particular example, the intersection falls to the left of the curve. The curve in Figure 6.5 is a plot of the ASR benefit/cost ratio equal to one. It is predicated on the theory that since the ASR serves primarily an IFR function, its annual operating cost should be ammortized during the period that it is being used under IFR conditions. A manual approach control facility becomes a candidate location for ASR when the intersection of the Delay Cost/Hour of Operation and the Number of Busy IFR Hrs/Yr. falls on or to the right of the curve. If it falls on the curve, the benefit/cost ratio is one; if it falls to the right of the curve, as in the example, the benefit/cost ratio is greater than one, its value increasing as the intersection moves farther to the right of the curve.

FIGURE 6.1

Total Aircraft Delay Cost By
Category of Aircraft



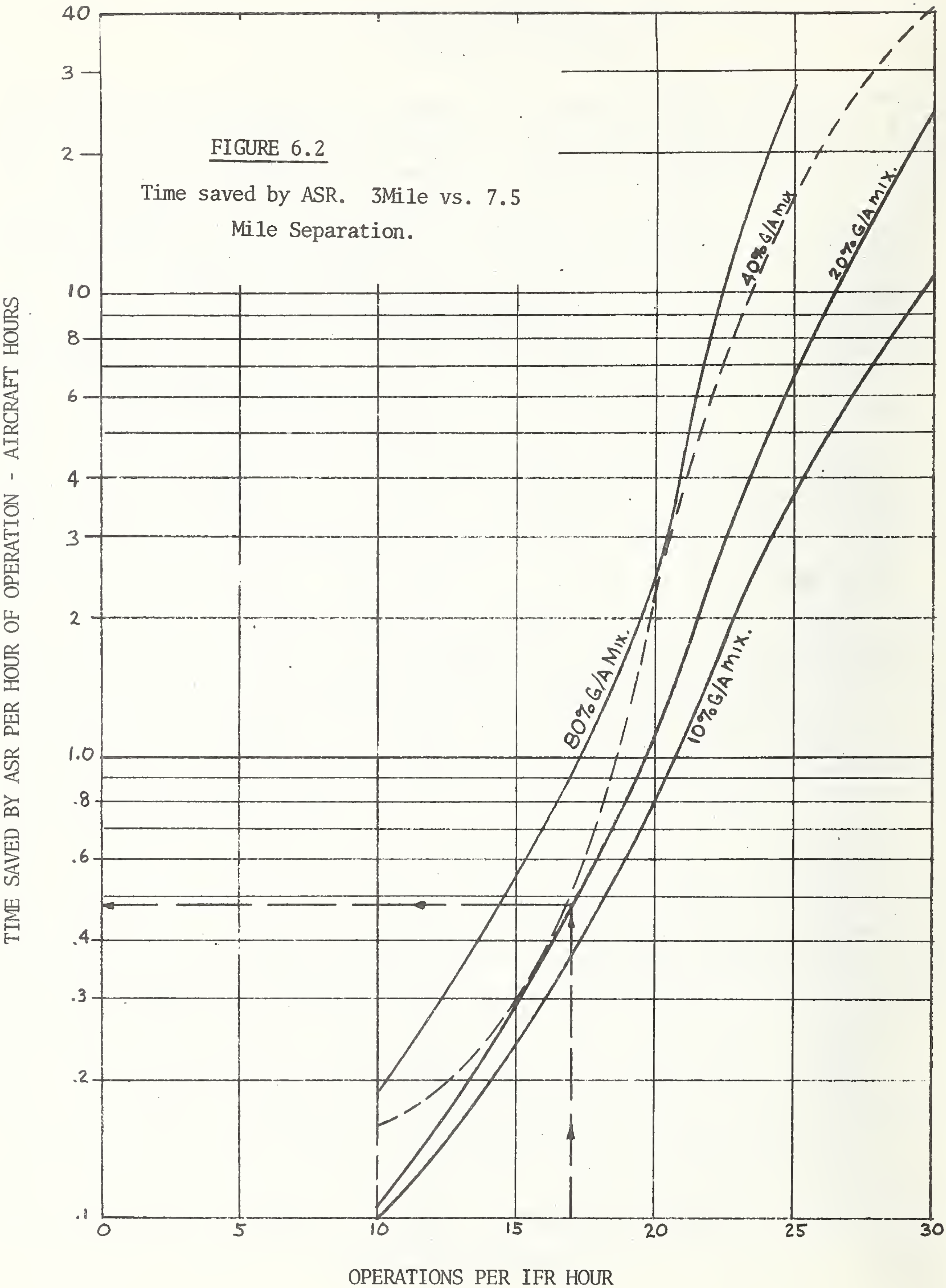


FIGURE 6.2

Time saved by ASR. 3Mile vs. 7.5 Mile Separation.

FIGURE 6.3

Time Saved By ASR. 3 Mile vs. 10 Mile Separation

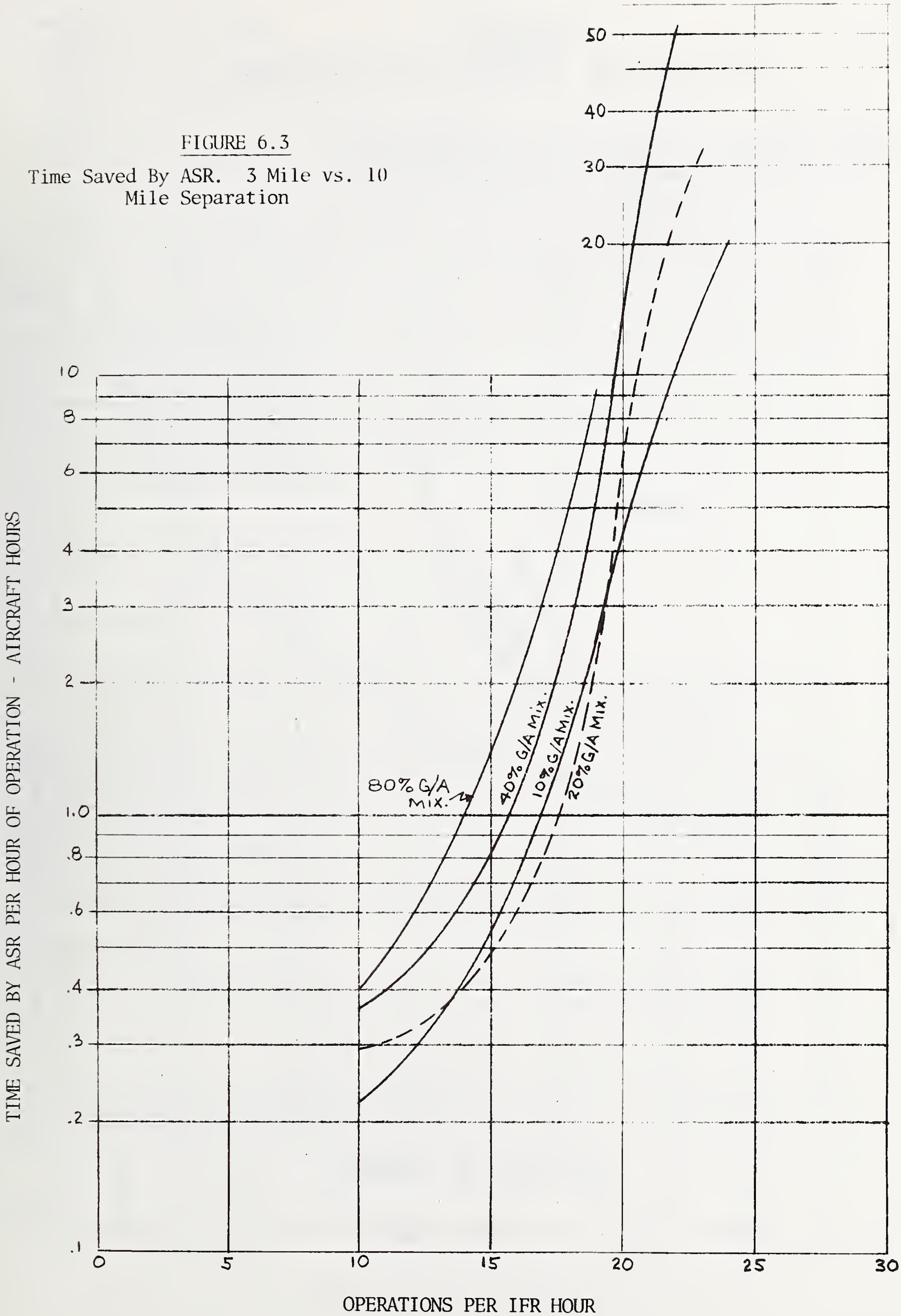


FIGURE 6.4

Time Saved By ASR. 3 Mile vs. 15 Mile Separation

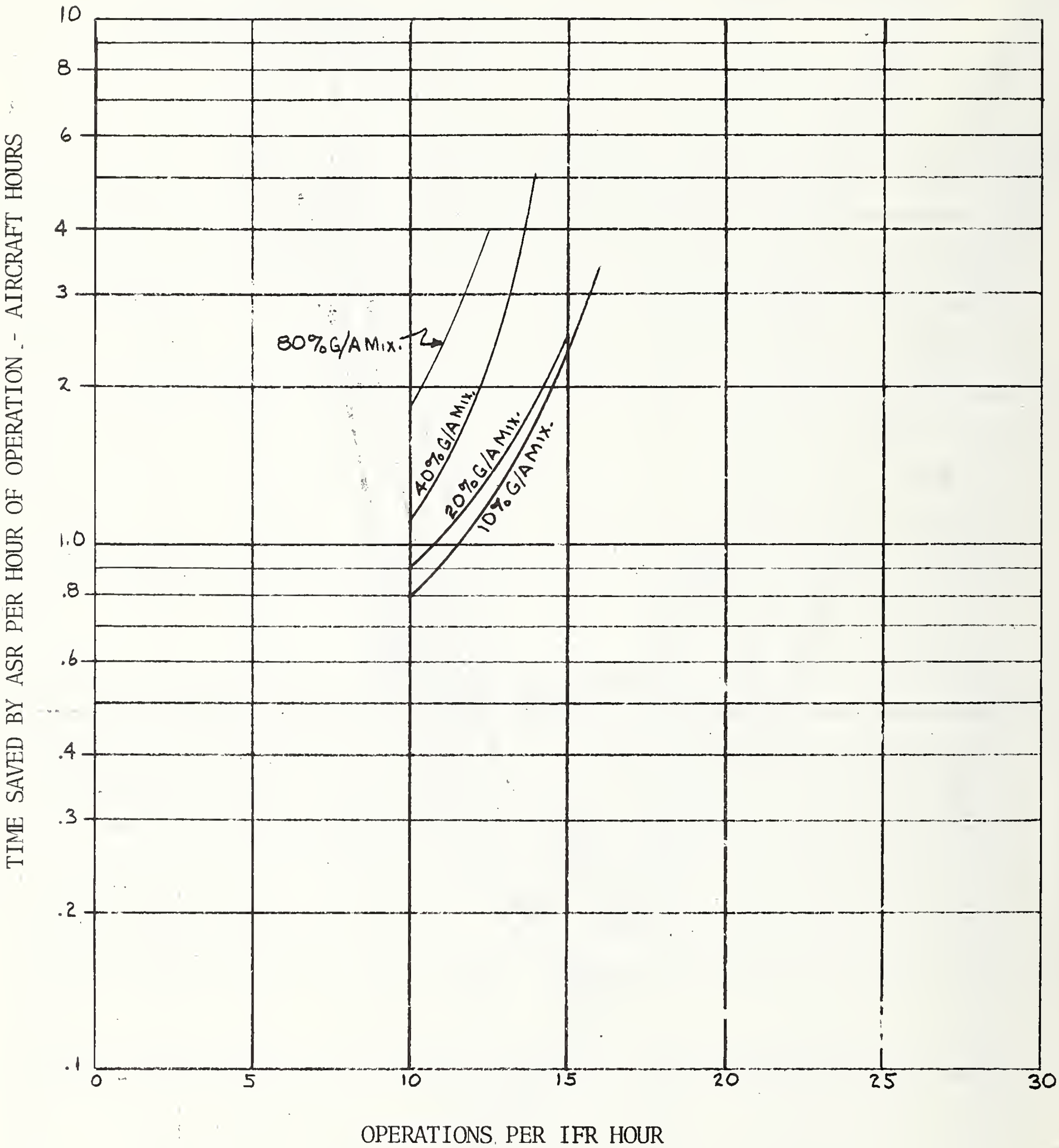
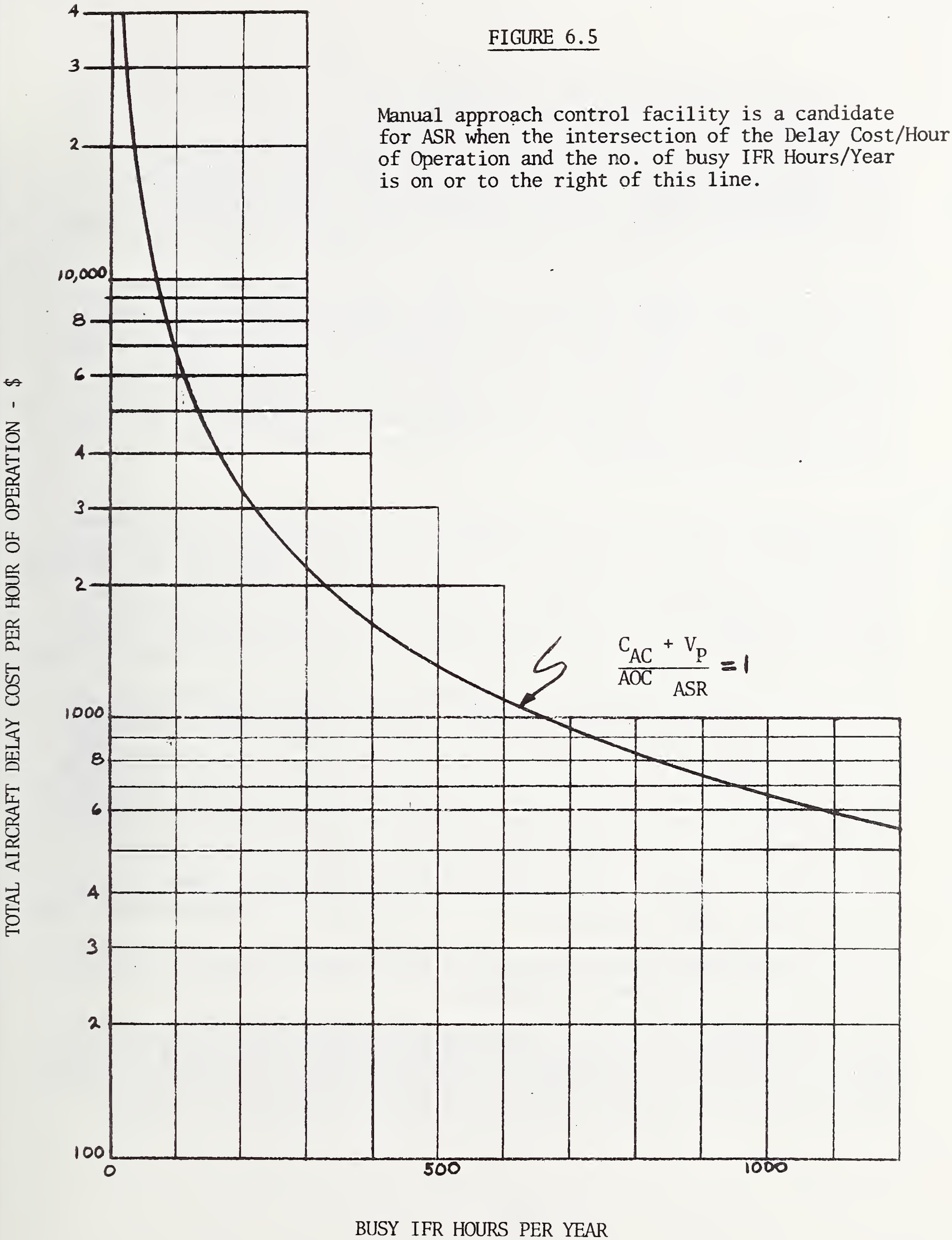


FIGURE 6.5


Manual approach control facility is a candidate for ASR when the intersection of the Delay Cost/Hour of Operation and the no. of busy IFR Hours/Year is on or to the right of this line.
$\frac{C_{AC}}{AOC} + \frac{V_P}{ASR} = 1$
TOTAL AIRCRAFT DELAY COST PER HOUR OF OPERATION - $
BUSY IFR HOURS PER YEAR
4
3
2
10,000
8
6
4
3
2
1000
8
6
4
3
2
100
0
500
1000

7.0 Comments on Proposed Establishment Criteria

7.1 The time and resources allocated for this study did not permit a sufficiently comprehensive analysis of all of the aspects of the proposed new establishment criteria for ASR. Although the limited analysis that was accomplished is felt to demonstrate that the proposed concept has promise, there are areas which should be studied in more detail. Some of these are:

7.1.1 While it would be desirable to limit the proposed establishment criteria to the primary function of the ASR, some credit must be assigned to additional functions of the ASR in order that the establishment criteria not be too rigid. The purpose of establishment criteria is to provide FAA management with a tool by which the establishment of new FAA facilities and services may be controlled or adjusted to be in consonance with such constraints as the FAA budget, user requirements and safety considerations. Thus the degree of rigidity of new establishment criteria should be determined by FAA management.

7.1.2 The principle basis for the justification of an ASR in the proposed establishment criteria is limited to values of the differences in delay which would occur in a radar versus non-radar environments. Good delay data has been historically difficult to obtain. For the purposes of this analysis, the delay data generated by the DELCAP (discussed in Paragraph 5.6) simulation model developed by NBS for the FAA were used. The delay generated by this model is considered to be reasonably representative of the real world situation.

7.1.3 The air traffic activity data required to implement the proposed concept are available, although not published, from flight strip information gathered by the candidate locations. The DELCAP simulation can quickly and reasonably generate the required estimates of delay that would be eliminated by the ASR. FAA determined factors for aircraft operating costs, passenger or occupant load factors, and value of passengers' time are used in this analysis. The passenger or occupant load factor data are the most subjective of these factors and actual data would be preferable but are difficult to obtain. The factor of 75% used to determine the busy IFR hour and the number of IFR hours per year should be validated by collecting and analyzing appropriate data from a larger sample of airports.

7.1.4 Decommissioning and improvement criteria compatible with the proposed establishment criteria must be developed.

7.2 Considerable work has been conducted on the development of benefit/cost type of establishment criteria for FAA facilities and services during the past four or five years. The desirability of this approach in a world of rapidly escalating costs and tighter budgets is universally recognized. Previous efforts have been confronted by problems of developing benefit/cost type criteria which can be simply explained, readily applied, and easily understood by all concerned. In addition, some of these criteria consider numerous ancillary benefits, based largely on subjective data, that the primary operational requirement for which a facility or service is established becomes almost totally submerged in irrelevant considerations. It is felt that the proposed establishment criteria for ASR contained in this study avoids these problems.

APPENDIX A

ESTIMATED ANNUAL OPERATING COST

ASR/ATCRBS/BDS

ANNUAL AMORTIZATION OF INVESTMENT

ESTABLISHMENT COST	$2,000,000	
ANNUAL AMORTIZATION (15 Yrs)	133,333	
ANNUAL INTEREST (10% Simple)	100,000	
ANNUAL AMORTIZATION & INTEREST		$233,000

ANNUAL MAINTENANCE

	Man Years	
ASR	2.48	
ATCRBS	1.14	
BDS	0.19	
CONTROL END EQUIP.	1.44	
TOTAL ANNUAL MANPOWER	5.25 @ $20975	$110,120

OTHER COSTS (UTILITIES, ETC.)

ASR	$6,749	
ATCRBS	2,172	
BDS	723	
CONTROL END EQUIP.	5,221	
TOTAL OTHER COSTS		$14,685

STOCKS & STORES

ASR	$9,600	
ATCRBS	1,400	
BDS	2,700	
TOTAL STOCKS & STORES		$13,700

STAFFING

15 ADDITIONAL CONTROLLERS @ $19,250	$288,750
ANNUAL FLIGHT CHECK	2,000
TOTAL ANNUAL OPERATING COST	$662,583

SOURCES:

ESTABLISHMENT AND MAINTENANCE COSTS - AFS

STOCKS & STORES COSTS - ALG

STAFFING COSTS BASED ON DISCUSSIONS WITH ATS PERSONNEL AND INFORMATION CONTAINED IN "AIR TRAFFIC CONTROL STAFFING STANDARD SYSTEM, ORDER 1380.33", June 8, 1973

APPENDIX B

AIRPORT ACTIVITY SURVEY FORMS

Airport: Monterey Peninsula (MRY)

Location: Monterey, Ca.

Category of Operation	Number of Operations During the Most Active Hour of a Week[1]		Number of Operations on A Normal Traffic Activity Day[2]	
	Under VFR Conditions	Under IFR Conditions	Under VFR Conditions	Under IFR Conditions
Itinerant	41	18	275	80
Local	20	3	75	20
Total	(A) 61	21	350	100
Instrument	5	(B) 21	40	100

[1]Please estimate the respective number of operations per hour during heavy traffic activity day(s) under VFR and IFR weather conditions. The estimates should reflect typical heavy traffic activity and not necessarily the "busy hour" or "peak day" of the year.

[2]Please estimate the respective number of daily operations during a normal traffic activity day under VFR and IFR weather conditions. The estimates should reflect a normal or average activity day and not the heavy or light activity days.

Estimate the number of hours per year, the total operations shown in blocks A and B above, equal or exceed 75% of the counts noted:

75% of A 45.
Hours per year total operations equal or exceed this value under VFR conditions: 1352 hours

75% of B 15.
Hours per year total operations equal or exceed this value under IFR conditions: 1196 hours

Please give a brief description of the pattern of heavy traffic (hours of day, days of week, months of year, etc.) if a pattern can be determined.

Traffic very low in Summer due to Fog (4 Months)
VFR Winter - Heavy Traffic 10 AM — 6 PM 7days/week
Nov. — May - Clear VFR Weather

Estimate of number of days per year total operations equal or exceeds 520
20 days.

Additional comments:

Airport: Palm Spring Municipal (PSP)

Location: Palm Springs, Ca.

Category of Operation	Number of Operations During the Most Active Hour of a Week[1]		Number of Operations on A Normal Traffic Activity Day[2]	
	Under VFR Conditions	Under IFR Conditions	Under VFR Conditions	Under IFR Conditions
Itinerant	60	14	280	40
Local	50	0	110	0
Total	(A) 110	14	390	40
Instrument	40	(B) 14	200	40

[1]Please estimate the respective number of operations per hour during heavy traffic activity day(s) under VFR and IFR weather conditions. The estimates should reflect typical heavy traffic activity and not necessarily the "busy hour" or "peak day" of the year.

[2]Please estimate the respective number of daily operations during a normal traffic activity day under VFR and IFR weather conditions. The estimates should reflect a normal or average activity day and not the heavy or light activity days.

Estimate the number of hours per year, the total operations shown in blocks A and B above, equal or exceed 75% of the counts noted:

75% of A 82.
Hours per year total operations equal or exceed this value under VFR conditions: 800 hours

75% of B 10.
Hours per year total operations equal or exceed this value under IFR conditions: 600 hours

Please give a brief description of the pattern of heavy traffic (hours of day, days of week, months of year, etc.) if a pattern can be determined.

Heaviest Traffic during winter months

Week ends heavy summer and winter

Estimate of number of days per year total operations equal or exceeds 430
35 days.

Additional comments:

Airport: Walker Field (GJT)

Location: Grand Junction, Co.

Category of Operation	Number of Operations During the Most Active Hour of a Week[1]		Number of Operations on A Normal Traffic Activity Day[2]	
	Under VFR Conditions	Under IFR Conditions	Under VFR Conditions	Under IFR Conditions
Itinerant	15	5	115	33
Local	30	0	60	0
Total	(A) 45	5	175	33
Instrument	5	(B) 5	33	33

[1]Please estimate the respective number of operations per hour during heavy traffic activity day(s) under VFR and IFR weather conditions. The estimates should reflect typical heavy traffic activity and not necessarily the "busy hour" or "peak day" of the year.

[2]Please estimate the respective number of daily operations during a normal traffic activity day under VFR and IFR weather conditions. The estimates should reflect a normal or average activity day and not the heavy or light activity days.

Estimate the number of hours per year, the total operations shown in blocks A and B above, equal or exceed 75% of the counts noted:

75% of A 34.
Hours per year total operations equal or exceed this value under VFR conditions: 1456 hours

75% of B 4.
Hours per year total operations equal or exceed this value under IFR conditions: 560 hours

Please give a brief description of the pattern of heavy traffic (hours of day, days of week, months of year, etc.) if a pattern can be determined.

4 to 5 months of Ski Season - very busy

Estimate of number of days per year total operations equal or exceeds 206 / 100 days.

Additional comments:

Boarded over 103,000 people in 1973 thru Air Carrier Only

Airport: Tweed - New Haven (TWD)

Location: New Haven, Conn.

Category of Operation	Number of Operations During the Most Active Hour of a Week[1] Under VFR Conditions	Under IFR Conditions	Number of Operations on A Normal Traffic Activity Day[2] Under VFR Conditions	Under IFR Conditions
Itinerant	35	15	245	45
Local	50	0	125	0
Total	(A) 85	15	370	45
Instrument	7	(B) 15	27	45

[1] Please estimate the respective number of operations per hour during heavy traffic activity day(s) under VFR and IFR weather conditions. The estimates should reflect typical heavy traffic activity and not necessarily the "busy hour" or "peak day" of the year.

[2] Please estimate the respective number of daily operations during a normal traffic activity day under VFR and IFR weather conditions. The estimates should reflect a normal or average activity day and not the heavy or light activity days.

Estimate the number of hours per year, the total operations shown in blocks A and B above, equal or exceed 75% of the counts noted:

75% of A 64.
Hours per year total operations equal or exceed this value under VFR conditions: 192 hours

75% of B 11.
Hours per year total operations equal or exceed this value under IFR conditions: 9 hours

Please give a brief description of the pattern of heavy traffic (hours of day, days of week, months of year, etc.) if a pattern can be determined.

Heavy Traffic 11AM - 12 Noon and 1 PM - 3 PM and 4 PM - 6 PM
Heavy Traffic (VFR) Fri - Sun.
Heavy IFR Traffic May - Sept - Fri - Sun.

Estimate of number of days per year total operations equal or exceeds 680 10 days.

Additional comments:

Airport: (Hagler) Pensacola Regional (PNS)

Location: Pensacola, Fa.

Category of Operation	Number of Operations During the Most Active Hour of a Week[1] Under VFR Conditions	Under IFR Conditions	Number of Operations on A Normal Traffic Activity Day[2] Under VFR Conditions	Under IFR Conditions
Itinerant	75	5	140	10
Local	35	20	360	50
Total	(A) 110	25	500	60
Instrument	75	(B) 45	600	450

[1]Please estimate the respective number of operations per hour during heavy traffic activity day(s) under VFR and IFR weather conditions. The estimates should reflect typical heavy traffic activity and not necessarily the "busy hour" or "peak day" of the year.

[2]Please estimate the respective number of daily operations during a normal traffic activity day under VFR and IFR weather conditions. The estimates should reflect a normal or average activity day and not the heavy or light activity days.

Estimate the number of hours per year, the total operations shown in blocks A and B above, equal or exceed 75% of the counts noted:

75% of A 83.
Hours per year total operations equal or exceed this value under VFR conditions: 312 hours

75% of B 19.
Hours per year total operations equal or exceed this value under IFR conditions: 104 hours

Please give a brief description of the pattern of heavy traffic (hours of day, days of week, months of year, etc.) if a pattern can be determined.

Military Starts 6 AM - Stops 10 PM - Steady Mon - Fri.

Sun. 4-6 PM - GA traffic Very Heavy

Estimate of number of days per year total operations equal or exceeds 563
150 days.

Additional comments:

5 Military Bases Served

Navy Doesn't Fly on weekend.

Most Military Traffic Local (FY73 - 7317 Itin. vs 14,477 Local)

Airport: Bangor International (BGR)

Location: Bangor, Me.

Category of Operation	Number of Operations During the Most Active Hour of a Week[1] Under VFR Conditions	Under IFR Conditions	Number of Operations on A Normal Traffic Activity Day[2] Under VFR Conditions	Under IFR Conditions
Itinerant	50	22	175	90
Local	70	8	175	10
Total	(A) 120	30	350	100
Instrument	30	(B) 30	80	100

[1]Please estimate the respective number of operations per hour during heavy traffic activity day(s) under VFR and IFR weather conditions. The estimates should reflect typical heavy traffic activity and not necessarily the "busy hour" or "peak day" of the year.

[2]Please estimate the respective number of daily operations during a normal traffic activity day under VFR and IFR weather conditions. The estimates should reflect a normal or average activity day and not the heavy or light activity days.

Estimate the number of hours per year, the total operations shown in blocks A and B above, equal or exceed 75% of the counts noted:

75% of A 90.
Hours per year total operations equal or exceed this value under VFR conditions: 10 hours

75% of B 22.
Hours per year total operations equal or exceed this value under IFR conditions: 25 hours

Please give a brief description of the pattern of heavy traffic (hours of day, days of week, months of year, etc.) if a pattern can be determined.

Air Guard Mission - 1st Sat. of Month
Daily Heavy Traffic 9:30AM - 11:30 AM and 3:00PM - 5:30 PM
July & Aug. - Heavy Traffic induced by Good Weather and Flying School

Estimate of number of days per year total operations equal or exceeds 595 6 (Max.) days.

Additional comments:

Airport: Flint-Bishop (FNT)

Location: Flint, Mich.

Category of Operation	Number of Operations During the Most Active Hour of a Week[1]		Number of Operations on A Normal Traffic Activity Day[2]	
	Under VFR Conditions	Under IFR Conditions	Under VFR Conditions	Under IFR Conditions
Itinerant	45	30	150	125
Local	80	0	250	0
Total	(A) 125	30	400	125
Instrument	45	(B) 60	150	225

[1]Please estimate the respective number of operations per hour during heavy traffic activity day(s) under VFR and IFR weather conditions. The estimates should reflect typical heavy traffic activity and not necessarily the "busy hour" or "peak day" of the year.

[2]Please estimate the respective number of daily operations during a normal traffic activity day under VFR and IFR weather conditions. The estimates should reflect a normal or average activity day and not the heavy or light activity days.

Estimate the number of hours per year, the total operations shown in blocks A and B above, equal or exceed 75% of the counts noted:

75% of A 93.
Hours per year total operations equal or exceed this value under VFR conditions: 1000 hours

75% of B 22.
Hours per year total operations equal or exceed this value under IFR conditions: 900 hours

Please give a brief description of the pattern of heavy traffic (hours of day, days of week, months of year, etc.) if a pattern can be determined.

Fri — Mon Heavy 12 Noon - 9 PM.

Estimate of number of days per year total operations equal or exceeds 633
110 days.

Additional comments:

Flint ASR Also serves several Satellite airports.

Airport: Youngstown Municipal (YNG)

Location: Youngstown, Ohio

Category of Operation	Number of Operations During the Most Active Hour of a Week[1]		Number of Operations on A Normal Traffic Activity Day[2]	
	Under VFR Conditions	Under IFR Conditions	Under VFR Conditions	Under IFR Conditions
Itinerant	57	28	180	112
Local	29	0	95	20
Total	(A) 86	28	275	132
Instrument	40	(B) 29	75	130

[1]Please estimate the respective number of operations per hour during heavy traffic activity day(s) under VFR and IFR weather conditions. The estimates should reflect typical heavy traffic activity and not necessarily the "busy hour" or "peak day" of the year.

[2]Please estimate the respective number of daily operations during a normal traffic activity day under VFR and IFR weather conditions. The estimates should reflect a normal or average activity day and not the heavy or light activity days.

Estimate the number of hours per year, the total operations shown in blocks A and B above, equal or exceed 75% of the counts noted:

75% of A 65.
Hours per year total operations equal or exceed this value under VFR conditions: 104 hours

75% of B 22.
Hours per year total operations equal or exceed this value under IFR conditions: 52 hours

Please give a brief description of the pattern of heavy traffic (hours of day, days of week, months of year, etc.) if a pattern can be determined.
Heavy IFR - Feb - May, Weds. PM Thru Fri. and Sun. - Heavy For All Traffic

No significant seasonal changes

Estimate of number of days per year total operations equal or exceeds 501 60 days.

Additional comments:

Youngstown Mon. ASR also serves 5 satellite airports

Airport: Harrisburg Int'l-Olmsted Fld-(MDT)

Location: Middletown, Pa.

Category of Operation	Number of Operations During the Most Active Hour of a Week[1]		Number of Operations on A Normal Traffic Activity Day[2]	
	Under VFR Conditions	Under IFR Conditions	Under VFR Conditions	Under IFR Conditions
Itinerant	15	8	140	135
Local	15	5	160	70
Total	(A) 30	13	300	205
Instrument	10	(B) 13	60	85

[1]Please estimate the respective number of operations per hour during heavy traffic activity day(s) under VFR and IFR weather conditions. The estimates should reflect typical heavy traffic activity and not necessarily the "busy hour" or "peak day" of the year.

[2]Please estimate the respective number of daily operations during a normal traffic activity day under VFR and IFR weather conditions. The estimates should reflect a normal or average activity day and not the heavy or light activity days.

Estimate the number of hours per year, the total operations shown in blocks A and B above, equal or exceed 75% of the counts noted:

75% of A 23.
Hours per year total operations equal or exceed this value under VFR conditions: 832 hours

75% of B 10.
Hours per year total operations equal or exceed this value under IFR conditions: 416 hours

Please give a brief description of the pattern of heavy traffic (hours of day, days of week, months of year, etc.) if a pattern can be determined.

Mon. Thru Fri. (Excluding Holidays)
0930 - 1100
1400 - 1600
1800 - 2230

Estimate of number of days per year total operations equal or exceeds 439 10 days.

Additional comments:

Must Control All Traffic To & From 1 Runway, which has but One Taxiway Turn-off (Mid-Field).

Airport: Yakima Municipal (YKM)

Location: Yakima, Wa.

Category of Operation	Number of Operations During the Most Active Hour of a Week[1]		Number of Operations on A Normal Traffic Activity Day[2]	
	Under VFR Conditions	Under IFR Conditions	Under VFR Conditions	Under IFR Conditions
Itinerant	25	12	125	44
Local	40	0	300	6
Total	(A) 65	12	425	50
Instrument	25	(B) 12	125	50

[1]Please estimate the respective number of operations per hour during heavy traffic activity day(s) under VFR and IFR weather conditions. The estimates should reflect typical heavy traffic activity and not necessarily the "busy hour" or "peak day" of the year.

[2]Please estimate the respective number of daily operations during a normal traffic activity day under VFR and IFR weather conditions. The estimates should reflect a normal or average activity day and not the heavy or light activity days.

Estimate the number of hours per year, the total operations shown in blocks A and B above, equal or exceed 75% of the counts noted:

75% of A 48.
Hours per year total operations equal or exceed this value under VFR conditions: 720 hours

75% of B 9.
Hours per year total operations equal or exceed this value under IFR conditions: 108 hours

Please give a brief description of the pattern of heavy traffic (hours of day, days of week, months of year, etc.) if a pattern can be determined.

March Through October - very Active
Nov. Through Feb. - inactive

Estimate of number of days per year total operations equal or exceeds 731* *2 (Max.) days.

Additional comments:

* >75% Peak day is usually only one day per year - The day of the local air show.

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16. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)

The purpose of this study is to present a benefit/cost concept for new establishment criteria for the Airport Surveillance Radar (ASR). The annual operating costs of the ASR were determined by combining data obtained from the FAA. The primary benefit of the ASR was identified as reduction in delay.

An analysis was made of the available operational data from twenty randomly selected airports whose total operations per year ranged from 50,000 to 250,000. This analysis revealed an extremely erratic pattern of the number of operations per year and other characteristics related to the stablishment of an ASR.

A limited field survey was made to obtain data concerning operating conditions related to the primary function of an ASR. The results of this survey supplied the necessary data to allow the DELCAP simulation model developed at NBS in 1971, to be used in obtaining estimated of delay with and without an ASR under IFR (Instrument Flight Regulation) weather conditions. Combining the information obtained, a methodology was established to allow the benefits derived from the time saved by an ASR to be directly compared with the actual operating cos of an ASR.

17. KEY WORDS (six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons) Airport surveillance radar; Benefit/cost analysis; Establishment criteria; IFR Hourly Activity; Reduction of delay; Ultimate hourly capacity

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