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Report No. FAA-AP-78-1

A REVIEW OF CERTIFICATED AIRPORT CRASH FIRE RESCUE SERVICE CRITERIA

Bertrand F. Ruggles

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DECEMBER 1977

FINAL REPORT

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Prepared for

U S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Office of Airports Programs
Washington, D.C. 20591

Technical Report Documentation Page

1. Report No. AAP-78-1	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle A REVIEW OF CERTIFICATED AIRPORT CRASH FIRE RESCUE SERVICE CRITERIA		5. Report Date December 1977
		6. Performing Organization Code AAP-720
7. Author(s) Bertrand F. Ruggles		8. Performing Organization Report No. AP-78-1
9. Performing Organization Name and Address Federal Aviation Administration Office of Airports Programs Washington, D.C. 20591		10. Work Unit No. (TRAIS)
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address Department of Transportation Federal Aviation Administration 800 Independence Ave., S.W. Washington, D.C. 20591		13. Type of Report and Period Covered Final
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

This study reviews the minimum level of crash fire suppression service required by Federal Aviation Regulation (FAR) Part 139 and compares the required minimum with the recommended level for Index A, AA and B airports. It outlines the economic impact of the present airport index threshold criteria. It presents a discussion of the expected hazard, the population base, and the operational base as factors affecting the level of crash, fire and rescue (CFR) services required at airports and as factors affecting the airport's ability to support that level of CFR service. Conclusions are presented relative to the feasibility of fulfilling the following objectives.

1. Enhance the overall safety of airport operations at all Index A and AA airports without incurring increased operation and maintenance costs.

2. Minimize the increase in the operation and maintenance costs of CFR services presently being experienced by airport owners/operators when transitioning from Index AA to Index B certification.

3. Reduce the operations and maintenance costs of CFR services currently being provided at small Index B airports while maintaining or enhancing the present level of safety.

17. Key Words Airport Certification Crash, fire, and rescue service Airport Indexing Criteria Rapid Intervention Vehicles Crash trucks		18. Distribution Statement Availability unlimited. Document may be released to the National Technical Information Service, Springfield, VA 22151 for sale to the public.	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 26	22. Price

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

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FOREWORD

Aircraft size is the primary factor used to establish the airport's Index and the recommended level of crash, fire and rescue (CFR) service to be provided at a given airport. This recommended level of protection is well grounded in scientific experiment.(1-7)

Historically, economic and operational factors have influenced the actual implementation of recommended safety standards. The level of CFR services recommended in the document sited below was, in fact, modified to reflect some economic realities, some extinguishing agent and agent delivery equipment limitations, as well as the number of air carrier operations. The modified recommendations were made a requirement for all certificated air carrier airports under FAR Part 139. Implementing guidance was published in the Federal Aviation Administration (FAA) Advisory Circular 150/5210-12, Fire and Rescue Service for Certificated Airports, dated March 2, 1976. (8)

With the benefit of five years operating experience under FAR Part 139, a review has been made of the economic, operational and safety factors involved in specifying the various levels of CFR services. The intent of the review was to determine what modifications might be made that would enhance safety for the flying public and reduce the economic burden for the airport owner/operator. This study was conducted on a part-time basis over the period extending from October 1976 through June 1977 using the in house resources of the Operations and Safety Branch, Operations Division, Office of Airports Programs. A detailed specification guide for the proposed rapid intervention vehicle (RIV) outlined in Appendices A and B has been developed and will be published as an advisory circular upon completion of coordination.

CHAPTER 1. INTRODUCTION

Scope

This study reviews the factors and criteria which led to the present level of CFR services prescribed by FAR Part 139 for Index A, AA and B airports. It was written in an effort to develop recommended changes that would result in an improved level of safety without increased costs, or reduce costs with an equivalent level of safety.

Objectives

This study was undertaken to determine what might be done to accomplish the following objectives:

1. Enhance the overall safety of airport operations at all Index A and AA airports without incurring increased operation and maintenance costs.

2. Minimize the increase in operation and maintenance costs of CFR services presently being experienced by airport owners/operators when transitioning from Index AA to Index B certification.

3. Reduce the operations and maintenance costs of CFR services currently being provided at small Index B airports while maintaining or enhancing the present level of safety.

Background

FAR Part 139 requires that owner/operators of certificated, Index AA airports provide one lightweight (fast response), firefighting vehicle containing at least 500 gallons (1900 l) of water for protein foam production and 300 pounds (135 kg) of a compatible dry chemical extinguishant. This requirement is predicated on the following operational conditions:

1. The airport is serving CAB certificated air carriers operating turbine engine powered aircraft more than 90 (27m) but less than 126 feet (38m) long, i.e., Index B aircraft.

2. The airport has less than five operations per day (using an annual average) of the Index B aircraft.

When the annual daily average at an Index AA airport becomes five or more operations involving Index B aircraft, the airport is reclassified as Index B and the owner/operator is required by FAR Part 139 to provide one additional

self-propelled firefighting vehicle. The two vehicles together must provide at least 1,500 gallons (5,600 l) of water for protein foam production and 300 pounds (135 kg) of a compatible dry chemical extinguishant. Substitution of AFFF for protein foam is authorized is authorized and permits a reduction of approximately one-third in the volume of water that must be provided.

The safety equipment required by FAR Part 139 is eligible for Federal participation under the Airport Development Aid Program (ADAP). However, the operation and the maintenance costs for this equipment (including the salaries and training for the required firefighting personnel) are borne entirely by the airport owners/operators. Some airport owners/operators contend that the operation and maintenance costs for the required CFR services have increased their annual budgets from 50 to 100 percent in recent years. (9 & 10)

Section 612 of the Federal Aviation Act of 1958 was amended by the Airport and Airway Development Act Amendments of 1976 authorizing the Administrator of the FAA to: "...exempt any operator of an air carrier airport enplaning annually less than one-quarter of 1 percent of the total number of passengers enplaned at all air carrier airports from the requirements imposed by Subsection (b) of Section 612 relating to fire fighting and rescue equipment if he finds that such requirements are, or would be, unreasonably costly, burdensome or impractical."

CHAPTER 2. ECONOMIC AND OPERATIONAL FACTORS

Economic Impact of Airport Index Threshold Criteria

An increase in either the size of aircraft served or the number of aircraft of a given size served per day at an airport can cause reclassification to a progressively higher Index. That higher classification carries with it a responsibility on the part of the owner/operator of a certificated airport to provide an increased level of CFR service.(11) The change from an Index A to an Index AA has only a minor economic impact on a small airport's operating budget. However, the change from an Index AA airport with a healthy volume of Index A traffic and with four allowable operations of the larger Index B type aircraft to an Index B airport with a nominal increase in Index B aircraft operations can be a serious financial burden.(12) This situation arises from the requirement to change from one CFR vehicle with a crew of firefighting/rescue personnel to the requirement for two CFR vehicles with two crews of firefighting/rescue personnel.

The purchase of the additional vehicle has only a small impact when Federal participation through ADAP is considered. However, that part of the added operations and maintenance costs related to salaries for firefighting/rescue personnel and personnel training can suddenly double the cost of providing the CFR services required to support one additional flight per day. This is a conservative description of the potential triple or quadruple increase. The full impact is subject to the many local differences such as operational schedules (including night, weekend and holiday differentials) manning factors used to provide for trained alternate personnel during annual leave and sickness and the actual manpower requirements of the vehicles due to design. The use of full or part-time professional firefighters as opposed to volunteers, multi-duty personnel or other methods also greatly affects the operational costs in specific cases.

Level of Protection Required Versus That Recommended

FAR Part 139 currently permits the operator of a certificated Index A airport to serve Index B aircraft at an annual average daily rate not to exceed four operations (called Index AA). Under this arrangement, the foam producing capability of the CFR service is 66 percent deficient when compared to the capability required at an Index B airport having 5 or more operations per day of that same sized aircraft. When compared to that capability which is recommended in AC 150/5210-6B and by international standards for an Index B type aircraft, it is 84 percent deficient in foam and 60 percent in dry chemical extinguishant.(13 & 14) Table 1 presents a summary of the general situation for Index A, AA and B airports as it is today. Table 1 also shows the potential for improved safety when a larger capacity, turret equipped, combination agent, RIV is substituted for the present Index AA airport CFR

TABLE 1. COMPARISONS OF THE CAPABILITY OF THREE SETS OF CFR EQUIPMENT 1/

	Level of Fire Fighting Capability	INDEX A Not More Than 90 Feet Long	INDEX AA 4 or Less Flights Per Average Day of Aircraft >90 ft. <126 ft.	INDEX B 5 or More Flights Per Average Day of Aircraft >90 ft. <126 ft.
PRESENT REQUIREMENTS FAR Part 139 and AC 150/5210-12	500 gal.(1900 l) Water For Protein Foam	+ 900	0	- 66
	300 lbs.(135 kg) Dry Chemical	- 33	0	0
	1 Truck	Note: A Lesser Capacity Truck is Specified by Part 139	Meets Present Requirements of FAR Part 139	
	1,500 gal.(5600 l) Water For Protein Foam	+ 2,900	+ 200	0
	300 lbs.(135 kg) Dry Chemical	- 33	0	0
	2 Trucks			Meets Present Requirements of FAR Part 139
PROPOSED VEHICLE	1,000 gal.(3800 l) Water and AFFF Premixed	+ 1,900	+ 100	0
	500 lbs.(225 kg) Dry Chemical	+ 11	+ 66	+ 66
	1 Truck			
RECOMMENDED PRACTICES AC 150/5210-6B Note: ICAO Recommended Practices are Similar to This	500 gal.(1900 l) Water For Protein Foam	- 69	This Hybrid Airport is Not Discussed in AC 150/5210-6B	- 84
	300 lbs.(135 kg) Dry Chemical	- 40		- 60
	1 Truck			
	1,500 gal.(5600 l) Water For Protein Foam	- 18	This Hybric Airport is Not Discussed in AC 150/5210-6B	- 53
	300 lbs.(135 kg) Dry Chemical	- 40		- 60
	2 Trucks			
PROPOSED VEHICLE	1,000 gal.(3800 l) Water and AFFF Premixed	- 16	This Hybrid Airport is Not Discussed in AC 150/5210-6B	- 50
	500 lbs.(225 kg) Dry Chemical	0		- 30
	1 Truck			

1/ Body of table shows percent excess (+) or shortage (-) in available agent that a given level of fire fighting capability provides when compared to the requirement or recommended practice.

vehicle. This change, if it were put into effect at all Index AA airports, and the definition of AA airports were expanded to include many of the small Index B airports, has the potential for:

1. An increase in the level of protection;

2. A significant savings in personnel costs; and

3. A reduction in operations and maintenance costs.

Before implementation, an evaluation would be required to determine how many of the small Index B airports can feasibly convert to a newly defined Index AA and maintain the overall level of safety by using the proposed CFR vehicle. This evaluation would include: The combined effects of the physical layout of the individual airports; the total operational activity; and the actual frequency distribution of that activity.

CHAPTER 3. FACTORS AFFECTING LEVEL OF CFR SERVICES AT AIRPORTS

Expected Hazard

For airports serving large, turbine engine powered aircraft, the number of CFR vehicles to be provided should be based on the operational concept of protecting both sides of the aircraft fuselage at the same time and should be capable of supplying the quantities and types of agent at the application rates shown in Table 2. Ideally, sufficient trucks should be provided so that if one is out of service, the capability will not be reduced more than 50 percent. In addition to considering the quantitative capability of the trucks, the total number should be based upon the operational needs of the airport and the need to fulfill or preferably exceed the present response time requirements. The ability of the CFR vehicle to traverse the off-pavement terrain common to the airport being equipped is also of primary importance.

Population Base

An analysis was made to discover any "natural" relationships that may exist between the size of the community being served and the airports of interest. The tabulated data showing the number of AA and B Index airports presently serving communities of various sizes is presented in Table 3.(15 & 16) To facilitate the review, the population of the communities was divided into increments of 5,000 from 1,000 through 100,000 and into increments of 25,000 from 101,000 through 200,000 and a final grouping of communities over 200,000. The objectives of this study deal with Index AA and small Index B airports. Therefore, further analysis was confined to those airports serving communities with a population of 100,000 or less. This included 95 percent of all Index AA and 77 percent of all Index B airports. Figures 1 and 2 show the distribution of these airports by community size.

Operational Base

The Airport Activity Statistics of Certificated Route Air Carriers for the 12 months ending June 30, 1975, was reviewed for all Index B airports serving primary communities with a population of 100,000 or less. (17) The following information relating to the Index B airports was extracted:

1. The total number of air carrier operations per year.

2. The number of Index B aircraft operations per year.

3. The number of Index C aircraft operations per year.

TABLE 2

QUANTITIES OF FIRE EXTINGUISHING AGENTS FOR AIRPORTS (13)

Index 1/	Primary Agents				Supplementary Agent
	Protein Foam		Aqueous Film Forming Foam (AFFF)		
	Water for Foam Production (gal.)	Solution Application Rate (gpm)	Water for Foam Production (gal.)	Solution Application Rate (gpm)	Dry Chemical Powders (lb.)
A	1,830 2/	1,100	1,190	720	500 3/
B	3,180	1,590	2,070	1,050	750
C	4,820	2,110	3,140	1,370	1,000
D	7,290	2,890	4,740	1,880	1,500
E	9,770	3,620	6,350	2,350	1,500

1/ Indexes A through E in this table refer to those identified in Part 139.49 and AC 150/5210-12.

2/ Rounded off from 1834 gallons - as the other quantities in this table were rounded off to the nearest 10 gallons. For practical application, it is suggested that the quantities in Columns 2 and 4 be adjusted upward to coincide with the conventional capacities of water tanks which are normally sized in increments to 500 gallons, 1,000 gallons, etc.

3/ The total quantities of dry chemical agent are based on sodium bicarbonate. Potassium base dry chemicals may be substituted in quantities up to 10 per cent less by weight. Compatibility with the foam agent is a must!

TABLE 3

DISTRIBUTION OF AIRPORTS BY COMMUNITY POPULATION

Population x 1,000	Number of Index AA Airports	Number of Index B Airports
< 1	11	0
1-5	12	1
6-10	6	4
11-15	12	1
16-20	9	5
21-25	4	4
26-30	8	2
31-35	6	5
36-40	8	7
41-45	4	5
46-50	4	3
51-55	3	2
56-60	2	3
61-65	5	3
66-70	6	3
71-75	1	3
76-80	1	2
81-85	0	0
86-90	2	4
91-95	2	2
96-100	1	1
Subtotal	107	60

Population x 1,000	Number of Index AA Airports	Number of Index B Airports
101-125	1	5
126-150	3	6
151-175	1	3
176-200	1	2
> 200	0	2
TOTAL	113	78

FIGURE 1

NUMBER OF INDEX AA AIRPORTS SERVING PRIMARY COMMUNITIES IN VARIOUS POPULATION RANGES

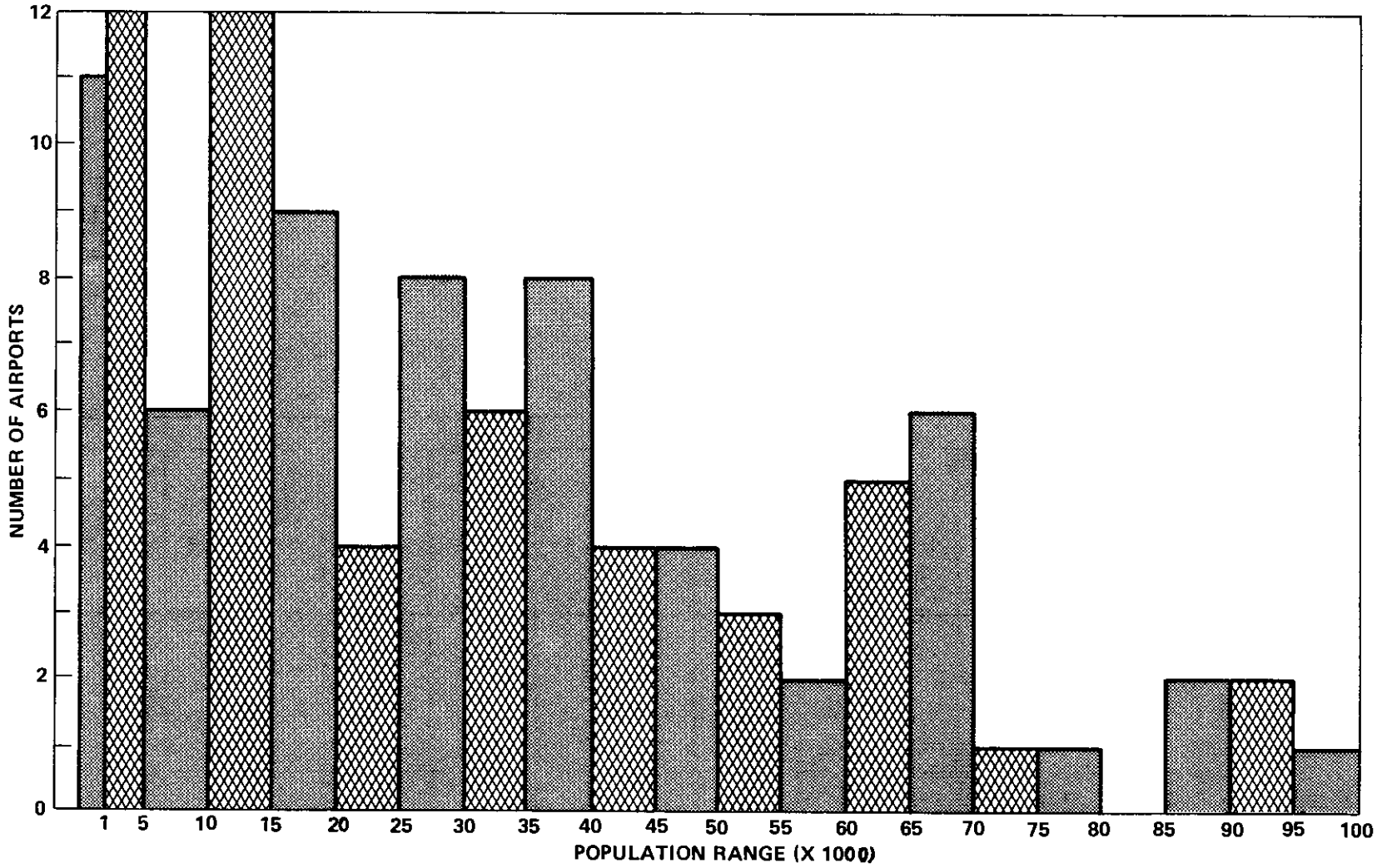
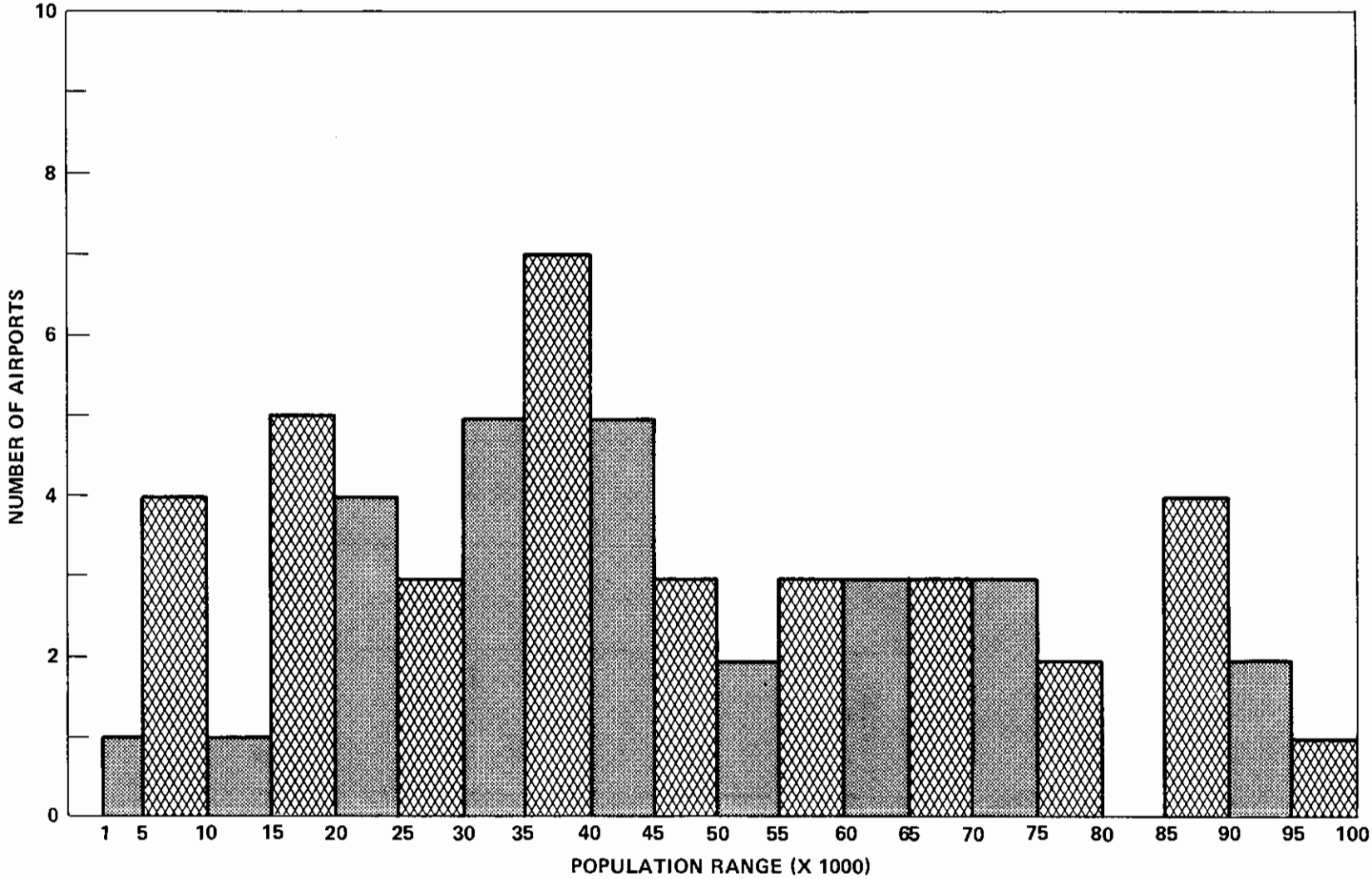


FIGURE 2

NUMBER OF INDEX B AIRPORTS SERVING PRIMARY COMMUNITIES IN VARIOUS POPULATION RANGES



That information was converted to annual average daily figures, combined with the Index B airport community population data from Table 3, and is displayed in Tables 4, 5 and 6. Those tables show the distribution of airports by size of community served and by annual average daily operations. It is interesting to note that as the number of Index B daily operations (Table 5) increases from five or less, to eight, the number of airports included which serve communities of 30,000 or less doubles. This can be seen more dramatically in Figure 3. Additionally, Figure 3 shows that this step increase in the number of airports involved holds reasonably constant as we examine communities of larger sizes. However, any additional increase in the number of daily operations above eight, community size not withstanding, only results in a small change in the total number of airports involved.

TABLE 4

TOTAL NUMBER OF OPERATIONS PER DAY AT INDEX B AIRPORTS	POPULATION BASE OF PRIMARY COMMUNITY SERVED (x 1,000)					
	≤ 5	≤ 15	≤ 30	≤ 50	≤ 75	≤ 100
≥ 1	0	0	0	0	0	0
≤ 3	0	0	0	0	0	0
≤ 5	0	0	3	6	7	8
≤ 8	0	2	9	17	20	22
≤ 10	0	2	12	25	32	34
≤ 15	1	5	15	34	44	47
≤ 20	1	6	16	35	49	56
≤ 25	1	6	16	36	51	57
≤ 30	1	6	17	37	51	59
≤ 40	1	6	17	37	51	60

TABLE 5

NUMBER OF INDEX B OPERATIONS PER DAY AT INDEX B AIRPORTS	POPULATION BASE OF PRIMARY COMMUNITY SERVED (x 1,000)					
	≤ 5	≤ 15	≤ 30	≤ 50	≤ 75	≤ 100
= 1	0	0	0	0	1	1
≤ 3	0	0	2	3	5	6
≤ 5	0	0	7	12	19	20
≤ 8	1	5	14	30	39	43
≤ 10	1	5	16	36	46	50
≤ 15	1	6	17	37	51	58
≤ 20	1	6	17	37	51	60

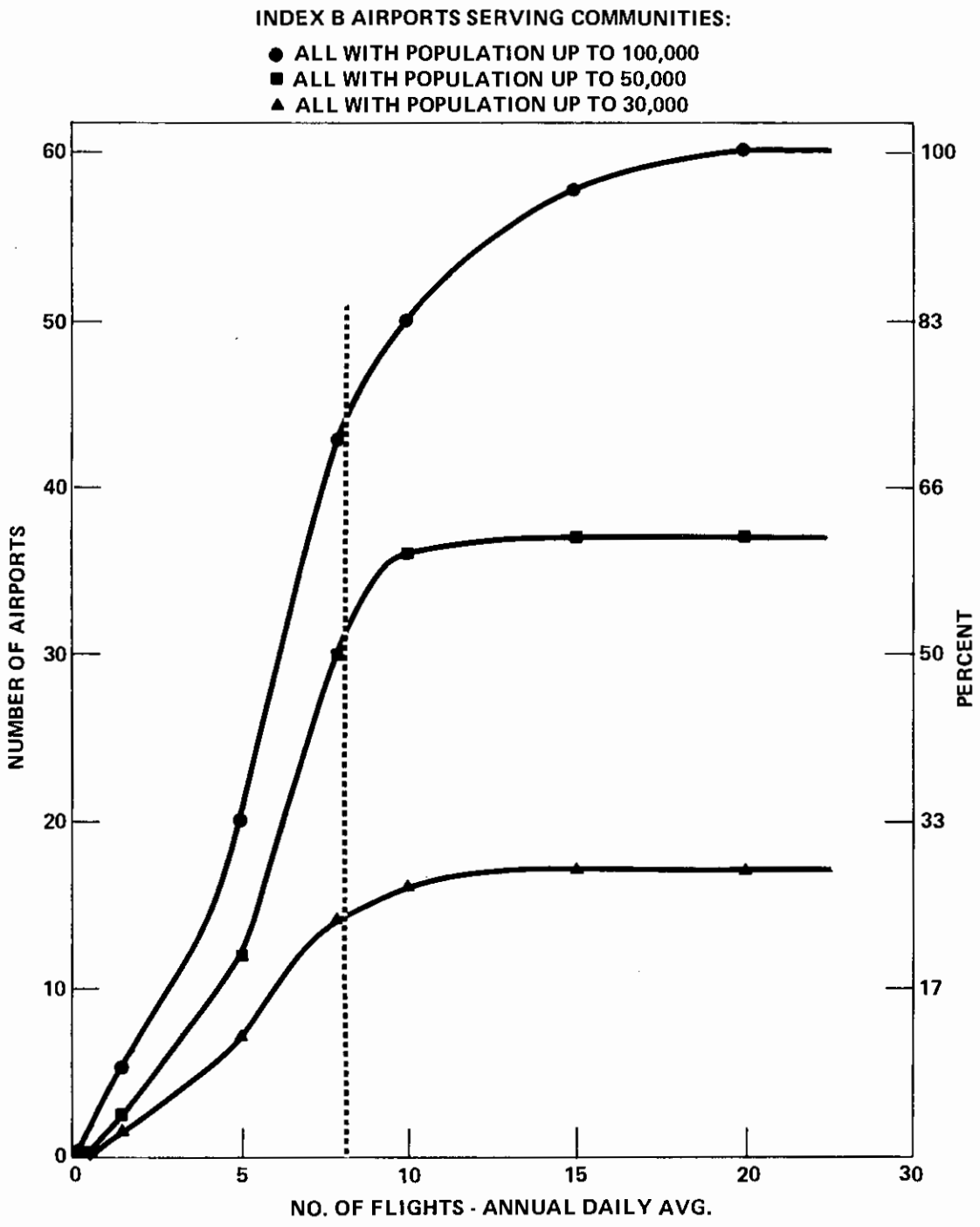
TABLE 6

NUMBER OF INDEX C OPERATIONS PER DAY AT INDEX B AIRPORTS	POPULATION BASE OF PRIMARY COMMUNITY SERVED (x 1,000)					
	≤ 5	≤ 15	≤ 30	≤ 50	≤ 75	≤ 100
= 1	0	0	2	5	8	10
≤ 3	0	1	4	8	14	17
< 5	0	2	8	12	20	23

TABLE 7

ANNUAL AVERAGE OF DAILY OPERATIONS	3	5	8	10	15	20	25
ANNUAL TOTAL	1,095	1,825	2,920	3,650	5,475	7,300	9,120

FIGURE 3


INDEX B AIRPORTS SERVING COMMUNITIES:
● ALL WITH POPULATION UP TO 100,000
■ ALL WITH POPULATION UP TO 50,000
▲ ALL WITH POPULATION UP TO 30,000
NUMBER OF AIRPORTS
PERCENT
0
10
20
30
40
50
60
17
33
50
66
83
100
0
5
10
15
20
30
NO. OF FLIGHTS - ANNUAL DAILY AVG.

SUMMARY

A review of the economic impact of present airport index threshold criteria and the associated CFR service indicates that there is a significant financial burden imposed on an airport when normal growth requires that it transition from Index AA to B. The specific magnitude of the burden has a wide variation and is dependent upon some regulatory factors as well as many local operational and management factors over which the FAA has no control or opportunity to offer relief.

A review of CFR protection level recommended by the FAA and the minimum level required for certification indicates that a higher level of protection can be achieved at many airports for significantly lower total system lifetime costs. This can be achieved by taking full advantage of the past ten years of technological improvements of both the extinguishing agents and the agent delivery system performance capabilities.

A review of the interrelationships between the major factors affecting the level of CFR services required/recommended at airports indicates that to achieve the goal of improved/equivalent safety and reduced financial burden, the operational threshold for the Index AA/B transition should be redefined and an RIV with superior performance characteristics over those now required should be used.

A review of the CFR equipment industry literature indicated that a superior RIV can be produced within the limits of current heavy equipment manufacturing technology. The general performance characteristics for a proposed vehicle were assembled as the baseline for the development of a specification guide for a new combination agent RIV.

CONCLUSIONS

1. It is technically feasible to enhance the overall safety of airport operations at all Index AA airports. Through the use of improved agents and an increase in the quantity of both water/foam and dry chemical agents, the fire suppression capability of the Index AA airports can be raised to a level that is more realistic in terms of a potential Index B aircraft fire. This can be accomplished through the substitution/replacement of the CFR vehicle presently required by FAR Part 139 with a CFR vehicle of greater agent carrying capability, improved response characteristics, improved off-road performance, and equal or reduced CFR crew requirements. Initial purchase price of such a vehicle is estimated to be two to three times the original purchase price of the RIVs now in service at most Index AA airports.

2. It is technically feasible to fulfill the CFR agent requirements presently required of airport owners/operators when transitioning from Index AA to Index B certification and to minimize the initial and long term costs of the transition. The present agent quantity requirements can be fulfilled through the use of one larger combination agent vehicle in lieu of the two vehicles presently required, i.e., the small combination agent vehicle and the one additional water/foam truck. This substitution would result in initial cost savings in the purchase of the vehicle and in a savings in long term operations, maintenance and personnel costs. The latter being most significant as they are constantly recurring and increasing with time.

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APPENDIX A

GENERAL PERFORMANCE CRITERIA FOR PROPOSED RAPID INTERVENTION VEHICLE

FIRE SUPPRESSION SYSTEM

Agents

Aqueous Film Forming Foam 6% concentrate + water = approximately 1000 gal.
Dry Chemical = 500 lbs. (Potassium Base Preferred)

AGENT DISCHARGE ENERGY SOURCE

Dry Chemical Agent

400 cubic foot dry nitrogen cylinder; code ICC-3AA-2400

AFFF Agent

Diesel engine driven water pump; separate or power takeoff

TURRETS

Flow Rates - Twinned turrets designed to dispense potassium based dry chemical and aqueous film forming foam (AFFF) shall be capable of discharging their agent in accordance with table 8.

TABLE 8

TWINNED AGENT TURRET EFFECTIVE STREAM PATTERNS

		0° Nozzle Sweep		
Agent	Minimum Discharge Rate	Far Point at Least (ft.)	Near Point No Closer Than (ft.)	Full Width at Least (ft.)
Dry Chemical	16 lb/sec.	100 ft.	--	17 ft.
Aqueous Film Forming Foam (AFFF)	150 gpm	90 ft.	17 ft.	15 ft.

NOTE: Dry chemical turret barrel in horizontal position. AFFF turret barrel elevated from 10° to 30° so that stream pattern falls to the ground just behind the dry chemical stream pattern.

Operations - "Twinned" turrets shall be arranged in accordance with the following provisions:

a. The turrets shall be physically linked together to provide coordinated application by one operator while seated in either the driver's seat or in the second crew seat.

b. The system shall be designed so that each agent may be discharged separately in addition to a combined discharge.

c. Turrets shall be capable of being depressed at least 15°, elevated at least 45° and capable of being rotated at least 60° to each side (total traverse at least 120°).

Activation - The turret agent activation controls will be accessible to either crew station occupant.

HAND LINE

Activation - Manual by a single quarter turn valve handle extension located close to twinned nozzle storage area. Quick opening valves to energize both lines to nozzle trigger valves.

Hose - 100 feet (single length) of 1 inch ID and 3/4 inch ID twinned chemical hose.

Nozzles - Independently operable, manually triggered liquid agent and dry chemical discharge nozzles physically linked for use by single operator.

Flow Rates - Dry chemical nozzle 5 lbs/sec
- AFFF nozzle 60 GPM

VEHICLE

Acceleration: 0 - 50 mph in 25 seconds or less.

Gross Vehicle Weight: Not to exceed 31,999 pounds.

Engine: Diesel approximate MGHP/1,000 pounds GVW = 12 - 15.

Drive Train: Torque converter, automatic transmission, all wheel drive.

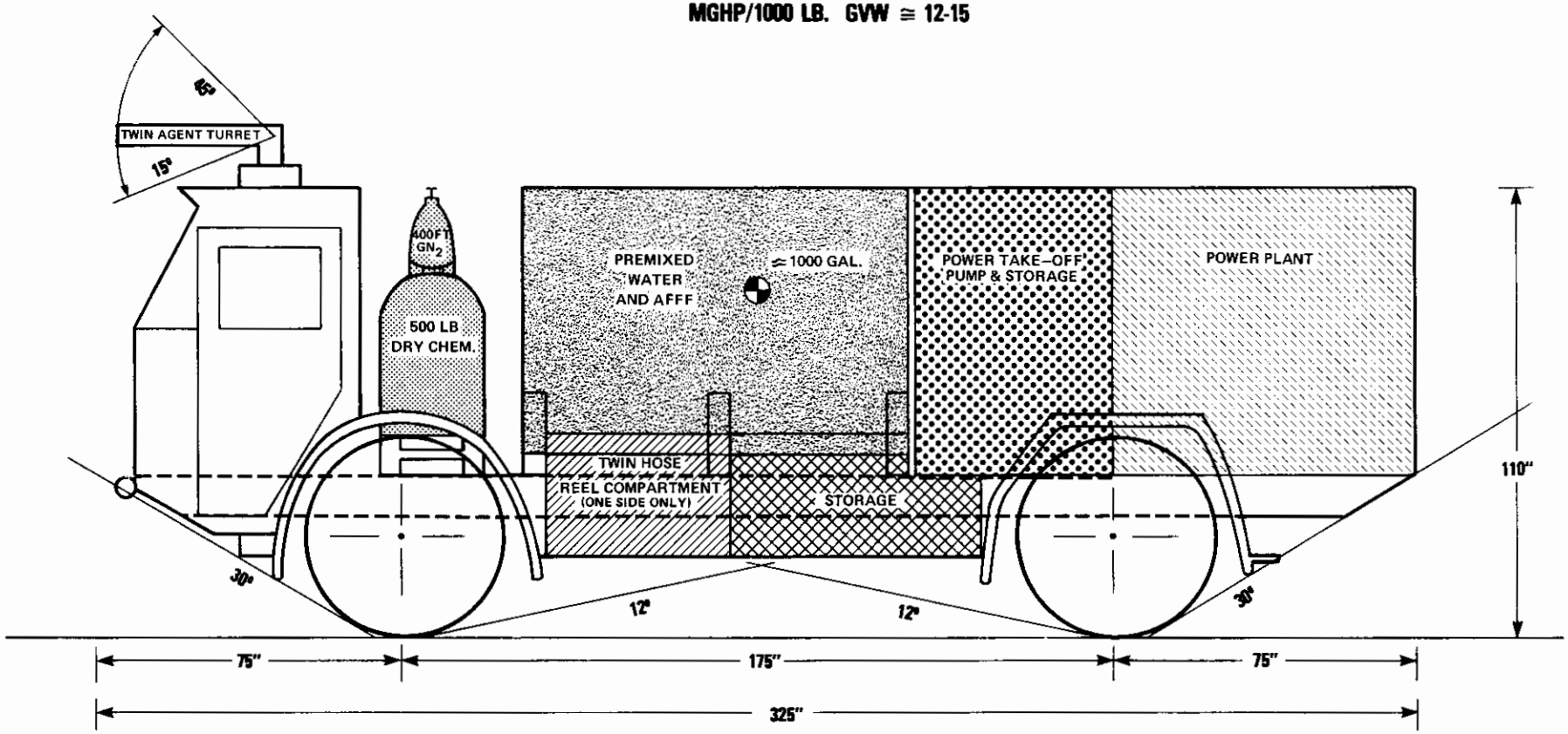
Cab: Seating two firefighters, full opening doors on both sides, maximum window space and space for two firefighter's personal safety equipment.

EMERGENCY WARNING DEVICES

Rotating Beacon

Siren

APPENDIX B

GVW < 32000 LBS.

MGHP/1000 LB. GVW ≅ 12-15