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NFPA 403 Aircraft Rescue and Fire Fighting Services at Airports 1988 Edition

National Fire Protection Association Batterymarch Park, Quincy, MA 02269

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Policy Adopted by NFPA Board of Directors on December 3, 1982

The Board of Directors reaffirms that the National Fire Protection Association recognizes that the toxicity of the products of combustion is an important factor in the loss of life from fire. NFPA has dealt with that subject in its technical committee documents for many years.

There is a concern that the growing use of synthetic materials may produce more or additional toxic products of combustion in a fire environment. The Board has, therefore, asked all NFPA technical committees to review the documents for which they are responsible to be sure that the documents respond to this current concern. To assist the committees in meeting this request, the Board has appointed an advisory committee to provide specific guidance to the technical committees on questions relating to assessing the hazards of the products of combustion.

Statement on NFPA Procedures

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NATIONAL FIRE PROTECTION ASSOCIATION

NFPA 403

Standard for

Aircraft Rescue and Fire Fighting Services at Airports

1988 Edition

This edition of NFPA 403, *Standard for Aircraft Rescue and Fire Fighting Services at Airports*, was prepared by the Technical Committee on Aircraft Rescue and Fire Fighting, released by the Correlating Committee on Aviation, and acted on by the National Fire Protection Association, Inc. at its Fall Meeting held November 9-11, 1987 in Portland, Oregon. It was issued by the Standards Council on December 2, 1987, with an effective date of December 22, 1987, and supersedes all previous editions.

The 1988 edition of this standard has been approved by the American National Standards Institute.

Origin and Development of NFPA 403

Committee work leading to the development of a recommended practice by the Association commenced in 1947 following a request from the Civil Aeronautics Board (U.S.A.) for information on what constituted "adequate" ground fire fighting equipment and personnel for airports served by air carrier aircraft.

NFPA Committee work continued during 1948 and in 1949 the Association adopted a tentative text at its Annual Meeting held in San Francisco, California. In 1952 a revised text was submitted for adoption by the Association, and unanimously accepted. Since its original adoption, this text has been revised periodically with editions issued in 1954, 1955, 1956, 1957, 1958, 1959, 1960, 1961, 1962, 1965, 1966, 1967, 1970, 1971, 1972, 1973, 1974, 1975, and 1978.

This 1988 edition comprises a complete revision to the text of the document to make it a standard and to segregate mandatory requirements from advisory material. Prior to this 1988 edition, all editions were recommended practices.

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NOTE: Membership on a Committee shall not in and of itself constitute an endorsement of the Association or any document developed by the Committee on which the member serves.

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NFPA 403

Standard for

Aircraft Rescue and Fire Fighting Services at Airports

1988 Edition

NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates explanatory material on that paragraph in Appendix A.
Information on referenced publications can be found in Chapter 8 and Appendix B.

Chapter 1 Administration

1-1 Scope.

1-1.1 This standard contains the minimum requirements for aircraft rescue and fire fighting (RFF) services at airports. Requirements for other airport fire protection services are not covered in this document.

1-2 Purpose.

1-2.1 This standard is prepared for the use and guidance of those charged with providing and maintaining aircraft rescue and fire fighting services at airports.

1-2.2 The principal objective of a rescue and fire fighting service is to save lives. For this reason, the provision of means of dealing with an aircraft accident or incident occurring at, or in the immediate vicinity of, an airport assumes primary importance because it is within this area that there are the greatest opportunities of saving lives. This must assume at all times the possibility of, and need for, extinguishing a fire which may occur either immediately following an aircraft accident or incident, or at any time during rescue operations.

1-2.3 The most important factors bearing on effective rescue in a survivable aircraft accident are: the training received, the effectiveness of the equipment, and the speed with which personnel and equipment designated for rescue and fire fighting purposes can be put into use.

1-3 Definitions.

Aircraft Accident. An occurrence during the operation of an aircraft in which any person involved suffers death or serious injury or in which the aircraft receives substantial damage.

Aircraft Incident. An occurrence, other than an accident, associated with the operation of an aircraft, which affects or could affect continued safe operation if not corrected. An incident does not result in serious injury to persons or substantial damage to aircraft.

Aircraft Fire Fighting. The control or extinguishment of fire adjacent to or involving an aircraft following ground accidents/incidents. Aircraft fire fighting does not include the control or extinguishment of airborne fires in aircraft.

Aircraft Rescue. The fire fighting action taken to prevent, control or extinguish fire involving, or adjacent to, an aircraft for the purpose of providing maximum fuselage integrity and escape area for its occupants. Rescue and fire fighting personnel, to the extent possible, will assist in evacuation of the aircraft using normal and emergency means of egress. Additionally, rescue and fire fighting personnel will, by whatever means necessary, and to the extent possible, enter the aircraft and provide all possible assistance in the evacuation of the occupants.

Airport Air Traffic Control. A service established to provide air and ground traffic control for airports.

Airport Fire Chief. The individual normally having operational control over the airport's aircraft rescue and fire fighting equipment and personnel specifically made available for aircraft rescue and fire fighting activity at the airport or a designated assistant. The chief has both the authority and responsibility for decisions affecting rescue and fire fighting activity and is normally in sole command of such operations during emergencies.

Airport Fire Department Personnel. Personnel under the operational jurisdiction of the chief of the airport fire department assigned to aircraft rescue and fire fighting.

Airport Manager. The individual having managerial responsibility for the operation and safety of an airport. The manager may have administrative control over aircraft rescue and fire fighting services, but normally does not exercise authority over operational fire and rescue matters.

Approved.* Acceptable to the "authority having jurisdiction."

Authority Having Jurisdiction.* The "authority having jurisdiction" is the organization, office or individual responsible for "approving" equipment, an installation or a procedure.

Fixed Base Operator (FBO). An enterprise based on the airport which provides storage, maintenance, or service for aircraft operators.

Flight Service Station (FSS). An air traffic facility which briefs pilots, processes, and monitors flight plans and provides in-flight advisories.

Fuselage. The fuselage is the body of an aircraft containing the passenger cabin, flight deck, and cargo compartments.

ICAO. International Civil Aviation Organization.

May. This term is used to state a permissive use, or an alternative method to a specified requirement.

Movement Area. That part of an airport to be used for the take-off, landing and taxiing of aircraft, consisting of the maneuvering area and the apron(s).

Mutual Aid. Mutual aid is synonymous with "mutual assistance," "outside aid," "memorandums of understanding," "letters of agreement," or other similar agreements, written or not, which constitute an agreed assistance plan between emergency services.

Rapid Response Area (RRA).* A rectangle which includes the runway and the surrounding area extending to but not beyond the airport property line. Its width extends 152 m (500 ft) outward from each side of the runway centerline, and its length is 500 m (1600 ft) beyond each runway end. (*See Figure A-1-3.*)

RFF Personnel. Personnel actively engaged in the pursuit of rescue and fire fighting at the scene of an airport incident.

Response Time. The time elapsed between the initial notification of an accident/incident and the time of the first discharge of extinguishing agent at the site.

Shall. Indicates a mandatory requirement.

Should. This term, as used in the Appendix, indicates a recommendation or that which is advised but not required.

Table Top Training. A workshop-style of training involving a realistic emergency scenario and requiring problem-solving participation by personnel responsible for management and support at emergencies.

Chapter 2 Organization of Rescue and Fire Fighting (RFF) Services

2-1 Administrative Responsibilities.

2-1.1 The airport management shall be responsible for the provisions of aircraft RFF services on the airport.

2-1.2 Regardless of the functional-control of RFF services on the airport, a high degree of mutual aid shall be prearranged between such services on airports and any off-airport fire or rescue agencies serving the environs of the airport.

2-1.3 The aircraft owner/operator shall ensure that provisions have been made for the security of the aircraft until such time as a legally appointed accident investigation authority assumes responsibility. The airport manager or authority having jurisdiction may assist or assume the authority in the absence of the aircraft owner/operator.

2-2 Emergency Preparedness.

2-2.1* Airports shall prepare a disaster plan, taking into account airport emergency services and mutual aid services available in the event of a disaster.

2-2.2 Full scale airport disaster plans shall be tested at least every other year. In addition, table top training shall be conducted at least annually.

2-3 Categorizing Airports for RFF Services.

2-3.1* The authority having jurisdiction shall determine the level of protection based on the largest aircraft scheduled into the airport. Airports shall be categorized for RFF services in accordance with Table 2-3.1.

2-3.2* The airport category for a given aircraft shall be based on the overall length of the aircraft or the fuselage width. If, after selecting the category appropriate to the aircraft's overall length, the aircraft's fuselage width is greater than the maximum width given in Table 2-3.1, then the category for that aircraft shall be the next one higher.

Chapter 3 Extinguishing Agents

3-1 Primary Agents.

3-1.1* One or more of the following types of primary agents shall be used for aircraft fire fighting.

(a) Aqueous Film Forming Foam (AFFF)

(b) Fluoroprotein Foam (FPF)

(c) Protein Foam (PF).

3-2 Complementary Agents.

3-2.1* Either one or both of the following complementary agents shall be available for aircraft fire fighting:

(a) Potassium Bicarbonate Dry Chemical

(b) Halon 1211.

3-3 Quantity of Agents.

3-3.1 The minimum amounts of water for foam production, and the minimun amounts of complimentary agents necessary shall be as specified in Tables 3-3.1(a) or

Table 2-3.1 Airport Category by Overall Length and Width of the Aircraft

Airport Category U.S.			Overall Length of Aircraft up to but not Including		Maximum Exterior Width up to but not Including	
NFPA	FAA	ICAO	Feet	Meters	Feet	Meters
1	GA-1	1	30	9	6.6	2
2	GA-1	2	39	12	6.6	2
3	GA-2	3	59	18	9.8	3
4	A	4	78	24	13.0	4
5	A	5	90	28	13.0	4
6	B	6	126	39	16.4	5
7	C	7	160	49	16.4	5
8	D	8	200	61	23.0	7
9	E	9	200 and over	61 and over	23.0	7

Table 3-3.1(a) Minimum Extinguishing Agent Quantities and Discharge Rates

Airport Category	AFFF Water U.S. Gallons	AFFF Discharge Rate gpm	Fluoroprotein Foam Water U.S. Gallons	Fluoroprotein Foam Discharge Rate gpm	Protein Foam Water U.S. Gallons	Protein Foam Discharge Rate gpm	Potassium Bicarbonate Pounds	Potassium Bicarbonate Discharge Rate lbs/sec	Halon 1211 Pounds	Halon 1211 Discharge Rate lbs/sec
1	60	60	80	75	90	85	100	5	100	5
2	185	130	225	180	240	195	200	5	200	5
3	315	230	425	310	460	335	300	5	300	5
4	600	390	820	530	900	575	300	5	300	5
5	1450	825	2000	1135	2200	1230	450	5	450	5
6	2200	1100	3000	1480	3300	1620	450	5	450	5
7	3300	1440	4500	1970	4900	2150	450	5	450	5
8	4800	1900	6600	2600	7100	2845	900	10	900	10
9	6500	2400	9250	3300	9700	3480	900	10	900	10

Table 3-3.1(b) Minimum Extinguishing Agent Quantities and Discharge Rates

Airport Category	AFFF Water Liters	AFFF Discharge Rate Liters/min	Fluoroprotein Foam Water Liters	Fluoroprotein Foam Discharge Rate Liters/min	Protein Foam Water Liters	Protein Foam Discharge Rate Liters/min	Potassium Bicarbonate kg	Potassium Bicarbonate Discharge Rate kg/min	Halon 1211 kg	Halon 1211 Discharge Rate kg/sec
1	250	225	300	290	330	320	45	2.25	45	2.25
2	650	500	850	680	925	745	90	2.25	90	2.25
3	1200	800	1600	1165	1750	1270	135	2.25	135	2.25
4	2300	1500	3100	2000	3400	2180	135	2.25	135	2.25
5	5500	3000	7500	4300	8200	4650	205	2.25	205	2.25
6	8300	4000	11500	5600	12500	6138	205	2.25	205	2.25
7	12500	5500	17000	7450	19000	8135	205	2.25	205	2.25
8	18200	7000	25000	9850	27500	10770	410	4.5	410	4.5
9	24500	9000	35000	12500	37000	13560	410	4.5	410	4.5

3-3.1(b) of this chapter based on the system of categorizing airports listed in Table 2-3.1 of this standard.

3-3.2 Sufficient foam concentrate shall be provided to proportion, at the prescribed percentage of foam concentrate to water, into double the quantity of water specified in Table 3-3.1(a) or 3-3.1(b) of this chapter.

3-3.3 The amount of water for foam production shall be increased by ⅓ for aircraft containing fuel tanks in the tail section.

3-4 Compatibility of Agents.

3-4.1* Chemical compatibility shall be assured between foam and complementary agents when used simultaneously or consecutively.

3-5 Combustible Metal Agents.

3-5.1* Extinguishing agents for combustible metal fires shall be provided in portable fire extinguishers that are rated for Class D fires in accordance with Section 1-4 of NFPA 10, *Standard for Portable Fire Extinguishers*. At least one nominal 20 lb extinguisher shall be carried on each vehicle specified in Table 4-1.1 of this standard.

3-6 Agent Discharge Capabilities.

3-6.1 The discharge capabilities of extinguishing agents shall not be less than the rates specified in Table 3-3.1(a) or 3-3.1(b) of this chapter, and Sections 2-15.6, 3-13.9, and 4-13.9, as applicable, of NFPA 414, *Standard for Aircraft Rescue and Fire Fighting Vehicles*.

3-6.2 Other than at Category 1, 2, and 3 airports, where the handline nozzles can be used, the discharge rates for foam shall be met using only the RFF vehicle turret(s).

Chapter 4 Aircraft Rescue and Fire Fighting (RFF) Vehicles

4-1 Rescue and Fire Fighting Vehicles.

4-1.1* The minimum number of RFF vehicles provided at each airport shall be as specified in Table 4-1.1 of this chapter.

Table 4-1.1 Minimum Number of RFF Vehicles

Airport Category	1	2	3	4	5	6	7	8	9
Number of Vehicles	1	1	1	1	2	2	3	3	3

4-1.2* RFF vehicles shall be constructed to comply with the provisions of NFPA 414, *Standard for Aircraft Rescue and Fire Fighting Vehicles*, and Table 3-3.1(a) or 3-3.1(b) of this standard.

4-1.3 Consideration shall be given to the provision of an additional vehicle or vehicles in order that minimim requirements may be maintained during periods when a vehicle is out of service.

4-1.4 All foam-producing RFF vehicles shall be tested at least annually in accordance with NFPA 412, *Standard for Evaluating Foam Fire Fighting Equipment on Aircraft Rescue and Fire Fighting Vehicles*.

4-2 Tools and Equipment.

4-2.1* Vehicles shall be provided with tools and equipment to effectively support rescue and fire fighting operations.

Chapter 5 Airport Emergency Communications

5-1 Communications and Alarms.

5-1.1 Airport RFF services communications shall have a capability that is consistent with the airport's operational needs.

5-1.2* The operational communications system shall provide a primary and, where necessary, an alternate effective means for direct communication between the following, as applicable:

(a) The alerting authority such as the control tower or flight service station, airport manager, fixed-base operator, or airline office and the airport RFF service;

(b) Air traffic control tower or flight service station and RFF vehicles enroute to an aircraft emergency or at the accident/incident site;

(c) The fire department alarm room and RFF vehicles at the accident/incident site;

(d) The airport RFF services and appropriate mutual aid organizations located on or off the airport, including an alert procedure for all auxiliary personnel expected to participate; and

(e) The RFF vehicles.

5-1.3 To assure that the communications system is operational under a variety of airport emergency conditions, provisions shall be made for an emergency standby power source or alternate backup communication system.

5-1.4 A preventive maintenance program shall be carried on to keep all communications equipment in a fully serviceable condition.

5-1.5 The functional performance of all communications systems shall be tested at intervals not exceeding 24 hours.

Chapter 6 RFF Personnel and Protective Clothing

6-1 Personnel.

6-1.1 A person shall be appointed to direct the airport RFF services. The responsibilities of this person shall include overall administrative supervision of the organization, effective training of personnel, and operational control of emergencies involving aircraft within the airport jurisdiction.

6-1.2 During flight operations, sufficient trained personnel shall be detailed and be readily available to ride the rescue and fire fighting vehicles and to operate the equipment at maximum capacity. These trained personnel shall be deployed in a way that ensures that minimum response times can be achieved and that continuous agent application at the appropriate time can be fully maintained. Consideration shall be given to the use of hand line(s), ladder(s) and other rescue and fire fighting equipment normally associated with aircraft rescue and fire fighting operations.

6-1.3* All RFF personnel shall meet the requirements of NFPA 1003, *Standard for Airport Fire Fighter Professional Qualifications*.

6-1.4 All RFF and other authorized personnel shall be given suitable uniforms or identifying insignia to prevent any misunderstanding as to their right to be in the fire area or the aircraft movement area of an airport during an emergency.

6-2 Protective Clothing.

6-2.1* Approved protective clothing and equipment including protective coat, protective trousers, helmet, gloves and self-contained breathing apparatus (SCBA) shall be provided, maintained, and readily available for use by all RFF personnel.

6-2.2* SCBA for RFF personnel shall meet the requirements of NFPA 1981, *Standard on Self-Contained Breathing Apparatus for Fire Fighters*.

6-2.3 Station/work uniforms worn by RFF personnel shall meet the requirements of NFPA 1975, *Standard on Station/Work Uniforms for Fire Fighters*.

6-2.4 Other than RFF vehicle driver/operators, all RFF personnel engaged in any rescue or fire fighting operation shall wear complete protective clothing including SCBA and shall not remove any protective clothing or SCBA until they are in a safe area and so directed by the officer in charge.

Chapter 7 Airport Fire Station Location and Response Capability

7-1 Siting and Response.

7-1.1* RFF vehicles shall be garaged at one or more strategic locations as needed to meet required response times.

7-1.2* Emergency equipment shall have immediate and direct access to critical aircraft movement areas and the capability of reaching all points within the Rapid Response Area (RRA) in the time specified. Therefore, the location of the airport fire station shall be based on minimizing response time to aircraft accident and incident high hazard areas. Locating the airport fire station for structural fire fighting utility is of secondary importance.

7-1.3* The demonstrated response time of the first responding vehicle to reach any point on the operational runway shall be in two minutes or less and to any point remaining within the on airport portion of the rapid response area shall be no more than two and one half minutes, both in optimum conditions of visibility and surface conditions. Other RFF vehicles necessary to achieve the agent discharge rate listed in Table 3-3.1A or 3-3.1B shall arrive at intervals not exceeding 30 seconds.

Chapter 8 Referenced Publications

8-1* The following documents or portions thereof are referenced within this standard and shall be considered part of the requirements of this document.

8-1.1 NFPA Publications. National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

NFPA 10, *Standard for Portable Fire Extinguishers*, 1988.

NFPA 412, *Standard for Evaluating Foam Fire Fighting Equipment on Aircraft Rescue and Fire Fighting Vehicles*, 1987.

NFPA 414, *Standard for Aircraft Rescue and Fire Fighting Vehicles*, 1984.

NFPA 1003, *Standard for Airport Fire Fighter Professional Qualifications*, 1987.

NFPA 1975, *Standard on Station/Work Uniforms for Fire Fighters*, 1985.

NFPA 1981, *Standard on Self-Contained Breathing Apparatus for Fire Fighters*, 1987.

Appendix A

This Appendix is not a part of the requirements of this NFPA document but is included for information purposes only.

A-1-3 Approved. The National Fire Protection Association does not approve, inspect or certify any installations, procedures, equipment, or materials nor does it approve or evaluate testing laboratories. In determining the acceptability of installations or procedures, equipment or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization concerned with product evaluations which is in a position to determine compliance with appropriate standards for the current production of listed items.

A-1-3 Authority Having Jurisdiction. The phrase "authority having jurisdiction" is used in NFPA documents in a broad manner since jurisdictions and "approval" agencies vary as do their responsibilities. Where public safety is primary, the "authority having jurisdiction" may be a federal, state, local or other regional department or individual such as a fire chief, fire marshal, chief of a fire prevention bureau, labor department, health department, building official, electrical inspector, or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the "authority having jurisdiction." In many circumstances the property owner or his designated agent

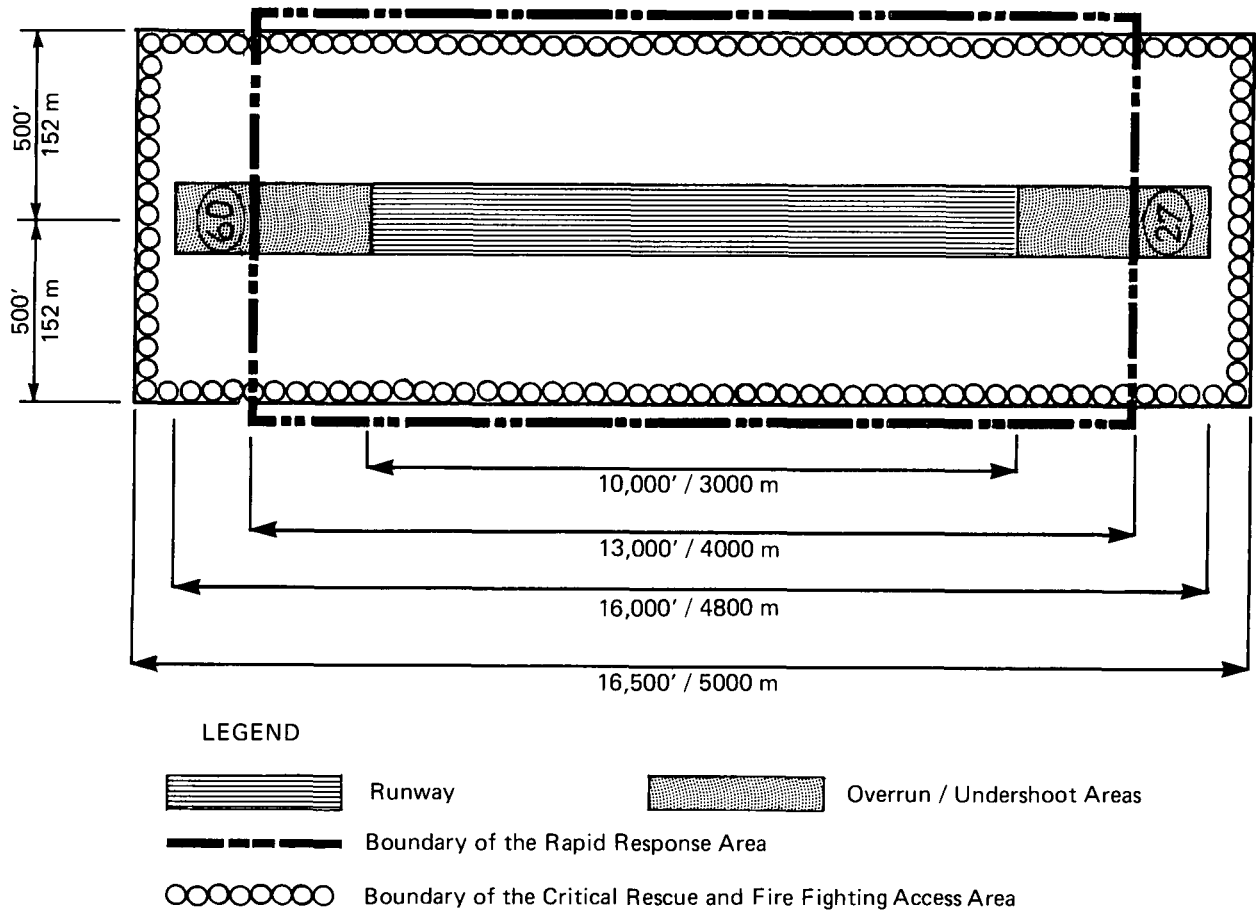

Figure A-1-3 Response Areas.

assumes the role of the "authority having jurisdiction"; at government installations, the commanding officer or departmental official may be the "authority having jurisdiction."

A-1-3 Rapid Response Area (RRA). Approximately 85 percent of the accidents as historically recorded in the CRFFAA occurred within the boundary of the RRA and response time to the on airport portion of the RRA should meet the times specified in 7-1.3. (*See Figure A-1-3.*)

A-2-2.1 See NFPA 424M, *Manual for Airport/Community Emergency Planning* for comprehensive guidance.

A-2-3.1 The level of RFF services required for airports is calculated using the following factors:

(a) aircraft size;

(b) potential size of fire;

(c) probable size of fire;

(d) effectiveness of fire suppressing agents;

(e) time frame within which fire must be controlled; and

(f) time span over which the area will need to be secured.

The above factors applied to a given airport will indicate the amount of fire suppressing agent(s) required and the rate at which agent(s) must be applied.

The factors for calculating RFF requirements are based on the potential size of an aircraft crash fire. This area is called the Theoretical Critical Area (TCA) and is a rectangle, the longitudinal dimension of which is the overall length of the aircraft, and a width that includes the fuselage and extends beyond it by a predetermined set distance that is dependent on the aircraft overall width. Therefore, aircraft length multiplied by the calculated width equals the size of the TCA.

The probable size of an aircraft crash fire is called the Practical Critical Area (PCA). Experience has shown that fire will have to be suppressed in only two-thirds of the TCA. Therefore, the area of the TCA multiplied by a factor of 0.667 equals the size of the PCA. See Figure A-2-3.1 (a).

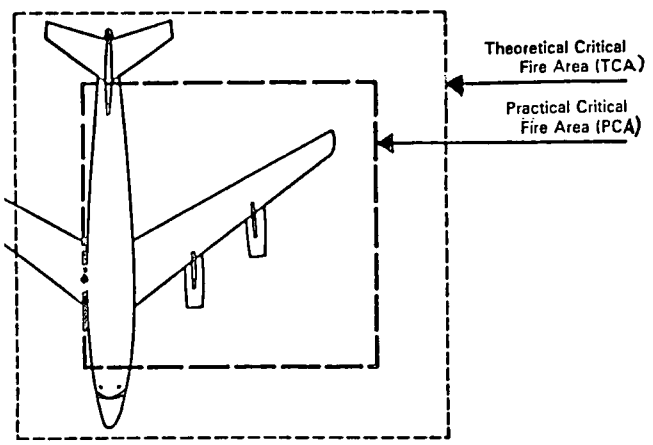

Figure A-2-3.1(a)

Fire suppressing agents are rated based on the quantity required to suppress one square meter of fire in one minute, which is the time frame within which all fire must be suppressed in the PCA. The time span over which conditions that will support life can be maintained is somewhat imprecise, as it is based on what experience has shown to be the occupant load of aircraft. The quantity of foam required to maintain a secure area can be dependent on the burnback resistance of the fire suppressing agent.

The quantity of water for foam production required for one minute fire control of the PCA is referred to as Q_1. In calculating this quantity the size of the PCA and the performance characteristics of foam agents as determined by large scale tests and practical experience is used. Specifically, the foregoing has indicated that to extinguish fire in one square meter or one square foot of fire area the application rate required is as follows:

(a) AFFF - 5.5 L/min/m² or 0.13 gpm/sq ft.;

(b) FPF - 7.5 L/min/m² or 0.18 gpm/sq ft; and

(c) PF - 8.2 L/min/m² or 0.2 gpm/sq ft.

The quantity of water for foam production required for reserve (Q_2) is calculated as a percentage of Q_1. It is based on what experience has shown to be the time span over which conditions that will support life in the PCA must be maintained. This volume of agent is used to repair foam blanket damage that may be caused by the evacuees and rescue workers walking through the foamed areas, or by hot surfaces created by the initial fire. Furthermore, Q_2 is needed to maintain a fire free area in the practical critical fire area and, where deemed appropriate, extinguish fires outside the practical critical fire area, that were initially determined to pose no threat to life. Agent from Q_2 also provides standby protection, before total extinguishment, during the time required to conduct interior aircraft search operations and for the removal of survivors after fire control. It is also used for securing the fire area during initial salvage operations immediately after total fire extinguishment.

The total quantity of water for foam production (Q) is the sum of Q_1 and Q_2. See Figure A-2-3.1 (b).

Water requirements for foam production on airports is therefore determined through application of the following formula:

$Q = Q_1 + Q_2$ Where Q = total water required.
Q_1 = requirement for control of the fire in the practical critical area.
Q_2 = water required to maintain control and/or extinguish the remaining fire.

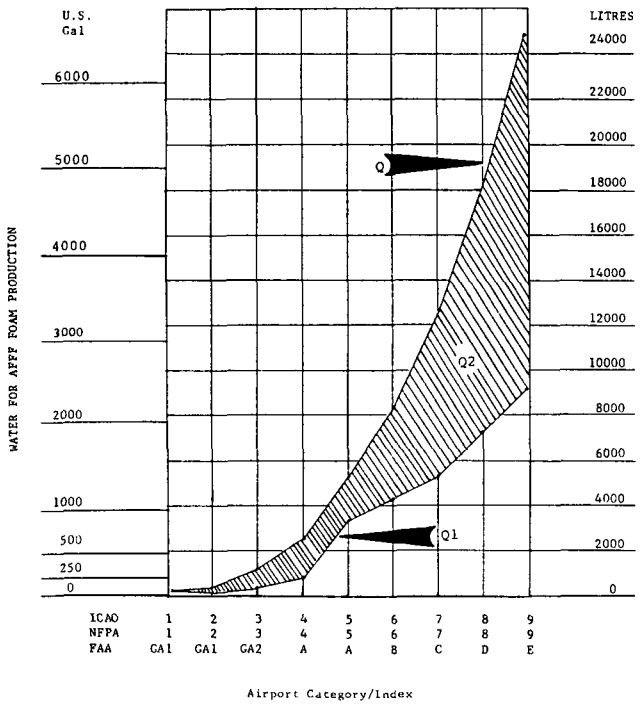

Figure A-2-3.1(b) Airport Category/Index.

Example

Airport Category 4

$= L \times (K + W)$

TCA $= 68.5 \times 62.6 = 4290\ ft^2$

PCA $= \frac{2}{3} \times TCA = \frac{2}{3} \times 4290 = 2860\ ft^2$

$Q_1 = .13\ gpm \times 2860\ ft^2 \times 1\ min$

$= 372$ gal

$Q_2 = 58\% \times Q_1$

$= .58 \times 372$

$= 215$ gal

$Q = Q_1 + Q_2$

$= 372 + 215$

Q = 587 gal or Q = 600 gal → rounded off

This quantity is shown in the second column of Table 3-3.1(a).

This example is given simply to illustrate the logic and the factors used to arrive at the quantity of water for foam production required for an airport category. Because of the arbitrary choice of aircraft length and width within categories and the fact that the relationship between Q_1 and Q_2 were developed by judgment, precise mathematical verification of the values shown in Table 3-3.1(a) should not be expected.

The value of Q_2 as a percentage of Q_1 has been determined to be:

A/P Cat.	Q_2 %Q_1	A/P Cat.	Q_2 %Q_1
1	0	6	100
2	27	7	129
3	30	8	152
4	58	9	170
5	75		

These values were based on the following considerations:

(a) Maximum gross weight of aircraft.

(b) Maximum passenger capacity;

(c) Previous experience (analysis of aircraft rescue and fire fighting operations); and

(d) Maximum fuel capacity.

The operational significance of Q is substantial in that Q_1 relates to both the specific quantities of fire suppression agents required to control fire in the PCA and to the requirement that the specified quantity of agents be applied to the PCA within a time frame of one minute. In turn, Q_2 relates to the need to have sufficient fire suppression agents available to maintain conditions that do not pose a threat to life in the PCA, until such time as rescue operations are completed. The secondary role of Q_2 is to extinguish all fires in and peripheral to the PCA.

Large scale tests and practical experience have indicated that an application rate of 5.5 L/min/m² (0.13 gpm/sq ft) for aqueous film forming foam and 8.2 L/min/m² (0.2 gpm/sq ft) for protein foam should control an aircraft fuel fire within one minute. A rate of 7.5 L/min/m² (0.18 gpm/sq ft) is used for fluoroprotein foam.

The theoretical area is determined from the following formula:

$A = L \times (K + W)$ Where A = theoretical area
L = length of aircraft
W = width of aircraft
and where K = values shown below

Feet	Meters
K = 39 when L = less than 39	K = 12 when L = less than 12
= 46 when L = 39 up to but not including 59	= 14 when L = 12 up to but not including 18
= 56 when L = 59 up to but not including 79	= 17 when L = 18 up to but not including 24
= 98 when L = 79 and over	= 30 when L = 24 and over

The quantity of water required for foam production is:

For AFFF: $(A \times 0.667 \times 5.5) = Q_1$
Quantity required $= Q_1 + Q_2$ (liters)

FPF: $(A \times 0.667 \times 7.5) = Q_1$
Quantity required $= Q_1 + Q_2$ (liters)

PF: $(A \times 0.667 \times 8.2) = Q_1$
Quantity required $= Q_1 + Q_2$ (liters)

For AFFF: $(A \times 0.667 \times .13) = Q_1$
Quantity required $= Q_1 + Q_2$ (gallons)

FPF: $(A \times 0.667 \times .18) = Q_1$
Quantity required $= Q_1 + Q_2$ (gallons)

PF: $(A \times 0.667 \times .20) = Q_1 + Q_2$ (gallons)

Airport categories are provided in order to eliminate the need for specific quantities of extinguishing agents for each type of aircraft.

The aircraft length factor used in calculating RFF requirements is the median of the length of the aircraft in the category. When the largest aircraft operating into an airport is the largest permitted for the category, authorities should provide additional quantities of extinguishing agents.

Table A-2-3.2 Representative Aircraft for Each Category

Airport Category	Aircraft Type	Overall External Fuselage Length		External Cabin Width	
		Meters	Feet	Meters	Feet
One	Beech Bonanza 35	8.01	26.33	1.07	3.50
	Cessna Stationair	8.61	28.25	1.12	3.67
	Cessna 310	8.99	29.50	1.23	4.00
	Piper Turbo Arrow	8.23	27.00	1.05	3.50
Two	Cessna 400 Series	11.30	36.33	1.42	4.67
	Piper Aerostar	10.55	34.67	1.17	3.85
	Piper Cheyenne	9.78	32.10	1.27	4.15
	Piper PA31	10.55	34.67	1.27	4.15
Three	Beech 99	13.56	44.50	1.04	4.60
	Cessna Citation III	16.90	55.50	1.73	5.67
	DHC6 Twin Otter	15.77	51.75	1.61	5.30
	EMB Bandeirante	15.10	49.50	1.60	5.25
	Lear 55	16.80	55.10	1.80	5.90
	Piper Cheyenne III	13.23	43.40	1.30	4.00
	Rockwell Saberliner	15.37	50.40	1.60	5.25
	Short 330	17.69	58.00	1.98	6.50
Four	Swearingen Metro 226	18.09	59.40	1.57	5.15
	Gulfstream III	23.72	77.85	2.24	7.33
	Gulfstream IC	22.96	75.33	2.24	7.33
	Fokker F27 MK200	23.56	77.25	2.73	8.96
	HS 748 Series 2B	20.42	67.00	2.46	8.10
	Short 360	21.59	70.85	1.93	6.33
Five	DHC-7 Dash 7	24.60	80.67	2.59	8.50
	Fokker F28 MK300	27.40	89.90	3.10	10.15
	HS 146 Series 100	26.16	85.85	3.38	11.10
Six	Bac Series 525	29.67	97.33	3.50	11.25
	Boeing 737 Series 200	29.54	96.90	3.52	11.50
	DC9 Series 30	36.37	119.00	3.07	10.10
Seven	Boeing 727 Series 200	41.51	136.15	3.55	11.67
	Boeing 757	47.90	155.30	3.96	13.00
	Boeing 707-311C	42.31	138.85	3.55	11.67
	DC8 Series 50	45.87	150.50	3.50	11.50
	DC9 Series 80	41.30	135.50	3.07	10.15
Eight	Boeing 767	48.49	159.10	5.02	16.50
	Airbus A300	52.03	178.70	5.35	17.60
	Boeing 747 SP	56.31	184.50	6.13	20.13
	Airbus A-310	45.13	148.00	5.29	14.38
	DC 10	51.97	170.50	5.72	18.75
	L1011 Series 200	54.17	177.67	5.77	18.90
Nine	Boeing 747 Series 200B	68.63	225.15	6.13	20.13
	C5A	75.54	247.00	5.79	19.00
	BAC/SUD Concorde	62.10	203.75	2.63	8.63

A-3-1.1 Foams used for control and extinguishment of aircraft fires involving fuel spills are produced by incorporation of air into a solution of foam concentrate and water. Their characteristics, as indicated by expansion and drainage rate, are influenced by the amount of mechanical agitation to which the water, foam concentrate, and air are subjected. They extinguish fire by physically separating the fuel vapors from the heat and oxygen necessary for combustion, spreading over the surface of the fuel to effectively suppress vaporization and secure an extinguished area by protecting it from reignition. Foam, being essentially water, cools the surface of the fuel and any metal surfaces in the fuel. The solution drainage from some foams forms an aqueous film on most aviation fuels. It is advantageous for a foam blanket to re-seal if disrupted, and essential that either the foam has good thermal and mechanical stability or that provision is made to renew the foam blanket from time to time during a lengthy rescue operation.

Foam liquid concentrates of different types or of different manufacturers should not be mixed unless it is first established that they are compatible. Protein and fluoroprotein foam concentrates, in particular, are generally not compatible with AFFF concentrates and should not be mixed, although foams generated separately from these concentrates are compatible and can be applied simultaneously to a fire. All foams used as primary agents are available for use at 3% and 6% concentrations, usually in either fresh or salt water, and some for use at other concentrations such as 1% or 5%.

Foam can be produced in a number of ways. The method of foam production selected should be carefully weighed, considering the techniques best suited for the equipment concerned, the rates and patterns of discharge desired and the manpower needed to properly utilize the foam capabilities of the vehicles. The principal methods of foam production are given in NFPA 412, *Evaluating Foam Fire Fighting Equipment on Aircraft Rescue and Fire Fighting Vehicles.*

The quality of water used in making foam can affect the foam performance. Locally available water might require adjustment of the proportioning device to achieve optimum foam quality. No corrosion inhibitors, freezing point depressants, or any other additives should be used in the water supply without prior consultation and approval of the foam concentrate manufacturer.

Caution.

Converting aircraft crash fire fighting and rescue vehicles to use a type of foam concentrate other than that for which they were initially designed should not be accomplished without consultation with the equipment manufacturer and without a thorough flushing of the agent and the complete foam delivery system. Particular attention should be given to assuring that the system component materials are suitable for the particular concentrate being substituted and that, where necessary, the proportioning equipment is recalibrated and reset.

Aqueous Film Forming Foam (AFFF) Concentrates.

These concentrates utilize fluorochemical and hydrocarbon surfactants. The foam produced acts both as a barrier to exclude air or oxygen, and as a reservoir which releases a vapor suppressing aqueous film with the ability to spread over the surface of most aviation fuels. This film-forming activity will continue as long as foam is present, but the foam blanket should not be relied on to be permanent and should be renewed from time to time during a lengthy rescue operation. The foam produced from AFFF concentrates is dry chemical compatible and is therefore suitable for use in combination with that agent.

Fluoroprotein Foam Concentrates.

These concentrates are essentially similar to protein foam concentrates with the addition of a fluorochemical surfactant, giving the foam greater tolerance to fuel contamination and an acceptable degree of compatability with dry chemicals. They form a fluid air-excluding blanket of foam and may also deposit a vapor-suppressing aqueous film on some fuels.

Protein Foam Concentrates.

These concentrates consist primarily of protein hydrolysate with stabilizing additives to give good fire resistance, and other additives to enhance the properties of the foam concentrate and resist bacterial decomposition. They form a stable cohesive foam blanket on the fuel surface. Because protein foams are generally not compatible with dry chemical agents, great care should be exercised if it is necessary to use the two agents in close proximity.

A-3-2.1(a) There are a number of chemical compounds offered on a proprietary basis which are referred to as dry chemical fire extinguishing agents. Historically, sodium bicarbonate based compounds were initially so described, but in recent years, a number of other chemicals have been tested and potassium bicarbonate based powders have proven most effective as a means of quickly extinguishing flammable liquid fires when applied with a proper technique and at an adequate rate. Potassium bicarbonate has good flooding characteristics and can penetrate to otherwise inaccessible areas. Dry chemicals, as currently used in aircraft rescue and fire fighting, can be used to extinguish three dimensional liquid fuel or running fires where foam is present on the ground.

A-3-2.1(b) Halogenated extinguishing agents are hydrocarbons in which one or more hydrogen atoms have been replaced by atoms from the halogen series: fluorine, chlorine, bromine, or iodine. This substitution confers not only nonflammability but flame extinguishment properties to many of the resulting compounds. Halogenated agents are used both in portable fire extinguishers and in extinguishing systems. The three halogen elements commonly found in extinguishing agents are fluorine (F), chlorine (Cl) and bromine (Br).

The extinguishing mechanism of the halogenated agents is not clearly understood. However, there is undoubtedly a chemical reaction which interferes with the combustion processes. Halogenated agents act by chemically interrupting the continuing combination of the fuel radicals with oxygen in the flame chain reactions. This process is known as "chain breaking."

The discharge of Halon 1211 may create hazards to personnel such as dizziness, impaired coordination, reduced visibility, and exposure to toxic decomposition products. In any proposed use of Halon 1211 where there is a possibility that people may be trapped in or enter into atmospheres made hazardous, suitable safeguards should be provided to ensure prompt evacuation of and to prevent entry into such atmospheres and also to provide means for prompt rescue of any trapped personnel. Breathing apparatus should be worn.

Halon 1211 is a liquefied gas discharged as an 85 percent liquid stream which forms a vapor cloud when in contact with the fire which permits penetration of obstructed and inaccessible areas. Halon 1211 leaves no agent residue and is the preferred agent for aircraft tire fires, engine fires, interior aircraft fires, electrical component fires, and flightline vehicle/equipment engine fires.

A-3-4.1 It is important that the compatability of the foam and dry chemical agents be established if they are to be used together. Halon 1211 is compatible with all foams.

A-3-5.1 A variety of metals burn when heated to high temperatures by friction or exposure to external heat; others burn from contact with moisture or in reaction with other materials. Because accidental fires can occur during the transportation of these materials, it is important to understand the nature of the various fires and hazards involved. The most common combustible metals used in aircraft are magnesium and titanium.

The hazards involved in the control or complete extinguishment of combustible metal fires include extremely high temperatures, steam explosions, hydrogen explosions, toxic products of combustion, explosive reaction with some common extinguishing agents, breakdown of some extinguishing agents with the liberation of combustible gases or toxic products of combustion, and dangerous radiation in the case of certain nuclear materials. Some agents displace oxygen, especially in confined spaces. Therefore, extinguishing agents and methods for their specific application should be selected with care. Some combustible metal fires should not be approached without suitable self-contained breathing apparatus and protective clothing, even if the fire is small. Other combustible metal fires can be readily approached with minimum protection.

Numerous agents have been developed to extinguish combustible metal (Class D) fires, but a given agent does not necessarily control or extinguish all metal fires. Although some agents are valuable in working with several metals, other agents are useful in combating only one type of metal fire. Despite their use in industry, some of these agents provide only partial control and cannot be classed as actual extinguishing agents. Certain agents that are suitable for other classes of fires should be avoided in the case of combustible metal fires, because violent reactions can result (e.g., water on sodium; vaporizing liquids on magnesium fires).

Certain of the combustible metal extinguishing agents have been in use for years, and their success in handling metal fires has led to the terms "approved extinguishing powder" and "dry powder." These designations have appeared in codes and other publications where it was not possible to employ the proprietary names of the powders. These terms have been accepted in describing extinguishing agents for metal fires and should not be confused with the name "dry chemical" which normally applies to an agent suitable for use on flammable liquid (Class B) and live electrical equipment (Class C) fires.

A-4-1.1 It is desirable to have more than one vehicle available to facilitate attacking aircraft fires from more than one point or quarter, as an aid to expedite rescue, to reduce the potential seriousness of vehicle breakdown, and to minimize the "out of service" consequences when a vehicle is in need of routine maintenance or repairs. Having at least two fire fighting vehicles available is particularly important when dealing with transport-type aircraft due to the need to rapidly cover any burning fuel spill to protect the aircraft and its occupants from radiated heat during the evacuation and rescue period, and to main-

tain the secure area around the fuselage to permit the safe evacuation and rescue of the occupants.

A-4-1.2 The capacity of each vehicle with regard to fire fighting, rescue equipment, and staffing should be compatible with the desired performance characteristics established for vehicles in the various catagories specified in NFPA 414, *Standard for Aircraft Rescue and Fire Fighting Vehicles*. It is particularly important that the vehicle not be overloaded so as to reduce the required acceleration, top speed, or vehicle flotation below the acceptable minimums set forth in NFPA 414, *Standard for Aircraft Rescue and Fire Fighting Vehicles*.

The off-pavement performance capability of each RFF vehicle should be established by tests at each airport during the various weather and terrain conditions experienced at that airport to establish, prior to an actual emergency, the capabilities and limitations of the vehicle for off-pavement response to accident/incident locations. In addition, periodic tests should be conducted to assure that the performance requirements of the vehicle are as originally designed, and that the skill levels of the driver/operators remain high.

Where climatic or geographic conditions exist which considerably reduce the effectiveness of conventional wheeled vehicles, it is often necessary to carry extinguishing agents in a specialized vehicle suitable for traveling the airport terrain, such as a tracked, amphibious, air cushioned, or high mobility wheeled vehicle. Where these difficult operational conditions exist, experts should be consulted to develop a vehicle specification which matches the vehicle's performance capabilities to the unique conditions present at the airport.

Overall vehicle dimensions should be within practical limits with regard to local highway practices, width of gates and height and weight limitations of tunnels and bridges, and other local considerations.

Simplicity of vehicle operation with emphasis on operation of the extinguishing agent discharge devices is extremely important due to the time restrictions imposed for successful aircraft rescue and fire fighting operations and the need to keep the fire fighting crew to the minimum required for safe and efficient operations. Successful control of the fire in the PCA is essential using the minimum amount of agent necessary to secure the objective. To control an aircraft fire it is necessary to apply extinguishing agents at a rate higher than the fire is capable of destroying the control effort. Hand hose lines are usually not adequate for fire involving larger types of aircraft due to their limited discharge rate and are used primarily for protection of rescue parties, maintaining control of the fire in the PCA area, and combating fires in aircraft interiors. For these reasons, turrets are needed to rapidly knock down the fire and secure the evacuation routes.

Improvements in vehicle and equipment design over recent years have increased the fire fighting efficiency of these units and have outdated older rescue and fire fighting vehicles. Before procuring any used vehicle for an airport rescue and fire fighting service, the possible savings in initial cost should be carefully weighed against the lower maintenance cost, the reduced manpower requirements, and the greater fire fighting efficiency that can be expected from new vehicles and equipment built in accordance with NFPA 414, *Standard for Aircraft Rescue and Fire Fighting Vehicles*. Secondhand vehicles might have been subjected to abusive service, components may have been overstressed, and repair parts might be impossible to obtain. Foam fire fighting equipment purchased for this service should be tested in accordance with NFPA 412, *Standard for Evaluating Foam Fire Fighting Equipment on Aircraft Rescue and Fire Fighting Vehicles*.

Specialized vehicles such as elevated platform devices or aerial water towers might be needed at some airports to allow fire fighters to reach elevations above the normal range of airport RFF vehicles. Provision of escape slides or other rapid evacuation systems on these vehicles might be invaluable in effecting a rapid rescue.

All essential vehicles should be provided with two-way radio communications with air traffic control (ATC) or the airport controlling facility, i.e., air-radio, flight service station, etc.

A-4-2.1 The following equipment should be carried on each RFF vehicle:

(a) One ladder of overall length appropriate to the aircraft using the airport. This ladder is to be of lightweight alloy, aluminum or magnesium, 16-in. minimum width, and mounted in quick release brackets on the apparatus and readily accessible. This ladder is not intended for evacuation use.

(b) RIV's and Class 1 Major Fire Fighting Vehicles should be equipped with a ladder capable of extending to a length of at least 16 ft.

Class 2, 3 and 4 Major Fire Fighting Vehicles should be equipped with a ladder capable of extending to a length of at least 20 feet.

(c) Two portable six-volt electric, weatherproof, handheld lanterns having a minimum 25,000 beam candle power rating with carrying straps.

(d) One six-pound crash axe with a serrated cutting edge and designed to prevent full penetration.

(e) One adjustable hydrant wrench capable of accommodating up to a 1.75-in. pentagon nut and up to a 1.25-in. square nut.

(f) One set of double male and double female connectors to fit each tank fill connection size provided on the vehicle. The connector material should be specified.

(g) Appropriate coupling wrenches for each size of hose carried on the vehicle.

(h) Two approved fire extinguishers having a minimum 80B:C UL rating of either dry chemical or Halon 1211. The dry chemical extinguishers should be the external propellant cartridge type.

(i) One 36-in. crowbar.

(j) One "D" handle pike pole with a shaft of fiberglass or other nonconductive material of similar density.

(k) One rubber mallet suitable for removing long-handled pipe caps.

(l) One 36 unit first aid kit.

(m) One general purpose cutter with capacity to cut

up to .38 in. diameter hardened steel (Bhn 300) bolts.

(n) Two Dzus fastener keys.

(o) One tool roll to include at least the following equipment:

(1) One aircraft cable cutter, 14-in., capacity to ¼ in.

(2) One lineman's pliers, heavy duty, 8 in. long.

(3) One grappling hook and rope sling, 40 in. long.

(4) One hack saw frame, adjustable 8 to 12 in.

(5) Three hack saw blades, 10-in. steel.

(6) Six fuel line plugs: 3 hardwood, 3 neoprene.

(7) One rescue knife with "V" blade.

(8) One vise grip wrench, 10 in. long.

(9) One metal cutting saw, 20-in. blade.

(10) Two industrial grade slot-type screwdrivers (one 4- and one 6-in. blade).

(11) Two industrial grade Phillips screwdrivers (one 4- and one 6-in. blade).

(12) One hande axe with serrated face and insulated handle.

One hydraulic rescue kit should be carried on an in-service RFF vehicle.

A-5-1.2 At those locations where the primary alerting authority (such as a control tower) is not operational during all the hours that the airport is open to aircraft traffic, a secondary alerting authority should be designated and trained. Appropriate communications and alarm control devices should be available at the secondary alerting authority's operating location and be operational during all times that the primary alerting authority is not available.

At those locations where a city/town/county off-airport fire department furnishes the airport rescue and fire fighting personnel, and the alerting/dispatch of those personnel for airport emergencies is handled by an emergency direct-line telephone between the airport alerting authority and the off-airport alarm room, the airport fire station alarm(s) should ring upon activation of the direct emergency line. If possible, this type of "third party" dispatching of airport fire fighting and rescue services should be avoided.

Because the majority of the calls for aircraft RFF services are initiated by or first received by air traffic controllers, the airport fire department alarm room and the control tower, the flight service station or other air traffic control point should be linked by two-way radio and direct-line telephone to enhance the response time of the fire and rescue crews.

The emergency direct-line telephone should not pass through any intermediate automated switchboard or operator that could subject the alert calls to delays.

The tone of the emergency telephone bell (or buzzer) should be distinctly different from all other communications signaling devices within hearing of personnel in the alarm room, on the apparatus floor or, in living quarters as applicable.

Protection against delays due to telephone bell/buzzer failure should be provided by use of redundant warning lights activated by the same input signal as the telephone ringer. The lights should be strategically located throughout the alarm room, the apparatus floor, and living space as dictated by the fire station design and the normal activities of the fire and rescue service personnel.

The fire station alarm should be linked to the emergency telephone so that a call on the emergency telephone circuit simultaneously actuates the audible alarm throughout the fire station.

Consideration should be given to having the alarm circuitry open the vehicle bay doors in the fire station upon sounding the alarm. However, some climatic conditions can make this impractical, or noise when doors are opened can interfere with hearing the dispatch.

The notification of all units designated to respond to an aircraft emergency on a large airport should be done through the use of a "conference" circuit that allows simultaneous notification. This "conference" circuit should include, as appropriate, the following units or offices:

(a) Control tower, flight service station, or other control point;

(b) Rescue and fire fighting;

(c) Airport police;

(d) Airport management;

(e) Airline station manager(s) as appropriate;

(f) Military units (joint-use airports); and

(g) Other authorities on or off the airport as required by the airport's emergency plan.

At airports with several air carriers, the notification of the appropriate station manager might be accomplished more effectively by the use of individual paging devices.

Fire stations where personnel are normally present for duty, but may be preoccupied with "housekeeping" or training duties, should be equipped with a public address system. This is particularly important in fire stations where the alarm room, training room, and living quarters are physically separated from the apparatus floor. Such a system should significantly enhance response time and fire fighter effectiveness by providing vital details of the emergency to each fire fighter during response, e.g., location of accident or incident site, type of aircraft, number of persons involved, aircraft fuel load, preferred vehicle routing, etc.

At airports with a main fire station and one or more substations, an interconnected public address system should be provided.

At airports employing dual function personnel or auxiliary fire fighters, an audible alarm should be installed in all areas where auxiliary fire fighting personnel are employed to notify them of any emergency recall for fire and rescue duties. It should be a distinctly different sound and loud enough to be clearly heard above the normal noise level.

At airports equipped with ground-to-air radio, the person authorized to receive in-flight emergency messages

should be provided with a device for actuating these alarms.

Alarm actuating stations should be provided near hangars, shops, fueling stations, and aircraft parking areas.

Individual paging devices, although potentially more expensive, can be used. This method has the advantage of notifying those persons with assigned rescue fire fighting duties.

A reliable voice communications capability should be available between the airport rescue and fire fighting service and any off-airport organizations expected to participate in the airport-community mutual aid plan.

Each emergency response vehicle on an airport should be equipped with two-way voice radio communication between the alerting authority, all other aircraft rescue and fire fighting vehicles, and the designated command post.

On airports with a control tower the communications channel between vehicles and the tower should be on the assigned standard ground control frequency, or as designated in the Airport Emergency Plan Letter of Agreement between airport management, the control tower and/or flight service station.

On airports without a control tower but having another means of ground-to-air communications, the rescue and fire fighting vehicles should be equipped to communicate on a frequency common with the control point.

Where practicable, the two-way radio capability on the airport fire and rescue service vehicle(s) should not be "tied into" Public Service frequencies (City-County or Airport Maintenance). This independent communications network will help ensure interruption-free communication in an emergency situation.

On-scene commanders (OSC) should have a communication capability while outside or remote from their vehicle communications systems. Portable radios can be used by the OSC for direct contact with the airport fire services and air traffic control services.

A reliable form of communication should be provided between the aircraft commander, the OSC, RFF services and the airport alerting authority to preclude unnecessary aircraft emergency evacuation or misunderstandings.

Direct communications can be established between the flight deck and the OSC or RFF personnel by use of flight-deck-to-ground lines. Normally this communication capability results from the use of a ground service headset which is plugged into a wheel well or nose interphone jack.

The airport rescue and fire fighting service alarm room should be designed and operated in such a manner that an alarm can be received, evaluated, and acted upon with a minimum of activity and/or consultation.

For an alarm room to serve its intended function, provisions should be made to assure that all personnel assigned to alarm room duties are trained in communication equipment operations, proper communication procedures, and local emergency plan implementation procedures.

A-6-1.3 A carefully organized training program should be developed to meet the qualification requirements of NFPA 1003, *Standard for Airport Fire Fighter Professional Qualifications*. The following guidelines are offered for structuring such a program.

The objectives of a training program for aircraft rescue and fire fighting personnel at airports should be to:

(a) Teach the safe application of recognized practices and procedures.

(b) Develop and maintain the confidence and competency of all personnel assigned RFF duties;

(c) Instill the concept of professionalism;

(d) Serve as a source of accurate technical information whereby the lessons gained from aircraft accidents or incidents are properly analyzed and the information disseminated to others concerned with RFF operations; and

(e) Enhance the esprit-de-corps of aircraft rescue and fire fighting personnel by creating an appreciative awareness of the hazards and dangers they may face in carrying out RFF operations.

Control and Planning.

The complete training and educational program for aircraft rescue and fire fighting personnel should be under the direction of one officer of the airport fire department for planning, development and supervision.

Resources for Training.

Training material resources for a training program oriented specifically to meet the needs of aircraft rescue and fire fighting personnel should take into consideration providing suitable amounts of extinguishing agents, such as foam concentrate, dry chemical, and Halon 1211; and fuel for training fires.

Phases of Training.

Training of aircraft rescue and fire fighting personnel should include seven phases. Training in all phases should be conducted for support personnel used as auxiliary fire fighters and for full-time aircraft rescue and fire fighting personnel. Because of the factor of time availability for schooling, the depth into which subjects are covered will vary, but the scope should not be reduced for auxiliary fire fighters.

Indoctrination.

Indoctrination training should include the following:

(a) The rules and regulations applicable to RFF services;

(b) Knowledge of the basic duties and responsibilities and those of co-workers;

(c) Emergency response procedures;

(d) The command structures for administration and operations; and

(e) The importance of practicing occupational safety.

Operating RFF Equipment.

All aircraft rescue and fire fighting personnel should be capable of effectively handling fire and rescue equipment under varied conditions of terrain and weather. The aim of training should be to assure that every fire fighter is so well versed in handling all types of appliances and tools used in RFF operations that under stressful conditions individual fire fighters can take effective action without the need for specific direction. Among the items that should be covered are:

(a) Complete knowledge of each tool and piece of equipment;

(b) The location of each piece of equipment and tool carried on each vehicle;

(c) The method of using each piece of equipment and tool, with emphasis on personal safety factors;

(d) Special handling precautions for the use of power tools;

(e) Knowledge of, and training in, the use of breathing apparatus and other protective equipment;

(f) The techniques employed in utilizing the available communication equipment;

(g) Knowledge of the apparatus, its built-in equipment, including the pump and its performance capabilities, the agents carried and their delivery systems;

(h) Actual operation of all vehicle controls and behind-the-wheel driver training under circumstances including negotiating obstacles and muddy or snow-covered soil conditions. This is done to provide a degree of assurance that the vehicle will not get bogged down or damaged during emergencies.

(i) Knowledge of departmental policies on positioning of apparatus for tactical service at accidents/incidents under the variety of possible conditions to be encountered; and

(j) Recordkeeping to document the efficiency and effectiveness of the various vehicles utilized by the airport fire department.

Fire Behavior and Fire Suppression.

Aircraft rescue and fire fighting personnel should possess a sound knowledge of fire behavior.

Instruction in this phase should include:

(a) The principles of combustion, with emphasis on the types of aircraft fuels;

(b) How fire propagates through the effects of heat conduction, convection, and radiation;

(c) The influence of fuel distribution on heat production;

(d) The principles of fire suppression by the various types of agents utilized in aircraft rescue and fire fighting operations;

(e) Live fire exercises that include but are not limited to exterior fuel fires, interior fires, engine fires, wheel fires, and fires involving on-board auxiliary power units; and

(f) The effects of heat exposure on individuals.

Training should be given covering the advantages and disadvantages of each fire extinguishing agent employed. Every opportunity should be taken to use the agents on realistic training fires. Each routine equipment test should be used as a training exercise to provide experience in the proper handling of the equipment, and to establish the proper technique of application of each agent available.

Rescue and Fire Fighting Procedure

Care should be taken to ensure that aircraft rescue and fire fighting personnel fully understand that to achieve the objective of safeguarding the lives of those involved in an aircraft accident requires that fire in the practical critical area be controlled quickly and that this area be kept secure. Strict discipline should be maintained to ensure that fire suppression agents are not expended on fire outside the PCA until it is positively established that the immediate and long term security of the PCA will not be jeopardized.

Personnel should be given thorough instructions in the following subject areas:

(a) The Standard Operating Procedures (SOP) to be expected from the aircraft crew members under specified circumstances;

(b) The locations within aircraft where victim concentration may be anticipated under accident conditions of various types;

(c) Behavior patterns of individuals involved in major disasters;

(d) Means of preventing and/or minimizing panic;

(e) Means of gaining entry through normal aircraft openings;

(f) Locations most suitable for forcible entry into the aircraft;

(g) Requirements of setting up triage and treatment areas which should be part of the Airport/Community Emergency Plan (*see NFPA 424*); and

(h) Methods of carrying injured persons (one-person and by teams).

Familiarization with Local Terrain.

A thorough knowledge of the terrain of the airport and its immediate vicinity is essential. The existence of any areas which may from time to time become impassable because of weather or other conditions (tides, growth of brush, etc.) should be known to all crew members. Training should include actual RFF vehicle operations over primary and secondary travel routes on the airport and runway overrun areas. Familiarization with areas outside the airport boundary to which the on-airport RFF equipment might be authorized to respond can be accomplished with other vehicles. Personnel should also receive training during periods of diminished visibility.

The instruction program should include:

(a) Locations of obstacles both temporary and permanent;

(b) Locations of exit points (gates and/or frangible sections) in the security fence;

(c) Location of rendezvous points for mutual aid apparatus as planned in the Airport/Community Emergency Plan;

(d) Areas that might become impassable in inclement weather;

(e) Availability of helicopters, boats, swamp buggies, air cushion vehicles or other off-road conveyances; and

(f) The operation of each RFF vehicle and its capability to negotiate the existing terrain under the various conditions that may be anticipated.

Aircraft Familiarization Training.

Aircraft rescue and fire fighting personnel should be familiar with:

(a) Locations of phone jacks on different types of aircraft;

(b) The availability and method of operation of aircraft escape devices;

(c) The location of aircraft batteries, and means of disconnect;

(d) The amount and type of aircraft fuel carried and the fuel storage locations in each aircraft;

(e) The location and quantity of oxygen carried;

(f) Access to wheel wells, engine accessory compartments, and other areas of critical concern; and

(g) The fire behavior characteristics and locations in the aircraft of combustible metals (magnesium, titanium), plastics (cabin liners, seating), combustible insulation (for electrical wiring and sound deadening), hydraulic fluids, lubricating oil, rubber, and similar combustibles and flammable materials.

Emergency Medical Training.

Every member of the airport RFF services should be given initial and recurrent training in emergency medical procedures.

A-6-2.1 Although NFPA 1971, *Standard on Protective Clothing for Structural Fire Fighters*; NFPA 1972, *Standard on Helmets for Structural Fire Fighters*; and NFPA 1973, *Standard on Gloves for Structural Fire Fighters*, do not apply to RFF protective clothing, RFF protective clothing should at least meet the minimum requirements of these standards. Guidance and proximity of protective clothing can be found in FAA Advisory Circular 150/5210-14 dated 12 March 1986.

Fire entry suits are not recommended for civil airport application. Rapid fire control afforded by present fire fighting equipment and short times for survival without fire control make the fire entry suit unnecessary and inappropriate.

A-6-2.2 Tests have shown that many toxic gases are produced when aircraft cabin interior finish materials are burned or charred. These gases include carbon monoxide, hydrogen chloride, chlorine, hydrogen cyanide and other cyanogen components, and carbonyl chloride (phosgene). A principal cause of difficulty lies in the fact that the supply of breathing air is greatly reduced by combustion of these cabin finish materials. It is, there-

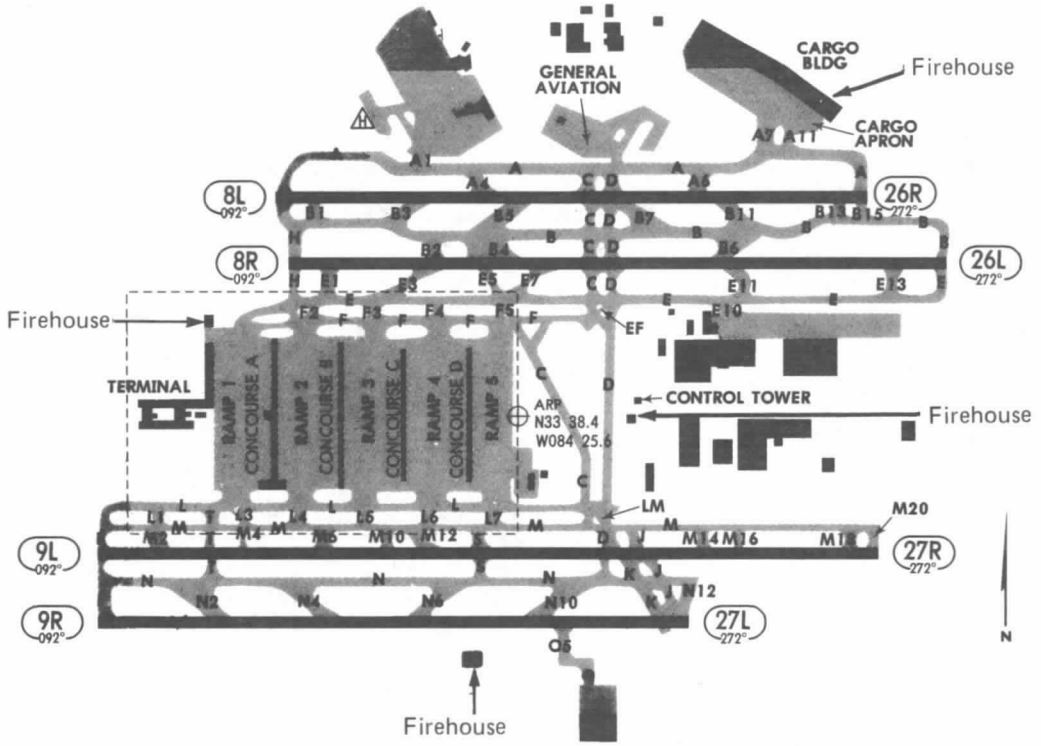

Figure A-7-1.2(a) Example of Category 9 Airport Fire Station Locations.

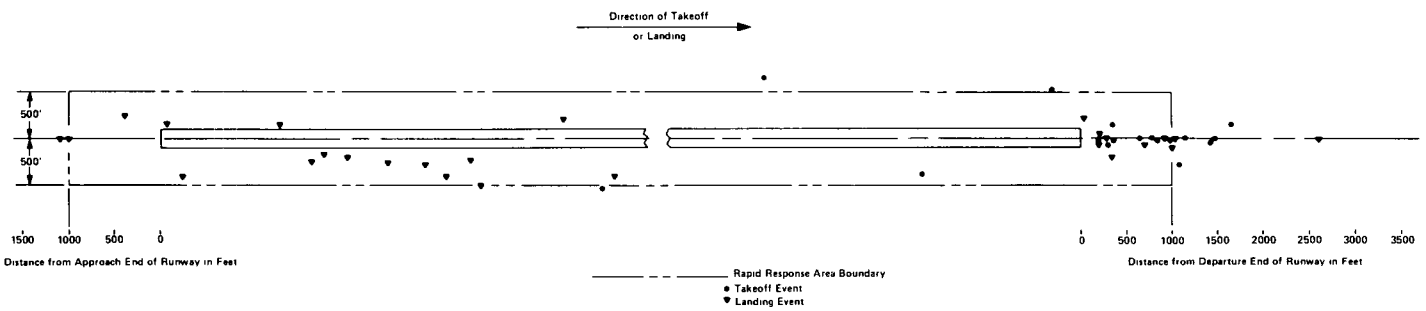

Figure A-7-1.2(b)

fore, necessary that RFF personnel who enter or operate in the vicinity of an aircraft during the fire sequence be equipped with self-contained breathing equipment. Helmets or hoods should be designed to accommodate the SCBA facepiece without interference; most existing proximity hoods do not have this provision.

A-7-1.1 Factors that influence response time include:

(a) The means of notification of the RFF force;

(b) The completeness of the information in the activation message;

(c) The location of the fire station;

(d) The acceleration, top speed, on-road handling and off-road mobility characteristics of the vehicles;

(e) The degree of preparatory training;

(f) The provision of emergency access roads; and

(g) Climatic conditions.

A-7-1.2 The geographical center of an airport might not be the best location for siting the airport fire station. Before selecting the actual location, time trials should be run to determine the optimum location that assures the quickest response to all potential accident sites. Also, an evaluation should be placed on present and future usage of the airport movement areas to assure proper selection of the fire station site. See Figures A-7-1.2(a), and (b).

Care should be taken to ensure that access to or from the airport fire station cannot and will not be blocked by taxiing or parked aircraft or vehicular traffic.

Airport fire stations located close to taxiways and runways or adjacent to flight patterns should have soundproof training rooms, living quarters, and an alarm room. The high noise level of turbine engines can cause damage to hearing; accordingly, at airports handling turbine powered aircraft, fire fighters on duty outside of soundproofed areas should be provided with aural protection. Where high noise levels are encountered it might be necessary to supplement audible signals with visual signals, such as flashing lights, to alert fire fighters.

Where airport response plans call for response outside the airport fences, suitable exits should be provided around the perimeter of the airport for RFF vehicles. Particular attention should be given to the provision of ready access to the RRA and CRFFAA. The Critical Rescue and Fire Fighting Access Area (CRFFAA) is the rectangular area surrounding any given runway. Its width extends 150 m (500 ft) outward from each side of the runway centerline, and its length is 1000 m (3,300 ft) beyond each runway end. This is the area where accidents historically have occurred. (*See Figure A-7-1.2(b).*)

A-7-1.3 Two or more airport fire stations should be strategically located on the airport where a centrally located fire station cannot meet the response criteria given in 7-1.3.

A-8-1 The edition indicated for each reference is the current edition as of the NFPA issuance of this document.

Appendix B Referenced Publications

B-1 The following documents or portions thereof are referenced within this standard for informational purposes only and thus are not considered part of the requirements of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

B-1.1 NFPA Publications. National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

NFPA 10, *Standard for Portable Fire Extinguishers*, 1988

NFPA 402M, *Manual for Aircraft Rescue and Fire Fighting*, 1984

NFPA 408, *Standard on Aircraft Hand Fire Extinguishers*, 1984

NFPA 419, *Guide for Master Planning Airport Water Supply Systems for Fire Protection*, 1987

NFPA 422M, *Aircraft Fire Investigators Manual*, 1984

NFPA 424M, *Manual for Airport/Community Emergency Planning*, 1986.

B-1-2 Other Publications.

International Fire Service Training Association Publications.

IFSTA 206, Aircraft Fire Protection and Rescue Procedures. Available from International Fire Service Training Association, Oklahoma State University, Stillwater, OK, 74078 or Canadian Association of Fire Chiefs, 1590-7 Liverpool Court, Ottawa, Canada K1B 4L2.

ICAO Publications.

Available from International Civil Aviation Organization, 1000 Sherbrooke St. W., Montreal, Quebec, Canada*, H3A 2R2.

International Standards and Recommended Practices - Aerodromes, Annex 14, Eighth Edition, March 1983.

Airport Services Manual, Part 1 - Rescue and Fire Fighting, Second Edition, 1984, Doc 9137-AN/898, Part 1.

Airport Services Manual, Part 7 - Airport Emergency Planning, First Edition, 1980, Doc 9137-AN/898, Part 7.

Airport Services Manual, Part 8 - Airport Operational Services, First Edition, 1983, Doc 9137-AN/898, Part 8.

Heliport Manual, Second Edition, 1985, Doc 9261-AN/903/2.

Training Manual, Aerodrome Fire Services Personnel, First Edition, 1976, Doc 7912-AN/857, Part E-2.

Manual of Aircraft Accidents Investigation, Fourth Edition, 1970, Doc 6920-AN/855/4.

Aerodrome Manual, Part 6 — Fourth Edition, 1971, Doc. 7920-AN/865, Part 6.

*And other offices in Bangkok, Thailand; Cairo, Egypt; Dakar, Senegal; Lima, Peru; Mexico City, Mexico; Paris, France.

Air Line Pilots Association Publications.

ALPA - Guide for Airport Standards, Third Edition 1981. (Available from Air Line Pilots Association, Engineering and Air Safety Department, 535 Herndon Parkway, PO Box 1169, Herndon Virginia, 20070.)

Federal Aviation Administration Publications.

Available from the Department of Transportation, Distribution Unit, M-494.3, Washington, D.C. 20590.

Advisory Circulars. - This listing is limited to advisory circulars of substance concerning aircraft rescue and fire fighting. For complete listing of FAA advisory circulars write the FAA and request copy of latest "Advisory Circular Checklist and Status of Federal Aviation Regulations." This checklist is published periodically in the Federal Register.

150/5200-12A, Fire Department Responsibility in Protecting Evidence at the Scene of an Aircraft Accident (4-8-85). Guidance on the proper preservation of evidence at the scene of an aircraft accident.

150/5200-13, Removal of Disabled Aircraft (8-27-70). Covers the responsibility for disabled aircraft removal and need for preplanning to facilitate removal from airport operating areas.

150/5200-18, Airport Safety Self-Inspection (2-5-72). Suggests functional responsibility, procedures, a checklist and schedule for an airport safety self-inspection.

150/5210-2A, Airport Emergency Facilities and Services (11-27-84). Provides information and advice so that airports may take specific voluntary preplanning actions to assure at least minimum first-aid and medical readiness appropriate to the size of the airport in terms of permanent and transient personnel.

150/5210-5B, Painting, Marking, and Lighting of Vehicles Used on an Airport (7-11-86). Provides guidance, specifications, and standards, in the interest of airport personnel safety and operational efficiency, for painting, marking, and lighting of vehicles operating in the airport air operations area.

150/5210-6B, Aircraft Fire and Rescue Facilities and Extinguishing Agents (1-26-73), with CH I (8-22-73) and CH 2 (5-14-74). Outlines scales of protection considered as the recommended level compared with the minimum level in FAR Part 139.49.

150/5210-7B, Aircraft Fire and Rescue Communications (4-30-84). Provides guidance for planning and implementing an airport communications system for airport fire and rescue service.

150/5210-12, Fire and Rescue Service for Certificated Airports (3-2-72). Explains the minimum criteria to be applied when evaluating the service for compliance with FAR Part 139.

150/5210-13, Water Rescue Plans, Facilities, and Equipment (5-4-72). Suggests how to effectively perform rescue operations when an aircraft lands in a body of water, swamp, or tidal area where normal aircraft fire fighting and rescue service vehicles are unable to reach the accident scene.

150/5210-14, Airport Fire and Rescue Personnel Protective Clothing (3/12/86) Developed to assist airport management in the development of local procurement specifications for an acceptable, cost-effective proximity suit for use in aircraft rescue and fire fighting operations.

150/5230-4, Aircraft Fuel Storage, Handling, and Dispensing on Airports (8-27-82). The title is self-explanatory.

150/5280-1, Airport Operations Manual (6-16-72). Sets forth guidelines to assist airport operators in developing such a manual.

150/5280-3, Fire Fighting Exemptions Under the 1976 Ammendment to the Federal Aviation Act. (2-4-77)

150/5325-5B, Aircraft Data (7-30-75). Presents a listing of aircraft giving dimensional data.

150/5370-2C, Operational Safety on Airports During Construction (5-31-84). Title is self-explanatory.

139.49-1, Programs for Training of Fire Fighting and Rescue Personnel (11-12-74). Suggested training programs for airport fire fighting and rescue personnel.

FAR Part 139, Certification and Operations; Land Airports Serving Certain Air Carriers. (Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.)

Department of Transportation Documents.

DOT/FAA/AS/80-2, Airport Crash/Fire/Rescue (CFR) Service Cost and Benefit Analysis (Vol I Text, Vol. II Appendices). NTIS #PB 82-220773; Paper—$30.00, Microfiche—$4.00.

DOT/FAA/AS82-1, Airport Crash, Fire, and Rescue; Policy Alternatives Suitable for Further Analysis. NTIS #PB 82-220781; Paper—$10.50.

DOT/FAA/AS/82-2, Airport Crash, Fire, and Rescue; Technical Research Program. NTIS #PB 82-220799; Paper—$7.50, Microfiche—$4.00.

DOT/FAA/AS/82-3, Airport Crash, Fire, and Rescue; Estimating the Effects of Leading Policy Alternatives. NTIS #PB 82-220807; Paper—$36.00, Microfiche—$4.00.

DOT/FAA/AS/82-4, A Cost-Benefit Analysis of Airport Crash, Fire, and Rescue Policy Alternatives: Summary and Recommendations. NTIS #PB 82-220815; Paper—$10.50, Microfiche—$4.00.

Any person may purchase a copy of any or all of the reports by submitting a request to the National Technical Information Service, 5288 Port Royal Road, Springfield, VA 22161, or by calling (703) 487-4650. Make check payable to "National Technical Information Service." Prices subject to change.

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