NFPA® 403

Standard for Aircraft Rescue and Fire-Fighting Services at Airports

2009 Edition

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An International Codes and Standards Organization

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Standard for

Aircraft Rescue and Fire-Fighting Services at Airports

2009 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. It was issued by the Standards Council on July 24, 2008, with an effective date of September 5, 2008, and supersedes all previous editions.

This edition of NFPA 403 was approved as an American National Standard on September 5, 2008.

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 (USA) 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. 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.

The 1988 edition comprised a complete revision to the text of the document to make it a standard and to segregate mandatory requirements from advisory material. Prior to the 1988 edition, all editions were recommended practices. The standard was revised again in 1993.

The 1998 edition was a partial revision.

The major change to the 2003 edition was the addition of staffing requirements.

The 2009 edition has modified some definitions. Additional cleanup of the document was made by moving nonmandatory language to Annex A. The FAA Airport Category column in Table 4.3.1 has been updated.

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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.

Committee Scope: This Committee shall have primary responsibility for documents on aircraft rescue and fire-fighting services and equipment, for procedures for handling aircraft fire emergencies, and for specialized vehicles used to perform these functions at airports, with particular emphasis on saving lives and reducing injuries coincident with aircraft fires following impact or aircraft ground fires. This Committee also shall have responsibility for documents on aircraft hand fire extinguishers and accident prevention and the saving of lives in future aircraft accidents involving fire.

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

Changes other than editorial are indicated by a vertical rule beside the paragraph, table, or figure in which the change occurred. These rules are included as an aid to the user in identifying changes from the previous edition. Where one or more complete paragraphs have been deleted, the deletion is indicated by a bullet (•) between the paragraphs that remain.

Information on referenced publications can be found in Chapter 2 and Annex F.

Chapter 1 Administration

1.1 Scope. This standard contains the minimum requirements for aircraft rescue and fire-fighting (ARFF) 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 preparation for dealing with an aircraft accident or incident occurring at, or in the immediate vicinity of, an airport is of primary importance because it is within this location that the greatest opportunity to save lives exists. The possibility of, and need for, extinguishing a fire that can occur either immediately following an aircraft accident or incident, or at any time during rescue operations, must be assumed at all times.

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 to use.

1.3 Equivalency. Nothing in this standard is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this standard.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 10, *Standard for Portable Fire Extinguishers,* 2007 edition.

NFPA 412, *Standard for Evaluating Aircraft Rescue and Fire-Fighting Foam Equipment,* 2009 edition.

NFPA 414, *Standard for Aircraft Rescue and Fire-Fighting Vehicles,* 2007 edition.

NFPA 1003, *Standard for Airport Fire Fighter Professional Qualifications,* 2005 edition.

2.3 Other Publications.

2.3.1 Military Specification Publications. Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

U.S. Military Specification MIL-F-24385, *Fire Extinguishing Agent, Aqueous Film-Forming Foam (AFFF), Liquid Concentrate, for Fresh and Sea Water,* Revision F, January 7, 1992.

2.3.2 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

UL 162, *Standard for Foam Equipment and Liquid Concentrates,* 6th edition, March 7, 1989.

2.3.3 Other Publications. *Merriam-Webster's Collegiate Dictionary,* 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections. (Reserved)

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary,* 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3 Shall. Indicates a mandatory requirement.

3.2.4 Should. Indicates a recommendation or that which is advised but not required.

3.3 General Definitions.

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

3.3.2 Actual Response Time. The total period of time measured from the time of an alarm until the first ARFF vehicle arrives at the scene of an aircraft accident and is in position to apply agent.

3.3.3 Aircraft Accident. An occurrence associated with the operation of an aircraft that takes place between the time any person boards the aircraft with the intention of flight and until all such persons have disembarked and in which any person suffers death or serious injury or in which the aircraft receives substantial damage.

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

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

3.3.6* Aircraft Rescue. Action taken to save or set free persons involved in an aircraft incident/accident by safeguarding the integrity of the aircraft fuselage from an external/internal fire, to support self-evacuation, and to undertake the removal of injured and trapped persons.

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

3.3.8 Airport Fire Chief. The individual normally having operational control over the airport's rescue and fire-fighting personnel and equipment, or a designated appointee.

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

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

3.3.11 Area Classifications.

3.3.11.1 *Critical Rescue and Fire-Fighting Access Area (CRFFAA).* The rectangular area surrounding any runway within which most aircraft accidents can be expected to occur on airports. *(See Figure A.3.3.11.3.)*

3.3.11.2 *Movement Area.* That part of an airport to be used for the takeoff, landing, and taxiing of aircraft, and the apron(s).

3.3.11.3* *Rapid Response Area (RRA).* A rectangle that includes the runway and the surrounding area extending to a width of 500 ft (150 m) outward from each side of the runway centerline and to a length of 1650 ft (500 m) beyond each runway end, but not beyond the airport property line. *(See Figure A.3.3.11.3.)*

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

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

3.3.14 Foam. An aggregation of small bubbles used to form an air-excluding, vapor-suppressing blanket over the surface of a flammable liquid fuel.

3.3.14.1* *Aqueous Film-Forming Foam (AFFF).* A concentrated aqueous solution of one or more hydrocarbon and/or fluorochemical surfactants that forms a foam capable of producing a vapor-suppressing, aqueous film on the surface of hydrocarbon fuels.

3.3.14.2* *Film-Forming Fluoroprotein Foam (FFFP).* A protein-based foam concentrate incorporating fluorinated surfactants that forms a foam capable of producing a vapor-suppressing, aqueous film on the surface of hydrocarbon fuels.

3.3.14.3 *Fluoroprotein Foam (FP).* A protein-based foam concentrate with added fluorochemical surfactants that forms a foam showing a measurable degree of compatibility with dry chemical extinguishing agents and an increase in tolerance to contamination by fuel.

3.3.14.4 *Protein Foam (P).* A protein-based foam concentrate that is stabilized with metal salts to make a fire-resistant foam blanket.

3.3.15 Foam Concentrate. A concentrated liquid foaming agent that is mixed with water and air in designated proportions to form foam.

3.3.16 Fuselage. The main body of an aircraft.

3.3.17 International Civil Aviation Organization (ICAO). An international body charged with matters dealing with the development, coordination, and preservation of international civil aviation.

3.3.18 Mutual Aid. Reciprocal assistance by emergency services under a prearranged plan.

3.3.19 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 4 Organization of Aircraft Rescue and Fire-Fighting (ARFF) Services

4.1 Administrative Responsibilities.

4.1.1 The airport management shall be responsible for the provisions of ARFF services on the airport.

4.1.2 Regardless of the functional control of ARFF 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.

4.1.3 The aircraft owner or 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 can assist or assume the authority in the absence of the aircraft owner or operator.

4.2* Emergency Preparedness. The airport shall develop a risk management plan for fire emergency scene strategy.

4.2.1 Airports shall prepare and maintain in current status an airport/community emergency plan. The plan shall assign specific duties and responsibilities and include all airport and community resources necessary to cope with a major aircraft emergency.

4.2.2* Airport/community emergency plans shall be tested at least every two years in the form of a full-scale exercise. In addition, tabletop training shall be conducted at least annually.

4.2.3 Airport management and resource agencies shall participate in annual tabletop training exercises that encompass their duties and responsibilities depicted in the emergency plan.

4.3 Categorizing Airports for ARFF Services.

4.3.1 The authority having jurisdiction shall determine the level of protection based on the largest aircraft scheduled into the airport. Airports shall be categorized for ARFF services in accordance with Table 4.3.1. *(See Annex B.)*

Table 4.3.1 Airport Category by Overall Length and Width of 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	m	ft	m	ft
1	A*	1	9	30	2	6.6
2	A*	2	12	39	2	6.6
3	A*	3	18	59	3	9.8
4	A	4	24	78	4	13.0
5	A	5	28	90	4	13.0
6	B	6	39	126	5	16.4
7	C	7	49	160	5	16.4
8	D	8	61	200	7	23.0
9	E	9	76	250	7	23.0
10		10	90	295	8	25.0

Notes:
(1) Airport categories are used in the calculations to eliminate the need for calculating specific quantities of extinguishing agents for each type of aircraft.
(2) Although only water is normally necessary for interior handline attack, logistically and tactically it should be discharged as foam and is therefore included in the quantities of water necessary for foam production in Table 5.3.1(a) and Table 5.3.1(b).
* It is FAA Category A if the airport has scheduled service with aircraft that have more than nine passenger seats.

4.3.2* 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 4.3.1, then the category for that aircraft shall be the next one higher.

Chapter 5 Extinguishing Agents

5.1 Primary Agents.

5.1.1* One or more of the following types of primary agents shall be used for aircraft fire fighting involving hydrocarbon fuels:

(1) Aqueous film-forming foams (AFFF)
(2) Fluoroprotein foam (FP) or film-forming fluoroprotein foam (FFFP)
(3) Protein foam (P)

5.1.2* All foam concentrates shall be listed based on the following performance test requirements.

5.1.2.1* Aqueous film-forming foam agents shall meet the requirements of U.S. Military Specification MIL-F-24385, *Fire Extinguishing Agent, Aqueous Film-Forming Foam (AFFF), Liquid Concentrate for Fresh and Sea Water.*

5.1.2.2 Film-forming fluoroprotein foam (FFFP), protein foam (P), and fluoroprotein foam (FP) agents shall meet the applicable fire extinguishment and burnback performance requirements of Underwriters Laboratories Inc. Standard UL 162, *Standard for Foam Equipment and Liquid Concentrates* (Type 3 application).

5.1.2.3 Any primary agent used at the minimum quantities and discharge rates for AFFF in Table 5.3.1(a) and Table 5.3.1(b) shall meet the applicable fire extinguishment and burnback performance requirements of 5.1.2.1.

5.2 Complementary Agents. All ARFF vehicles responding shall carry either one or both of the following categories of complementary agents:

(1)*Potassium bicarbonate or potassium bicarbonate dry chemical
(2)*Halogenated agent

5.3 Quantity of Agents.

5.3.1* The minimum amounts of water for foam production and the minimum amounts of complementary agents necessary shall be as specified in Table 5.3.1(a) or Table 5.3.1(b), based on the system of categorizing airports listed in Table 4.3.1.

5.3.2 Sufficient foam concentrate shall be provided on each vehicle to proportion, at the prescribed percentage of foam concentrate to water, into double the quantity of water specified in Table 5.3.1(a) or Table 5.3.1(b) at the maximum tolerance specified in NFPA 412, *Standard for Evaluating Aircraft Rescue and Fire-Fighting Foam Equipment.*

5.3.3* Each airport shall conduct and document a needs analysis to determine a minimum 100 percent water resupply capability within the critical rescue and fire-fighting access area and shall ensure that local arrangements fulfill that capability.

5.4* Compatibility of Agents. Chemical compatibility shall be ensured between foam and complementary agents where used simultaneously or consecutively.

5.5* Combustible Metal Agents. Extinguishing agents for combustible metal fires shall be provided in portable fire extinguishers that are rated for Class D fires in accordance with 5.2.4 of NFPA 10, *Standard for Portable Fire Extinguishers.* At least one nominal 20-lb (9.1-kg) extinguisher shall be carried on each vehicle specified in Table 6.1.1.

5.6 Agent Discharge Capabilities.

5.6.1 The discharge capabilities of extinguishing agents shall not be less than the rates specified in Table 5.3.1(a) or Table 5.3.1(b) of this standard and Table 4.1.1(c) and Table 4.1.1(d) of NFPA 414, *Standard for Aircraft Rescue and Fire-Fighting Vehicles.*

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

Table 5.3.1(a) Extinguishing Agents, Discharge and Response Capability in SI Units

			AFFF		Fluoroprotein or FFFP		Protein Foam		Complementary Agents[a]	
Airport Category	Response Phases	Response Capa-bility (sec)	Required Water (L)	Discharge Capa-bility (L/min)	Required Water (L)	Discharge Capa-bility (L/min)	Required Water (L)	Discharge Capa-bility (L/min)	Quantity (kg)	Discharge (kg/sec)
	Q1[b]	120	450	450	600	600	700	700	45	2.25
1	Q2[c]		0		0		0			
	Q3[d]		0		0		0			
TOTAL			**450**		**600**		**700**			
	Q1[b]	120	591	591	787	787	906	906	90	2.25
2	Q2[c]	180	159		213		244			
	Q3[d]		0		0		0			
TOTAL			**750**		**1,000**		**1,150**			
	Q1[b]	120	1,077	1,077	1,500	1,500	1,692	1,692	135	2.25
3	Q2[c]	180	323		450		508			
	Q3[d]	240	1,100	110	1,100	110	1,100	110		
TOTAL			**2,500**		**3,050**		**3,300**			
	Q1[b]	120	1,772	1,772	2,468	2,468	2,722	2,722	135	2.25
4	Q2[c]	180	1,028		1,432		1,578			
	Q3[d]	240	2,250	225	2,250	225	2,250	225		
TOTAL			**5,050**		**6,150**		**6,550**			
	Q1[b]	120	3,257	3,257	4,514	4,514	5,029	5,029	205	2.25
5	Q2[c]	180	2,443		3,386		3,771			
	Q3[d]	240	4,750	475	4,750	475	4,750	475		
TOTAL			**10,450**		**12,650**		**13,550**			
	Q1[b]	120	4,700	4,700	6,525	6,525	7,250	7,250	205	2.25
6	Q2[c]	180	4,700		6,525		7,250			
	Q3[d]	240	4,750	475	4,750	475	4,750	475		
TOTAL			**14,150**		**17,800**		**19,250**			
	Q1[b]	120	5,983	5,983	8,297	8,297	9,214	9,214	205	2.25
7	Q2[c]	180	7,717		10,703		11,886			
	Q3[d]	240	4,750	475	4,750	475	4,750	475		
TOTAL			**18,450**		**23,750**		**25,850**			
	Q1[b]	120	7,937	7,937	10,992	10,992	12,202	12,202	410	4.5
8	Q2[c]	180	12,063		16,708		18,548			
	Q3[d]	240	9,450	945	9,450	945	9,450	945		
TOTAL			**29,450**		**37,150**		**40,200**			
	Q1[b]	120	9,907	9,907	13,722	13,722	15,259	15,259	410	4.5
9	Q2[c]	180	16,843		23,328		25,941			
	Q3[d]	240	9,450	945	9,450	945	9,450	945		
TOTAL			**36,200**		**46,500**		**50,650**			
	Q1[b]	120	12,103	12,103	16,759	16,759	18,603	18,603	410	4.5
10	Q2[c]	180	22,997		31,841		35,347			
	Q3[d]	240	18,900	1,890	18,900	1,890	18,900	1,890		
TOTAL			**54,000**		**67,500**		**72,850**			

[a]The minimum quantity is based on ISO qualified potassium bicarbonate. Powder can be substituted by a listed agent exceeding the performance of potassium bicarbonate.

[b]Quantity of water for foam production for initial control of the pool fire.

[c]Quantity of water for foam production to continue control or fully extinguish the pool fire.

[d]Water available for interior fire fighting.

Table 5.3.1(b) Extinguishing Agents, Discharge and Response Capability in U.S. Customary Units

			AFFF		Fluoroprotein or FFFP		Protein Foam		Complementary Agents[a]	
Airport Category	Response Phases	Response Capa-bility (sec)	Required Water (U.S. gal)	Discharge Capability (gpm)	Required Water (U.S. gal)	Discharge Capability (gpm)	Required Water (U.S. gal)	Discharge Capability (gpm)	Quantity (lb)	Discharge (lb/sec)
	Q1[b]	120	120	120	160	160	180	180	100	5
1	**Q2[c]**		0		0		0			
	Q3[d]		0		0		0			
TOTAL			**120**		**160**		**180**			
	Q1[b]	120	157	157	213	213	236	236	200	5
2	**Q2[c]**	180	43		57		64			
	Q3[d]		0		0		0			
TOTAL			**200**		**270**		**300**			
	Q1[b]	120	285	285	392	392	438	438	300	5
3	**Q2[c]**	180	85		118		132			
	Q3[d]	240	300	60	300	60	300	60		
TOTAL			**670**		**810**		**870**			
	Q1[b]	120	468	468	646	646	715	715	300	5
4	**Q2[c]**	180	272		374		415			
	Q3[d]	240	600	60	600	60	600	60		
TOTAL			**1,340**		**1,620**		**1,730**			
	Q1[b]	120	863	863	1,194	1,194	1,331	1,331	450	5
5	**Q2[c]**	180	647		896		999			
	Q3[d]	240	1,250	125	1,250	125	1,250	125		
TOTAL			**2,760**		**3,340**		**3,580**			
	Q1[b]	120	1,245	1,245	1,725	1,725	1,920	1,920	450	5
6	**Q2[c]**	180	1,245		1,725		1,920			
	Q3[d]	240	1,250	1,25	1,250	125	1,250	125		
TOTAL			**3,740**		**4,700**		**5,090**			
	Q1[b]	120	1,585	1,585	2,192	2,192	2,437	2,437	450	5
7	**Q2[c]**	180	2,045		2,828		3,143			
	Q3[d]	240	1,250	125	1,250	125	1,250	125		
TOTAL			**4,880**		**6,270**		**6,830**			
	Q1[b]	120	2,095	2,095	2,901	2,901	32,22	3,222	900	10
8	**Q2[c]**	180	3,185		4,409		4,898			
	Q3[d]	240	2,500	250	2,500	250	25,00	250		
TOTAL			**7,780**		**9,810**		**10,620**			
	Q1[b]	120	2,619	2,619	3,626	3,626	4,030	4,030	900	10
9	**Q2[c]**	180	4,451		6,164		6,850			
	Q3[d]	240	2,500	250	2,500	250	2,500	250		
TOTAL			**9,570**		**12,290**		**13,380**			
	Q1[b]	120	3,195	3,195	4,424	4,424	4,915	4,915	900	10
10	**Q2[c]**	180	6,069		8,405		9,338			
	Q3[d]	240	5,000	500	5,000	500	5,000	500		
TOTAL			**14,260**		**17,830**		**19,250**			

[a]The minimum quantity is based on ISO qualified potassium bicarbonate. Powder can be substituted by a listed agent exceeding the performance of potassium bicarbonate.

[b]Quantity of water for foam production for initial control of the pool fire.

[c]Quantity of water for foam production to continue control or fully extinguish the pool fire.

[d]Water available for interior fire fighting.

Chapter 6 Aircraft Rescue and Fire-Fighting (ARFF) Vehicles

6.1 Rescue and Fire-Fighting Vehicles.

6.1.1* The minimum number of ARFF vehicles provided at each airport shall be as specified in Table 6.1.1.

Table 6.1.1 Minimum Number of ARFF Vehicles

Airport Category	Number of Vehicles
1	1
2	1
3	1
4	1
5	2
6	2
7	3
8	3
9	4
10	4

6.1.2* Vehicles with sufficient collective capacities shall be constructed to comply with the provisions of NFPA 414, *Standard for Aircraft Rescue and Fire-Fighting Vehicles*, and Table 5.3.1(a) or Table 5.3.1(b).

6.1.3 Consideration shall be given to the provision of an additional vehicle or vehicles in order that minimum requirements are maintained during periods when a vehicle is out of service.

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

6.1.5 The equipment delivering the complementary extinguishing agent shall be tested at least annually, and the authority having jurisdiction shall determine the test procedure.

6.2* Tools and Equipment.

6.2.1 Tools and equipment to effectively support aircraft rescue and fire-fighting services shall be available at the incident or accident scene within the required response time.

6.2.2 Consideration shall be given to the addition of a vehicle termed as a *rescue truck* for the purpose of carrying a wide range of rescue equipment suited for conditions and aircraft utilizing the Category 7 or larger airports.

Chapter 7 Airport Emergency Communications

7.1 Communications and Alarms.

7.1.1 Airport ARFF services communications shall have a capability that is consistent with the airport's operational needs.

7.1.2 The operational communications system shall provide a primary and, where necessary, an alternate effective means for direct communication between the following, as applicable *(see Annex C)*:

(1) Alerting authority such as the control tower or flight service station, airport manager, fixed-base operator, or airline office and the airport ARFF service
(2) Air traffic control tower or flight service station and ARFF vehicles en route to an aircraft emergency or at the accident or incident site
(3) Fire department alarm room and ARFF vehicles at the accident or incident site
(4) Airport ARFF services and appropriate mutual aid organizations located on or off the airport, including an alert procedure for all auxiliary personnel expected to participate
(5) ARFF vehicles
(6) Responding vehicles and an aircraft in a situation of emergency using an established discreet VHF frequency

7.1.3 To ensure 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 communications system.

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

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

Chapter 8 ARFF Personnel, Protective Clothing, and Equipment

8.1 Personnel.

8.1.1 A person shall be appointed to direct the airport ARFF 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.

8.1.2* During flight operations and 15 minutes prior and 15 minutes following, a sufficient number of trained personnel shall be readily available to staff the rescue and fire-fighting vehicles and to perform fire-fighting and rescue operations.

8.1.2.1 The minimum total number of trained personnel responding to an initial alarm, based on the minimum response times in Chapter 9 and extinguishing agent discharge rates and quantities required in Chapter 5, shall be in accordance with Table 8.1.2.1.

8.1.2.2 A Task and Resource Analysis shall be performed to determine additional staffing requirements.

Table 8.1.2.1 Minimum Required ARFF Personnel at Airports

Airport Category	ARFF Personnel
1	2
2	2
3	2
4	3
5	6
6	9
7	12
8	12
9	15
10	15

8.1.2.2.1 This analysis shall be documented.

8.1.2.2.2 Under no circumstances shall the minimum required staffing be less than those values appearing in Table 8.1.2.1. *(See Annex D.)*

8.1.3 Responding units shall include personnel trained and equipped for cabin interior fire fighting and shall demonstrate the ability to apply extinguishing agent to the interior of the aircraft within 4 minutes of the alarm.

8.1.4 All ARFF personnel shall meet the requirements of NFPA 1003, *Standard for Airport Fire Fighter Professional Qualifications*. All ARFF personnel shall undertake recurrent training. *(See Annex E.)*

8.1.5 All ARFF 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.

8.1.6 Wherever possible, at international airports, the incident commander shall have a reasonable command of the English language to facilitate communication with the flight crew.

8.2 Protective Clothing.

8.2.1* A complete set of approved personal protective clothing and equipment shall be provided, maintained, and readily available for use by each person required to perform duties in the immediate area of an aircraft accident.

8.2.2* All personnel engaged in operations within the immediate emergency area of an aircraft accident shall wear approved personal protective clothing and equipment commensurate with their level of involvement and shall not remove any portion of such clothing and equipment until in a declared safe area or directed to do so by the incident commander or his or her representative.

Chapter 9 Airport Fire Station Location and Response Capability

9.1 Siting and Response.

9.1.1* ARFF vehicles shall be garaged at one or more strategic locations as needed to meet required response times.

9.1.2* 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 shall be of secondary importance.

9.1.3* The demonstrated response time of the first responding vehicle to reach any point on the operational runway shall be 2 minutes or less, and to any point remaining within the on-airport portion of the rapid response area shall be no more than 2½ minutes, both in optimum conditions of visibility and surface conditions. Other ARFF vehicles necessary to achieve the agent discharge rate listed in Table 5.3.1(a) or Table 5.3.1(b) shall arrive at intervals not exceeding 30 seconds.

9.1.4 The demonstrated response time to reach an incident/accident involving any aircraft with passengers in the aircraft movement area beyond or outside the runway and rapid response area shall be 3 minutes or less, both in optimum conditions of visibility and surface conditions to meet the requirements in Table 5.3.1(a) or Table 5.3.1(b).

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.3.2.1 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, 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 that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, 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, or 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 or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.3.6 Aircraft Rescue. 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.

A.3.3.11.3 Rapid Response Area (RRA). Approximately 85 percent of the accidents as historically recorded in the CRFFAA occurred within the boundary of the RRA. Response time to the on-airport portion of the RRA should meet the times specified in 9.1.3. *(See Figure A.3.3.11.3.)*

A.3.3.14.1 Aqueous Film-Forming Foam (AFFF). The foam produced from AFFF concentrates is dry chemical compatible and, therefore, is suitable for use in combination with that agent.

A.3.3.14.2 Film-Forming Fluoroprotein Foam (FFFP). This foam might show an acceptable level of compatibility to dry chemicals and might be suitable for use with those agents.

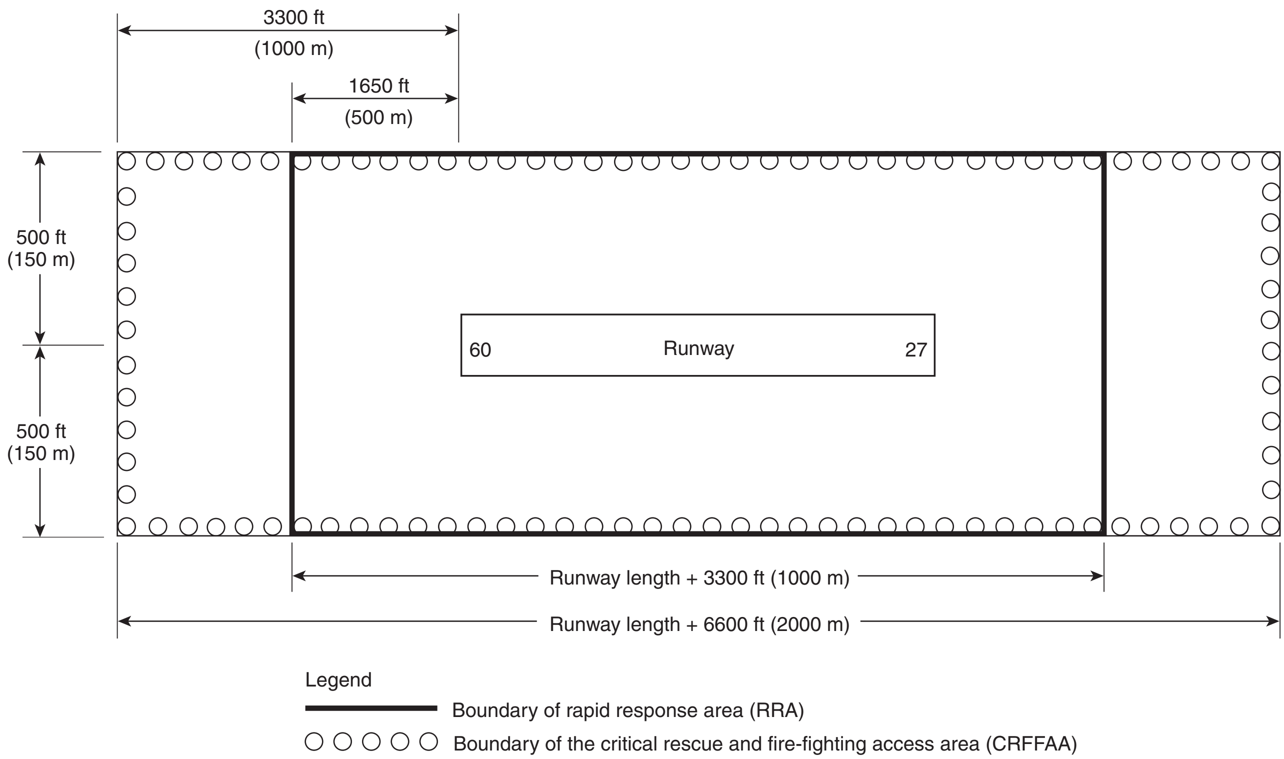

FIGURE A.3.3.11.3 Response and Access Areas.

A.4.2 The risk management plan should be based on an offensive and defensive policy. Strategic decisions establish the basic positioning of resources and the types of functions they will be assigned to perform at the scene of a fire or emergency incident. The level of risk to which members are exposed is driven by the strategy; offensive strategy places members in interior positions where they are likely to have direct contact with the fire, while defensive strategy removes members from interior positions and high-risk activities. The attack plan is based on the overall strategy and drives the tactical assignments that are given to individual or groups of companies/crews and the specific functions they are expected to perform. Risk identification, evaluation, and management concepts should be incorporated into each stage of the command process.

A.4.2.2 Information on airport/community emergency plans and full-scale exercises is provided in NFPA 424, *Guide for Airport/Community Emergency Planning*.

A.4.3.2 See Table A.4.3.2, which shows aircraft types and their measurements by category.

A.5.1.1 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 reseal 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 from 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 percent and 6 percent concentrations, usually in either fresh- or saltwater, and some are for use at other concentrations such as 1 percent or 5 percent.

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, *Standard for Evaluating Aircraft Rescue and Fire-Fighting Foam Equipment*.

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.

Table A.4.3.2 Representative Aircraft by Airport Categories

Airport Category	Aircraft Type	Overall Fuselage Length		External Fuselage Width	
		m	ft	m	ft
1	Beech Bonanza 35	8.01	26.33	1.07	3.05
	Cessna 206	8.20	26.90	1.22	4.00
	Mooney M-20	7.60	24.90	1.13	3.70
2	Cessna 414	11.06	36.30	1.43	4.70
	Piper Aerostar	10.60	34.80	1.19	3.90
	Piper Cheyenne 2	10.60	34.70	1.31	4.30
3	Beech 1900	17.65	57.90	1.40	4.60
	Beech Kingaire 200	13.35	43.80	1.77	5.80
	Lear 55	16.80	55.20	1.58	5.20
4	D.H. Dash 8	22.25	73.00	2.69	8.83
	Fokker F-27 2000	23.56	77.30	2.70	8.86
	Short 360	21.60	70.90	1.95	6.40
5	ATR 72	27.16	89.10	2.87	9.40
	D.H. Dash 7	24.60	80.70	2.59	8.50
	Gulfstream 3	25.30	83.10	2.71	7.40
6	BAE 146-200	28.55	93.67	3.56	11.68
	Airbus A-320 300	37.57	123.27	3.95	12.96
	Boeing 737-300	33.40	109.60	3.76	12.34
7	Boeing 727-200	46.68	156.16	3.76	12.34
	Boeing 757	47.34	155.30	3.96	13.00
	M.D. 88	45.10	147.90	3.34	10.96
8	Airbus A-300	53.61	175.90	5.64	18.50
	Boeing 767-300	54.96	180.30	5.03	16.50
	D.C. 10-40	55.54	182.23	6.02	19.75
	Lockheed L-1011	54.44	178.62	5.97	19.59
9	Airbus A-340 300	63.67	208.90	5.64	18.50
	Boeing 747-200	70.40	230.99	6.50	21.40
	Concorde	62.10	203.75	2.87	9.42
	M.D. 11	61.24	200.90	6.07	19.90
10	Airbus Industrie A380/800	73	239.5	7.14	23.4
	Airbus Industrie A380/900	79.4	260.5	7.14	23.4
	Antonov AN-225	84.10	275.70	6.40	20.90

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 ensuring that the system component materials are suitable for the particular concentrate being substituted and that, where necessary, the proportioning equipment is recalibrated and reset.

CAUTION: Any salvageable aircraft that comes in contact with foam agents during fire-fighting or fuel spill–securing operations should be thoroughly flushed with freshwater as soon as practicable. Both the foam manufacturer and the airframe manufacturer should be contacted for any additional requirements that may be associated with specific foam agents or aircraft components.

A.5.1.2 The two test methods cited in 5.1.2 have wide application in North America but might not be recognized in other areas of the world. In particular, ICAO has developed guidance that references foam evaluation methods having significantly different test parameters such as test fuel, application rate, and extinguishment density. The intent of this standard is that primary foam agents meet minimum performance criteria. It is the intent that aqueous film-forming foams achieve a level of performance consistent with the MIL-F-24385, *Fire Extinguishing Agent, Aqueous Film-Forming Foam (AFFF), Liquid Concentrate, for Fresh and Sea Water,* when the lowest discharge rates/quantities in Table 5.3.1(a) and Table 5.3.1(b) are used. The national (ICAO State) civil aviation authority having jurisdiction can adopt or reference standards recognized in that particular part of the world. It is incumbent on the national (ICAO State) authority to determine that alternate test methods are consistent with the minimum agent rates/quantities they have adopted. The national (ICAO State) civil aviation authority having jurisdiction should make this determination to prevent inconsistencies at the local or regional level.

A.5.1.2.1 Aqueous film-forming foam agents meeting all of the criteria of the U.S. Military Specification MIL-F-24385, *Fire Extinguishing Agent, Aqueous Film-Forming Foam (AFFF), Liquid Concentrate, for Fresh and Sea Water,* appear on the Qualified Products List (QPL-24385-28). Other standards organizations have fire test criteria comparable to the U.S. Military Specification MIL-F-24385. The authority having jurisdiction should obtain from their foam manufacturer, certification documentation on the foam fire performance equivalency. Freshwater or seawater can be used for the fire test.

A.5.2(1) A number of chemical compounds are offered on a proprietary basis that 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.5.2(2) 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 that 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 can 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 might 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 that 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 or equipment engine fires. Halon agent is, however, included in the Montreal Protocol on Substances that Deplete the Ozone Layer, signed September 16, 1987. The protocol permitted continued availability of halogenated fire-extinguishing agents at reduced production levels until the year 1994. Halon use should be limited to extinguishment of unwanted fire and should not be used for routine training of personnel.

A.5.3.1 Table A.5.3.1 provides fuel weight conversions.

Table A.5.3.1 Fuel Weight Conversions at 15°C (59°F)

From/To	Pounds Avgas	Pounds Jet A Jet A-1 Jet A-2 Arctic Diesel	Pounds Jet B JP-4 F-40	Pounds JP-6 JP-8
Gallons Avgas	6.01			
Gallons Jet A Jet A-1 Jet A-2 Arctic Diesel		7.00		
Gallons Jet B JP-4 F-40			6.68	
Gallons JP-6 JP-8				6.50

A.5.3.3 Fire-fighting vehicles meeting the requirements of 5.3.2 carry a sufficient quantity of foam concentrate for one refill; therefore, rapid water resupply is of prime importance. The reserve water supply can be maintained in tankers or structural equipment. Hydrants can be considered if they are adequately located. Mutual aid services can be considered for this purpose if they are capable of responding in the critical time required to maintain the fire attack.

A.5.4 It is important that the compatibility of the foam and dry chemical agents be established if they are to be used together. Halon 1211 is compatible with all foams.

A.5.5 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 classified 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.6.1.1 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 maintain the secure area around the fuselage to permit the safe evacuation and rescue of the occupants.

A.6.1.2 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 categories 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.

The off-pavement performance capability of each ARFF 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 or incident locations. In addition, periodic tests should be conducted to ensure that the performance requirements of the vehicle are as originally designed and that the skill levels of the driver/operator remain high.

Where climatic or geographic conditions exist that 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 that 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, 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. Secondhand vehicles might have been subjected to abusive service, components might 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 Aircraft Rescue and Fire-Fighting Foam Equipment*.

Specialized vehicles might be needed to allow fire fighters to safely reach elevations that are above the efficient range of ground ladders and the normal range of ARFF vehicles. Fire fighters should have the ability to access any level of the aircraft to effectively perform their mission with an interior access vehicle as described in NFPA 414.

All essential vehicles should be provided with two-way radio communications with air traffic control (ATC) or the airport controlling facility, for example, air-radio, flight service station, and so forth.

At least one elevated boom and where specified, a cabin skin penetration device, should be provided at airports of Category 6 through 9; Category 10 should have two.

A.6.2 A comprehensive and up-to-date list of tools is provided in NFPA 414, *Standard for Aircraft Rescue and Fire-Fighting Vehicles*.

A.8.1.2 The personnel required for the initial alarm is based on the information in Table A.8.1.2.

Table A.8.1.2 ARFF Personnel Based on Airport Category

Airport Category	ARFF Personnel
1–3	2 ARFF trained personnel
4	3 ARFF trained personnel including an Incident Commander
5	6 ARFF personnel including an Incident Commander and 2 trained personnel for Rapid Intervention
6–10	The minimum total number of trained personnel responding should be based on the equivalent of 3 per ARFF vehicle. Additionally, an Incident Commander and 2 trained personnel for Rapid Intervention should be provided.

A.8.2.1 Personal protective clothing and equipment should meet the requirements of the following NFPA standards:

(1) NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services.*
(2) NFPA 1975, *Standard on Station/Work Uniforms for Fire and Emergency Services.*

Canadian references for personal protective equipment are as follows:

(1) FF protective clothing, CAN/CGSB-155-1, April 1998.
(2) FF protective boots, CAN/BNQ 1923-410.

U.K. references for personal protective equipment are as follows:

(1) *Helmets for firefighters:* EN443 (1997), with full-face visor.
(2) Tunic/overtrousers (turnout gear) — *Protective clothing for firefighters. Requirements and test methods for protective clothing for firefighting:* EN469 (1995).
(3) *Protective gloves for firefighters:* EN659 (2003).
(4) Footwear (Safety Footwear), EN345-1 (1993): *Safety footwear for professional use, Part 1: Specification (General);* Footwear (Safety Footwear), EN345-2 (1997): *Safety footwear for professional use, Part 2: Additional specifications* (including footwear for fire fighters).
(5) Conspicuous clothing *(Specification for high-visibility warning clothing — general purpose, not fire retardant):* EN471 (1994).
(6) *Flash hoods,* Draft European standard: preEN13911.

Guidance and proximity of protective clothing can be found in FAA Advisory Circular 150/5210-14A.

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.8.2.2 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, therefore, necessary that ARFF 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.9.1.1 Factors that influence response time include the following:

(1) Means of notification of the ARFF force
(2) Completeness of the information in the activation message
(3) Location of the fire station
(4) Acceleration, top speed, on-road handling, and off-road mobility characteristics of the vehicles
(5) Degree of preparatory training
(6) Provision of emergency access roads
(7) Climatic conditions
(8) ARFF personnel expeditious response to vehicles in the fire station
(9) 45 and 90 degree turns

Fire house garage doors should be wide enough to provide adequate clearance to permit drivers to easily back into the garage without damaging either the vehicle or the garage.

The minimum size of the firehouse garage door(s) for a major fire-fighting vehicle should be at least 5.5 m wide by 5.5 m high (18 ft by 18 ft).

A.9.1.2 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 would ensure 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 ensure proper selection of the fire station site. *[See Figure A.9.1.2(a) and Figure A.9.1.2(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 ARFF vehicles. Particular attention should be given to the provision of ready access to the RRA and critical rescue and fire-fighting access area (CRFFAA). The CRFFAA is the rectangular area surrounding any given runway. Its width extends 500 ft (150 m) outward from each side of the runway centerline, and its length is 3300 ft (1000 m) beyond each runway end. This is the area where accidents historically have occurred. *[See Figure A.9.1.2(b).]*

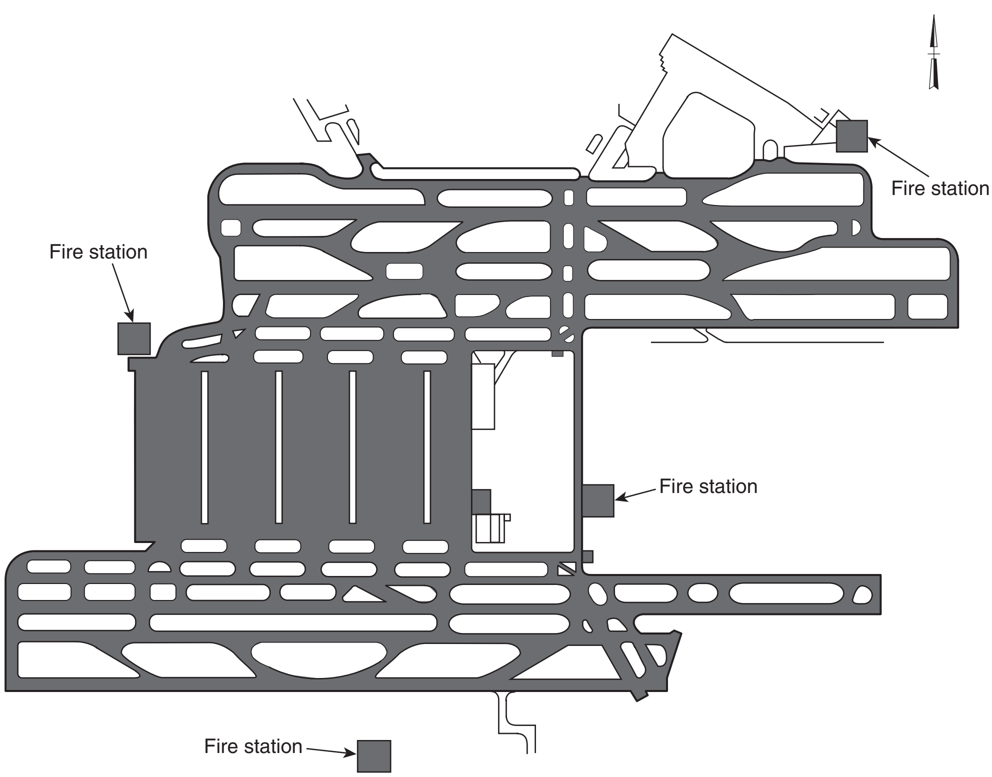

FIGURE A.9.1.2(a) Example of Category 9 Airport Fire Station Locations.

A.9.1.3 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 9.1.3.

When creating the response roadways from the firehouse to the incident area(s), the airport designer should consider the information in Table A.9.1.3(a) and Table A.9.1.3(b) when sizing the radius of curves. ARFF vehicles accelerate much faster than over-the-road vehicles and are very capable of obtaining higher speeds in a very short distance.

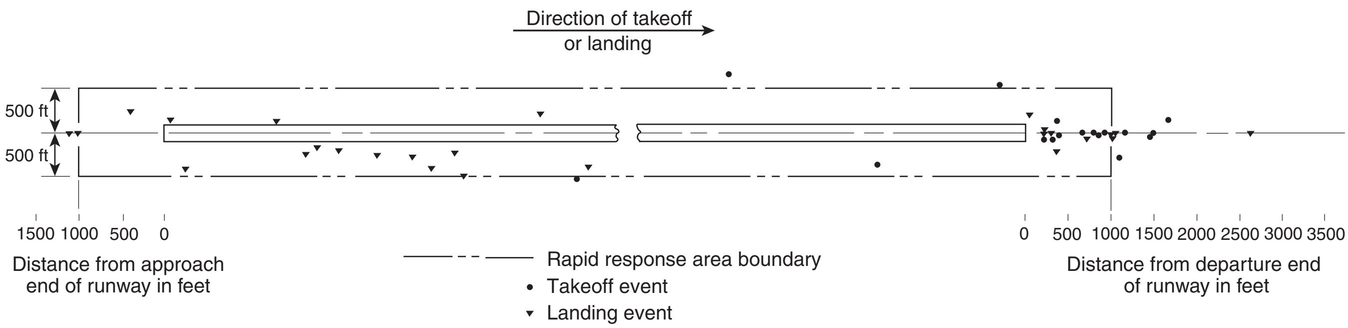

FIGURE A.9.1.2(b) Rapid Response Area (RRA) Boundary.

Table A.9.1.3(a) Vehicle Speed over Distance from a Standing Start

Distance Traveled from a Standing Start of the Vehicle		Speed of Vehicle at the Given Distance					
		Vehicle Water Tank Capacity 227 L to 1999 L (60 gal to 528 gal)		Vehicle Water Tank Capacity >1999 L to 6000 L (>528 gal to 1585 gal)		Vehicle Water Tank Capacity >6000 L (>1585 gal)	
m	ft	kph	mph	kph	mph	kph	mph
30.5	100	29.0	18	32.2	20	29.0	18
76.2	250	40.2	25	48.3	30	40.2	25
152.4	500	48.3	30	64.4	40	48.3	30
228.6	750	64.4	40	72.4	45	64.4	40
304.8	1000	72.4	45	80.5	50	72.4	45

Table A.9.1.3(b) Minimum Radius of a Curve Based on Speed

Speed		Minimum Radius of a Curve with a 0.04 Superelevation (Almost Flat)*	
kph	mph	m	ft
32.2	20	39.6	130
48.3	30	92.0	302
64.4	40	174.6	573
80.5	50	291.1	955
88.5	55	436.5	1432
96.6	60	498.9	1637

* Values were extracted from "A Policy on Geometric Design of Highways and Streets," American Association of State Highway and Transportation Officials, 1990 edition.

Annex B Background

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

B.1 Area Concept. The first meeting of the Rescue and Fire-Fighting Panel (RFFP-I) was convened by the International Civil Aviation Organization (ICAO) in Montreal, Canada, from March 10 to March 20, 1970.

At that time, the method contained in Annex 14, Attachment C (5th edition), for the determination of the level of protection (agent quantities and number of vehicles) to be provided at airports for fixed wing aircraft was based on the fuel load and passenger capacity of the aircraft. As a result of correspondence exchanged among the Panel members there was general agreement that a new or revised method for specifying the quantity of extinguishing agents and rescue equipment to be provided was needed.

The Panel unanimously agreed that the concept for determining the level of protection should be the "critical area." This was an area to be protected in any post-accident situation that would permit the safe evacuation of the aircraft occupants. The purpose of the critical area concept was not to define fire attack procedures. Instead, it was to serve as the basis for calculating the quantities of extinguishing agents necessary to achieve protection within an acceptable period of time.

Based on the logic that passenger capacity was related to length, the Panel also unanimously agreed that the critical area should be a rectangle having as one dimension the length of the fuselage. However, a wide division of opinion existed as to what width should be used. The RFF Panel's report documents five proposed means of defining the width of the critical area.

It was finally agreed that no single system could be used to express the area to be protected for all sizes of aircraft. In the end, the Panel agreed that the critical area should be a rectangle, having as one dimension the overall length of the aircraft, and as the other dimension the overall length of the aircraft for aircraft with wing spans of less than 30 m (100 ft) and should be 30 m (100 ft) for aircraft with wing spans of 30 m (100 ft) or more. A standard fuselage width of 6 m (20 ft) was assumed. Using this approach, the aircraft in service at that time were grouped into a series of eight categories. Beginning with category one, each successive category represented a logical progression in aircraft length (Hewes 1970, p. 2-1).

The concept of using graduated aircraft categories as a means of assessing fire protection needs has survived to the present time with only minor revisions to reflect changes in the operating aircraft fleet. This general concept has been adopted worldwide by both consensus standard-writing organizations and national regulatory authorities.

By correspondence following RFFP-I, the members agreed that the use of the area concept for determining the level of fire-fighting agents and equipment needed to combat an aircraft accident fire was based on the following facts:

(1) The quantity of agent necessary to control or cover the fire area could be relatively accurately determined.
(2) The rate of application of the agents to control the fire in the most effective time period could also be determined.

Hence, when RFFP-II convened in 1972, the Panel confirmed the critical area concept where one dimension of the area would be the length of the aircraft. However, there was no consensus as to length of the other side. In addition, the Panel concluded that there was a need to distinguish between the *theoretical critical area* within which it might be necessary to control a fire and a *practical critical area* that was representative of actual aircraft accident conditions. Although the Panel had not agreed on the dimensions, it did agree that the theoretical critical area should be defined as covered in B.1.1.

B.1.1 Theoretical Critical Area — Definition. The theoretical area adjacent to an aircraft in which fire must be controlled for the purpose of ensuring temporary fuselage integrity and providing an escape area for its occupants.

The RFFP-II had the benefit of large test fire experiments conducted by a member country aimed at estimating the size of the theoretical critical fire area (Geyer 1972). This study paid particular attention to the width on each side of the fuselage that would have to be secured to protect the aircraft's skin from melting under severe fire conditions. On the basis of the data presented in this report, the Panel agreed that the theoretical critical area should be a rectangle having as one dimension the overall length of the aircraft, and the other dimension determined by the following:

(1) For aircraft with an overall length of less than 20 m (65 ft): 12 m (40 ft) plus the width of the fuselage
(2) For aircraft with an overall length of 20 m (65 ft) or more: 30 m (100 ft) plus the width of the fuselage (Harley 1972, p. 3-1f)

The theoretical critical area serves only as a means for categorizing aircraft in terms of the magnitude of the potential fire hazard in which they might become involved. It is not intended to represent the average, maximum, or minimum spill fire size associated with a particular aircraft. The original formula for the maximum theoretical critical area, as presented in the RFFP-II report, was given as follows (Harley 1972, p. 3-16):

$$A_T = L \times (30 + w) \quad \text{where } L > 20 \text{ m}$$

or

$$A_T = L \times (100 + w) \quad \text{where } L > 65 \text{ ft, and}$$
$$A_T = L \times (12 + w) \quad \text{where } L > 20 \text{ m}$$

or

$$A_T = L \times (40 + w) \quad \text{where } L < 65 \text{ ft}$$

where:
A_T = theoretical critical area (TCA)
L = overall length of the aircraft
w = width of the aircraft fuselage

The data analyzed by RFFP-II in its effort to respond to the issue of TCA versus practical critical area (PCA) appeared to indicate that the PCA was approximately two-thirds of the TCA. This had been verified by a study conducted by one of the member countries of actual spill fire sizes and aircraft accidents (Ansart 1970). Another analysis of aircraft rescue and fire-fighting operations had not included the study of the PCA as compared to the TCA (Harley 1972, p. 1-1). However, that study did compare the actual amount of water used for foam at those accidents with the amounts recommended by RFFP-I. It was found that out of 106 accidents for which this information was available, in 99 cases or 93 percent the amounts recommended by the Panel were in excess of those required in the actual aircraft accident. In light of the findings, the Panel decided to use two-thirds of the TCA as the PCA (Harley 1972, p. 3-3). *(See Figure B.1.1 for a graphic display of this concept.)* The formula for the PCA developed by RFFP-II for fixed-wing aircraft can be expressed as follows:

$$\text{PCA} = (0.67) \times (\text{TCA})$$

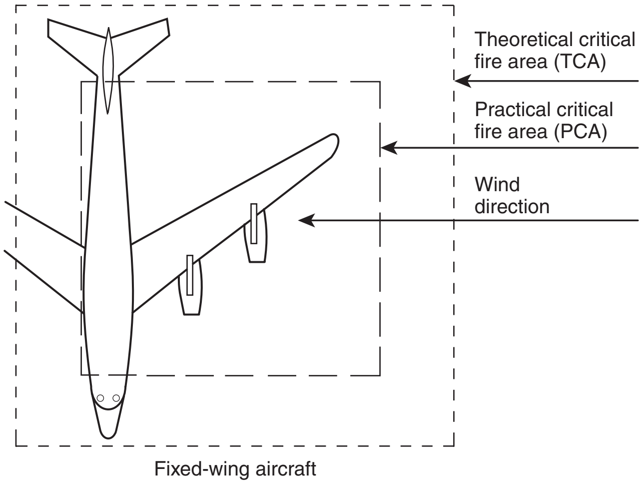

FIGURE B.1.1 Theoretical Critical Fire Area (TCA) Relative to Practical Critical Fire Area (PCA).

B.2 Control Time. After defining the critical area to be protected and developing a system of fire protection categories, RFFP-I turned its attention to the issues of discharge rates and the extinguishing agents to be applied to the critical area. The Panel concluded that fire control time and fire extinguishment time within the critical area should be considered individually and defined as follows:

(1) *Control time:* The time required from the arrival of the first fire-fighting vehicle to the time the initial intensity of the fire is reduced by 90 percent.
(2) *Extinguishment time:* The time required from arrival of the first fire-fighting vehicle to the time the fire is completely extinguished (Hewes 1970, p. 2-2).

RFFP-II confirmed these definitions, and based on an analysis of accident data furnished by member countries, it considered that the equipment and techniques to be used should be capable of controlling the fire in the PCA in 1 minute (Harley 1972, p. 3-4). This concept has not only survived to the present time, but it has, with minor revisions from time to time to update changes in the operating aircraft fleet, been adopted worldwide by both consensus standards-making organizations and national regulatory authorities.

RFFP-II was unable to identify a recommended time period for the extinguishment time. This was due to the numerous variables involved at each aircraft accident, such as the size of the aircraft, area of fire, and three-dimensional fires (Harley 1972, p. 3-4).

B.3 Discharge Rate. At RFFP-I, the Panel agreed that discharge rates should be designed to achieve the lowest possible fire control time that is consistent with the objective of preventing the fire from melting through the fuselage or causing an explosion of the fuel tanks. The Panel also agreed that the equipment and techniques to be used should be capable of controlling the fire in the critical area in 1 minute and of extinguishing the fire within another minute. Using available fire extinguishment test data based on protein foam, the Panel concluded that for a single agent attack an application rate of 8.2 (L/min)/m^2 (0.2 U.S. gpm/ft^2) for 2 minutes would be sufficient to meet the fire control and fire extinguishment time requirements. The Panel also agreed that when dual agent attack techniques were used (foam and dry chemical, CO_2, or a halocarbon), a reduced application rate could be used. A minimum of 6.1 (L/min)/m^2 (0.15 U.S. gpm/ft^2) was recommended.

Based on the consideration that the lighter construction of small aircraft increased their vulnerability to fire penetration, the Panel also recommended that the same discharge rates be used for small aircraft.

All of the discussions and recommendations at RFFP-I were based on the performance of protein foam only. The Panel's report recognized the existence of both fluoroprotein and aqueous film-forming foams and indicated that some member countries were starting to use them. However, the Panel generally agreed that there was insufficient documentation of performance upon which to base recommendations. The report also indicated a general understanding among Panel members that the suitability of other agents and their relationship with protein foam would be considered later (Hewes 1970, p. 2-2).

At RFFP-II, the Panel confirmed the application rate for protein foam recommended by RFFP-I and agreed that an application rate of 5.3 (L/min)/m^2 (0.13 U.S. gpm/ft^2) for aqueous film-forming foam was suitable. The Panel could not agree on a suitable recommendation for fluoroprotein due to the wide variety of foams. However, it did recognize them as useful aircraft fuel fire-fighting foams and left the application rate to the authority having jurisdiction, to be based on test data for the individual foams (Harley 1972, p. 3-4f).

B.4 Quantities of Agent to Be Provided. By multiplying the TCA corresponding to the upper limit of the airport category times the recommended protein foam application rate, times a factor of two for the recommended discharge time, RFFP-I produced a table of recommended water quantities for foam production. The table also included recommended weights for complementary agents and the recommended discharge rates for both single and dual agent attack for eight airport categories (Hewes 1970, p. 2-17).

At RFFP-II, the Panel agreed that when determining the amounts of extinguishing agents to be provided, the amounts required to control and to extinguish a fire should be determined separately. The quantities were named and defined in B.4.1 and B.4.2.

B.4.1 Quantity Q_1 — Definition. The quantity required to obtain a 1-minute control time in the PCA.

The formula for the water required for control (Q_1) in the PCA can be expressed as

$$Q_1 = \text{PCA} \times R \times T$$

where:
PCA = practical critical area
R = rate of application for the specific foam
T = time of application

B.4.2 Quantity Q_2 — Definition. The quantity required for continued control of the fire after the first minute or for complete extinguishment of the fire or for both.

The Panel concluded that the amount of water required for Q_2 could not be calculated exactly, as it depended on a number of variables. Those variables considered of primary importance by the Panel were the following:

(1) Maximum gross weight
(2) Maximum passenger capacity

(3) Maximum fuel load
(4) Previous experience (analysis of aircraft rescue and fire-fighting operations)

These factors were used by RFFP-II to generate Q_2 values for each airport category where $Q_2 = f \times Q_1$. The values of *f* ranged from 3 percent for Category 1 airports through 170 percent for Category 8 airports (Harley 1972, p. 3-16ff).

B.5 Today's Situation. The basic concepts developed by the ICAO RFFPs are still considered valid. However, the variables previously mentioned that are used to develop the *f* factor for Q_2 have been refined over time and are now expressed as follows:

(1) *Aircraft Size.* Aircraft size reflects the potential level of risk. This risk factor is a composite of the passenger load, the potential internal fire load, flammable liquid fuel capacity, and the fuselage length and width. Careful consideration of all these factors allows the identification of a meaningful operational objective, that is, the area to be rendered fire free (controlled or extinguished).
(2) *Relative Effectiveness of Agent Selected.* This variable is accounted for by the specific application rate identified for each of the common generic foam concentrate types.
(3) *Time Required to Achieve PCA Fire Control.* Information from reliable large-scale fire tests, empirical data from a wide variety of sources, and field experience worldwide indicate that 1 minute is both a reasonable and a necessary operational objective.
(4) *Time Required to Maintain the Controlled Area Fire Free or to Extinguish the Fire.* An operational objective that provides a safety factor for the initial fire attack on the PCA while waiting for the arrival of backup support or to complete extinguishment of remaining fires outside the PCA.

The quantity of water for foam production required for 1-minute fire control of the PCA is still referred to as Q_1. However, data collected in the ensuing years now permit us to specify the required application rates for three generic foam types needed to extinguish fire in 1 m^2 or 1 ft^2 of the PCA as follows:

(1) AFFF = 5.5 (L/min)/m^2 or 0.13 gpm/ft^2
(2) FP = 7.5 (L/min)/m^2 or 0.18 gpm/ft^2
(3) PF = 8.2 (L/min)/m^2 or 0.20 gpm/ft^2

Over time the changes in aircraft size factor have required revisions to the values of both Q_1 and Q_2 and the introduction of a third component, Q_3, which make up the total quantity of water (Q) required for the production of foam.

For example, Q_1 changes as a function of the accepted foam application rates and the size of the operational aircraft common to the various airport categories. And, because Q_2 is a function of Q_1, it too is impacted by changes in aircraft size and requires revision from time to time to accurately reflect the changes in the operational aircraft fleet.

The operational significance of the components making up Q is substantial in that Q 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 agent be applied to the PCA within a time frame of 1 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.

The development of the requirement for these two quantities of water is based on exterior aircraft fuel spill fire control parameters. Information from actual incidents in recent years has shown that with increased aircraft crash worthiness, water for interior fire-fighting operations is also necessary. This quantity of water, called Q_3, is based on the need for handlines to be used for interior fire fighting. Hence, the total quantity of water (Q) is now defined as follows:

$$Q = Q_1 + Q_2 + Q_3$$

where:
Q_1 = water requirement for control of PCA
Q_2 = water requirement to maintain control or extinguish the remaining fire or both
Q_3 = water requirement for interior fire fighting

See Figure B.5.

B.5.1 The method for calculating the values for each component of Q are presented here:

$$Q_1 = \text{PCA} \times R \times T$$

where:
PCA = $(0.67) \times$ TCA, TCA = $L \times (K + W)$, and
L = length of aircraft
W = width of fuselage
R = application rate of selected agent
T = time of application (1 minute)
K = values shown in Table B.5.1

B.5.2 The current values of Q_2 as a percentage of Q have been determined to be as shown in Table B.5.2.

B.5.3 The values of Q_3 are based on accepted water flow requirements for the type of fire-fighting operations to be experienced when combating an interior aircraft fire. They are determined as shown in Table B.5.3.

In December 2000, ICAO RFFP-9 met. It was agreed that to accomplish the role of a timely interior fire suppression, all necessary equipment and personnel should be in place and the suppression activity should be in action within 5 minutes of notification of the accident event. This requirement places a premium on the need to have sufficient personnel and equipment to perform this task in the first responders group.

B.5.4 Sample Calculation Using Airport Category 4 and AFFF Foam.

TCA = $L \times (K + W)$
= 77.8 × (56 + 12.9) = 5360 ft^2

PCA = ⅔ × TCA = ⅔ × 5360 ft^2 = 3573 ft^2

Q_1 = 0.13 gpm/ft^2 × 3573 ft^2 × 1 = 464 gal

Q_2 = 58% × Q_1 = 0.58 × 464 = 269 gal

Q_3 = 600 gal

now

$Q = Q_1 + Q_2 + Q_3$
= 464 + 269 + 600 = 1333 gal
rounded up to 1340 gal

This quantity is shown in Table 5.3.1(b).

The example is given to illustrate the logic and the factors used to arrive at the quantity of water for foam production required for an airport Category 4.

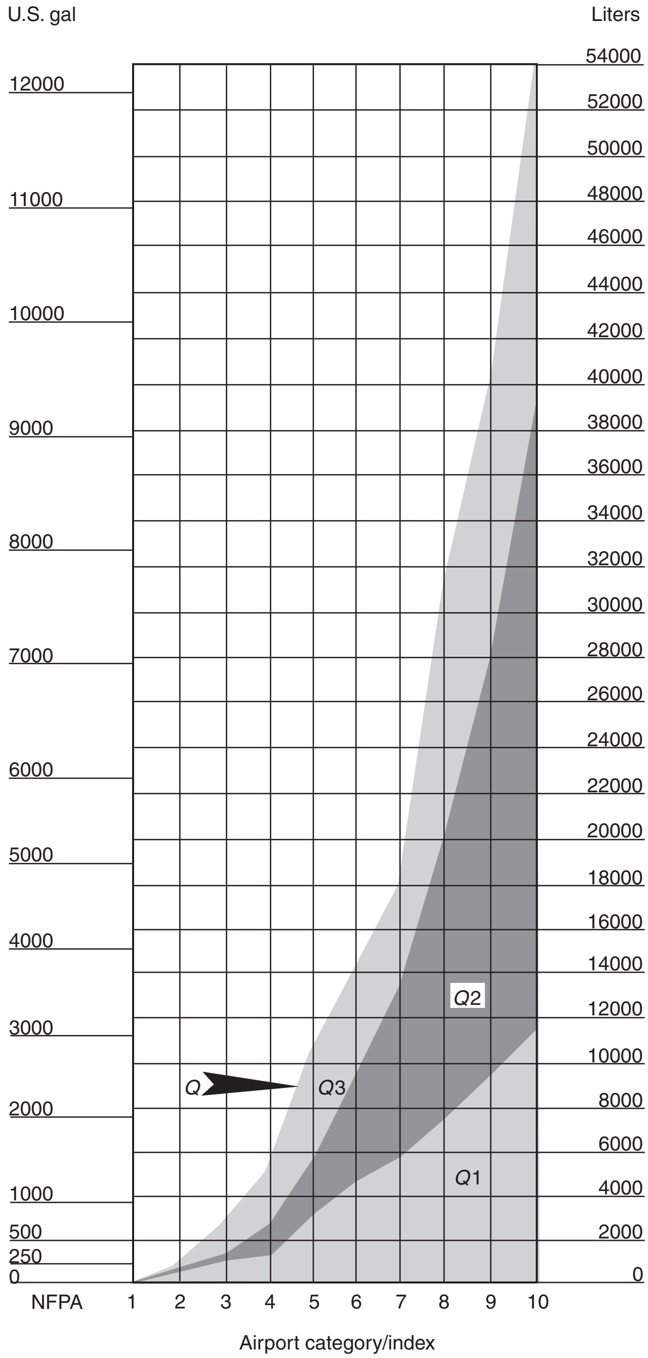

FIGURE B.5 Comparison of Water by Volume of Q_1, Q_2, Q_3, and Q for Producing Foam Solution Using AFFF.

Annex C Operational Communications System

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

C.1 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 or town or county off-airport fire department furnishes the airport rescue and fire-fighting personnel, and the alerting/dispatching 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 ARFF 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.

Table B.5.1 K Factors

	Feet
K	= 39 where L = less than 39
	= 46 where L = 39 up to but not including 59
	= 56 where L = 59 up to but not including 78
	= 98 where L = 78 and over
	Meters
K	= 12 where L = less than 12
	= 14 where L = 12 up to but not including 18
	= 17 where L = 18 up to but not including 24
	= 30 where L = 24 and over

Table B.5.2 Q_2 as a Percent of Q_1

Airport Category	Q_2% Q_1	Airport Category	Q_2% Q_1
1	0	6	100
2	27	7	129
3	30	8	152
4	58	9	170
5	75	10	190

Table B.5.3 Quantity of Water for Handlines

Airport Category	Q_3 Equals (U.S. gal)
1	0
2	0
3	60 gpm × 5 min = 300 gal
4	60 gpm × 10 min = 600 gal
5	125 gpm × 10 min = 1250 gal
6	125 gpm × 10 min = 1250 gal
7	125 gpm × 10 min = 1250 gal
8	250 gpm × 10 min = 2500 gal
9	250 gpm × 10 min = 2500 gal
10	500 gpm × 10 min = 5000 gal

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 or 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:

(1) Control tower, flight service station, or other control point
(2) Rescue and fire fighting
(3) Airport police
(4) Airport management
(5) Airline station manager(s), as appropriate
(6) Military units (joint-use airports)
(7) 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 might 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, for example, location of accident or incident site, type of aircraft, number of persons involved, aircraft fuel load, preferred vehicle routing, and so forth.

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 with 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 (OSCs) 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, ARFF services, and the airport alerting authority to preclude unnecessary aircraft emergency evacuation or misunderstandings.

Additionally, direct communications can be established between the flight deck and the incident commander or ARFF personnel by use of the discrete emergency frequencies (DEF) and deck to ground lines. Normally this communication capability results from the use of a ground service headset that 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 on with a minimum of activity or consultation.

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

Annex D Task and Resource Analysis Model

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

D.1 General. The most appropriate approach to accurately determine the necessary levels of staffing in airports was developed by reviewing and combining several task analysis methodologies from airport regulators and fire departments. The recommended Task and Resource Analysis model for this approach is described in this annex.

D.2 Scope. This annex describes the stages that must be followed by an airport operator in performing a Task and Resource Analysis in order to justify the minimum number of qualified personnel required for an airport rescue and fire-fighting service (ARFF) to respond effectively to an aircraft incident/accident. If an airport operator requires the ARFF to attend to structural incidents/accidents in addition to aircraft incidents/accidents, the possibility of being unable to meet required response times must be considered.

D.3 Purpose. The Task and Resource Analysis uses a risk-based approach and focuses on possible worst-case scenarios. This allows it to identify the minimum number of personnel required to perform identified tasks in real time before external services are needed at the incident/accident site to effectively support the ARFF services.

The Task and Resource Analysis also should include the types of aircraft using the aerodrome and the need for personnel to use breathing apparatus, handlines, ladders, and other aircraft rescue and fire-fighting equipment provided at the aerodrome.

D.4 Preliminary Information. The airport operator should first establish the minimum number of ARFF vehicles required for delivering the extinguishing agents at the required discharge rate for the specified airport category.

D.5 Task and Resource Analysis/Risk Assessment. A Task and Resource Analysis should consist primarily of a qualitative analysis of the rescue and fire-fighting service (RFFS) response to a realistic, worst-case aircraft accident scenario. The purpose of this analysis is to review the current and future staffing levels of the RFFS deployed at the aerodrome. The analysis should be supported by a quantitative risk assessment to estimate risk reduction. This risk assessment could be related to risk reduction to passengers and aircrew as a result of deploying additional personnel. One of the most important elements of the assessment is determining the impact of any critical paths that were identified by the qualitative analysis.

D.6 Qualitative Analysis. A Task and Resource Analysis and a Workload Assessment are used to examine the effectiveness of the current staffing level and determine the level of improvement that would result from additional staffing. A worst-case accident scenario should be analyzed to assess the relative effectiveness of at least two levels of RFFS staffing.

D.7 Quantified Risk Assessment. Generally, the quantified risk assessment will be used to support the conclusions of the qualitative analysis by examining the risks to passengers and aircrew from aircraft accidents at the airport. This risk assessment allows the employment of additional RFFS staff to be evaluated in terms of reducing the risk of passenger and aircrew lives lost and expressed in monetary terms. This value can be compared with the cost of employing additional personnel. However, this comparison is of little, if any, value in determining minimum levels of personnel.

D.8 Task and Resource Analysis. The basic contents of an analysis are as follows:

(1) Description of aerodrome, including the number of runways
(2) RFFS category (AIP)
(3) Response criteria, such as area, number of fire stations, times
(4) Rate of movements — that is, remission factor
(5) Hours of operation
(6) Current structure and establishment
(7) Level of staffing
(8) Level of supervision
(9) RFFS competence in terms of training and facilities
(10) Extraneous duties such as domestic and first aid response
(11) Alarm system
(12) Appliances and available media (targets — aerodrome manual)
(13) Specialist equipment such as fast-rescue craft, hovercraft, water carrier, hose line
(14) Role responsibilities at medical facilities
(15) Pre-determined attendees: local police, fire fighters, and EMTs
(16) Worst-Case Accident Scenario Analysis/Workload Assessment (This analysis should include personnel mobilization, deployment at the scene, scene management, fire fighting, suppression/extinguishment, complementary media, post-fire security, personal protective equipment (PPE), rescue team(s), aircraft evacuation, and media replenishment. Note: This analysis/assessment should identify any conflicts between the current and proposed workloads.)
(17) Appraisal of existing RFFS provision
(18) Future requirements, aerodrome development and expansion
(19) Enclosures such as maps, event trees, and so forth.

The preceding list is not exhaustive and should only act as a guide.

D.9 Stage 1. The airport operator must understand the goals and objectives of the ARFF staff services and the tasks that personnel are required to perform.

Example:

Goal. To maintain a dedicated ARFF staff of qualified and experienced fire and rescue personnel with specialist equipment to make an immediate response to an aircraft incident/accident in an airport or its immediate vicinity.

Objectives. To save lives and to render humanitarian services.

Tasks:

(1) Meet the required response time.
(2) Extinguish an external fire.
(3) Protect exit routes.
(4) Assist in passenger and aircrew self-evacuation.
(5) Extinguish an internal fire.
(6) Rescue trapped personnel.

The above list is not exhaustive.

D.10 Stage 2. Identify a selection of representative realistic accidents that could occur at the airport. This selection can be identified by analyzing statistics of previous accidents at airports and data from both international and national sources.

(Note: All accidents/incidents are to involve fire to represent worst-case scenarios.)

Example:

(1) Internal aircraft fire
(2) Aircraft engine failure with a fire
(3) Aircraft aborts and overruns with fire
(4) Aircraft into aircraft with fire
(5) Aircraft into terminal building(s) with a fire

D.11 Stage 3. Identify the types of aircraft commonly used at the airport. This stage is important because the type of aircraft and its configuration has a direct impact on the resources required in meeting Stage 1. For ease of analysis, it might be necessary to group the types in relation to common aircraft configuration.

Example:

(1) Long, wide-bodied aircraft with multiple passenger decks and multiple aisles
(2) Long, narrow-bodied aircraft with single aisle, high passenger density
(3) Short, narrow-bodied aircraft with single aisle, high passenger density and restricted over-wing exits

A representative aircraft from this example can then be chosen as one of the following:

(1) Boeing 747
(2) Boeing 757
(3) Boeing 737

D.12 Stage 4. Every airport is unique in that the airport location, runway and taxiway configuration, aircraft movements, airport infrastructure and boundary, and so forth, could present specific additional risks to the airport operator.

For the worst-case accident scenario to be modeled, a major factor to consider is the worst-case location for the most likely accident type that could occur.

The worst-case location should be confirmed by a facilitator using a team of experienced fire service personnel who have knowledge of the airport and the worst-case locations in which an aircraft accident could occur.

The role of the facilitator is to assist the team in reaching agreement on the worst-case locations and, by using a scoring system, to rank order these locations.

The team must determine their reasons for identifying the worst-case locations. Each team member gives each location a weighted number. The numbers for each location can then be added up to correspond to each identified location.

Example:

The team could have identified that the following factors contributed to a worst-case location:

(1) Travel time
(2) Route to the accident site — that is, hard or soft ground
(3) Terrain
(4) Crossing active runways
(5) Aircraft congestion
(6) Surface conditions
(7) Communications
(8) Supplementary water supplies
(9) Adverse weather conditions
(10) Additional lighting

An additional time delay that could result from any of these factors should be estimated and recorded, and the location with the highest additional response time should be identified as a worst-case location.

It is important to note that the location of an accident could have an impact on the resources and tasks required to be performed by ARFF personnel.

From this analysis, a location or a number of locations will be identified, and in agreement with the airport operator, a sample number of the top risks should be chosen as identified by the ranked score.

Example:

1, Taxiway leading onto Runway 06L
2, Runway 06R Crossing point
3, Runway 06L Overshoot
3, Aircraft Stand 33

D.13 Stage 5. This stage combines the accident types to be examined, as described in Stage 2, with the aircraft identified in Stage 3 and the worst-case locations as described in Stage 4.

The accident types should be correlated with the possible worst-case location. In some cases, an accident could occur in more than one location in an airport, for each of which a Task and Resource Analysis needs to be carried out.

This information is to be integrated into a complete accident scenario that can be analyzed by experienced fire fighters for the Task and Resource Analysis described in Stage 6.

Example: Scenario Number 1

Accident Type — Internal fire (Stage 2)

Aircraft Identified — Boeing 747-400 (Stage 3)

Accident Location — Taxiway leading onto Runway 06L (Stage 4)

The Boeing 747-400 is a wide-bodied multi-deck aircraft. Its typical seating configuration is 340 Economy, 23 Business, and 18 First Class passengers on the lower deck. On the upper deck, provision is made for 32 additional Business Class passengers, giving a total aircraft seating capacity of 413, excluding the crew. The aircraft typically has four exits on both sides of the lower deck and one exit on each side of the upper deck.

During the taxi-out from the terminal using the taxiway leading to Runway 06L, a small incendiary device activates within a toilet compartment situated between the rear of the Business Class section and the front of the main Economy Cabin. The fire develops rapidly. The Cabin Crew notifies the Flight Deck Crew, who halts the aircraft and orders an evacuation. Due to the noise of the device's activation, there is considerable panic and confusion onboard the aircraft, and the lower deck rapidly fills with smoke.

The Boeing 747-400 is one in a line of aircraft that is taxiing out to Runway 06L and is blocked in by the aircraft to the front and rear. The ARFF services are unable to access the aircraft along the main taxiway, and they have to leave the hard surface and cross soft ground to reach the aircraft.

Due to the fire and smoke, Emergency Exits Right 2 and Left 2 on the lower deck are not used for evacuation. The incident results in a serious internal fire from which a number of passengers will fail to self-evacuate.

D.14 Stage 6. By using a facilitator with teams of experienced airport fire fighters, the accident scenarios developed in Stage 5 are subject to a Task and Resource Analysis carried out in a series of table-top exercises.

When performing a Task and Resource Analysis, the objective should be to identify in *real time*, and in sequential order, the minimum number of ARFF personnel required at *any one time* to achieve the following:

(1) Receive and dispatch ARFF response. (The dispatcher might have to respond as part of the riding strength.)
(2) Respond and operate ARFF vehicles.
(3) Use extinguishing agents and equipment.
(4) Assist in passenger and crew self-evacuation.
(5) Access aircraft to carry out specific tasks, for example, fire fighting, rescue.
(6) Support and sustain the deployment of fire-fighting and rescue equipment.

(7) Support and sustain the delivery of supplementary water supplies.
(8) Replenish foam supplies.

The Task and Resource Analysis should identify the optimum time when additional resources will be available to support and replace resources supplied by ARFF services.

Note: ARFF personnel required in agreement with the airport operator to attend other airport-related incidents should be subject to a separate Task and Resource Analysis.

To start a Task and Resource Analysis, the required airport category must be identified as required by the regulatory authority. The category will confirm the number of vehicles and the minimum extinguishing agent requirements and discharge rates. This information will determine the number of personnel required to operate these vehicles.

The results of the analyses should be recorded in a table or spreadsheet format *(see Table D.14)* and should be laid out in such a way as to ensure that the following are recorded:

(1) Time — Starts from receipt of call, and the time line continues in minutes until additional external resources arrive
(2) List of assessed tasks and priorities
(3) The resources (personnel and equipment) required for each task
(4) Comments column to allow team member comments to be recorded

Example:

Major foam tenders are identified as MFTs A, B, C, D, E, or F.

Existing personnel riding the MFT are identified as A1, A2, B1, B2, and so forth.

Stated objectives:

(1) Respond within the required response time.
(2) Assist in passenger and aircrew self-evacuation.
(3) Extinguish internal fire.
(4) Ventilate aircraft to create survivable conditions.

Table D.14 shows that 16 fire fighters and an officer in charge are required, supported by 6 major foam tenders. However, no additional personnel were available to assist passengers in self-evacuation.

The time line can be further verified by the use of practical exercises to establish whether the times are realistic and achievable.

Example:

(1) How long does it take to don protective clothing?
(2) How long does it take to don breathing apparatus?
(3) How long does it take to slip and pitch a ladder?
(4) How long does it take to open an aircraft door from the head of a ladder?
(5) How long does it take to run out one, two, or three ECT lengths of hose?
(6) How long does it take to carry any item of rescue equipment over a specified distance and get it to work?

Table D.14 also illustrates that the scenario will dictate tasks and resources to be evaluated.

The Task and Resource Analysis model can also be used to identify equipment shortages and training needs for personnel required to deal with identified tasks.

Annex E Training Program

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

E.1 A carefully organized training program should be developed to meet the qualification requirements of NFPA 1003, *Standard for Airport Fire Fighter Professional Qualifications*, and follow the guidance within NFPA 405, *Standard for the Recurring Proficiency of Airport Fire Fighters*. The following guidelines are offered for structuring such a program.

The objectives of a training program for aircraft rescue and fire-fighting (ARFF) personnel at airports should be to accomplish the following:

(1) Teach the safe application of recognized practices and procedures
(2) Develop and maintain the confidence and competency of all personnel assigned ARFF duties
(3) Instill the concept of professionalism
(4) 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 ARFF operations
(5) Enhance the esprit de corps of ARFF personnel by creating an appreciative awareness of the hazards and dangers they could face in carrying out ARFF operations

E.2 Control and Planning. The complete training and educational program for ARFF personnel should be under the direction of one officer of the airport fire department for planning, development, and supervision.

E.3 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 the provision of suitable amounts of extinguishing agents, such as foam concentrate, dry chemical, and Halon 1211, and fuel for training fires.

E.4 Phases of Training. Training of ARFF personnel should include seven phases. Training in all phases should be conducted for support personnel used as auxiliary fire fighters and for full-time ARFF 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.

E.5 Indoctrination. Indoctrination training should include the following:

(1) The rules and regulations applicable to ARFF services
(2) Knowledge of the basic duties and responsibilities and those of co-workers
(3) Emergency response procedures
(4) The command structures for administration and operations
(5) The importance of practicing occupational safety

E.6 Operating ARFF Equipment. All ARFF 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 ensure that every fire fighter is so well versed in handling all types of appliances and tools used in ARFF operations that under stressful conditions individual fire fighters can take effective action without the need for specific direction. Some of the items that should be covered are included in the following list:

(1) Complete knowledge of each tool and piece of equipment.
(2) Location of each piece of equipment and tool carried on each vehicle.

Table D.14 Example of a Task and Resource Analysis

Time (Minutes)	Task	Resource	Comments
00.00	Call received as AGI to taxiway leading to Runway 06L, explosion and internal fire.	Dispatcher	
	ARFF personnel mobilized by dispatcher.		
	Call made to operate the airport emergency community plan.		
00.30	With the exception of the drivers and officer in charge (O i/c), all personnel dress in PPE on route to incident.	Minimum riding strength	
01.00	Four fire fighters don breathing apparatus en route.	A3, A4, F3, F4	
	O i/c requests captain to switch to frequency 121.6 via ATC.		Evacuation might have already taken place.
	Priority identified as to assist in self-evacuation, and to create and maintain survivable conditions within the aircraft.		
01.46	MFTs in position at aircraft.		
01.50	O i/c and drivers dress in PPE.		
01.52	Assistance required for self-evacuation.		No additional personnel available.
	C1 nominated as the Breathing Apparatus Control Officer.	C1	Remains with MFT C to provide additional water supply.
	Identify access to aircraft pitch ladder to door L2 and open door.	A3, A4, F3, F4	To slip and pitch ladder and open door and enter, four personnel are required.
	B1 remains as Turret Operator and provides escape route protection.	MFT B, B1	
	B2 and C2 run out extended sideline and hand to A3, A4, F3, F4 and charge.	B2, C2	
	A1 remains MFT A supplying water to internal crew.	MFT A, A1	
	C2 foots ladder for internal crew.	C2	
	D2, A2 assists with charged line for BA entry team.	D2, A2	
	O i/c upgrades incident to Aircraft Accident and liaises with Airside Operations.	O i/c	
	O i/c requests Airside Operations to assist in containing exiting passengers and crew and obtaining a head count.	O i/c	
03.13	O i/c requests ATC to instruct aircraft front and rear to shut down engines.	O i/c	
	D1, E2, don BA and enter at door L2.	D1, E2	
	MFT E, with E1 on pump to supply water to D1, E2.	MFT E, E1	
	B2 and F2 run out extended sideline and hand to D1, D2.	B2, F2	
06.30	MFT F, F1 supplies additional water to MFT A.	F1	
	MFT C supplies additional water to MFT E.	C1	
07.30	Supplementary water is required from nearest hydrant B2, F2.	B2, F2	Hydrant number flow and pressure.
	Assist in the deployment of fire ground equipment A2.	A2	
09.00	Internal crew start to extinguish and ventilate aircraft.		
10.00	External supporting services arrive at scene.		