



ICAO

Doc 9137-AN/898

Airport Services Manual

Part 1 — Rescue and Firefighting
Fourth Edition, 2015



Approved by and published under the authority of the Secretary General

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Published in separate English, Arabic, Chinese, French, Russian
and Spanish editions by the
INTERNATIONAL CIVIL AVIATION ORGANIZATION
999 University Street, Montréal, Quebec, Canada H3C 5H7

For ordering information and for a complete listing of sales agents
and booksellers, please go to the ICAO website at www.icao.int

Third edition — 1990
Fourth edition — 2015

Doc 9137, Airport Services Manual
Part I — Rescue and Firefighting
Order Number: 9137P1
ISBN 978-92-9249-815-3

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AMENDMENTS

Amendments are announced in the supplements to the *Products and Services Catalogue*; the Catalogue and its supplements are available on the ICAO website at www.icao.int. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

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FOREWORD

In accordance with the provisions of Annex 14 — *Aerodromes*, Volume I — *Aerodrome Design and Operations*, States are required to provide rescue and firefighting equipment and services at an airport. The purpose of the material in this manual is to assist States in the implementation of these specifications and thereby help to ensure their uniform application.

The methodology for rescue and firefighting at an aerodrome is based on the critical area concept developed by the Rescue and Fire Fighting Panel and adopted by ICAO via Amendment No. 30 to Annex 14 in 1976. The concept is based on the critical area to be protected in any post-accident fire situation with the objective of creating and maintaining survivable conditions, providing egress routes for aircraft occupants and to initiate the rescue of those occupants unable to make their escape without direct aid.

The third edition of this Manual was produced in 1990 and updated in 2014 as a result of a series of amendments to Annex 14, Volume I, up to and including Amendment 11. This fourth edition incorporates revisions and additions resulting from an overall review by the ICAO Secretariat; significant revisions/additions are:

- a) the introduction of the new principal extinguishing agent, i.e. performance level C foam (Chapter 2 and Chapter 8);
- b) guidance on the use of a task resource analysis in determining the minimum number of rescue and firefighting personnel (Chapter 10);
- c) updated procedures for aircraft rescue and firefighting (Chapter 12, including training in Chapter 14);
- d) guidance on preventive maintenance of vehicles and rescue equipment (Chapter 17);
- e) guidance on human factors principles in rescue and firefighting (Chapter 18);
- f) downloadable and up-to-date crash charts for commonly used aircraft using electronic linkage to aircraft manufacturers' websites (Appendix 1).

The content of the Manual was developed over a period of several years with input from the Rescue and Fire Fighting Working Group of the Aerodromes Panel. The working group included aerodrome rescue and firefighting experts, airports and pilot representative organizations and aircraft manufacturers. The manual was thereafter submitted for an extensive peer review to collect and take into account comments from the expert community. It is intended that the manual be kept up to date. Future editions will most likely be improved on the basis of experience gained and of comments and suggestions received from users of this manual. Therefore, readers are invited to give their views, comments and suggestions on this edition. These should be directed to:

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List of Acronyms

AC – Alternating current
ADREP – Accident incident data reporting
AFFF – Aqueous film forming foam
APUs – Auxiliary power units
ATC – Air traffic control
ATIS – Automatic terminal information service
BA – Breathing apparatus
BAECO – Breathing apparatus entry control officer
CCTV – Closed-circuit television
CFR – Code of Federal Regulations
DEVS – Driver enhanced vision system
FFFP – Film forming fluoroprotein foam
FLIR – forward looking infrared
HRET – High reach extendable turrets
IATA – International Air Transport Association
ISO – International Organization for Standardization
JATO – Jet assisted take-off
MFT – Major foam tender
NFPA – National Fire Protection Association
NID – Noise induced deafness
OEM – Original equipment manufacturer
PPE – Personal protective equipment
RESA – Runway end safety area
RFF – Rescue and firefighting
RFFS – Rescue and firefighting service
RTF – Radiotelephone
SCBA – Self-contained breathing apparatus
SHEL – Software, hardware, environment and liveware
SNAP – Significant New Alternatives Policy
SOP – Standard operating procedures
SPAAT – Skin penetrating agent applicator
TRA – Task resource analysis

Chapter 1

GENERAL CONSIDERATIONS

1.1 INTRODUCTION

1.1.1 The principal objective of an RFF (rescue and firefighting) service is to save lives in the event of an aircraft accident or incident occurring at, or in the immediate vicinity of, an airport. The RFF service is provided to create and maintain survivable conditions, to provide egress routes for occupants and to initiate the rescue of those occupants unable to make their escape without direct aid.

1.1.2 This service must assume at all times the possibility of and need for extinguishing a fire which may:

- a) exist at the time an aircraft is landing, taking off, taxiing, parked, etc.; or
- b) occur immediately following an aircraft accident or incident; or
- c) occur at any time during rescue operations.

The rupture of fuel tanks in an aircraft crash and the consequent spillage of highly volatile fuels, and other flammable liquids used by aircraft, present a high degree of probability of ignition if these liquids come into contact with hot metal parts of the aircraft or because of sparks caused by the movement of wreckage or disturbance of the electrical circuit. Fires may also occur through the discharge of accumulated electrostatic charges at the time of ground contact or during fuelling operations. A distinctive characteristic of aircraft fires is their tendency to reach lethal intensity within a very short time. This presents a severe hazard to the lives of those directly involved and can hamper rescue or evacuation efforts.

1.1.3 For this reason, the provision of adequate and special means of dealing promptly with an aircraft accident or incident occurring at, or in the immediate vicinity of, an airport assumes primary importance because it is within this time frame that there are the greatest opportunities of saving lives.

1.1.4 The extent of aircraft fires which may affect rescue is influenced largely by the quantity and disposition of fuel carried by the aircraft and the location of any fuel released as a result of the accident or incident.

1.1.5 Emergency exits and their ability to be opened from the inside and outside of an aircraft is of primary importance in rescue and evacuation operations. The provision of special tools for rescue crews in order to gain access to the interior of a fuselage is essential. However, their use can only be regarded as an extreme measure to be taken whenever normal means of access (including emergency exits) are unavailable or unsuitable for use.

1.1.6 The most important factors bearing on effective rescue in a survivable aircraft accident is the training received, the effectiveness of the equipment and the speed with which personnel and equipment, designated for RFF purposes, can be deployed.

1.1.7 The proposals set out hereunder concerning these services are intended as a general guide, to be applied to the fullest extent practicable.

1.2 ADMINISTRATION

1.2.1 The RFF service at an airport should normally be under the administrative control of the airport management, which should also be responsible for ensuring that the service provided is organized, equipped, staffed, trained and operated in such a manner as to achieve its principle objective of saving lives in the event of an aircraft accident or incident. The airport management may designate public or private organizations suitably located and equipped to provide/support the RFF service. It is intended that the fire station housing the RFF service be located on the airport premises and suitably located so that responses will not be delayed and will ensure response times can be met.

1.2.2 It is intended that the above include the availability of suitable specialist vehicles, rescue equipment and services for an airport located close to water, swamp, desert or other difficult environments, where a significant portion of aircraft approach or departure operations takes place over these areas. The purpose of these specialist vehicles, rescue equipment and services is to rescue aircraft occupants at an aircraft accident that may occur in these areas. Material related to rescue operations in difficult environments may be found in Chapter 13.

1.2.3 Coordination between the RFF service at an airport and public protective agencies (such as local fire departments, police forces, coast guard and hospitals) that may be called upon as supporting agencies should be established by prior agreement for assistance in dealing with an aircraft accident or incident. Guidance related to airport emergency planning and procedures can be found in the *Airport Services Manual* (Doc 9137), Part 7 — *Airport Emergency Planning*.

1.2.4 A detailed grid map(s) of the airport and its immediate vicinity (with date of revision) should be provided for the use of the airport services concerned. Information concerning topography, access roads and location of water supplies should be indicated. This map should be visibly posted in the control tower and the fire station and be available on the RFF vehicles as well as other supporting vehicles required to respond to an aircraft accident or incident. Copies should also be distributed to external agencies, such as police and medical services as required. The issuing authority for the detailed grid maps should have a document control process to ensure all agencies are made aware of any changes or re-issues.

Chapter 2

LEVEL OF PROTECTION TO BE PROVIDED

2.1 AIRPORT CATEGORY

2.1.1 The level of protection to be provided at an airport should be based on the dimensions of the aeroplanes normally using the airport as adjusted for their frequency of operations.

2.1.2 The airport category for RFF should be based on the overall length of the longest aeroplanes normally using the airport and their maximum fuselage width. The airport category should be determined using Table 2-1 by categorizing the aeroplanes using the airport, by first evaluating their overall length and second, their fuselage width. If after selecting the category appropriate to an aeroplane's overall length that aeroplane's fuselage width is greater than the maximum width in column (3) for that category, then the category for that aeroplane is actually one category higher.

Table 2-1. Airport category for rescue and firefighting

<i>Airport category</i>	<i>Aeroplane overall length</i>	<i>Maximum fuselage width</i>
(1)	(2)	(3)
1	0 up to but not including 9 m	2 m
2	9 m up to but not including 12 m	2 m
3	12 m up to but not including 18 m	3 m
4	18 m up to but not including 24 m	4 m
5	24 m up to but not including 28 m	4 m
6	28 m up to but not including 39 m	5 m
7	39 m up to but not including 49 m	5 m
8	49 m up to but not including 61 m	7 m
9	61 m up to but not including 76 m	7 m
10	76 m up to but not including 90 m	8 m

2.1.3 Airports should be categorized for RFF purposes by counting the aeroplane movements in the busiest consecutive three months of the year as follows:

- a) when the number of movements of the aeroplanes in the highest category normally using the airport is 700 or greater in the busiest consecutive three months, then that category should be the airport category (see examples nos. 1 and 2); and

- b) when the number of movements of the aeroplanes in the highest category normally using the airport is less than 700 in the busiest consecutive three months, then the airport category may be one less than the highest aeroplane category (see examples nos. 3 and 4) even when there is a wide range of difference between the dimensions of the aeroplanes which are included in reaching 700 movements) (see example no. 5).

2.1.4 It should be noted that the level of protection provided based on frequency of operations in 2.1.3 b) shall not be less than one category below the determined category.

2.1.5 Either a take-off or a landing constitutes a movement. Movements of scheduled, non-scheduled and general aviation operations should be counted in determining the airport category. A classification of representative aeroplanes by the airport category shown in Table 2-1 is included in Appendix 2.

2.1.6 The following examples illustrate the method for determining the airport category.

Example No. 1

<i>Aeroplane</i>	<i>Overall length</i>	<i>Fuselage width</i>	<i>Category</i>	<i>Movements</i>
Airbus A320	37.6 m	4.0 m	6	600
Bombardier CRJ 900	36.4 m	2.7 m	6	300
Embraer 190	36.2 m	3.0 m	6	500
ATR 72	27.2 m	2.8 m	5	200

The longest aeroplanes are categorized by evaluating, using Table 2-1, first their overall length and second, their fuselage width, until 700 movements are reached. It may be seen that the number of movements of the longest aeroplanes in the highest category totals more than 700. The airport in this case would be category 6.

Example No. 2

<i>Aeroplane</i>	<i>Overall length</i>	<i>Fuselage width</i>	<i>Category</i>	<i>Movements</i>
Airbus A350-900	66.8 m	6.0 m	9	300
Boeing 747-8	76.3 m	6.5 m	10	400
Airbus A380	72.7 m	7.1 m	10	400

The longest aeroplanes are categorized by evaluating, using Table 2-1, first their overall length and second, their fuselage width, until 700 movements are reached. It may be seen that the number of movements of the longest aeroplanes in the highest category totals more than 700. It may also be noted that when evaluating the category appropriate to the Airbus A380 aeroplane's overall length, e.g. category 9, the category selected is actually one higher as the aeroplane's fuselage width is greater than the maximum fuselage width for category 9. The airport in this case would be category 10.

Example No. 3

<i>Aeroplane</i>	<i>Overall length</i>	<i>Fuselage width</i>	<i>Category</i>	<i>Movements</i>
Boeing 737-900ER	42.1 m	3.8 m	7	300
Bombardier CRJ 900	36.4 m	2.7 m	6	500
Airbus A319	33.8 m	4.0 m	6	300

The longest aeroplanes are categorized by evaluating, using Table 2-1, first their overall length and second, their fuselage width, until 700 movements are reached. It may be seen that the number of movements of the longest aeroplanes in the highest category totals only 300. The minimum category for the airport in this case would be category 6, which is one category below that of the longest aeroplane.

Example No. 4

<i>Aeroplane</i>	<i>Overall length</i>	<i>Fuselage width</i>	<i>Category</i>	<i>Movements</i>
Airbus A380	73.0 m	7.1 m	10	300
Boeing 747-8	76.3 m	6.5 m	10	200
Boeing 747-400	70.7 m	6.5 m	9	300

The longest aeroplanes are categorized by evaluating, using Table 2-1, first their overall length and second, their fuselage width, until 700 movements are reached. It may be seen that the number of movements of the longest aeroplanes in the highest category totals only 500. It may also be noted that when evaluating the category appropriate to the Airbus A380 aeroplane's overall length, e.g. category 9, the category selected is actually one higher as the aeroplane's fuselage width is greater than the maximum fuselage width for category 9. The minimum category for the airport in this case would be category 9, which is one category below that of the longest aeroplane.

Example No. 5

<i>Aeroplane</i>	<i>Overall length</i>	<i>Fuselage width</i>	<i>Category</i>	<i>Movements</i>
Airbus A321	44.5 m	4.0 m	7	100
Boeing 737-900ER	42.1 m	3.8 m	7	300
ATR 42	22.7 m	2.9 m	4	500

The longest aeroplanes are categorized by evaluating, using Table 2-1, first their overall length and second, their fuselage width, until 700 movements are reached. It may be seen that the number of movements of the longest aeroplanes in the highest category totals only 400. It would appear from 2.1.3 b) above that the minimum category for the airport would be category 6; however, even when there is a relatively wide range of difference between the length of the longest aeroplane (Airbus A321) and the aeroplane for which the 700th movement is reached (ATR 42), the minimum category for the airport may only be reduced to category 6.

2.1.7 Notwithstanding the above, during anticipated periods of reduced activity the airport category may be reduced to that of the highest category of aeroplane planned to use the airport during that time irrespective of the number of movements.

2.1.8 **Cargo operations.** The level of protection at aerodromes used for all-cargo aeroplane operations may be reduced in accordance with Table 2-2. This is based on the need to protect only the area around the cockpit of an all-cargo aeroplane in the critical area concept. Using this rationale, the aerodrome category for an all-cargo aeroplane may be reduced by providing enough water quantity Q_1 for the control of fire. Information on the critical area concept and the method by which the scale of extinguishing agents has been related to the critical area may be found in 2.4.

Table 2-2. Airport category for all-cargo aeroplanes

<i>Aerodrome category</i>	<i>Reclassification of aerodrome category for all-cargo aeroplanes</i>
1	1
2	2
3	3
4	4
5	5
6	5
7	6
8	6
9	7
10	7

Note 1.— This table has been determined using the average size of aeroplane in a given category.

Note 2.— An all-cargo aeroplane is an aeroplane operated for the transportation of goods, without fare-paying passengers.

2.2 TYPES OF EXTINGUISHING AGENTS

2.2.1 Both principal and complementary agents should normally be provided at an airport. Principal agents produce a permanent control, i.e. for a period of several minutes or longer. Complementary agents have rapid fire suppression capability but offer a “transient” control which is usually only available during application.

2.2.2 The principal extinguishing agent should be:

- a) a foam meeting the minimum performance level A; or
- b) a foam meeting the minimum performance level B; or
- c) a foam meeting the minimum performance level C; or
- d) a combination of these agents.

The principal extinguishing agent for airports in categories 1 to 3 (see 2.4.10) should preferably meet the minimum performance levels B or C foam.

2.2.3 The complementary extinguishing agent should be:

- a) dry chemical powders (classes B and C powders); or
- b) other extinguishing agents with at least the same firefighting capability.

When selecting dry chemical powder for use with foam, care must be exercised to ensure compatibility.

2.2.4 Characteristics of the recommended extinguishing agents may be found in Chapter 8.

2.3 AMOUNTS OF EXTINGUISHING AGENTS

2.3.1 The amounts of water for foam production and the complementary agents to be provided on the RFF vehicles should be in accordance with the airport category determined under 2.1.2 and Table 2-3, except that for airport categories 1 and 2, up to 100 per cent of the water may be substituted with a complementary agent.

2.3.2 The amounts in Table 2-3 are the minimum amounts of extinguishing agents to be provided and are based on the average overall length of aeroplanes in a given category. If the aeroplane operating at an airport is larger than the median aeroplane, the amounts should be recalculated in accordance with 2.3.7.

2.3.3 The amounts in Table 2-3 have been determined by adding the quantity of extinguishing agents which are required to obtain a one-minute control time in the practical critical area and the quantity of extinguishing agents which are required for continued control of the fire thereafter and/or for possible complete extinguishment of the fire. Control time is the time required to reduce the initial intensity of the fire by 90 per cent. Information on the critical area concept and the method by which the scale of extinguishing agents has been related to the critical area may be found in 2.4.

2.3.4 The quantity of foam concentrate separately provided on vehicles for foam production should be in proportion to the quantity of water provided and the foam concentrate selected. The amount of foam concentrate should be sufficient to supply at least two full loads of such quantity of water where sufficient additional water supplies are immediately available to ensure a rapid replenishment of the water content carried.

2.3.5 The amounts of water specified for foam production are predicated on an application rate of 8.2 L/min/m² for a foam meeting performance level A, 5.5 L/min/m² for a foam meeting performance level B and 3.75 L/min/m² for a foam meeting performance level C. These application rates are considered to be the minimum rates at which control can be achieved within one minute.

2.3.6 The amounts of foams given in Table 2-3 have been determined on the assumption that the foams meet minimum specifications approved by the State. Guidance on basic characteristics of foams is contained in Chapter 8.

2.3.7 From 1 January 2015, at aerodromes where operations by aeroplanes larger than the average size in a given category are planned, the quantities of water shall be recalculated and the amount of water for foam production and the discharge rates for foam solution shall be increased accordingly.

2.3.8 Table 2-4 provides guidance on the calculation of the quantities of water and discharge rates based on the largest overall length of aeroplane in a given category. The table is based on the use of performance level A foam with an application rate of 8.2 L/min/m². Where performance level B or C foam is used, similar calculations should be made using the appropriate application rates. The formulae indicated in Table 2-4 are used only for the recalculation of quantities in accordance with 2.3.7.

Table 2-3. Minimum useable amounts of extinguishing agents

Aerodrome category	Foam meeting performance level A		Foam meeting performance level B		Foam meeting performance level C		Complementary agents	
	Water (L)	Discharge rate foam solution/minute (L)	Water (L)	Discharge rate foam solution/minute (L)	Water (L)	Discharge rate foam solution/minute (L)	Dry chemical powders (kg)	Discharge rate (kg/second)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	350	350	230	230	160	160	45	2.25
2	1 000	800	670	550	460	360	90	2.25
3	1 800	1 300	1 200	900	820	630	135	2.25
4	3 600	2 600	2 400	1 800	1 700	1 100	135	2.25
5	8 100	4 500	5 400	3 000	3 900	2 200	180	2.25
6	11 800	6 000	7 900	4 000	5 800	2 900	225	2.25
7	18 200	7 900	12 100	5 300	8 800	3 800	225	2.25
8	27 300	10 800	18 200	7 200	12 800	5 100	450	4.5
9	36 400	13 500	24 300	9 000	17 100	6 300	450	4.5
10	48 200	16 600	32 300	11 200	22 800	7 900	450	4.5

Note.— The quantities of water shown in columns 2, 4, and 6 are based on the average overall length of aeroplanes in a given category.

2.3.9 As of 1 January 2015, at aerodromes where the level of protection is reduced in accordance with the remission factor allowed in 2.1.3 b) and where operations by aeroplanes larger than the average size in a given category are planned, the recalculation of quantities of extinguishing agents required in 2.3.7 would need to be computed based on the largest aeroplane in the reduced category. As an example, an Airbus A380 (category 10) is operating infrequently into a B747 aerodrome (category 9). If the number of movements of the A380 is less than 700 movements in the busiest consecutive three months, the aerodrome is allowed to provide a category 9 level of protection, as permitted in 2.1.3 b). However, as of 1 January 2015, the quantities of an agent are to be recalculated for aerodromes where operations by aeroplanes larger than the average size in a given category are planned (see 2.3.7). As the A380 is larger than the average aeroplane used for calculation of quantities of extinguishing agents for category 9 in Table 2-3, the actual quantities to be provided need to be recalculated. Since 2.1.3 b) permits a remission factor of one, the largest quantity for category 9, i.e. 41 483 L (for performance level A foam) should be provided. As a comparison, this quantity is more than the median quantity of 36 400 L for category 9 in Table 2-3 but less than the maximum quantity of 54 242 L for category 10 in Table 2-4.

Table 2-4. Maximum quantities of extinguishing agents based on the largest dimension of an aeroplane (performance level A foam, application rate 8.2 L/min/m²)

RFF category	Largest theoretical length of aeroplane, L (m)	Fuselage width, W (m)	Total width of protection area (k ₁ + W) (m)	Theoretical critical area, A _T = L x (k ₁ +W)	Practical critical area, A _P = $\frac{2}{3}$ A _T	Q ₁ = 8.2 x 1 x A _P	Q ₂ =k ₂ x Q ₁ (see 2.4.10 for values of k ₂)	ΣQ = Q ₁ +Q ₂ (litres)	Discharge rate (L/min) = A _P x (application rate of 8.2 L/min/m ²)
1	9	2	12+2 = 14	126	84	689	0, 0	689	689
2	12	2	12+2 = 14	168	112	918	0.27 x 918=248	1 166	918
3	18	3	14+3 = 17	306	204	1 673	0.30 x 1 673=502	2 175	1 673
4	24	4	17+4 = 21	504	336	2 755	0.58 x 2 755=1 598	4 353	2 755
5	28	4	30+4 = 34	952	635	5 207	0.75 x 5 207=3 905	9 112	5 207
6	39	5	30+5 = 35	1 365	910	7 462	1.0 x 7 462=7 462	14 924	7 462
7	49	5	30+5 = 35	1 715	1 144	9 381	1.29 x 9 381=12 101	21 482	9 381
8	61	7	30+7 = 37	2 257	1 505	12 341	1.52 x 12 341=18 758	31 099	12 341
9	76	7	30+7 = 37	2 812	1 876	15 383	1.70 x 15 383=26 100	41 483	15 383
10	90	8	30+8 = 38	3 420	2 281	18 704	1.9 x 18 704=35 538	54 242	18 704

2.3.10 There may be aerodromes that use more than one type of performance level foams, such as a combination of level A and B foams, which could lead to error in quantity calculation or replenishment. The use of a combination of different performance level foams at an aerodrome is therefore not encouraged.

2.3.11 For the purpose of replacing water for foam production by complementary agents, 1 kg of a complementary agent shall be taken as equivalent to 1.0 L of water for production of a foam meeting performance level A. Higher equivalencies for complementary agents may be used if results of tests conducted on the complementary agents used by the State have indicated higher efficiencies than those recommended above. When any other complementary agent is used, the substitution ratios need to be checked.

2.4 CRITICAL AREA FOR CALCULATING QUANTITIES OF WATER

2.4.1 The critical area is a concept for rescue of the occupants of an aircraft. It differs from other concepts in that, instead of attempting to control and extinguish the entire fire, it seeks to control only that area of fire adjacent to the fuselage. The objective is to safeguard the integrity of the fuselage and maintain tolerable conditions for its occupants. The size of the controlled area required to achieve this for a specific aircraft has been determined by experimental means.

2.4.2 There is a need to distinguish between the theoretical critical area within which it may be necessary to control the fire and the practical critical area which is representative of actual aircraft accident conditions. 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 may become involved. It is not intended to represent the average, maximum or minimum spill fire size associated with a particular aircraft. The theoretical critical area is a rectangle having as one dimension the overall length of the aircraft and as the other dimension a length which varies with the length and width of the fuselage.

2.4.3 From experiments performed it has been established that for an aircraft with a fuselage length equal to or greater than 24 m, in wind conditions of 16 to 19 km/h and at right angles to the fuselage, the theoretical critical area extends from the fuselage to a distance of 24 m upwind and 6 m downwind. For smaller aircraft a distance of 6 m on either side is adequate. To provide for a progressive increase in the theoretical critical area, however, a transition is used when the fuselage length is between 12 m and 24 m.

2.4.4 The overall length of the aircraft is considered appropriate for the theoretical critical area as the entire length of aircraft must be protected from burning. If not, the fire could burn through the skin and enter the fuselage. Also, other aircraft such as T-tail aircraft often have engines or exit points in this extended portion.

2.4.5 The formula for the theoretical critical area A_T thus becomes:

<i>Overall length</i>	<i>Theoretical critical area A_T</i>
$L < 12 \text{ m}$	$L \times (12 \text{ m} + W)$
$12 \text{ m} \leq L < 18 \text{ m}$	$L \times (14 \text{ m} + W)$
$18 \text{ m} \leq L < 24 \text{ m}$	$L \times (17 \text{ m} + W)$
$L \geq 24 \text{ m}$	$L \times (30 \text{ m} + W)$

where L = the overall length of the aircraft, and

W = the maximum width of the aircraft fuselage.

2.4.6 As mentioned earlier, in practice it is seldom that the entire theoretical critical area is subject to fire and a smaller area, for which it is proposed to provide firefighting capacity, is referred to as the practical critical area. As a result of a statistical analysis of actual aircraft accidents, the practical critical area A_p has been found to be approximately two-thirds of the theoretical critical area, or

$$A_p = 0.667 A_T$$

2.4.7 The quantity of water for foam production can be calculated from the following formula:

$$Q = Q_1 + Q_2$$

where Q = the total water required

Q_1 = the water for control of the fire in the practical critical area, and

Q_2 = the water required after control has been established and is needed for such factors as the maintenance of control and/or extinguishment of the remaining fire.

2.4.8 The water required for control in the practical critical area (Q_1), may be expressed by the following formula:

$$Q_1 = A \times R \times T$$

where A = the practical critical area

R = the rate of application, and

T = time of application.

2.4.9 The amount of water required for Q_2 cannot be calculated exactly as it depends on a number of variables. The factors considered of primary importance are:

- a) maximum gross mass of the aircraft;
- b) maximum passenger capacity of the aircraft;
- c) maximum fuel load of the aircraft; and
- d) previous experience (analysis of aircraft RFF operations).

These factors, when plotted on a graph, are used to calculate the total amount of water required for each airport category. The volume of water for Q_2 , as a percentage of Q_1 , varies from about 0 per cent for category 1 airports to about 190 per cent for an airport category 10.

2.4.10 The graph mentioned in the preceding paragraph gives the following approximate values for aeroplanes representative of each airport category:

<i>Airport category</i>	<i>Q₂ = percentage of Q₁ percentage</i>
1	0
2	27
3	30
4	58
5	75
6	100
7	129
8	152
9	170
10	190

2.5 DISCHARGE RATES

2.5.1 The discharge rates of the foam solution should not be less than the rates shown in Table 2-3. The recommended discharge rates are those required to obtain a one-minute control time on the practical critical area and have therefore been determined for each category by multiplying the practical critical area by the application rate. The discharge rate of the foam solution is thus equal to the water quantity Q_1 in a control time of one minute.

2.5.2 The discharge rates of complementary agents should be no less than the rates shown in Table 2-3.

2.6 SUPPLY AND STORAGE OF EXTINGUISHING AGENTS

2.6.1 The quantities of the various extinguishing agents to be provided in the RFF vehicles should be in accordance with the airport category and Table 2-3. A reserve supply of foam concentrate equivalent to 200 per cent of the quantities of these agents identified in Table 2-3 should be maintained on the airport for vehicle replenishment purposes. This will permit an immediate complete recharge of the vehicles, if necessary, subsequent to an emergency and retention of a second complete recharge should another emergency occur before airport stocks can be replenished. For the purpose of determining quantities of reserve supply, the quantities of foam concentrate carried on fire vehicles in excess of the quantity identified in Table 2-3 can be considered contributing to the reserve.

2.6.2 A reserve supply of a complementary agent, equivalent to 100 per cent of the quantity identified in Table 2-3, should be maintained on the aerodrome for vehicle replenishment purposes. Sufficient propellant gas should be included to utilize this reserve complementary agent. Additionally, category 1 and 2 aerodromes that have replaced up to 100 per cent of the water with a complementary agent should hold a reserve supply of a complementary agent of 200 per cent.

2.6.3 Where a major delay in the replenishment of the supplies is anticipated, the amount of reserve supply in 2.6.1 and 2.6.2 should be increased as determined by, among others, the following considerations:

- a) location of RFF service (may be remote);
- b) availability of supplies;
- c) delivery times; and
- d) customs considerations.

2.6.4 Vehicle foam tanks must be kept full at all times when the vehicle is in operational service because partially filled tanks will create stability problems when the vehicle is cornering at speed. Furthermore, serious sludging problems can occur where protein foam is carried through oxidation and agitation if there is an air space above the surface of the foam. Where protein foam concentrates are used, the entire contents should be periodically discharged and the entire system washed through to ensure that the tank does not contain stale protein foam.

2.7 RESPONSE TIME

2.7.1 The operational objective of the RFF service should be to achieve response times of two minutes and not exceeding three minutes to the end of each runway, as well as to any other part of the movement area, in optimum conditions of visibility and surface conditions. Response time is considered to be the time between the initial call to the RFF service and the time when the first responding vehicle(s) is(are) in position to apply foam at a rate of at least 50 per cent of the discharge rate specified in Table 2-3. Determination of realistic response times should be made by RFF vehicles operating from their normal locations and not from positions adopted solely for test purposes.

2.7.2 Consideration of response times should also be given to landing and take-off areas for the exclusive use of helicopters.

2.7.3 Any other vehicles required to deliver the amounts of extinguishing agents specified in Table 2-3 should arrive in three minutes and no more than four minutes from the initial call so as to provide continuous agent application.

2.7.4 The requirements in 2.7.1 may require an evaluation of the RFF vehicles at airports where the first responding vehicle(s) is(are) not capable of applying foams at the rate of at least 50 per cent of the recommended discharge rate for the airport category. This should be considered as an objective to be achieved as the airport vehicle fleet is upgraded.

2.7.5 To meet the operational objective as nearly as possible in times of traffic/apron congestion or in less than optimum conditions of visibility, it may be necessary to provide suitable guidance, equipment, access routes and/or procedures for RFF vehicles. These may include navigation equipment installed in the vehicles such as:

- a) a driver enhanced vision system (DEVIS) with on-board navigation equipment utilizing the global navigation satellite system to provide the driver with the vehicle's location thus serving as an aid in navigating to the accident sites;
- b) tracking using digital radio datalink to assist the vehicle driver in locating and navigating to the accident site, thereby reducing driver communications workload and improving situational awareness; and

- c) low visibility enhanced vision using a forward looking infrared (FLIR) device (or other comparable state-of-the-art low visibility enhanced vision technology) by sensing thermal radiation instead of visible light to improve visual awareness in a smoky, foggy or dark environment.

2.7.6 In addition, other suitable provisions such as bypass access roads as well as the provision of ground movement guidance instructions by radiotelephone from air traffic control based on surveillance radar, accident site location by air traffic control and a collision avoidance facility either from equipment installed in the vehicles or provided by surveillance radar from air traffic control. For the guidance of the RFF vehicles from their station(s) or standby position(s) to the accident site, vehicles can move in a convoy and air traffic control can direct the leading vehicle(s).

2.8 FIRE STATION

2.8.1 All RFF vehicles should normally be housed in a fire station. Satellite fire stations should be provided whenever the response time cannot be achieved from a single fire station.

2.8.2 The fire station should be located so that the access for RFF vehicles into the runway area is direct and clear, requiring a minimum number of turns. Details of characteristics of fire stations can be found in Chapter 9.

2.9 COMMUNICATION AND ALERTING SYSTEMS

2.9.1 A discrete communication system should be provided linking a fire station with the control tower, any other fire station on the airport and the RFF vehicles.

2.9.2 An alerting system for RFF personnel should be provided at a fire station, capable of being operated from that station, any other fire station on the airport and the airport control tower.

2.10 NUMBER OF VEHICLES

2.10.1 The minimum number and types of conventional RFF vehicles provided at an airport so as to effectively deliver and deploy the agents specified for the airport category should be in accordance with Table 2-5.

2.10.2 Details on special vehicles to be available at airports where the area to be covered by the service includes a difficult environment can be found in Chapter 13.

2.10.3 In addition to the above, suitable rescue equipment and services should be available at airports where the area to be covered by the service includes water, swamp or other difficult environments that cannot be fully served by conventional wheeled vehicles. This is particularly important where a significant portion of approach/departure operations takes place over this area. The purpose of these special vehicles is to rescue aircraft occupants at an aircraft accident that may occur in this area. Details on characteristics of these types of vehicles can be found in Chapter 5.

2.10.4 A preventive maintenance plan should be derived to ensure maximum mechanical efficiency of the RFF vehicles. In this connection, due regard should be made to the possible need to provide reserve vehicles to take the place of those which become temporarily unserviceable. Guidance on fire vehicle preventive maintenance are available in Chapter 17.

Table 2-5. Minimum number of vehicles

<i>Airport category</i>	<i>RFF vehicles</i>
1	1
2	1
3	1
4	1
5	1
6	2
7	2
8	3
9	3
10	3

Chapter 3

AIRPORT FACILITIES AFFECTING RESCUE AND FIREFIGHTING SERVICES

3.1 AIRPORT WATER SUPPLY

3.1.1 Supplementary water supplies, for the expeditious replenishment of RFF vehicles, should be prearranged. The objective of providing additional water supplies at adequate pressure and flow is to ensure rapid replenishment of aerodrome RFF service (RFFS) vehicles. This supports the principle of continuous application of extinguishing media to maintain survivable conditions at the scene of an aircraft accident for far longer than that provided for by the minimum amounts of water set out in Chapter 2.

3.1.2 Additional water to replenish vehicles may be required in as little as five minutes after an accident, therefore an analysis should be conducted to determine the extent to which the replenishing vehicles and their associated storage and delivery facilities, should be provided.

3.1.3 When conducting the analysis, the following factors are items which should be considered but not limited to:

- a) sizes and types of aircraft using the aerodrome;
- b) the capacities and discharge rates of aerodrome fire vehicles;
- c) the provision of strategically located hydrants;
- d) the provision of strategically located static water supplies;
- e) utilization of existing natural water supplies for firefighting purposes;
- f) vehicle response times;
- g) historical data of water used during aircraft accidents;
- h) the need and availability of supplementary pumping capacity;
- i) the provision of additional vehicle-borne supplies;
- j) the level of support provided by local authority emergency services;
- k) the pre-determined response of local authority emergency services;
- l) fixed pumps where these may provide a rapid and less resource-intensive method of replenishment;
- m) additional water supplies adjacent to airport fire service training areas; and
- n) overhead static water supplies.

3.2 EMERGENCY ACCESS ROADS

3.2.1 Emergency access roads should be provided on an airport where terrain conditions permit their construction so as to facilitate the achievement of minimum response times. Particular attention should be given to the provision of ready access to approach areas up to 1 000 m from the threshold or at least from the threshold to the airport boundary. Where the airport is fenced, access to outside areas should be facilitated by the provision of emergency gates or frangible barriers.

3.2.2 Emergency access roads and any associated bridges should be capable of supporting the heaviest vehicles, which will use them and be constructed so as to be effectively available in all weather conditions. Roads within 90 m of a runway should be constructed to prevent surface erosion and the transfer of debris to the runway. Sufficient vertical clearance should be provided from overhead obstructions for the largest vehicles. Wherever possible, roads should permit the passage of vehicles in both directions.

3.2.3 When the surface of the road is indistinguishable from the surrounding area, or in areas where snow may obscure the location of the roads, edge markers should be placed at intervals of about 10 m.

3.2.4 Where an emergency access road, normally provided with a gate or frangible barrier, leads emergency vehicles on to a public road, the exterior face of the gate or barrier should be marked to indicate its purpose, with a prohibition of vehicle parking in its immediate vicinity. Suitably designed corners, with adequate radii for the manoeuvring of RFF vehicles, should be provided to facilitate the departure of responding vehicles through the airport fence emergency gates or barriers.

3.2.5 The combined facilities of emergency access road and gate or barrier should be subject to regular inspection and physical tests where necessary to prove the proper functioning of any mechanical element, to ensure their availability in an emergency.

3.2.6 If any gates are non-frangible and secured by other mechanical means, access through the gate(s) should be readily available, such as, but not limited to, the provision of keys to the gates to be kept in the RFF vehicles.

Chapter 4

COMMUNICATION AND ALARM REQUIREMENTS

4.1 SYSTEM FACILITIES

4.1.1 The efficiency of an RFF service is significantly dependent on the reliability and effectiveness of its communication and alarm system. In addition, the successful conduct of the total firefighting and related rescue operation will be facilitated by the system for alerting and mobilizing other participating emergency support personnel. The importance of prompt and clear communications cannot be over-emphasized.

4.1.2 Consistent with the individual requirements of each airport there should be provision for:

- a) direct communication between air traffic control (or other activating authority provided by the airport authority) and the airport fire station(s) to ensure the prompt dispatch of RFF vehicles in the event of an aircraft emergency;
- b) communication between air traffic control and the RFF crews en route to, or in attendance at, an aircraft accident/incident. To provide guidance to the RFF vehicles during low visibility conditions, some form of navigational assistance may be required (see 2.7.5);
- c) communication between the fire station, or the main station, where more than one is provided, and the RFF vehicles;
- d) communication between the RFF vehicles, including where necessary, a system to provide inter-communication between the crew members of an RFF vehicle; and
- e) emergency alarm systems to alert auxiliary personnel and appropriate organizations located on or off the airport.

4.1.3 Additionally, direct communication may be provided between the RFF services and the flight crew of an aircraft in an emergency on the ground.

4.2 FIRE STATION COMMUNICATIONS

4.2.1 In considering the scope of fire station communications, two important factors need to be considered. The first is the extent of the workload in the watchroom when an aircraft accident or incident occurs. The range of communication facilities will naturally be related to this workload and if some part of the emergency mobilization can be undertaken elsewhere, at the airport telephone exchange room or emergency operations centre, for example, then the fire station watchroom can be more effectively equipped and operated in its primary role. The second consideration relates to those airports operating more than one fire station. Where two or more stations are provided it is usual to designate one as the main station and its watchroom as the master watchroom, which is continuously staffed. A satellite station may also have a watchroom with fewer facilities commensurate with its subordinate role and usually staffed only until the satellite's vehicles respond to a call. In discussing fire station communications, it is essential to differentiate between the minimum requirements in main and satellite fire stations and to identify the systems which can serve both.

4.2.2 Calls to the airport fire station(s) for attendance at an aircraft accident/incident normally originate from air traffic control. Air traffic control should be linked with the main fire station by a direct telephone line not passing through any intermediate switchboard so as to avoid delays. This line is usually provided with a distinctive buzzer in the watchroom and is safeguarded against buzzer defects by a warning light. This line can be linked to the alarm system in the main and satellite fire station(s) so that the initiation of a call by air traffic control simultaneously alerts all personnel. The alarm system may also be used to activate RFF vehicle room doors. A separate switch for activating the alarm system should be provided in each fire station watchroom.

4.2.3 Fire stations should be provided with a public address system so that details of the emergency, giving location, type of aircraft involved, preferential routing for RFF vehicles, can be conveyed to crew members. Control of this system would normally be located in the master watchroom, which would also have a switch for silencing the alarm system to avoid any interference with the effective use of the broadcast facility.

4.2.4 Some calls for emergency services may reach the main fire station from the airport telephone switchboard and it is usual to have a special telephone circuit for these priority calls. As some of these calls will be of lower priority than that associated with an aircraft accident/incident, e.g. response to fuel spills, special services, etc., it is not necessary to link this circuit with the alarm system. The alerting and directing of these responses can be controlled from the master watchroom. A separate telephone circuit, for calls of a non-emergency nature, should also be provided in each watchroom.

4.2.5 Where the master watchroom is required to mobilize off-airport support services for aircraft-related or other emergency situations, direct telephone circuits with appropriate priority indications should be provided to the appropriate control centres.

4.2.6 Satellite fire station watchrooms should be linked to the master watchroom by a direct telephone line. The satellite fire station should be served by the public address and alarm system operated by the master watchroom as well as having the ability to activate the alarm system and make public address broadcasts within its station. A grid reference map(s) should be displayed.

4.2.7 In many instances, the master fire station watchroom tends to become overloaded with alarms, switches, buzzers, coloured lights, radio equipment, public address system, etc. The watchroom should be designed in such a way as to minimize the workload on the watchroom attendant during an emergency call. The objective should be to set out the watchroom in such a manner that a call can be received and dealt with by a minimum of movement on the part of the watchroom attendant. Grid reference maps, etc., should be placed directly in front of the watchroom attendant's position. Details on the design of the fire station watchroom can be found in 9.3.

4.2.8 All telephone and radio equipment in each watchroom should be regularly monitored for its serviceability and arrangements should exist for emergency repair and maintenance of this equipment. The continuity of electrical supplies to fire stations should be ensured by connection to secondary power supplies.

4.3 RFF VEHICLE COMMUNICATIONS

4.3.1 When RFF vehicles leave their fire stations and enter the manoeuvring area they come under the direction of air traffic control. These vehicles must be equipped with two-way radio communications equipment, through which their movements can at all times be subject to direction by air traffic control. The choice of a direct air traffic control/fire service frequency, monitored in the master watchroom, or a discrete airport fire service frequency, relaying air traffic control instructions and fresh information, will be a matter for the airport or appropriate authority to determine, based on local operational and technical considerations. A discrete frequency minimizes the extent to which fire service activities involve an air traffic control channel at a busy airport. It is important to provide the fire service with the facility to communicate with flight crew members in certain types of incidents, particularly where undercarriage situations are

involved or aircraft evacuation may be proposed. Technical solutions are available to permit both a discrete frequency and an aircraft “talk-through” facility, subject to air traffic control approval. All transmissions should be recorded once an emergency situation has been declared.

4.3.2 The radio equipment on RFF vehicles must accommodate communication between vehicles, en route to, and in operation at, an aircraft accident. Within individual vehicles there should be an intercommunication system, particularly between drivers and monitor operators, to optimize the deployment of the vehicles at an accident. The provision of a communication facility within an appliance must recognize the likelihood of high noise levels and this may require the use of noise-cancelling microphones, headsets and loudspeakers for effective intercommunication.

4.3.3 The RFF vehicles should be provided with communication equipment capable of communicating directly with an aircraft in an emergency situation using an aeronautical radio frequency. The aeronautical radio frequency permits the RFF service and the aircraft to communicate with each other directly allowing the RFF crew to issue critical information regarding the exact nature of, and the hazards associated with, an emergency in progress along with recommendations for actions. Where provided, the aeronautical radio frequency may be selected by air traffic control and notified to the aircraft and the RFF service. The requirements and responsibilities for the utilization of a radio frequency between the RFF service and the flight crew of an aircraft in an emergency situation should be detailed in a procedure agreed to between the air traffic services and the airport operator.

4.3.4 Communications between the flight crew, air traffic control and the RFF service should be maintained throughout the emergency response. Due to the critical and timely nature of the information transmitted on this frequency, transmissions should be limited to air traffic control, the pilot of the aircraft and the officer-in-charge of the RFF operations. The officer-in-charge of the RFF operations should delay transmissions to the aircraft until cleared by air traffic control, unless the nature of the transmission is critical to emergency operations.

4.3.5 One of the prerequisites for effective communication between the RFF service and the flight crew of the aircraft is language proficiency. Steps should be taken to ensure that the rescue and firefighting crew, in particular the officer-in-charge of the RFF operations, demonstrates knowledge of the ICAO language designated for use in air-ground communications and the ability to speak clearly so as not to adversely affect radio communication.

4.3.6 Standard operating procedures (SOP) explaining the use of the dedicated radio frequency should be developed outlining why, when and how it should be used.

4.3.7 At the accident site the officer-in-charge of RFF operations may leave the vehicle and make observations on foot, and can then direct and inform crew members in all aspects of fire-ground operations using a portable megaphone. This equipment may also serve a subsidiary role in communications with aircraft crew members, the occupants of the aircraft and other persons responding to the accident.

4.3.8 Rescue boats or other specialized vehicles intended for use in water, swampy areas or other difficult terrain should also be provided with two-way radio equipment. Special attention should be given to the selection of units intended for use in marine applications, particularly to their protective containment systems.

4.4 OTHER COMMUNICATION AND ALERTING FACILITIES

4.4.1 The mobilization of all parties and agencies required to respond to an aircraft emergency on a large airport will require the provision and management of a complex communications system. The requirement is examined in the *Airport Services Manual* (Doc 9137), Part 7 — *Airport Emergency Planning*, Chapter 12. Part 7 covers all aspects of airport emergency planning of which communications is a vital element, and which must be subject to individual consideration by airport authorities in relation to local facilities.

4.4.2 Where auxiliary personnel, not on standby duty, are required to respond to an emergency, an audible alarm (siren or air horn) should be provided which can be clearly heard in appropriate areas above normal noise level and all wind conditions. Personnel responding to alarm signals of this nature must have access to a telephone number, from which more precise information as to the nature of the emergency and their response requirement can be acquired and to appropriate transport facilities to achieve this response.

4.4.3 Direct communication between the RFF personnel and the flight crew during an emergency does not necessarily involve speech only as the possible use of hand signals, in particular at smaller airports, may be considered. Annex 2 — *Rules of the Air*, Appendix 1 contains standard emergency hand signals for emergency communication between the RFF personnel and the cockpit and/or cabin crews of the incident aircraft.

Chapter 5

FACTORS IN THE SPECIFICATION PROCESS FOR RESCUE AID FIREFIGHTING VEHICLES

5.1 INTRODUCTION

5.1.1 Acquisition of vehicles for RFF purposes requires a detailed study of a number of factors. In this process, the study will include consideration of the operational requirement, design and construction aspects and the overall compatibility of the completed vehicle fleet with the airport's RFF support services. Figure 5-1 provides a series of typical factors which should be included in a logical progression towards a decision to acquire a new vehicle. The diagram anticipates that local knowledge of all operating conditions and experience with existing RFF vehicles will be taken into account. Each of the factors in the diagram will be examined in more detail in this chapter. The objective of every study must be to acquire vehicles which will provide an effective and reliable service throughout their "operational lives". This can only be ensured by the selection of vehicles of proven performance and reliability, to be operated by trained personnel and supported by using programmes of preventive maintenance by qualified support personnel. A list of significant design, construction and performance features which should be considered in preparing a specification for an RFF vehicle is contained in 5.9.

5.1.2 It is not intended, in this chapter, to consider the specialized vehicles intended for use in difficult environments. These vehicles are discussed in Chapter 13. Communications equipment, which is an essential component of all RFF vehicles, is dealt with in Chapter 4. The locations of the vehicles, to ensure the most effective response capability, are considered in Chapter 9, which also includes advice on the housing and technical support aspects which will preserve the functional and mechanical qualities of these vehicles.

5.1.3 In any appraisal of design and construction there are features which must be regarded as essential and, therefore, must be expressed in a specification as the minimum acceptable level of provision. Other features can be specified, above the minimum level, to facilitate operational handling, preventive maintenance or the visual appearance of a vehicle, without necessarily making a significant contribution to the effectiveness of the vehicle in its primary role. While these additional items may be desirable, they will also add to the cost of the vehicle and, in some cases, to the extent and complexity of the maintenance programmes. Care must be taken so that in providing any additional capability, the primary role of the vehicle in aircraft firefighting is not impaired. In the following paragraphs, where appropriate, the distinction between essential and desirable features will be made. Such distinction is not intended to dismiss the value of refinements in systems, finishes or instrumentation where these are specified by the airport or appropriate authority and can be maintained in service.

5.1.4 Where, in this chapter, reference is made to a vehicle the material will also apply to the acquisition of more than one vehicle of the same design and capacity. The sole difference may lie in the procedure to be completed in the acceptance programme and in the commissioning of vehicles at the airports to which they are assigned (see 5.8.2).

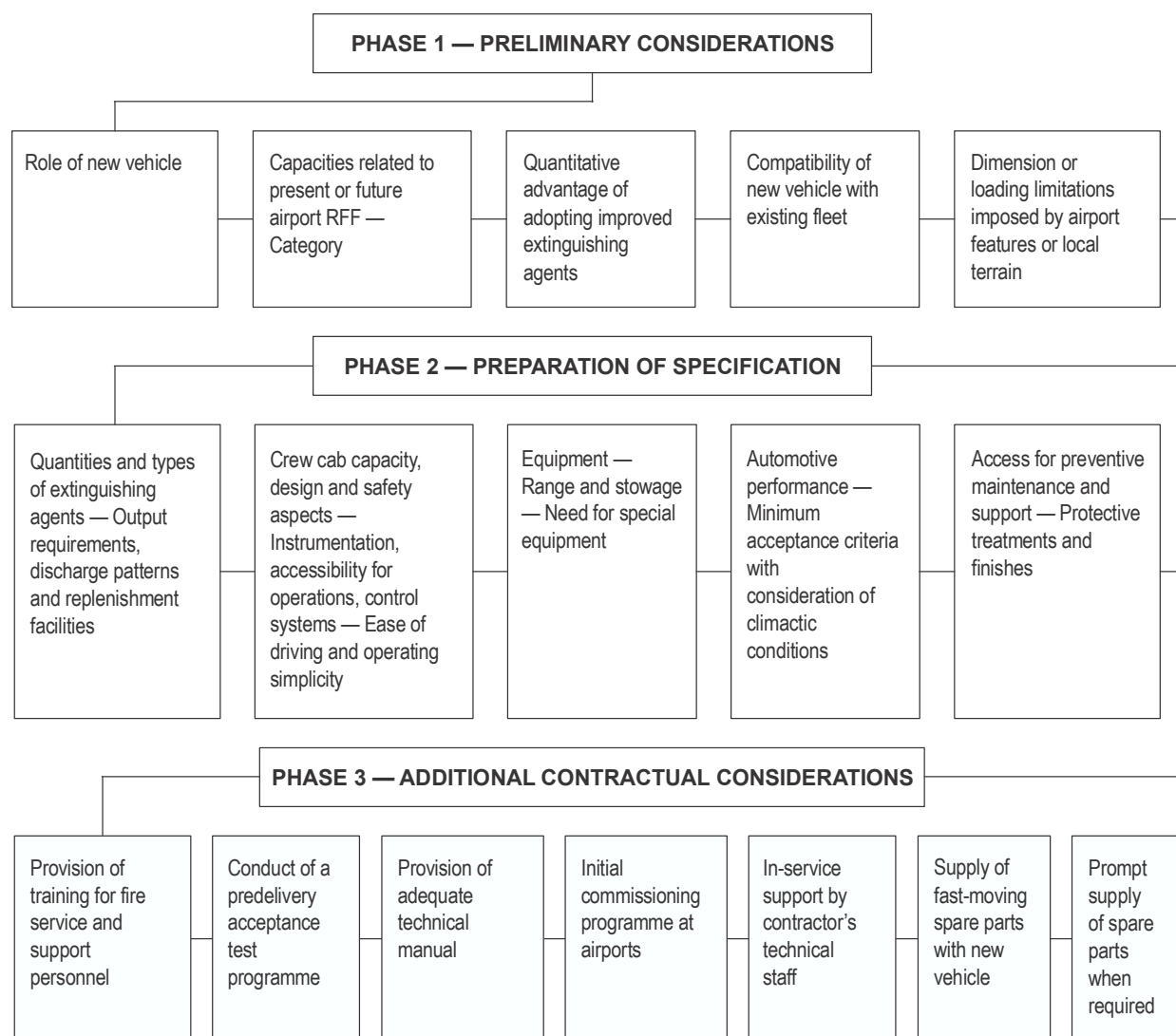


Figure 5-1. Typical factors for selection of rescue and firefighting (RFF) vehicles

5.1.5 No attempt is made in these suggestions to detail water pump capacities, pump inlet and outlet plumbing, power take-offs, foam proportioners and controls, the location of monitors (turrets) and their operation, hose reel location, hose sizes and length and similar equipment details, although they are all items requiring careful engineering and design. Basically, such equipment is related to the extinguishing agents used, the necessary discharge rates and the manpower available and needed to place the vehicle in full operation. The overall aim must be to provide operational simplicity, recognizing the relatively short period of time available for mounting a successful RFF operation. Where this entails a degree of engineering complexity the provision of adequate training for the staff appointed to maintain the vehicle will be essential.

5.2 PRELIMINARY CONSIDERATIONS

5.2.1 **Role of new vehicle.** In general terms, the vehicles to be used for aircraft RFF have the characteristics as expressed in Table 5-1. There are other vehicle types in use at airports, such as command vehicles, used by officers in charge of a duty watch that have virtually no rescue or firefighting capability. Some airports provide auxiliary water tank vehicles, equipped with a pump and delivery hose, to replenish foam-producing vehicles at an aircraft accident. While these can provide a useful service, particularly where there are limited installed water supplies, they cannot be described as primary vehicles. This chapter will consider only the RFF vehicles. Minimum characteristics related to these vehicles are expressed in Table 5-1. It is intended that these minimum characteristics be considered when upgrading the airport RFF vehicle fleet.

Table 5-1. Suggested minimum characteristics for RFF vehicles

	<i>RFF vehicles up to 4 500 L</i>	<i>RFF vehicles over 4 500 L</i>
Monitor	Optional for categories 1 and 2 Required for categories 3 to 9	Required
Design feature	High discharge capacity	High and low discharge capacity
Range	Appropriate to longest aeroplane	Appropriate to longest aeroplane
Handlines	Required	Required
Under truck nozzles	Optional	Required
Bumper turret	Optional	Optional
Acceleration	80 km/h within 25 s at the normal operating temperature	80 km/h within 40 s at the normal operating temperature
Top speed	At least 105 km/h	At least 100 km/h
All-wheel drive capability	Required	Required
Automatic or semi-automatic transmission	Required	Required
Single rear-wheel configuration	Preferable for categories 1 and 2 Required for categories 3 to 9	Required
Minimum angle of approach and departure	30°	30°
Minimum angle of tilt (static)	30°	28°

5.2.2 The original concept which created the rapid intervention vehicle was based on the then current inability of major vehicles to meet the response time specifications in 2.7.1. New technical advances in chassis design have produced RFF vehicles with greatly improved performance considered capable of providing an adequate rapid intervention at airports. The role of RFF vehicles is to reach the accident site quickly, protect evacuation paths, control any outbreak of fire and to initiate rescue. Should the dual application of principal and complementary agents be considered, the quantity of complementary agent to be carried on a vehicle may be all, or some part of, that is required by the RFF category, the disposition of which to be related to the number of vehicles deployed at the airport. The rescue equipment may be carried on one vehicle or distributed among the vehicles that are making the initial attendance to an aircraft accident.

5.3 QUANTITIES OF EXTINGUISHING AGENTS

5.3.1 Where vehicles are provided, as proposed in Table 2-5, they must be capable of conveying and delivering at least the minimum quantities of extinguishing agents specified in Table 2-3, according to the airport category. The response time requirements specified in 2.7.1 should also be taken into account. The vehicles may also carry some of the rescue equipment. The selection of a vehicle of a particular capacity will be dependent on whether it is a replacement for a vehicle which is obsolete or redundant or whether it is a component of a fleet to be deployed at a new airport. In the latter case the consideration of its compatibility with existing vehicles does not arise.

5.3.2 The acquisition of a new vehicle provides an opportunity to consider not only its contribution as a replacement, but also the extent to which it may be specified so as to accommodate any future RFF categorization, as may be required by changes in the volume of traffic or the introduction of longer aircraft. The anticipated "operational life" of a vehicle, with reasonable care and maintenance, will be at least ten years, and an assessment of the probable growth of traffic in this period should be a factor in the specification of a vehicle.

5.4 ADVANTAGES IN ADOPTING IMPROVED EXTINGUISHING AGENTS

A comparison of the minimum quantities of water for foam production in Table 2-3 shows the advantages to be gained by the adoption of the foam concentrates capable of performance level B or C. Additional advantages also exist in adopting either dry chemical powders or equivalent complementary agents. In this case, the advantages lie not only in a reduction in the quantity of agent to be provided, but also in the improved fire suppression capabilities of these agents.

5.5 COMPATIBILITY OF NEW VEHICLES WITH EXISTING FLEET

In acquiring a new vehicle it will be natural to seek the incorporation of all improvements available from current technology. In securing these advantages it is essential to examine the extent to which they may impose new problems to personnel in the RFF and support services. In most cases, the new problems are capable of resolution by additional training and the provision of appropriate support equipment. The value of a compatibility study lies in the early recognition of problem areas and the provision of solutions. As an example at the simplest level, the introduction of firefighting delivery hoses, with jackets composed of synthetic materials rather than natural fibres, demands specialized repair equipment. At a more significant level, the incorporation of power-assisted control systems and electronic devices in automotive or firefighting applications is desirable since they are compact, efficient and reliable, increasing the contribution to be made by individual operatives at an aircraft accident. They will, however, require particular levels of skill in their maintenance and repair. Training will be essential to acquaint support personnel with appropriate procedures,

which may include the provision of specialized tools, instruments or maintenance facilities. Wherever power-assisted controls are provided in foam production and delivery systems, a manual-override facility must also be provided to permit foam production in the event of the failure of any power-assisted function. A system for monitoring the availability of power-assisted functions, to be used as part of the vehicle's daily inspection procedure, is desirable.

5.6 DIMENSIONAL OR LOADING LIMITATIONS

5.6.1 The most obvious consideration in this context in acquiring a new RFF vehicle is whether it can be accommodated in the existing fire station. Other elements of airport design and some in the response area adjacent to the airport are important. These include the dimensions of any tunnels, archways or subways through which the vehicle may be expected to pass in responding to an emergency. Overhead cables must also be considered. Bridges, culverts and cattle-grids must be evaluated if the weight of a new vehicle is greater than that of previous types. The length and width of the vehicle will be of significance in negotiating corners and in this connection it will be important to review the ability of any new vehicle to negotiate the emergency gates provided to meet the terms of 3.2.4.

5.6.2 The design and construction of the vehicle should be suitable for carrying its full load over all types of roads and unimproved surfaces on, and in the vicinity of, the airport in all reasonable weather conditions. Detailed specifications on characteristics concerning vehicle traction and flotation cannot be issued on a blanket basis because they will vary with the terrain conditions existing or liable to exist at the individual airport at which the vehicle is in service. The off-road performance of vehicles designed for this service should be a primary consideration in the selection of the vehicle. In most cases, this need makes it desirable to provide for all-wheel drive with tires capable of carrying the vehicle over the unimproved ground surfaces likely to be encountered. The importance of using tires of the proper design, construction and size, so inflated and mounted to assure maximum traction and flotation, cannot be over-emphasized. Tires should be selected to provide effective performance on the terrain to be encountered in the intended airport service. Inflation pressure should be the lowest possible consistent with the tire manufacturer's recommendations for the specific loading and service speeds of the tires selected.

5.7 PREPARATION OF A SPECIFICATION

5.7.1 Having reached conclusions in the preliminary stage of consideration it will be possible to produce a specification for the required vehicle. The quantities and types of extinguishing agents should be expressed at the "useable contents" levels to ensure that the containment and delivery systems are designed to take account of those quantities of each agent which cannot be discharged. Any monitor designed to discharge foam must produce a foam of the specified quality, dependent on the type of concentrate used (see Chapter 8). The output, effective range and selective patterns of discharge must be related to the requirements of the airport RFF category and to the operational tactics to be employed by the crew. Complementary agents, also discussed in Chapter 8, must be capable of delivery through monitors or extended hose lines at the defined rates of discharge, with a variable discharge capability where this would enhance their fire suppression properties. It is essential to consider the replenishment processes associated with the principal and complementary agent systems as the duration and complexity of these processes have a significant effect on vehicle availability. Where agents of all types are discharged, at accidents or in training, it is essential to return vehicles to complete availability in the shortest possible time.

5.7.2 The design of the crew compartment on any RFF vehicle can contribute to the efficiency of the vehicle in a number of ways. The first consideration is that it should be large enough to accommodate the specified crew and certain elements of equipment. The number of crew members will be determined by the total operational role to be fulfilled by the vehicle, which may anticipate activities external to the vehicle simultaneously with the discharge of extinguishing agents from the vehicle. Combined activities of this nature may be characteristic of the first responding vehicle. Other complementary agents, will normally commence their fire attack by delivering their principal agent, retaining at this stage

their ability to adopt new positions to optimize their fire suppression capability. The ability to maintain uninterrupted foam production while the vehicle is in motion at speeds up to 8 km/h is an essential design feature for all vehicles. In this mode, it will be impossible to deliver any complementary agent unless this is discharged through a monitor.

5.7.3 Many current vehicles are capable of operation at full capacity with one operator although some users prefer a two-member crew, consisting of a driver and a monitor operator, which provides a more effective distribution of the operational workload. In some States larger crews are provided and it is a matter for local decision as to an appropriate crewing level, having due regard to the operational effectiveness of additional crew members while the vehicle is in motion. In all cases the crew compartment must provide for the safe conveyance of the crew to an aircraft accident with sufficient space to facilitate the donning of elements of protective clothing. The driver must have all-round visibility, effective controls and instrumentation and some form of communication with the monitor operator during all firefighting operations. The monitor operator must be able to assume the operating position while the vehicle is in motion and operate the monitor through at least 60 degrees either side of the central axis of the vehicle. Depression of the monitor should deliver foam at ground level not more than 12 m ahead of the vehicle while providing an elevation of not less than 30 degrees. Monitors should produce foam in straight streams and diffused patterns and have a high and low discharge capability. The output from the monitor should be determined in relation to the minimum output specified for the airport category in Table 2-2. In this respect it should meet or exceed the specification, if the only monitor available, or provide an appropriate element of the total requirement when more than one monitor is in use at an aircraft accident. At airports receiving aircraft over 28 m in length it is desirable to have more than one vehicle equipped with a monitor to facilitate a fire attack from more than one point.

5.7.4 Other features of crew compartment design must include ease of access or egress for crew members, adequate insulation from vibration and noise and, where appropriate, measures, including the provision of equipment, to maintain an acceptable environment in temperature extremes. The calibration of instruments and the labelling or marking of controls, switches, lockers or other locations shall be in the units and in the language specified by the airport or appropriate authority. Wherever practicable, use should be made of symbols to minimize the need for interpretation of wording or the operation of a control. Consideration should be given to the use of status indicators, using illuminated devices to denote the availability of a facility or function or the operation of a control. These are simple to maintain and interpret and reduce the workload on drivers and monitor operators when the vehicle is in action at an accident or during training. They are preferable to analogue instrumentation unless this more complex type of equipment is required by legislation, as would be the case with a vehicle speedometer.

5.7.5 The capacity of the foam concentrate tank should be sufficient to provide the specified solution ratio for twice the capacity of the water tank. This level of provision is considered to be desirable at all airports where facilities exist for the rapid replenishment of the water tank. While rapid replenishment of the water tank may have a limited value in terms of an effective contribution at an aircraft accident, it will restore the vehicle to operational readiness, eliminating the delay entailed by the problems of refilling the foam concentrate tank.

5.7.6 The requirement for bumper turrets and undertruck protection has been the subject of considerable controversy. In their early forms, the two types of installation were conceived as providing protection for the vehicle during operations at an aircraft accident. Undertruck nozzles still provide this form of protection and are specified for vehicles with over 4 500 L capacity and considered optional for vehicles with up to 4 500 L capacity. Undertruck nozzles demand regular inspection to ensure their freedom from obstruction and corrosion. The term “bumper turret” defines an installation which is significantly different from the equipment fitted to earlier models of vehicles. The original forms consisted of a horizontal pipe, mounted on the front of the vehicle at a low level and delivering foam through a series of perforations. Later designs substituted the perforations for one or more fixed nozzles which delivered foam to form a protective carpet. The “bumper turret” designs, some types of which are known as “ground sweeps”, are intended to provide a dual role, not only protecting the vehicle but also offering a low-level foam application ability as a contribution to the total fire suppression capability of the vehicle. The intension is to deal with fires under wings and in areas for which the main monitor may not be entirely suitable although this task can also be undertaken with hand hose lines. Control of the discharge and direction of the “bumper turret” is usually from within the cab. It is to be noted that the provision of both “bumper turrets” and undertruck nozzles entails consumption of the principal agent which may not

contribute significantly to aircraft RFF operations. It may be concluded that, where these installations are specified, an additional quantity of water and foam concentrate should be added to the vehicle's capacity. The quantities in each case might be determined by including a two-minute discharge period of both installations, concurrent with the discharge of the monitor.

5.7.7 The equipment to be carried in a new vehicle will have been determined in the preliminary stage and will include some items of protective clothing for crew members, stowed near their riding positions in the crew compartment. Rescue and communications equipment must also be accommodated and the basic requirement for both is secure stowage to preserve each item, with ready access for inspection or use. The stowage must preclude the entry of damp or dust and the retaining devices within lockers or within the crew compartment must combine security of retention with immediate release for access, a difficult combination but one for which modern design can provide acceptable solutions. To establish the scope, types and quantities of rescue equipment applicable to the range of airport categories, a thorough assessment should be conducted at each location to ensure that the equipment levels maintained are commensurate with what is required. Table 5-2 provides guidance material only in relation to the range of rescue equipment normally applicable to the airport categories. The option exists, where more than one vehicle will attend an aircraft accident, to consider the disposition of the rescue equipment to several vehicles. All RFF vehicles should be provided with searchlights or floodlights.

5.7.8 It must be appreciated that where a rescue tool requires a source of power for its operation a decision must be made as to the means of providing this source. In some cases, the source can be portable, as is the situation with some pneumatic chisels, which utilize a compressed-air cylinder. Some rescue saws are operated by a small internal combustion engine, giving complete mobility but with a minor risk of introducing an ignition source in an area which may have fuel vapour concentrations. More complex rescue tools, using pneumatic, hydraulic or electrical power, require the support of equipment which can generate and maintain the power source. The two options which must then be considered are installed equipment in a vehicle or portable equipment, carried in the vehicle. In both solutions, there will be a requirement for accommodation within the vehicle with the balance of operational advantage resting with portable systems. With a portable system the radius of action afforded to the rescue tools is much greater, as it is not determined by the length of the supply lines, as would be the case with equipment installed in vehicles.

5.7.9 Another form of power-assisted rescue and firefighting equipment is now being specified by some airports. The outline of the original operational requirement is provided in 12.2.14, which identifies the problem created by fire situations in the elevated, rear-mounted engines of certain aircraft. At heights of up to 10.5 m, access to the intakes of the centrally mounted engines is further complicated by the configuration of the rear fuselage. Effective delivery of an extinguishing agent from ground level or from the top of an RFF vehicle may not be achieved in all weather conditions. The technical solution may well be to provide a mechanical device to elevate the nozzle delivering the extinguishing agent, with or without an operator. Articulated or extensible devices, capable of delivering a complementary agent at an acceptable rate, are available and some have been installed on RFF vehicles.

5.7.10 Preliminary studies indicate that there may be additional operational roles for such equipment, including use as a floodlight tower to illuminate an accident site, as an observation platform, with communications equipment to report observations and as a rescue aid, permitting the opening of aircraft doors and the subsequent attachment of a form of escape slide. In considering the extent to which these apparent operational advantages may be effectively realized, it is necessary to assess the frequency with which the specified situations occur. The equipment now available is effective, but it imposes weight penalties, design complexity and a significant cost element in its acquisition. Certain of the functions it offers are achievable by other means and, above all, any system which anticipates the elevation of an operator, in addition to the extinguishing agent, has, out of necessity, to be designed to ensure the safety of the operator. It is to be noted that use of these devices may pose a hazard to the vehicle. The device has to be located close to the subject aircraft, with extremely limited opportunity for rapid removal in an emergency.

Table 5-2. Guidance material related to rescue equipment carried on RFF vehicles

Equipment scope	Equipment item	Airport category			
		1-2	3-5	6-7	8-10
Forcible entry tools	Prying tool (hooligan, biel type)	1	1	1	2
	Crowbar 95 cm	1	1	1	2
	Crowbar 1.65 m	1	1	1	2
	Axe, rescue large non wedge type	1	1	1	2
	Axe, rescue small non wedge or aircraft type	1	2	2	4
	Cutter bolt 61 cm	1	1	2	2
	Hammer 1.8 kg – lump or club type	1	1	2	2
	Chisel cold 2.5 cm	1	1	2	2
A suitable range of rescue/cut-in equipment including powered rescue tools	Hydraulic/electrical (or combination) portable rescue equipment	1	1	1	2
	Powered rescue saw complete with minimum 406 mm diameter spare blades	1	1	1	2
	Reciprocating/oscillating saw	1	1	1	2
A range of equipment for the delivery of firefighting agent	Delivery hoses 30 m lengths x 50 and 64 mm diameters	6	10	16	22
	Foam branches (nozzles)	1	1	2	3
	Water branches (nozzles)	1	2	4	6
	Coupling adaptors	1	1	2	3
	Portable fire extinguishers				
	CO ²	1	1	2	3
	DCP	1	1	2	3
Self-contained breathing apparatus – sufficient to maintain prolonged internal operations <i>Note: Ideally one BA set per crew member.</i>	Breathing apparatus (BA) set complete with facemask and air cylinder				
	BA spare air cylinder				
	BA spare facemask				
Respirators	Full faced respirators complete with filters	One per responding firefighter			

Equipment scope	Equipment item	Airport category			
		1-2	3-5	6-7	8-10
A range of ladders	Extension ladder, rescue and suitable for critical aircraft	-	1	2	3
	Ladder general purpose – rescue capable	1	1	1	2
Protective clothing	Firefighting helmet, coats, over trousers (complete with braces), boots and gloves as a minimum	One set per operational firefighter plus a percentage of reserve stock			
Additional items for personal protection	Protective goggles	1	1	2	3
	Flash hoods	One per operational firefighter			
	Surgical gloves	1 box	1 box	1 box	1 box
	Blanket fire resisting	1	1	2	2
Rope lines	Rope line rescue 45 m	1	1	2	2
	Rope line general use 30 m	1	1	2	2
	Rope line pocket 6 m	One per operational firefighter			
Communication equipment	Portable transceivers (hand held and intrinsically safe)	1	2	2	3
	Mobile transceivers (vehicle)	One for each fire vehicle			
A range of hand-held/portable lighting equipment	Hand-held flashlight (intrinsically safe)	1	2	4	4
	Portable lighting – spot or flood (intrinsically safe)	1	1	2	3
A range of general hand tools	Shovel overhaul	1	1	2	2
Rescue tool box and contents		1	1	2	3
	Hammer, claw 0.6 kg				
	Cutters, cable 1.6 cm				
	Socket set				
	Hacksaw, heavy duty complete with spare blades				
	Wrecking bar 30 cm				
	Screwdriver set – slotted and Phillips heads				
	Pliers, insulated Combination 20 cm Side cutting 20 cm Slip joint – multi-grip 25 cm				
	Seat belt/harness cutting tool				
	Wrench, adjustable 30 cm				

Equipment scope	Equipment item	Airport category			
		1-2	3-5	6-7	8-10
	Spanners, combination 10 mm – 21 mm				
First aid equipment	Medical first-aid kit	1	1	2	3
	Automated External Defibrillator (AED)	1	1	2	3
	Oxygen Resuscitation Equipment (ORE)	1	1	2	3
Miscellaneous equipment	Chocks and wedges – various sizes				
	Tarpaulin – lightweight	1	1	2	3
	Thermal imaging camera	-	-	1	2

5.7.11 It is also considered that in those cases where a fire has not been extinguished by the discharge of the installed system in the aircraft, the use of foam streams, although not entirely effective in engine fire situations, will not add materially to the damage already sustained by the engine while preventing the development of the fire. The additional benefits, such as floodlighting and access to aircraft doors, are available by simpler means, including the use of equipment listed in Table 5-2. Statistical evidence derived from RFF interventions at aircraft accidents does not confirm a requirement for equipment of this kind. This is, however, a typical case of a desirable component for those who identify a need and can sustain the equipment in service. The training of operators, particularly drivers, will be a crucial element in any programme before introduction to operational use. The equipment must be installed in a large vehicle to provide the stable platform for its operation and this may suggest the duplication of the facility at an airport to ensure that the service remains available when one of these specialized vehicles is temporarily out of commission.

5.7.12 Automotive performance criteria for RFF vehicles are expressed at the minimum level of acceptability in Table 5-1, with other details relating to extinguishing agents and firefighting systems. In some cases, the minimum characteristics provided are less demanding than those now available from vehicle manufacturers. In particular, accelerations, top speeds and static tilt angles of completed appliances now in service exceed these specifications. In considering any proposals from manufacturers, the objective would be to obtain the maximum benefits arising from technological developments, particularly where these make a contribution to safety. In this connection, stability, as demonstrated by tilt angle, and crew cab integrity would be important.

5.7.13 There are additional automotive factors to those listed in Table 5-1, including those concerned with braking performance, turning circle, tire equipment, interaxle clearance, exhaust emission and, as discussed in 5.6, dimensions. As a basic requirement these must meet or exceed national or local legislation, subject to such special dispensation as may be accorded to emergency vehicles. The provision of audible and visual devices to identify an emergency vehicle should conform to national or local legislation, in addition to any standard lighting requirement of these regulations. An additional lighting requirement for vehicles to be operated in the aircraft manoeuvring area is defined in Annex 14 — *Aerodromes*, Volume I — *Aerodrome Design and Operations*, Chapter 6. Airport emergency vehicles should be finished in a conspicuous colour, preferably red, in accordance with Annex 14, Volume I, 6.2.2.2.

5.7.14 Local factors which may have effect on vehicular performance include:

- a) the altitude at which the vehicle is to operate. The performance of normally-aspirated engines may be affected at altitudes above 600 m and the use of turbochargers may be necessary to achieve acceleration and cruising speed specifications;

- b) any temperature extremes likely to be encountered by the vehicle. Very high temperatures may necessitate additional capacity in the engine cooling system. Very low temperatures may require protective equipment for the vehicle including the firefighting pump, associated plumbing and the water tank; and
- c) the presence of unusual quantities of sand or dust in the atmosphere, requiring augmented filtration in the induction system to the engine.

5.7.15 All vehicles will require regular inspection of every aspect of their structure, systems and operational functions. Servicing and preventive maintenance will ensure, as far as is practicable, that the vehicle will remain effectively available. The time taken to complete these processes will be directly related to the accessibility of all the areas to be inspected and serviced and the design of the vehicle must provide this facility. Additionally, in anticipation of the need to remove a major component, such as the engine, pump, tank or foam-making system, removable panels and suitable lifting connections must ensure that removal and replacement does not entail unacceptable extension of down-time. One design feature, indirectly related to vehicle serviceability and the extent to which some areas will require maintenance, is the application of protective treatments and finishes. Anti-corrosion treatments are essential in most airport environments and these can be extended to protect areas which may be exposed to any deposits of foam concentrate or dry chemical agents which may be spilled during replenishment operations. The under-chassis and some elements of the superstructure can be protected against abrasion from surface material thrown up by the tires. Any steps or walkways to be used by crew members can combine non-slip characteristics with features which protect adjacent surfaces against damage by footwear. The front and sides of the vehicle, which may sustain damage when the vehicle contacts brush, scrub or undergrowth, can be constructed of materials which can withstand this exposure, avoiding the need to regularly repaint the framework/bodywork. This range of protective measures can prolong the availability of a vehicle and make a significant reduction to the cost and duration of maintenance programmes.

5.7.16 For optimum foam firefighting and burn-back performance the foam-making equipment should produce expansions and 25 per cent drainage times of acceptable levels. Generally, expansion ranges from 6 to 10 for film-forming or fluorine free synthetic foams and from 8 to 12 for protein based foams. Drainage time should be in excess of 3 minutes for film-forming foams and in excess of 5 minutes for protein-based foams when tested in accordance with their respective methods.

5.8 ADDITIONAL CONTRACTUAL CONSIDERATIONS

5.8.1 There may be a need for staff training when a new vehicle is acquired, particularly where innovations in firefighting systems, automotive components or other structural features are to be incorporated. Many constructors of RFF vehicles are able to provide such facilities in the country of construction or of use. The most valuable opportunities are those in the country of construction where training can be given as the vehicle is assembled. This can be of special benefit to personnel who will be involved in the development of preventive maintenance and periodic overhaul programmes. Visits to the subcontractors of major components, such as the engine, transmission and fire pump, will provide invaluable professional advice, leading to a complete awareness of the total vehicle. Training of RFF personnel, particularly those with instructional duties, can also be arranged but this may be most effective in the country of use, where any special local conditions may be taken into account. This would be the case where driver training had to be provided. All training can be provided as part of the total contract for a new vehicle.

5.8.2 It is usual to include in a contract a series of tests to demonstrate the ability of a vehicle to meet a specification. These tests may be divided into two groups — those which measure aspects of the vehicle's performance as a rescue or firefighting unit and those which measure its vehicular performance. A typical series of tests would consider:

- a) foam output, through the monitor, any sidelines and the bumper turret and undertruck nozzles, where specified;

- b) the qualities of foam produced;
- c) the range and pattern of foam discharged, in both low and high levels of output, from the monitor;
- d) the operation, including the extension of any hose-line, of the complementary agent system, where specified;
- e) the conduct of replenishment procedures;
- f) the production of foam, while in motion, probably as part of a) above;
- g) the conduct of a flushing procedure on completion of foam production;
- h) acceleration and maximum speed tests;
- i) braking, turning and gradient performance tests;
- j) the weighing of the fully stowed vehicle, including separate axle weights; and
- k) static tilt test.

5.8.3 This series of tests is additional to any visual inspection of a vehicle to appraise design features, finishes, treatments and other aspects required by the specification. Where a number of identical vehicles are ordered it may be necessary to perform the tests in a) to k) above for the first production vehicle only. Acceleration and cruising speed tests should be conducted at the normal operating temperatures of the vehicle.

5.8.4 Technical manuals, describing systems, operating procedures and other construction features of the vehicle, are essential for RFF and support purposes. They can be used as instructional documents and in programming inspection and preventive maintenance procedures. Where a manual includes a list of components it can facilitate the acquisition of spare parts in precise terms. At least two copies of these technical manuals should be provided, one each for the principal officers in the RFF and maintenance services. The language in which these documents shall be presented will be for local determination.

5.8.5 Where the vehicle to be acquired has features or performance characteristics which are new to the RFF and maintenance services, it may be advantageous to the airport or appropriate authority to specify a commissioning programme when the vehicle is delivered to the airport. The contractor can provide one or more representatives to introduce the vehicle to those who will be responsible for its operation and serviceability, with particular attention to drivers. Experience has shown that vehicle drivers must be given training if they are to realize the full advantages of increased power and handling qualities offered by modern vehicles. While the water and foam concentrate tanks of vehicles will normally be kept filled to capacity, drivers should be made aware of the change in handling characteristics created by partially filled tanks, which may be experienced when returning from an incident or training period.

5.8.6 Although the standards of design and construction now employed will produce vehicles which are reliable in service, subject to the introduction of reasonable handling, inspection and maintenance procedures, some unserviceability is inevitable. The repair skills available to the airport will normally ensure the early return of vehicles to operational use but there may be occasions where technical assistance will be required from the vehicle constructor. Additionally, as a preventive measure, the airport or appropriate authority may wish to secure a periodic examination of a vehicle to assess its overall condition. To meet either of these requirements a clause can be included in the initial contract to secure these support facilities.

5.8.7 In any vehicle there are components with relatively short service "lives". These include windscreen wiper blades, fan belts, some lamps used in indicators or vehicle lighting systems and oil or air filters. These items are

described as fast moving spares and a schedule of these can be discussed with the contractor prior to the delivery of the vehicle. They are usually low-cost items and provision of a quantity of these as part of the initial contract will contribute to the availability of the vehicle.

5.8.8 During the “operational life” of a vehicle the failure of a major component or the consequences of a traffic accident may require the earliest provision of replacement parts additional to those held at the airport. A contract may secure an undertaking from the vehicle constructor to provide these replacements on an emergency basis, including the use of air freight facilities in appropriate cases.

5.9 ASPECTS TO BE CONSIDERED IN PREPARING A SPECIFICATION FOR AN RFF VEHICLE

This schedule lists some of the design, construction and performance features which should be considered in preparing a preliminary specification for an RFF vehicle. It is not intended to be fully comprehensive and it is anticipated that a more detailed specification will be developed in the negotiations with contractors who respond to the issue of the preliminary specification. This process permits the airport or appropriate authority to consider the inclusion of products and materials developed by the automotive and fire engineering industry and proposed by contractors in their submissions.

- a) Role of the vehicle to be specified (5.2.1 and 5.2.2).
- b) Extinguishing media to be carried (Chapters 2 and 8):
 - 1) principal agent:
 - quantity of water and preferred type of tank construction;
 - quantity and type of foam concentrate and preferred tank construction (5.4, 5.7.1 and 5.7.5);
 - monitor — outputs, related to dual-output monitors — ranges, patterns of delivery, monitor and monitor control locations — static and mobile foam production capability (5.7.2 and Table 5-1);
 - sideline deliveries — specify radius of action required, using hose-reel or delivery hose systems (5.7.1 and Table 5-1);
 - bumper turret — where known, state type, output, range, discharge pattern and location of controls (5.7.6 and Table 5-1);
 - undertruck protection — where known, state number and type of outlets, capacities, location of controls (5.7.6 and Table 5-1);
 - minimum foam qualities, related to type of concentrate (8.1.3 to 8.1.5);
 - replenishment facilities — water and foam concentrate (5.7.1);
 - systems flushing facilities;
 - specify any structural firefighting capability (5.1.3); and

- 2) complementary agents:
 - type, quantity, containment and discharge requirements (8.2); and
 - replenishment facilities (5.7.1).
- c) Crew cab design requirement:
 - minimum crew capacity (5.7.2);
 - type of seating and seat belt requirement;
 - equipment stowage — state types and quantities (5.7.7);
 - access and egress considerations (5.7.4);
 - driver's visibility and control requirements (5.7.2);
 - instrumentation and controls — labelling (5.7.4);
 - communications installations — state types — specify interference suppression standard (4.3 and 5.7.2);
 - safety features — elimination of protrusions or other hazards to crew members (5.7.4)
 - noise and vibration suppression (5.7.4); and
 - need for heating or air conditioning (5.7.4).
- d) Equipment stowage:
 - list equipment to be carried, provide dimensions and weights of items, where known (5.2.2 and Table 5-2);
 - state preferred locations and types of securing devices for each item (5.7.7);
 - specify type and location of emergency lighting installation and the type and location of the audible/visual emergency alarm system (5.7.7 and 5.7.13); and
 - specify type and capacity of power source and the associated equipment to be used for powered rescue tools or extensible firefighting apparatus (5.7.8 to 5.7.11).