STATE OF KUWAIT

AVIATION SAFETY DEPARTMENT

Guidance material

Rescue Fire Fighting

RFF

English

Issue-1,Rev 0
April 2017

الإدارة العامة للطيران المدني
Directorate General of Civil Aviation

List of Amendments

S/No.	Issue No.	Rev. No.	Amended by	Signature	Date
1)	1	0	Engr. Shaheen M Al-Ghanim Aviation Safety Director		April 2017

LIST OF EFFECTIVE PAGES

Number	Effective Date	Entered Date	Entered by

Forward

The Aviation Safety Department guidance material is published to keep pace with the guidelines prescribed by ICAO documents and publications. The objective of this guidance material is to assist Kuwait International Airport's staff towards safety and fulfil the obligations to comply with the published KCASRs.

STATE OF KUWAIT Directorate General of Civil Aviation		Aviation Safety Department AEERODROME CERTIFICATION & SECURITY DIVISION

Ref.: MEMO / ACS / 27/ 2017		**INTERNAL MEMO**		**20/04/2017**	
Recipient	**Aviation Safety Director**				
CC.	DIR ☒	SUPDT-I ☒	OPS ☐	AW ☐	LIC ☐	ACS ☐
	SUPDT-R ☐		TDF ☐	S&R ☐	Other☐:	
Attachment	Application☐ Document☐ Other ☐:					
Subject	**Aerodrome Guidelines Materials**					

Dear Sir,

With reference to the above mentioned subject, please find enclosed herewith the below mentioned Guidance Materials which is self-explanatory.

1)Aerodrome Certification Procedures (Issue-1,Rev 0,April 2017
2)Airport Emergency Planning (Issue-1,Rev 0,April 2017)
3)Apron Management Services (Issue-1,Rev 0,April 2017)
4)Calculation of declared distances (Issue-1,Rev-0,April 2017)
5)Pavement Surface Condition(Issue-1,Rev-0,April 2017)
6)Prevention of Runway Incursion(Issue-1,Rev-0,April 2017)
7)Rescue Fire Fighting (Issue-1,Rev-0,April 2017)
8)Safety Management System(Issue-1,Rev-0,April 2017)
9)Surface of Movement Guidance & Control System (Issue-1,Rev 0,April 2017)
10)Visual Aids (Issue-1,Rev-0,April 2017)
11)Wildlife Reduction & Control (Issue-1,Rev-0,April 2017)

This is for your approval and necessary action.

Thanking you.

Approved

Engr. Shaheen M. Al-Ghanim
Aviation Safety Director

Sender : **Engr Fahad Sh Al-Anzi** **Head of Aerodrome Certification and Security Division**	**Signature:** Eng. Fahad Sh. Alanzi Head of Aerodrome Certification & Security Division

List of Acronyms

A TC - Air traffic control
BA - Breathing apparatus
BAECO - Breathing apparatus entry control officer
MFT - Major foam tender
PPE - Personal protective equipment
RESA - Runway end safety area
RFF - Rescue and firefighting
RFFS - Rescue and firefighting service
SNAP - Significant New Alternatives Policy
TRA - Task resource analysis

Table of Contents

Chapter 1

PERSONNEL

1.1 GENERAL REQUIREMENTS

1.1.1 The total number of personnel, whether regular or auxiliary, required to deploy and operate the RFF service should be determined so as to meet the following criteria:

a) the RFF vehicles should be staffed so as to ensure their ability to discharge at their maximum designed capability extinguishing agents, principal or complementary, both effectively and simultaneously, at an aircraft accident/incident; and
b) any control room or communications facility operated by, and serving, the RFF service can continue to provide this service until altemative arrangements to undertake this function are initiated by the airport emergency plan.

1.1.2 In addition, in determining the minimum number of RFF personnel required, a task resource analysis (see 1.5) should be completed and the level of staffing documented in the Aerodromes Manual. During flight operations sufficient trained and competent personnel should be designated to be readily available to ride the RFF vehicles and to operate the equipment at maximum capacity. These personnel should be deployed in a way that ensures that minimum response times can be achieved and that continuous agent application at the appropriate rate can be fully maintained. Consideration should also be given for personnel to use hand-lines, ladders and other RFF equipment normally associated with aircraft RFF operations. The responding vehicles should provide at least the minimum discharge rates specified in the tables. The remainder of the vehicles may be staffed by personnel not necessarily employed in close proximity to their vehicles but able to respond when the alarm sounds so as to reach the scene of the accident no more than one minute after the first responding vehic1e(s) so as to provide continuous foam application.

1.1.3 All personnel (regular and/or auxiliary) provided for aircraft RFF duties, should be fully trained in the performance of their duties and under the direction of a designated chief of emergency crew. Selected personnel should receive special driving instructions in cross-country and soft-ground techniques. Where the response area of the RFF service includes water, swamps or other difficult terrain and suitable rescue equipment and procedures are provided for these locations, the personnel designated to respond should be adequately trained and exercised to provide a prompt and effective service.

1.2 SELECTION OF PERSONNEL FOR RFF DUTIES

1.2.1 Personnel recited for RFF services should be resolute, possess initiative, competent to f011n an intelligent assessment of a fire situation and, above all, must be well trained and fully qualified. Ideally, every individual should be capable of sizing up changing circumstances at an aircraft accident and taking the necessary action without detailed supervision. Where the available staff displays limited capacity to use initiative, the deficiency must be corrected by the provision of additional supervisory staff of a superior grade who will be responsible for exercising control of their crews.

Officer responsible for the organization and training of the RFF service should be an experienced, qualified and competent leader. The capabilities of this officer should have been proved wherever practicable by training at a recognized RFF service training establishment and measures should be taken to ensure the officers continuing proficiency.

1.2.2 Due regard should be given to the arduous nature of RFF duties and personnel selected for this work should be free from any physical disability which might limit their performance or which might be aggravated by a high level of exertion. Particular should be taken in selecting personnel as wearers of respiratory protection equipment, where psychological factors are significant, in addition to physical suitability.

1.3 MANAGEMENT OF' RFF PERSONNEL

1.3.1 Full-time RFF personnel, where provided, may be assigned other duties, provided that the performance of these duties does not impair their ability to respond immediately to an emergency, or restrict their performance of essential training, inspections and equipment maintenance. These subsidiary duties could include fire prevention inspections, fire guard duties or other functions for which their equipment and training make them particularly suitable. Arrangements must exist for their immediate mobilization in the event of an emergency and, wherever possible, a crew assigned to subsidiary duties should travel in the RFF vehicle to which they are appointed,
Maintaining constant contact with the fire station by radio.

1.3.2 The airport emergency plan should provide for the alerting of all personnel who may contribute to the effective performance of post-accident operations in a support role to the RFF crews.

1.4 PHYSICAL AND MEDICAL FITNESS ASSESSMENTS FOR RFF SERVICES

1.4.1 As the nature of RFF operations involves periods of intense physical activity, all RFF personnel have to possess a minimum level of physical fitness and medical fitness to be able to perform the tasks associated with these operations. Physical fitness and medical fitness is often described as the overall physical condition of the body, which can range from peak condition for performance at one end of the spectrum to extreme illness or injury at the other. The key fitness components for RFF are generally aerobic fitness, anaerobic fitness, flexibility and medical fitness. Optimum physical fitness and medical fitness for RFF personnel would mean that a firefighter is able to
CatTY out RFF activities safely, successfully and without undue fatigue.

1.4.2 Aerobic fitness is the ability to continue to exercise for prolonged periods of time at low to moderate or high intensity. This is typically what limits the ability to continue to run, cycle or swim for more than a few minutes and is dependent upon the body's heart, lungs and blood to get the oxygen to the muscles (V02) providing the sustained energy needed to maintain prolonged exercise. Typical aerobic activities include walking, jogging, cycling, rope skipping, stair climbing, swimming, or any other Endurance activities.

1.4.3 Anaerobic fitness works differently to aerobic fitness. It is an activity that requires high levels of energy and is done for only a few seconds or minutes. Intensity. The term *anaerobic* means "without oxygen". Participation in anaerobic activities leads to anaerobic fitness, which may be defined as higher levels of muscular strength, speed and power. Examples of anaerobic activities include heavy weight lifting, running up several flights of stairs, sprinting, power swimming, or any other rapid burst of hard exercises.

1.4.4 Flexibility refers to the ability to move the limbs and joints into specific positions at the end of their normal range of movement. Flexibility is important as it will allow the body to work in cramped positions without unduly stressing the muscles, tendons and ligaments and may reduce the risk of injury. Flexibility is best developed using slow controlled stretching exercises.

1.4.5 The physical fitness assessment should be catered to the components mentioned above. RFF services should develop various types of tests to ensure that these components are tested to determine if the RFF personnel has the required physical fitness level for the job. The physical fitness assessment should also be conducted at least once a year. The physical fitness assessment should be conducted for preemployment entry as a firefighter as well as ongoing physical fitness assessments for existing RFF staff to ensure they are maintaining their level of physical fitness.

1.4.6 Medical fitness assessments specific to RFF services should be developed. The medical fitness assessments should be conducted for pre-employment entry as a firefighter as well as ongoing medical fitness assessments for existing staff. The frequency of medical fitness assessments should be determined by each agency. The medical fitness assessments should be used to identify any underlying medical conditions, which may pose a risk to the individual firefighter during physically demanding activities.

1.5 TASK RESOURCE ANALYSIS

1.5.1 Introduction. The following guidance describes the stages that should be considered by an airport operator in carrying out a Task Resource Analysis (TRA) to establish justification as to the minimum number of qualified/competent personnel required to deliver an effective airport RFF service (RFFS) to deal with an aircraft incident/accident. If an airport operator requires the RFFS to attend structural incidents and road traffic accidents in addition to aircraft incidents/accidents, due regard must be given to the inability of not meeting required response times and robust procedures should be introduced accordingly.

1.5.2 Purpose. By using a qualitative risk based approach, which focuses upon probable and credible worstcase scenarios a task and resource analysis should be done to identify the minimum number of personnel required to undertake identified tasks in real time before supporting extemal services are able to effectively assist RFFS (see Table 1-1).

1.5.2.1 Consideration should also be given to the types of aircraft using the aerodrome, as well as the need for personnel to use self-contained breathing apparatus, handlines, ladders and other RFF equipment provided at the aerodrome associated with aircraft RFF operations. The importance of an agreed framework for incident command should form a primary part of the considerations.

1.5.3 General information: The airport operator should first establish the minimum requirements including: minimum number of RFFS vehicles and equipment required for the delivery of the extinguishing agents at the required discharge rate for the specified RFF category of the airport.

1.5.4 Task analysis/risk assessment. A task analysis should primarily consist of a qualitative analysis of the RFFS response to a realistic, worst-case, aircraft accident scenario. The purpose should be to review the current and future staffing levels of the RFFS deployed at the aerodrome. The qualitative analysis could be supported by a quantitative risk assessment to estimate the reduction in risk. This risk assessment could be related to the reduction in risk to passengers and aircrew from deploying additional personnel. One of the most important elements is to assess the impact of any critical tasks or pinch points identified by the qualitative analysis.

1.5.5 Qualitative approach. The task analysis including a workload assessment aims to identify the effectiveness of the current staffing level and to identify the level of improvement resulting from additional staffing. A credible worst-case accident scenario should be analysed to assess the relative effectiveness of at least two levels of
RFFS staffing.

1.5.6 Quantitative risk assessment. This assessment will generally be used to support the conclusions of the qualitative analysis by examining the risks to passengers and aircrew from aircraft accidents at the airport. This comparison of the risk allows the benefit of employing additional RFFS staff to be evaluated in terms of the risk reduction in passengers and aircrew lives saved. This could be expressed in monetary terms and may be compared with additional costs incurred in employing the additional personnel. However, this is of little, if any, value in determining minimum levels of personnel.

l.5.7 *Task analysis.* The following items will assist in determining the basic contents of an analysis:

a. Description ofaerodrome(s) including the number of runways;
b. Promulgated RFFS categories (Aeronautical Information Publication);
c. Response time criteria (area, times and number of fire stations);
d. Current and future types of aircraft movements;
e. Operational hours;

f. Current RFFS structure and establishment;
g. Current level of personnel;
h. Level of supervision for each operational crew;
1. RFFS qualifications/competence (training programmes and facilities);
J. Extraneous duties (to include domestic and first aid response);
k. Communications and RFFS alerting system including extraneous duties;
1. Appliances and extinguishing agents available;
m. Specialist equipment- fast rescue craft, hovercraft, water carrier, hose layer, extending boom technology;
n. First aid - role responsibility;
o. Medical facilities - role responsibility;
p. Pre-determined attendance: local authority services - police, fire and ambulance, etc.;
q. Incident task analysis - feasible worst-case scenarios) (workload assessment) (human Performance/Factors, To include: mobilization, deployment to scene, scene management, firefighting, suppression and extinguishment, applicator of complementary agent(s), post tire security/control, personnel protective equipment, rescue team(s), aircraft evacuation and extinguishing agent replenishment;
Note.- The aim is to identify any pinch points within the current workload and proposed workload.
r. Appraisal of existing RFFS provision;
s. Future requirements. Aerodrome development and expansion;
t. Enclosures could include: airport maps, event trees to explain tasks and functions conducted by the RFFS, etc.); and
u. Airport emergency plan and procedures.
Note.- The above list is not exhaustive and should only act as a guide.

1.5.7.1 **Phase 1**
The airport operator must be clear as to the aims and objectives for the RFF services,
Aim: To maintain a dedicated RFFS of qualified and competent fire and rescue personnel equipped with vehicles and specialist equipment to make an immediate response to an aircraft
incident/accident on or in the immediate vicinity of the airport within the specified response time criteria.
Principal Objective of the RFFS: The principal objective of an RFFS is to save lives in the event of an aircraft accident or incident. For this reason, the provision of means of dealing with an aircraft accident or incident occurring at, or in the immediate vicinity of, an aerodrome assumes primary importance because it is within this area that there are the greatest opportunities of saving lives. This must

assume at all times the possibility of, and need for, extinguishing a fire that may occur either immediately following an aircraft accident or incident, or at any time during rescue operations. Tasks:

a) meet the required response time;
b) extinguish an extemal fire;
c) protect escape slides and exit routes;
d) assist in the self-evacuation of the aircraft;
e) create a survivable situation;
f) rescue trapped personnel;
g) maintain post fire security/control; and
h) preserve evidence;

Note.- The above list is not exhaustive and all relevant tasks must be identified before moving to Phase 2. Each task/mission may include numerous functional activities/actions.

Identify a selection of representative realistic, feasible accidents that may occur at the airport. This can be achieved by a statistical analysis of previous accidents on airports and by analyzing data from international, national and local sources.

Note.- All incidents should involve .fire to represent a feasible worst-case scenario that would require an RFFS response.

Examples:

a) aircraft engine failure on take-off with a fire (aborted take-off);
b) aircraft aborts and overruns into the runway end safety area (RESA) with a fire on take-off;
c) aircraft into aircraft with fire (collision);
d) aircraft into structure- terminal building(s) with a fire;
e) aircraft leaves the runway on landing into the runway strip (full emergency evacuation); and
f) internal aircraft fire (cabin fire, baggage hold, cargo hold, avionics bay(s).

1.5.7.3 **Phase 3**

Identify the types of aircraft commonly in use at the airport; this is important as the type of aircraft and its configuration has a direct bearing on the resources required in meeting Phase

1. It may be necessary to group the aircraft types in relation to common aircraft configurations for ease of analysis or identify precise aircraft type that may have a unique configuration. Example:

a) long wide-bodied aircraft with multiple passenger decks and multiple aisles;
b) long narrow-bodied aircraft with single aisle, high passenger density; and

c) short narrow-bodied aircraft with single aisle, high passenger density. - A representative aircraft type can then be chosen, i.e. Airbus A 380, Airbus A 340, Airbus A
320, Boeing 747, Boeing 777, Boeing 757 and Boeing 737.

1.5.7.4 **Phase 4**

1.5.7.4.1 Every airport is unique in that the location, environment, runway and taxiway configuration, aircraft movements, airport infrastructure and boundary, etc., may present specific additional risks.

1.5.7.4.2 **In** order that the feasible accident scenario can be modelled/simulated, a major factor is to consider the probable location for the most realistic accident type that may occur.

1.5.7.4.3 To confirm the location of the scenario, it is important that a facilitator using a team of experienced fire service personnel, who have knowledge of the airport and the locations in which an aircraft accident is likely to occur, evaluate the scenario.

1.5.7.4.4 The role of the facilitator is to seek agreement in identifying the credible worst-case locations and, by using a scoring system place, these locations in order of reievan. and priority. The team must determine why the locations have been identified and provide a rationale for each location. One methodology would be to award a weighted number to each location, then total the numbers in relation to each identified location.

Example:

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

a) response time;

b) route to the accident site (on or off paved surfaces);

c) terrain;

d) crossing procedures for active runway(s);

e) aircraft congestion on route (taxiways);

f) surface conditions;

g) communications;

h) supplementary water supplies;

i) adverse weather conditions - low visibility procedures; and
j) daylight or darkness.

An additional time delay for any of the factors listed above should be estimated and recorded, then the location with the highest additional response time could be identified as the worst-case location. It is important to note that the location of an accident could have an impact on the resources and tasks that will be required to be carried out by RFF personnel.

From the above analysis, a location or a number of locations could be identified, in agreement with the airport operator and the TRA facilitator.

Example:

1) Taxiway Bravo: Runway holding position Bravo 1- leading onto runway 08L;
2) Runway 13- Runway and service road crossing point (grid reference AS);
3) Runway 28 overrun RESA;
4) Runway 24 undershoot RESA;
S) Aircraft stand A33 (Alpha apron);
6) Grid reference A6 (Runway 06 localizer road);
7) Taxiway Alpha: Intennediate taxi-holding position - A3; and
8) Aircraft stand AS (on taxilane).

Phase 5

Phase S combines the accident types to be examined as described in Phase 2, with the aircraft identified in Phase 3 and the locations as described in Phase 4; the accident types should be correlated with the possible location. In some cases this could be in more than one location on an airport, for which a task and resource analysis needs to be carried out.

The above information is to be built into a complete accident scenario that can be analyzed by experienced supervisors and firefighters for the task and resource analysis in Phase 6.

Example:

Scenario No 1:

Accident type: Aircraft overrun into Runway 06 RESA - Phase 2.

Aircraft identified: Boeing 747-400 - Phase 3.

Accident location: Runway 06 RESA - Phase 4.

1.5.7.5.3 The Boeing 747 400 is a wide-bodied multi-deck aircraft. Its typical seating

configuration can be 340 economy, 23 business, and 18 first class passengers on the lower deck. On the upper deck, provision is made for a further 32 business class passengers, giving an estimated aircraft seating capacity of 413 excluding the crew. The aircraft typically has four exits on both sides of the lower deck and one on each side of the upper deck.

During the take-off phase, the aircraft suffers a fire in the number 3 engine and the pilot decides to abort the take-off. During this phase, the fire develops rapidly and impinges on the fuselage. The aircraft overruns the runway and comes to rest in the RESA. The flight deck crew orders an evacuation.

The RFF services are informed by air traffic control (ATe) and respond accordingly and the aerodrome emergency procedures are activated.

Phase 6

By using a TRA facilitator with teams of experienced airport supervisors and firefighters the accident scenario(s) developed in Phase 5 is subject to a task and resource analysis carried out in a series of tabletop exercises/simulations.

When carrying out a task and resource analysis, the principal objective should be to identify in real time and in sequential order the minimum number of RFF personnel required at anyone time to achieve the following:

a) receive the message and dispatch the RFF service (the dispatcher may have to respond as part of the minimum riding strength);

b) respond utilizing communications, taking appropriate route and achieving the defined response criteria;

c) position appliances/vehicles in optimum positions and operate RFF appliances effectively;

d) use extinguishing agents and equipment accordingly;

e) instigate incident command structure - supervisors;

f) assist in passenger and crew self-evacuation;

g) access aircraft to carry out specific tasks if required, e.g. firefighting, rescue;

h) support and sustain the deployment of firefighting and rescue equipment;

i) support and sustain the delivery of supplementary water supplies; and

j) need to replenish foam supplies as needed.

The task and resource analysis should identify the optimum time when additional resources will be available to support/augment and/or replace resources supplied by RFF services (aerodrome emergency plan). It can also provide vital evidence to support the level of RFF vehicles and equipment.

In order to start a task and resource analysis the required category of the airport must be identified as required by the regulatory authority. This should confirm the minimum number of vehicles, and the minimum extinguishing agent requirements and discharge rates, this should also determine the minimum number of personnel required to functionally operate the vehicles and equipment.

The results of the analysis should be recorded in a table or spreadsheet format and should be laid out in a method that ensures that the following is recorded:

a) receipt of message and dispatch of the RFF response;

b) time - this starts from the initial receipt of call and the timeline continues in minutes and seconds until additional external resources arrive or the facilitator decides an end-time;
c) list of assessed tasks, functions and priorities achieved;
d) the resources (personnel, vehicles and equipment) required for each task should be defined;
e) comments to enable team members to record their findings; and
f) identified pinch points.
Working example ofa qualitative task resource analysis - Scenario 1.
Key to working example:
Major foam tenders are identified as MFT A, B, C and O.

Conclusion. A task analysis can be as detailed as necessary. The aim is to itemize the knowledge and practical skills (doing) involved in carrying out the task or function effectively and to the correct the standard of competence based on a qualitative analysis. Having gathered the appropriate data and agreed to the outcome, the TRA should enable an RFFS to confirm and subsequently provide the correct level of vehicles, equipment and personnel. It would also enable the RFFS to develop a training specification, and a learning programme can then be designed around role and task. When planning a task and resource analysis, ask the following questions:
a) What is done?
b) Why is it done?
c) When is it done?
d) Where is it done?
e) How is it done?
f) Who does it?
It is often difficult to assess the overall effectiveness of a complete unit by observation only. However, observation/demonstration does allow you to assess the effectiveness of individual units and any element(s) of the emergency arrangements. Documentary evidence relating to previous accidents or exercises may also assist in establishing if
the current RFFS is staffed at an appropriate level. The overall objective is to be satisfied that the RFFS is organized, equipped, staffed, trained and operated to ensure the most rapid deployment of facilities to the maximum effect in the event of an accident. The above process can also be used to identify equipment shortages and training needs for personnel required to deal with identified tasks.

Chapter 2

TRAINING

2.1 GENERAL

2.1.1 Personnel whose duties consist solely of the provision of RFF services for aircraft operations are infrequently called upon to face a serious situation involving life saving at a major aircraft fire. They will experience a few incidents and a larger number of standbys to cover movements of aircraft in circumstances where the possibility of an accident may reasonably be anticipated but will seldom be called upon to put their knowledge and experience to the test. It follows, therefore, that only by means of a most carefully planned and rigorously followed programme of training can there be any assurance that both personnel and equipment will be capable in dealing with a major aircraft fire should the necessity arise. The core training programme can be organized into nine faculties as follows:

a) fire dynamics, toxicity and basic first aid;
b) extinguishing agents and firefighting techniques;
c) handling of vehicles, vessels and equipment;
d) airfield layout and aircraft construction;
e) operational tactics and manoeuvres;
f) emergency communication;
g) leadership performance;
h) physical fitness; and
i) auxiliary modules (e.g. rescue in difficult terrain, response to biological/chemical threats, etc.).

2.1.2 The core training curriculum should include initial and recurrent instruction. The scope of instruction should vary with the degree of intelligence of the trainees. In most cases the simpler this form of instruction is kept, the more successful it is likely to be.

In no case should enthusiasm, engendered by the interest value of the subject, be allowed to carry the instruction beyond its practical application. Nevertheless, the officer responsible for the training programme must endeavour to maintain the interest and enthusiasm of the crew at all times. In certain respects this will not be too difficult. There are many factors affecting RFF procedures at an aircraft accident which may be anticipated, staged, and practised so that the officer has an opportunity of sustaining the interest indefinitely. Each new type of aircraft brings with it new problems which must be assessed and incorporated in the training programme. As certain routine aspects of training may become less interesting over a long period, it is therefore essential that the officer ensure each crew member realizes the need for such training. For example, it is a fundamental practice in the

RFF service that each crew member, when on duty, be satisfied that the equipment which may be used is serviceable. This particular aspect of a crew member's duty could deteriorate after a long period of comparative inaction unless that person is really convinced of the importance of this task.

2.1.3 The entire training programme must be designed to ensure that both personnel and equipment are at all times fully efficient. This represents a very high standard of achievement but anything less than full efficiency is unacceptable and may be dangerous both to those in need of aid and also to those who are seeking to give such aid. In addition, the training programme must also be designed to build cohesiveness between key functional units of an RFF team in order to deliver a consistent level of proficiency during emergencies. To ensure a high standard of operational readiness,

RFF services should develop a competency audit framework to assess the effectiveness of RFF training at both individual and team levels.

2.2 FIRE DYNAMICS, TOXICITY AND FIRST AID

2.2.1 All RFF personnel should have a general knowledge of the cause of fire, the factors contributing to the spread of fire and the principles of fire extinction. Only when armed with this knowledge can they be expected to react effectively when confronted with a serious fire situation. It must be known, for instance, that certain types of fire require a cooling agent while others need a blanketing or smothering action. RFF training should also touch on the toxicity of thermal decomposition products. This will enable firefighters to better understand the importance and limitations of their protective equipment. In doing so, firefighters will avoid a false sense of security and take extra precautions when leading the occupants of the aircraft through a dangerous atmosphere. In addition, every member of the rescue team should, if at all possible, be trained and periodically recertified in basic medical first aid, as a minimum. The prime reason for this qualification is to ensure that casualties are well handled so as to avoid the infliction of additional suffering and/or injury in the removal of the occupants from a crashed aircraft.

2.3 EXTINGUISHING AGENTS AND FIREFIGHTING TECHNIQUES

2.3.1 It is essential that a thorough knowledge should be acquired of the agents employed. In particular, every opportunity should be taken to practice the application of agents on fires in order to understand by experience not only the virtues but also the limitations of each agent. Each occasion of a routine equipment test should be used for a training exercise in the proper handling of equipment and the correct application of the particular agent involved. The combination of routine test procedures with training periods will minimize the costs involved in the discharge of extinguishing agents.

2.3.2 To carry out fire suppression at different phases of combustion, RFF personnel should be well versed in three types of extinguishment. 1) Direct straight stream firefighting method using a straight stream or solid hose stream to deliver water directly onto the base of the fire. 2) Indirect firefighting method; used in situations where the temperature is increasing and it appears that the cabin or fire area is ready to flash over. Attack is made from small fuselage openings such as slightly opened exits or openings made in cabin windows. An indirect method is based on the conversion of water spray into steam as it contacts the super-heated atmosphere. Firefighters direct the stream bursts of water at the ceiling to cool super-heated gases in the upper levels of the cabin or compartment. This method can prevent or delay flashover and allow the firefighters time to apply a direct stream to the base or seat of the fire.3) the three-dimensional method is deployed in the event that the fire is fuel fed, as in the case of an engine fire. Firefighter one directs semi-fog at the fire while firefighter two discharges a dry chemical or clean agent into the semi-fog stream starting at ground level and moving upward to the source of the fire. In cases of deep-seated aircraft fires, penetrating nozzles could be used. Penetrating nozzles could be in the form of vehicle turrets (monitors) or handlines capable of injecting extinguishing agents that provide wide angle coverage.

2.4 HANDLING OF VEHICLES, VESSELS AND EQUIPMENT

2.4.1 All RFF personnel must be capable of handling their vehicles, vessels, and equipment, not only under drill ground conditions, but also in rapidly changing circumstances. The aim must always be to ensure that every individual is so well versed in the handling of all types of vehicles, vessels, and equipment that, under emergency conditions, operation of these mission-critical resources will be automatic, leaving capacity to deal with unexpected scenarios. This can be accomplished in the initial stage of training by employing the snap "change-round" technique during standard drills, and later by training involving the use of two or more tire vehicles simultaneously. Particular attention should be paid to pump operations, high-reach extendable turrets, and other specialized rescue equipment. RFF crew should also be adequately trained in handling complex instrumental panels on board vehicles and vessels. This form of training is, of course, a continuing commitment.

2.4.2 Possessing in-depth knowledge of all vehicles, vessels, and equipment is essential in order to ensure thorough maintenance which is essential to guarantee operational efficiency under all circumstances. It is important that every firefighter be satisfied that any piece of equipment which may be used will work satisfactorily and, in the case of ancillary equipment, it is in its correct stowage position. The importance of correct stowage of small equipment to ensure that it can be instantly located cannot be over-stressed. Officers responsible for training are advised to hold periodic locker drills where individual crew members are required to produce a particular item immediately. All vehicles, vessels, and equipment must be regularly tested or inspected and records must be maintained of the circumstances and results of each test.

2.5 AIRFIELD LAYOUT AND AIRCRAFT CONSTRUCTION

2.5.1 A thorough knowledge of the airport and its immediate vicinity is essential. To counter the effects of complacency, it is recommended that vehicle operators practice mental mapping techniques to supplement routine onsite familiarization. The training programme should encompass those areas of operations dealing with:

a) thorough familiarization of the movement area so vehicle drivers can demonstrate their ability to:

1) select alternative routes to any point on the movement area when normal routes are blocked;

2) know the existence of ground which may become from time to time impassable in any part of the area to be covered by the service;

3) recognize landmarks which may be indistinctly seen;

4) operate vehicles over all types of terrain during all kinds of weather. The training programme may be conducted using vehicles other than the RFF vehicles provided they are radio controlled and have similar operating charact eri sti cs;

5) select the best routes to any point on the airport; and

6) use detailed grid maps as an aid in responding to an aircraft accident or incident; and

b) the use of guidance equipment when it is available. Normally air traffic control may be assistance in providing information on the location of the accident site and position of other aircraft or vehicles on the airport which may obstruct or impair vehicle movement.

2.5.2 The importance of this aspect of training cannot be over-emphasized. RFF personnel may be called upon to effect a rescue from an aircraft cabin in conditions of great stress working in an atmosphere heavily laden with smoke and fumes. If self-contained breathing apparatus is supplied, careful training in its use is essential. It is essential that every person have an intimate knowledge of all types of aircraft normally using the airport. Appendix 1 provides an electronic link to the web sites of the various aircraft manufacturers. The web sites contain diagrams that provide, general information on principles of rescue and firefighting procedures, as well as detailed information of concern to rescue and firefighting personnel on representative aircraft commonly used in the market. The knowledge cannot be acquired solely on a study of the diagrams. There is no substitute for a periodic inspection of the aircraft. Due to the complexity of modern aircraft and the variety of types in service, it is virtually impossible to train RFF personnel on all the important design features of each aircraft although they should become familiar with the types normally used at the airport. Priority training should be given to the largest passenger aircraft as it is likely to carry the highest number of occupants and incorporate unique features such as upper deck seating capacity. Information about the following design features is of special importance to RFF personnel to ensure effective use of their equipment:

a) location and operation of normal and emergency exits;

b) seating configuration;

c) type of fuel and location(s) of fuel tank(s);

d) location of batteries and isolation switches; and

e) position of break-in points on the aircraft.

2.5.3 As far as is practicable, RFF personnel should be allowed to operate the emergency exits and should certainly be fully conversant with the method of opening all the main doors. In general, the majority of the doors open forward. Some containing stairs will swing downwards and, on some wide-bodied aircraft, the doors retract into the ceiling area. Most large aircraft are fitted with inflatable emergency evacuation slides affixed to cabin doors and large emergency exit windows. If the emergency evacuation slides are not automatically disengaged, or if the system equipment malfunctions, the slides may become inflated when the exit is opened. The doors of large aircraft are normally operated from the inside. There are occasions, however, when responding RFF personnel may have to open doors from the outside of the aircraft to gain access to the cabin interior. In view of the variables noted above, the opening of the normal and emergency exits may be hazardous for the airport firefighter if the appropriate cautionary measures are not taken. For example, it is hazardous to open armed aircraft doors if the firefighter is standing on a ladder or to rest the ladder against the door to be opened.

2.5.4 Aircraft operators and flight crew members should be requested to cooperate to the fullest extent in arranging inspection by RFF personnel the different types of aircraft using the airport. An elementary knowledge of aircraft construction is highly desirable since such knowledge is invaluable if, as a last resort, forcible entry is necessary. The cooperation of the appropriate staff of the airline operators should be sought on this aspect of training.

2.5.5 All aircraft carry small portable fire extinguishers that could be of use to rescuers.
Extinguishers containing carbon dioxide, a halon agent or water are usually located on the flight deck, in galleys and at other points within the cabin. All extinguisher positions are indicated and the extinguisher body normally carries a label stating the type of fire for which its contents are suitable. Water and other beverages found in the buffet compartment provide an additional source of water for extinguishment purposes. It should be emphasized that these extinguishing agents are of secondary value and should not be relied on.

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2.6 OPERATIONAL TACTICS AND MANOEUVRES

2.6.1 When personnel are well versed in the handling of firefighting equipment they should receive training in operational tactics to be adopted at aircraft fires. This training is a continuing commitment and must be absorbed to the point where compliance with the initial action called for is instinctive, in the same sense that hose-running to a well-trained regular firefighter is automatic and will therefore follow even when working under stress. Only when this is achieved will the officer-in-charge be in a position to assume complete control of the situation. Operational tactics training is designed to deploy personnel and equipment to advantage in order to establish conditions in which aircraft occupants may be rescued from an aircraft which is involved in, or liable to become involved in, fire. The objective is to isolate the fuselage from the fire, cool the fuselage, establish and maintain an escape route and achieve the degree of fire control necessary to permit rescue operations to proceed.
This is fundamental and must be stressed in the training programme. The service to be provided is primarily a lifesaving organization, one, however, that must be

trained in firefighting because aircraft involved in a serious accident are frequently involved in fire. The firefighting operations must be directed to those measures which are necessary to permit rescue to be carried out until all the occupants of the aircraft are accounted for. This includes precautionary measures at those incidents where no fire has broken out. When the lifesaving commitment has been met it is necessary, of course, to utilize all available resources to secure protection of property.

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2.6.2 The main attack on the fire should usually be by means of mass application of foam in an endeavour to achieve maximum cooling and the rapid suppression of the fire. Since, however, foam, like every other agent, has limitations, a suitable back-up agent must be available to deal with those pockets of fire which are inaccessible to direct foam application. This will generally be provided in the f01111 of dry chemical powder.
The use of these should be confined to running liquid fuel fires, fires in enclosed spaces such as wing voids, or for dealing with a special fire such as a fire in an engine nacelle or undercarriage well.

2.6.3 Points which should be covered 111 the operational tactics training programme are described below.

2.6.4 ***The approach.*** Equipment should approach the accident site by way of the fastest route in order to reach the site in the shortest possible time. This is quite frequently not the shortest route because, in general, it is preferable, where possible, to travel on a man-made surface than to approach over rough ground or grassland. The essence is to ensure that RFF vehicles get there and are not subjected to unnecessary hazards en route. When nearing the scene of the accident a careful watch must be maintained for occupants who may be dashing away from the aircraft or who may have been flung clear and are lying injured in the approaches. This applies particularly at night and calls for competent use of spot or search lights.

2.6.5 Positioning of equipment. The positioning of equipment both from the airport and from any supporting local fire department is important in many respects and regard should be given to several factors. Correct positioning of equipment must permit the equipment operator an overall view of the fire area. The equipment must not be placed in a position of hazard due to fuel spills or ground slope or wind direction. It must not be positioned too close to the fire or to other equipment and thus restrict working space (this applies particularly to foam tenders and their attendant auxiliary water tenders). Other factors which should be taken into account are the location of aircraft occupants relative to the fire, the impact of wind, fire, locations of personnel and fuel tanks and the location of emergency exits.

2.6.6 In certain circumstances, it may be advantageous to leave the equipment on hard standing, though this may mean an additional length of fire hose. More time can be lost attempting to reach a closer position to the fire by negotiating rough ground than would be taken to run an additional length of fire hose. Moreover, if parked on hard standing the equipment is capable of being moved rapidly if conditions demand.
Aircraft accidents frequently occur in circumstances where equipment cannot be positioned in the immediate vicinity. Consequently, it is recommended that all firefighting and rescue equipment should be designed so that it can be brought to bear at some distance from the parent equipment. Operational tactics training can do much to reduce the problems of positioning equipment, can be conducted at very little cost and should be performed frequently to develop acceptable practices. For this particular phase of operational tactics training, it is not always necessary to produce water or foam; it is an example of how "dry drills" can help to raise efficiency standards.

2.6.7 In order to achieve the main initial objective of isolating and cooling the fuselage and to safeguard the escape route, it is evident that the positioning of foam streams is of the utmost importance. The number of streams available will vary with the type and the scope of the equipment provided.

2.6.8 Foam streams should be positioned as close as possible to the fuselage, the initial discharge being directed along the line of the fuselage and then directed to drive the fire outwards. When selecting the ideal position for the stream it should always be remembered that the wind has considerable influence upon the rate of fire and heat travel. The position should be chosen with this in mind, thus utilizing the wind, wherever possible, to assist in the main objective. Except in exceptional circumstances, foam streams should not be directed along the line of the wind towards the fuselage as this may tend to flush free fuel into the danger area. Similarly, care must be exercised to avoid the possibility of one stream disturbing the foam blanket laid down by another stream.

2.6.9 There are two basic methods of applying foam. One is to use a long straight stream to allow fall on the desired area. The other is to apply a diffused stream at close range. Often foam can be applied to a fire area by deflecting it from another surface such as the contour of the fuselage or main plane. Whenever foam, dry chemical powder, or other complementary agent equipment is being subjected to a periodic routine check, the opportunity should be taken to train emergency crew members in the methods of application. It is important that this be carried out on a fire so that each person will obtain an assessment of the value as well as the limitations, of each agent so applied, and be familiar with the heat conditions that will be experienced. These drills should be carried out at intervals of not more than one month. Increasingly, firefighting equipment is designed to provide high output through monitor/turrets to deal with accidents involving the largest aircraft currently in service. Monitor/turret operators must be highly skilled in the application of foam to be able to avoid wastage, through misdirection of aim, to know when to change from straight stream to diffused stream, and to readily appreciate how to avoid damage or injury to others by the potential force of the foam stream. It is vital that the RFF fleet manoeuvres in a coordinated formation and concentrate foam streams at areas where large numbers of passengers may be trapped. With precision manoeuvres, continuous mass application of foam will be met with the least wastage. For this reason, officers responsible for training should decide which particular pattern of equipment positioning is best suited to their available resources and then take steps to train crew members in its positioning and layout. At a fire there is little time for individual briefing of crew members and the initial layout may well be adjusted to cope with the existing circumstances, but it is necessary for the crew members to know exactly what their first action should be well in advance through a predetermined tactical plan as dictated by the circumstances. It should always be remembered that this layout of equipment should be standard practice at an aircraft accident even when fire has not broken out and that at least one monitor/turret should be staffed and in readiness to go into instant action should the occasion arise.

The main objective of the firefighting activity must be to extinguish the fire and secure it against reignition in the shortest possible time. It is also pertinent that RFF crew maintain a good sense of situational awareness at all times during an emergency. This demands skill, teamwork and understanding by all those involved. The first responding fire vehicle may carry agents which can achieve some rapid knockdown of an area of the fire, but this will in most cases require the early support of any othervehicle to continue the effort and secure the entire area against reignition and to promote the necessary cooling effect in the vicinity of the passenger compartment.

The entire effort must be concentrated on this area since the misapplication of foam or other agents is wasteful and could mean the difference between the success or failure of the operation. Where foam production through a monitor/turret is

undertaken with the vehicle in motion (i.e. pump and 1'011 mode), considerable skill is required to achieve maximum effect.
Great care must be exercised by monitor operators in the application of foam in straight streams in the vicinity of escape slides deployed from the aircraft. RFF
personnel must also anticipate that evacuating occupants may become distressed and disoriented by the presence of dry chemical powder clouds or by the impact of foam streams and should therefore conduct their operations so as to minimize these effects.
The training programme should provide instruction in search procedures, not only in of the area in the immediate vicinity of an aircraft accident and also in the path of the aircraft. As a broad principle, it should be taught that the persons involved in a fire are most frequently found near an exit, i.e. doors and windows, or will have sought shelter, however inadequate in lavatories and lockers, etc. Rescue is always best effected by way of a normal channel, if available.
The main cabin door of an aircraft should always be attempted first. Should the door be jammed, it will usually be quicker to force it by applying leverage at the right spot than to achieve entry and rescue through another form of opening. Success in this form of operation requires a full knowledge of the locking mechanism and direction of travel of the door concerned. Only when everything else has failed should forcible entry be attempted. External markings are now provided on many aircraft showing suitable points at which entry can be made.

2.6.14 Pressurized cabins will offer tough resistance to penetration by forcible entry tools, although entry can be made by a person well trained in the use of such tools and possessing a working knowledge of aircraft construction. The practice of providing power-operated saws and other similar forms of forcible entry tools on all airports normally handling these types of aircraft has increased. All operational staff should be trained in rescue procedures. The working space inside a cabin is somewhat restricted and it will generally be found advisable to limit the number of rescuers working inside the aircraft and to work on a chain principle. Where possible, the airport emergency plan should provide for the availability of staff other than RFF personnel, for the handling of casualties from the moment they are removed from the aircraft. All rescue staff should be trained in lifting and carrying casualties, and other forms of rescue.

2.7 EMERGENCY COMMUNICATION

2.7.1 Emergency communication refers to the information flow between various responding agencies during an emergency. Accurate and relevant information provides the RFF crew with shared real-time knowledge. This in turn empowers RFF teams to plan or initiate rescue efforts in an integrated manner. To ensure swift and accurate transmission of information, it is stressed that RFF staff be adequately trained in operating the primary and secondary communication systems installed at the fire stations and in fire vehicles/vessels. Equally important, RFF personnel should learn to converse succinctly using appropriate telephony language. RFF personnel should also be trained to communicate with the flight crew through internationally accepted ground-to-aircraft hand signals.

2.8 LEADERSHIP PERFORMANCE

2.8.1 The leadership qualities exhibited by an RFF team commander often determines the outcome in an emergency response. The commander leads and motivates the staff in achieving peak performance under a challenging operating environment. In this regard, a robust leadership training programme should be instituted to better prepare RFF leaders in assuming command during crises.

2.9 PHYSICAL FITNESS

2.9.1 During protracted rescue operations, the ability of RFF personnel to perform strenuous activities over an extended period of time influences the overall operational effectiveness. Therefore, firefighters must be aerobically and anaerobically fit to withstand the rigours of a variety of operations. Clearly, physical fitness training requirements should be designed to be commensurate with the equivalent fitness intensity generated in the performance of RFF operations, which include the use of breathing apparatus, hand-lines, ladders, heavy equipment and other associated rescue operations such as casualty handling.

2.10 AUXILIARY MODULES

Depending on the aerodrome operating environment, it may be necessary for RFF crew to be trained in dealing with difficult environments such as water rescue and handling biological/chemical threats. While RFF services should continue to strengthen their core capabilities, it is worthwhile to explore and train beyond the immediate operational responsibilities to deal with unexpected contingencies at or in the vicinity of the airport.