Aerodrome Rescue & Firefighting Services (ARFFS)

Presented by Kenya CAA

Outline of the Presentation

i. Regulatory Framework
ii. Safety Oversight of ARFFS
iii. Achievements/ Milestones
iv. Challenges
v. Way forward

Regulatory Framework

1) ICAO Annex 14 Volume I – Chapter 9
2) Airport Services Manual (Doc 9137- Part 1)
3) Civil Aviation (Aerodrome) Regulations, 2013 – Part XI- Aerodrome Operational Services, Equipment, Installation and Facilities (Regulations 99)
4) Manual on certification of Aerodromes (Doc 9774- Appendix 1, part 4.4- Rescue & Firefighting)

Objective of ARFFS

- The principal objective of 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 aerodrome.

- It (ARFFS) 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.

Objective of ARFFS

- The rescue may require the use of equipment and personnel other than those assessed primarily for Rescue and Firefighting purposes.

- The most important factors bearing on effective rescue in a survivable aircraft accident are:

  1) the training received,
  2) the effectiveness of the equipment and
  3) the speed with which personnel and equipment designated for rescue and firefighting purposes can be put into use.

Objective of ARFFS

- The ARFFS at an airport should 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 principal objective of saving lives in the event of an aircraft accident or incident

Level of Protection to be Provided

a) 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.

Level of Protection to be Provided

b) 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 and determined using Table 1 by first evaluating their

1) overall length and
2) fuselage width

c) and if a) and b) is greater than the maximum width in column (3) for that category, then the category for that aeroplane is one category higher.

Level of Protection to be Provided

Table 1

Aerodrome Category	Aeroplane overall length	Maximum fuselage width
(1)	(2)	(3)
1	0 m 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 including18 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 including61 m	7 m
9	61 m up to but not including76 m	7 m
10	76 m up to but not including 90 m	8 m

Level of Protection to be Provided

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

- when the number of movements of the aeroplanes in the highest category normally using the airport is

  1) 700 or greater in the busiest consecutive three months, then that category should be the airport category

  2) less than 700 in the busiest consecutive three months, then the airport category may be one less than the highest aeroplane category

Level of Protection to be Provided

- 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.

- **Cargo operations.** The level of protection at aerodromes used for all-cargo aeroplane operations may be reduced in accordance with Table 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 for the control of fire.

Level of Protection to be Provided

Table 2: Airport Category for All-Cargo aeroplanes

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

Types of extinguishing Agents

1. Principal- produce a permanent control, i.e. for a period of several minutes or longer and include
   a) foam meeting the minimum performance level A;
   b) foam meeting the minimum performance level B;
   c) foam meeting the minimum performance level C;
   d) combination of these agents.

2. Complementary- have rapid fire suppression capability but offer a "transient" control which is usually only available during application and include

   a) Dry chemical powders($NaHCO_3$)
   b) Other extinguishing agents with at least the same firefighting capability.

Types of extinguishing Agents

The amounts of water specified for foam production are predicated on an application rate of

a) 8.2 L/min/m2 for a foam meeting performance level A
b) 5.5 L/min/m2 for a foam meeting performance level B and
c) 3.75L/min/m2 for a foam meeting performance level C.

These application rates are the minimum rates at which control can be achieved within one minute.

Types of extinguishing Agents

- A fire fighting foam is a stable mass of small air-filled bubbles, which have a lower density than oil, gasoline or water. Foam is made up of three ingredients - water, foam concentrate and air.

Properties

1) Low density
2) Cohesive
3) Adhesive
4) Free- flow (Viscosity)
5) Heat resistant

Types of extinguishing Agents

Dry chemical powder($NaHCO_3$)

- Sodium Carbonate melts and decomposes at 270^0C on heating
- $2NaHCO_3$ + heat $\longrightarrow$ H_2O +CO_2 +Na_2CO_3 being endothermic the equilibrium constantly increases the temperature.
- Thus, at the temperature of the fire, heat is absorbed by the bicarbonate and CO_2 and H_2O are produced.
- $NaHCO_3$ works by absorbing heat from the fire and giving products which would help smoother it

Amount of Extinguishing Agents

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 and Table 3

Amount of Extinguishing Agents

Table 3: Minimum Usable Amount of Extinguishing Agents

	Foam meeting performance level A		Foam meeting performance level B		Foam meeting performance level C		Complementary agents	
Aerodrome category	Water[1] (L)	Discharge rate foam solution/ minute (L)	Water[1] (L)	Discharge rate foam solution/ minute (L)	Water[1] (L)	Discharge rate foam solution/ minute (L)	Dry chemical powders (kg)	Discharge rate kg/sec
(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	1100	135	2.25
5	8 100	4 500	5 400	3 000	3 900	2200	180	2.25
6	11800	6 000	7 900	4 000	5 800	2900	225	2.25
7	18200	7 900	12100	5 300	8 800	3800	225	2.25
8	27300	10 800	18200	7 200	12 800	5100	450	4.5
9	36400	13 500	24300	9 000	17 100	6300	450	4.5
10	48200	16 600	32300	11 200	22 800	7900	450	4.5

Response time

- 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 3 in optimum conditions of visibility and surface conditions

- Satellite fire stations should be provided whenever the response time cannot be achieved from a single fire station.

Minimum Number of Foam Tenders

Table 4: Minimum Number of Foam Tenders.

Airport Category	ARFF vehicles
1	1
2	1
3	1
4	1
5	1
6	2
7	2
8	3
9	3
10	3

Airport Facilities Affecting ARFFS

Airport Water Supply

The objective of providing additional water supplies at adequate pressure and flow is to ensure rapid replenishment of aerodrome ARFFS vehicles.

To support the principle of continuous application of extinguishing media to maintain survivable conditions at the scene of an aircraft accident longer than that provided for by the minimum amounts of water set out in Table 3.

Airport Facilities Affecting ARFFS

Determination of replenishment extent

a) sizes and types of aircraft using the aerodrome;

b) the capacities and discharge rates of foam tenders;

c) the provision of strategically located hydrants and static water supplies ;

d) utilization of existing natural water supplies for firefighting purposes;

e) vehicle response times;

f) historical data of water used during aircraft accidents;

Airport Facilities Affecting ARFFS

Determination of replenishment extent

g. the need and availability of supplementary pumping capacity;
h. the provision of additional vehicle-borne supplies;
i. the level of support provided by local authority emergency services;
j. the pre-determined response of local authority emergency services;
k. fixed pumps where these may provide a rapid and less resource-intensive method of replenishment;
l. additional water supplies adjacent to airport fire service training areas; and
m. overhead static water supplies.

Emergency Access Roads

1) Emergency access roads and any associated bridges should be
    a. provided on an airport where terrain conditions permit their construction to facilitate the achievement of minimum response times
    b. capable of supporting the heaviest vehicles, which will use them and be constructed to be effectively available in all weather conditions.

2) The emergency access road and gate or barrier should be subject to regular inspection and physical tests to ensure their availability in an emergency.

Fire Station

- The location of the airport fire station is a factor in ensuring that recommended response times can be achieved in optimum conditions of visibility and surface conditions

- RFF vehicles should have direct and safe access to the movement area that caters to the size of the fire vehicle(s) being deployed and capable of reaching the extremities of this area within the recommended response time.

- All fire stations should be located to have direct access to the runway, requiring the Foam tenders to negotiate minimum number of turns.

Fire Station

- The location should ensure that the vehicle running distances are as short as possible in relation to the runway(s) the fire station is intended primarily to serve.

- In all fire stations there must be a Watchroom sited in a position which overlooks as much of the movement area as possible. It may be necessary to elevate the watchroom to provide the maximum degree of surveillance

Personnel

Adequacy of personnel should be determined to meet:

a) Foam tenders should be staffed 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 alternative arrangements to undertake this function are initiated by the airport emergency plan.

Adequacy of personnel

The objective

a. ARFFS can achieve the principal objective

b. Foam tenders & equipment can be operated effectively and safely

c. continuous agent application at the appropriate rate(s) can be fully maintained

d. sufficient supervisory can implement a coordinated incident management system

e. ARFFS elements of the AEP can be effectively achieved.

Task Resource Analysis (TRA)

- Justification to the minimum number of competent personnel required to deliver an effective ARFFS.
- When carrying out a TRA, it is essential to fully understand the complexity of the various roles an individual is required to do in terms of actions, in order to achieve the principal objective of the ARFFS.
- The task analysis should observe human factor principles to obtain optimum response by all agencies participating in emergency operations

Task Resource Analysis (TRA)

The following items will assist in determining the basic contents of a TRA:

a) Description of the aerodrome(s) including runways.
b) Promulgated ARFFS categories
c) Response time (area, times and number of fire stations).
d) Current and future types of aircraft movements.
e) Operational hours.
f) Level of supervision for each operational crew.
g) ARFFS qualifications/competence
h) Extraneous duties (to include domestic and first aid response)

Task Resource Analysis (TRA)

The following items will assist in determining the basic contents of a TRA:

i) Communications and ARFFS alerting system including extraneous duties.

j) Appliances and extinguishing agents available.

k)Specialist equipment: fast rescue craft, hovercraft, water carrier, hose layer, extending boom technology and HRET technology.

Task Resource Analysis (TRA)

The following items will assist in determining the basic contents of a TRA:

i) Initial emergency medical aid- role and responsibility.

j) Medical facilities: role and responsibility.

k) Pre-determined attendance- local council authority services, police, fire and ambulances, etc.

l) Incident task analysis- feasible worst-case scenarios, workload assessment, human performance/factors. It should include:

Task Resource Analysis (TRA)

i. mobilization

ii. deployment to scene

iii. scene management

iv. firefighting

v. suppression and extinguishment

Task Resource Analysis (TRA)

vi. application of complementary agents

vii. post fire security/control

viii. personnel protective equipment (PPE)

ix. rescue teams

x. aircraft evacuation

xi. extinguishing agent replenishment (note: the aim is to identify any pinch points within the current workload and proposed workload).

Task Resource Analysis (TRA)

The following items will assist in determining the basic contents of a TRA:

p. Appraisal of existing ARFFS provision

q. Future aerodrome development and expansion

r. AEP and procedures.

Phases of TRA

Phase 1- Aims and objectives of ARFFS and tasks

Aim- To maintain a dedicated ARFFS of qualified and competent personnel equipped with vehicles and specialized equipment to make an immediate response to an aircraft

Tasks

1. Meet the required response time
2. Extinguish an external fire
3. Protect escape slides and exit routes
4. Assist in self-evacuation of the aircraft

Phases of TRA

Phase 1- Aims and objectives of ARFFS and tasks

Tasks

5. Create a survivable situation/ condition
6. Rescue trapped persons
7. Maintain post fire control
8. Preserve evidence

TRA to identify the optimum time when additional resources will be available to support and or replace resources supplied by ARFFS (AEP)

Phases of TRA

Phase 2

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 both International National & Local sources.

Phase 3

Identify the types of aircraft commonly in use at the airport (type of aircraft and its configuration has a direct bearing on the resources required in meeting Phase 1 above).

Phases of TRA

Phase 4

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

In order to simulate a feasible accident scenario a major factor is to consider the probable location for the most realistic accident type that may occur.

Phases of TRA

Phase 5

This Phase 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.

Phases of TRA

Phase 6

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

Safety Oversight of ARFFS

Areas to Check

- Category/ Level of protection published (facilities and Equipment)
- Personnel- Adequacy (Approved establishment, TRA) Training, PPEs
- Training school/academy (Instructors, Syllabus, Equipment (Simulator)
- Access roads

Safety Oversight of ARFFS

Areas to Check

- Emergency Exercise (frequency)- Aerodrome Emergency Plan
- Fire station (site, watchroom, Housing of FTs, Gym room
- Spillage cleanup
- EOC & MC-equipment
- Grid maps- updated

Safety Oversight of ARFFS

Areas to Check

- Disabled aircraft removal equipment (Plan/ Procedure)
- Emergency water supply (static tanks, hydrants)- should not be salty
- Communication
- Ambulance services/ MOUs
- Fire Prevention Unit
- Fire systems

Safety Oversight of ARFFS

Areas to Check

- Disabled aircraft removal equipment (Plan/ Procedure)
  a) List of equipment & personnel available for the purpose
  b) Arrangement for rapid receipt
  c) Name of coordinator designated to implement the plan
  d) Roles of the operator and holder of AOC

Safety Oversight of ARFFS

Areas to Check

- Disabled aircraft removal equipment (Plan/ Procedure)
  - e) Arrangement for notifying aircraft operator
  - f) Arrangement for liaising with ATC unit
  - g) Roles & telephone numbers for personnel responsible for arranging for the action as necessary including amendments of the AIS publications

Safety Oversight of ARFFS

Areas to Check

- Maintenance Regime
- Emergency water supply (static tanks, hydrants)- should not be salty
- Communication
- Ambulance services/ MOUs
- Emergencies in difficult environments (specialist rescue services/ MOUs)
- Extinguishing Agents and Reserve for replenishment

Achievements/ Milestone

2015 to date

- 6 special purpose and commercial ARFFS trucks respectively
- Full PPEs
- Foam testing kit
- Gym facility
- 4 Fire Instructors (Airport Fire Service Manager), UK
- 35 firefighters recruited and trained

Achievements/ Milestones

Aircraft Simulator

- Components
  1) Steel frame
  2) Containerized cat 9 aircraft
  3) ARFF truck simulator
  4) Hazmat training simulator
  5) Airside driving simulator and e-cargo
- Acquisition at tender evaluation stage
- Land already allocated (4 acres)

Challenges

- Training
- Minimum requirements
- EOC & MC
- Emergency exercises
- Grid maps/ crash site identification
- Disabled aircraft removal equipment /kit
- Location/siting of Fire station and watchroom

Challenges

- Failure to notify and report any deficiency that might affect level of protection
- Adequate personnel
  1) Lack of proper transfer of skills to the newly recruited firefighters
  2) New recruits assuming responsibilities/ roles they are not well trained to handle- leading to poor decision making
  3) Increased risk to flying public, damage to aerodrome facilities and equipment including injuries during normal and emergency operations
  4) Poor deployment of all operational areas and equipment

Challenges

- Succession plan
- SHELL model (Fatigue)

Way Forward

- Safety is a collective responsibility, but the ultimate responsibility remains with the MD/CEO who should show some level of commitment in providing Resources (Human and Capital)
- Cordial relationship between the Operator and Regulator
- JESIP

THANK YOU