The Guide for ARFF has been on ASAG's Web site for many years and we have reviewed it and updated with current links as of October 2, 2020. If you wish to go to the references hyperlinked, you must click on the Download PDF and then the hyperlinks throughout the document will be available. If you find a link that is not current, please let us know.

AIRCRAFT RESCUE FIRE FIGHTING (ARFF)

A well designed, training program for accident first responders will save lives, stop loss, and return the airport to normal as soon as possible. Airports with commercial airline service are required by the Federal Aviation Administration to meet 14 Code of Federal Regulations Part 139 certification. These certification standards mandate annual recurrent training, design

standards for training facilities, and equipment requirements that include adequate water supply and delivery systems, emergency planning and minimum response times.
Non-commercial service airports located in metropolitan areas and rural communities are not required to meet this higher standard, but it is desirable for local fire and rescue personnel serving general aviation airports to have at least one aviation specialist on duty at all times who is familiar with the special needs, risks and communications required for responding to an aircraft accident. These specialists should coordinate with airport and air traffic personnel in creating an airport emergency and Surface Movement plan. At minimum, aviation specialists should be able to:

- Easily locate and identify airport access points and gain quick entry using access codes, badges, key locks etc.
- Identify runways, ramps and taxiways by signs, color coded lighting and pavement markings.
- Be familiar with installations, features and terrain in the critical response areas that present a hazard to vehicles or limit response capability.
- Identify hazardous materials frequently stored on airport property and the probable direction of travel of fuel during a fuel leak.
- Identify the typical types of aircraft operating at the airport and be able to locate components of fuel, oxygen, hydraulics, electrical, fire protection, anti-icing, APU, ballistic recovery systems, brake, wheel and egress systems for those aircraft.
- Identify procedures used to adapt structural rescue and firefighting equipment for aircraft use.
- Identify hazards to firefighting personnel.
- Carry and operate a hand-held radio capable of transmitting and receiving on the airport tower and/or common traffic advisory frequency (CTAF).

The Federal Aviation Administration (FAA) maintains a series of Advisory Circulars that provide guidance for Crash Fire Rescue (CFR) personnel. A complete list and on-line access to these circulars is provided at:
https://www.faa.gov/airports/airport_safety/aircraft_rescue_fire_fighting/. A partial list with direct links to specific FAA pdf documents is provided at the end of this guide.

GENERAL AIRPORT SAFETY

Airports present special hazards to rescue and response personnel. Of paramount importance is airport familiarization and airport staff coordination during non-emergency situations to ensure that response procedures are carried out in a safe and efficient manner during an emergency. Aircraft emergencies on airport property should be responded to using considerable caution due to the airport operating environment and the hazards associated with it. Airports offer a variety of areas where extreme caution must be exercised before entering or transiting.

Runways - The most hazardous location on an airport is an active runway. Airports that have air traffic control towers (ATCT) should have procedures in place to stop take offs and landings during an aircraft emergency. Nevertheless, all persons responding to an aircraft emergency on an airport must exercise extreme caution when crossing or approaching a runway. Aircraft on approach to land or on takeoff roll present a collision hazard with vehicles and pedestrians on or

adjacent to runways. There should be communication between the ATCT and responding emergency personnel and equipment. In the event there is no ATCT on the field, or during hours when the control tower is closed, responders should be aware of and establish communications on the Common Traffic Advisory Frequency (CTAF) to alert approaching and departing aircraft of the emergency and any resulting runway or taxiway closures. In any event, responding units must be aware of the runway environment and certain that no collision hazard exists before entering the runway safety area.

Taxiways - Active taxiways are the second most hazardous location on an airport. All persons responding to an aircraft emergency on an airport must exercise extreme caution when approaching or crossing an aircraft taxiway. Aircraft moving on taxiways are a collision hazard to vehicles and pedestrians on or adjacent to taxiways. Airports that have air traffic control towers (ATCT) should have procedures in place to stop aircraft ground movement during an aircraft emergency. There should also be procedures to communicate between the ATCT and responding emergency personnel and equipment. Responding units must be aware of the taxiway environment and certain that no collision hazard exists before entering or crossing a taxiway

Airport Ramp and Apron Areas - Generally, open paved areas near airplane gates, terminal buildings, maintenance facilities and hangars are used for aircraft parking and for transitioning aircraft to the taxiway areas. As with airport taxiways, care should be exercised to avoid aircraft that are operating under power or being towed by service vehicles. Care should also be taken to avoid aircraft that are parked. Many times an apron area may be under the control of the air traffic control tower (ATCT) and movement should be coordinated with the tower or airport staff.

Site Preservation and Bystander Safety - Site preservation at an aircraft accident is a critical component of the response process. The first step to this process is to identify and document things that were modified or disturbed during the rescue and response procedure. The next step will be to establish an inner and outer perimeter around the emergency site to protect the integrity of the accident scene and protect non-respondents and bystanders from injury and exposure to dangerous conditions. Adhering to these procedures is crucial to the accident investigation phase and all responders must strive to prevent disturbances that are not imperative to life saving activities.

Airport Safety Rules and Guidelines - Maintaining awareness of your surroundings and movement of vehicles and aircraft is critical to operating safely during an aircraft emergency response. Responders should become familiar with airports in their community to ensure they know the general airport layout, location of perimeter roads, electrical lines and vaults, fuel storage areas and other dangers that may be present. Response personnel should work with airport staff to understand the rules, regulations, and common operations occurring at that particular airport. Consider also, that airfield construction projects can add another element of danger and create unexpected conditions.

SPECIFIC HAZARDS FROM AIRCRAFT

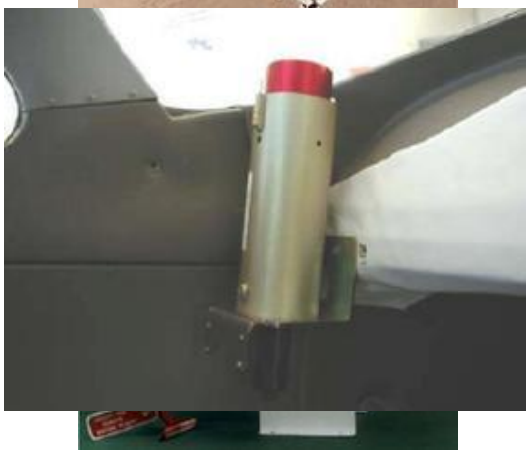
Many aircraft have standard equipment that can be hazardous if not dealt with properly. Hazards existing in normal operating conditions can become even more dangerous in an emergency situation. The following list represents some of the aircraft components and systems that require care and proper treatment during an aircraft emergency:

Fuel - All powered aircraft can hold considerable quantities of fuel on board. Aircraft fuels are highly flammable, burn at extremely high temperature, are corrosive to equipment and toxic to humans. Generally aircraft have fuel tanks in the wings and many have auxiliary tanks in the fuselage. Fuel lines may be present throughout the aircraft and may be pressurized. If leaking fuel is present in an emergency situation, care should be taken to avoid sparks and reduce heat that could ignite the fuel. If no leakage is present, care should be taken to avoid damaging fuel tank locations that could cause fuel release or ignition.

Tires and Wheels - In structural firefighting, fire is usually attacked "head-on" with water, but on aircraft, tire/wheel assembly fires should be approached only from fore or aft and dry chemical is the recommended extinguishing agent. More information on this can be obtained from IFSTA Aircraft Rescue Fire Fighting Sixth Edition Chapter 10.

Aircraft Electrical Systems - Powered aircraft may have 6v, 12v or 24v electrical systems. Light piston aircraft batteries may be located in the engine compartment forward of the firewall, aft of the firewall, or elsewhere in the fuselage. Turbine aircraft may have auxiliary electrical systems for use on the ground. Components are frequently found throughout the aircraft and may remain energized after the engine stops running or is separated from the aircraft.

Ballistic Recovery Systems (BRS) - Many modern aircraft, and some modified older aircraft are fitted with onboard parachute recovery systems. In an in-flight emergency, the pilot activated system launches a parachute from the aircraft at extremely high velocity. During the take-off and landing phase, aircraft are operating too close to the ground for the system to be effective so pilots would not normally activate the system in that situation. This may place the fire fighter at risk of accidentally activating the BRS during rescue operations. The systems are rocket propelled, accelerating to over 100 mph within a tenth of a second after ignition, and can cause injury or death to anyone in its path. A rescue worker who disregards the position of the ballistic parachute system, or who moves the aircraft or accident victim without determining the existence of a ballistic parachute system, may put him or herself in considerable jeopardy. The BRS is typically located behind the aircraft cabin or cockpit and activated by a pull handle and cable assembly that runs through the aircraft fuselage to the forward area of the cockpit. Accidental activation can occur by disturbing the cable activation system or the rocket propulsion system. The rocket will injure or kill anyone who may be in its escape trajectory. Responders should be familiar with these systems and the typical discharge areas of various aircraft. Care must be taken during rescue and recovery to identify the presence of BRS components and ensure that accidental activation does not occur. While the development of BSR systems was intended for larger single engine conventual aircraft, there use has grown to include aircraft in the experimental and ultralight category. A first responder to a general aviation accident should always anticipate the presence of a BSR system. For more complete illustrations of BRS safety for fire fighters, visit the BRS website at https://brsaerospace.com/wp-content/uploads/2018/02/First_Responders.pdf



Composites and toxic substances - Many aircraft contain materials that become hazardous when damaged, cut or burned. Some composite and plastic type materials emit toxic fumes when heated or burned. Other materials emit dust and microfibers when damaged or cut and may be toxic when inhaled or ingested. Care should be taken to avoid inhalation or ingestion of any fumes, vapors, or particles associated with aircraft emergency response. Cuts or abrasions suffered by responders during the rescue and recovery operations can offer a path for toxins to enter the body and cause hazardous exposure. Hydrochloric and other acids are contained in aircraft batteries or generated by burning materials or by the commingling substances during an accident situation. Extreme caution should be exercised to avoid contamination or exposure to these substances.

Compressed gasses - Many aircraft have compressed gasses on board such as oxygen and nitrogen. These gasses are contained in bottles or tanks, gas lines, and charged landing gear struts. Aircraft tires may be inflated to high pressures. Care should be taken during recovery to avoid damage to components that could result in explosive release.

Hazardous Cargo and Hazardous Materials - Aircraft can carry materials and cargo that are hazardous to recovery personnel in the event of fire or impact. Cargo should be treated with care until recovery personnel can be certain that materials contained within the aircraft are safe. As with many of the other hazards discussed in this text, fire and the mixing of materials in an accident can cause exposure hazards that may not be present in an otherwise stable condition. Recovery personnel should be aware of these hazards and use precautions to identify the presence of such materials and ensure they are handled safely and not disturbed during the rescue and recovery process.

Airbags - As with modern road vehicles, many aircraft now contain airbags to reduce injury in the event of an accident. These devices can be found forward and to the side of pilot and occupant seats and within the safety harnesses. They are designed to protect aircraft occupants from injury caused by impact, but delayed explosive deployment can cause injury to response personnel during inflation.

Ordinance and Munitions - Aircraft, and particularly military aircraft, may have onboard weapon systems that can be hazardous to recovery personnel. Air-to-Air gun ammunition, missiles, rockets or aerial bombs may be present and highly dangerous. Recovery personnel should be aware of these hazards and take precautions to identify the presence of such materials to ensure they are not disturbed during rescue operations and handled safely by qualified personnel during the recovery process.

Accumulators - Aircraft may have a variety of hydraulic and pneumatic accumulators that contain pressurized air or fluids to aid in the operation of movable control surfaces and landing gear. These accumulators can rupture under heat or stress and discharge their stored energy during rescue and recovery operations. Aircraft accident responders should become familiar with how to locate and make safe such devices during rescue and recovery operations.

Fluids - Many of the fluids contained in aircraft can be toxic or corrosive in nature and the burning of these materials can add to the risk of exposure. Response personnel should familiarize

themselves with the properties of common fuels, oils, hydraulic fluids, and acids that are present within typical aircraft and know the hazards associated with these substances. Some military aircraft may also have hypergolic liquids such as hydrazine present.

The following information is taken from an article by Kenneth D. Honig, EMT-P, CEN, senior course coordinator for Critical Incident Management and Training Associates (CIMAT) in North Bellmore, NY, for Advance Rescue Technology.

> Off Airport Fire Fighting - Unless a community is in close proximity to an airport, it is often difficult to commit resources to plan for a catastrophic aircraft accident. However, it is the responsibility of emergency managers to plan for the unthinkable. For those individuals who insist that these types of incidents only occur "someplace else," remember that to emergency managers in other municipalities, your community is somewhere else.
>
> In the event of a large aircraft disaster, the local EMS system will be overloaded, as will the local medical examiner and coroner's office. Response planning should include designation of primary and back-up locations for triage and treatment of victims.

ARFF METHODS

Due to the nature of combustibles involved in an aircraft crash, and the physical forces which are experienced, strategic priorities differ from other types of firefighting scenarios. In Aircraft Rescue and Fire Fighting (ARFF), the emphasis is more heavily weighted toward rescue than in structural firefighting. The rule of thumb is initially to fight only the fire that interferes with the rescue.

Foam First for Fire Fighter Safety

Structural firefighting protective clothing provides inadequate protection against extreme temperatures generated by burning aviation fuels. Responding firefighters should make the initial attack from upwind of the fire to reduce the amount of heat and smoke they will encounter. Unless the fire is encroaching on passenger or other inhabited areas, it should be ignored until passenger rescue is complete. Aviation fuels burn at extremely high temperatures, between 3,000°F-4,000°F. By employing the "area concept" technique of blanketing the outside of the fuselage with overlapping streams of firefighting product to draw off heat, escape time for passengers can increase significantly. Tests conducted at the Federal Aviation Administration's (FAA) research facility at Atlantic City Airport in New Jersey demonstrate that a fuel fire inside an aircraft cabin can lead to flash-over conditions in less than four minutes. The immediate application of massive quantities of cooling firefighting product to draw off this heat is the most effective technique for increasing survivability in a low-impact aircraft crash fire incident.

ARFF Product

Use foam product rather than water for ARFF. Class B firefighting foams are the primary agent used for fighting aircraft fires. Firefighting foams are generally available in 1%, 3% and 6% concentrates. The percentage refers to the number of gallons of concentrate to be mixed with water to produce 100 gallons of firefighting product. Since mobile proportioning systems cannot be accurately calibrated at the 1% level, these concentrates are not used for ARFF.

Many municipal fire departments are not financially able to purchase an ARFF vehicle to stand by in the event a plane crashes in their community. Therefore, agencies must determine how to adapt existing structural firefighting equipment for ARFF. One of the simplest and least expensive methods is calculation of the booster tank foam recipe for your equipment. This involves taking the capacity of the on-board water tank on the fire truck, calculating the amount of foam concentrate needed, and then storing it on the truck ready for use. For example, a 500-gallon booster tank would require 15 gallons or three 5-gallon buckets of 3% AFFF concentrate. Placed in the hose bed near the tank fill, the foam concentrate could be dumped into the tank before the apparatus departs. Firefighters should be familiar with, and have available, foam educators and a supply of foam concentrate at the scene to continue firefighting efforts.

ARFF Safety

Responders to aircraft accidents must take special precautions to protect themselves. Unburned jet fuel is a carcinogen that can be absorbed through the skin; prolonged inhalation of vapors can lead to development of chemical pneumonia; and some equipment can be permanently contaminated if it comes into contact with fuel. Damaged aircraft fuselages may produce sharp edges that can easily tear through bunker gear. Aircraft landing gears may react violently if extinguishment with water or foam. Aircraft engines may continue to operate for some minutes after a crash. Jet turbines may produce sufficient thrust to overturn responding apparatus and suck in loose equipment or even personnel who get too close. A bump against a propeller can restart a reciprocating engine if it has not been properly shut down. Oxygen may be distributed from central tanks through pressurized lines. Surface control cables can be under extreme tension. Electrical lines may remain energized. Awareness of these risks is an essential part of ARFF training.

Evidence preservation

A plane crash is a crime scene until proven otherwise. Establish a perimeter quickly to prevent unauthorized access. In flight breakup and high impact crashes scatter debris over large areas, and a number of local, state and federal law enforcement agencies will be involved in the investigation into the cause of the crash. Responders should take care not to unnecessarily disturb aircraft parts or ground markings. If it is necessary to move something, try to remember the original location or orientation of the part and convey that information to investigators. Before recovery of bodies or body parts commences, photographs should be taken to document their location in relation to the aircraft and surrounding area.

ROLE OF THE NATIONAL TRANSPORTATION SAFETY BOARD (NTSB)

The NTSB has jurisdiction over investigations of all aircraft accidents. On occasion, usually minor accidents with little or no bodily injury, the NTSB may delegate this responsibility to the FAA. Regardless of which of these agencies conducts the official accident investigation, it may be several hours before investigators arrive on scene. By then witnesses to the accident and

related events have often disappeared. It is important that local officials and first responders obtain names and contact information from possible witnesses who are present, conduct initial interviews and discourage witnesses from discussing the accident with one another in order to preserve precious memory and evidence.
In the case of an air carrier accident, the most sought after pieces of evidence will be the Flight Data and Cockpit Voice recorders. These recorders are made to withstand extreme g-forces, heat, cold and submersion in water. Should these devices be found, they should be identified and left in place for recovery by NTSB investigators.
Rules for reporting aircraft accidents and preserving the accident scene are found under Title 49 Part 830. https://ecfr.io/Title-49/Part-830

ARFF TRAINING PROGRAMS

ARFF Training Curriculum must include initial and recurrent instruction in:

- Airport Familiarization
- Aircraft Familiarization
- Personnel Safety
- Emergency Communications Systems
- Use of equipment and agents
- Aircraft evacuation
- Operations
- Adapting structural equipment for aircraft response
- Cargo hazards
- Fire fighter duties under an airport emergency plan
-

If the airport emergency plan calls for fire fighters to respond to special situations, such as water or treetop rescue, training specific to such situations should be provided. Fire fighters should also receive training in recognition of aircraft ballistic parachute systems during emergency operations.

It is highly recommended that fire fighters receive hands-on training on the aircraft that regularly serve their airport. This may be difficult unless there are aircraft that remain overnight or there is an aircraft maintenance facility on the airport. Where such hands-on training is not feasible, it is recommended that ARFF crews be given access to aircraft schematics and to computer-based training that are available in the commercial market.

The FAA has developed an on-line five module training course initially designed for firefighter which provides useful information to Emergency Medical Services and police. It also provides useful information to anyone coming across and aircraft accident.
https://www.faa.gov/aircraft/gen_av/first_responders/
Successful completion of this course provides the student with the minimum knowledge and improves skills necessary for handling an aircraft emergency effectively. Organizations can obtain additional seminar training through the regional FAA Safety Team. Contact your local FAA Flight Standards District Office.

U.S. Air Force Technical Order (TO) 00-105E-9, Aircraft Rescue Information (Fire Protection). The technical order describes procedures for fire service personnel responding to various types of emergencies involving military or civil aircraft. It also provides general information on aircraft firefighting and rescue as well as detailed information relating to military aircraft and civilian air carrier aircraft used by the military. Nonmilitary organizations having airport firefighting and rescue responsibilities at airports that serve military aircraft under routine and/or emergency conditions may obtain a copy of this technical order by sending a request to:
HQ AFCESA/CEXF
139 Barnes Drive
Suite 1
Tyndall Air Force Base, FL 32403-5319
Telephone: (850) 283-6150

International Fire Service Training Association's (IFSTA's) Aircraft Rescue and Fire Fighting, Fourth Edition manual was developed to provide information for both airport and structural fire department officers to effectively accomplish the various tasks involved in aircraft firefighting and rescue. It is designed for all types of fire protection organizations and includes the use of both conventional and specialized aircraft firefighting apparatus. Copies may be purchased from IFSTA at:
International Fire Service Training Association (IFSTA)
Fire Protection Publications
Oklahoma State University
930 North Willis
Stillwater, OK 74078-8045
http://www.ifsta.org/

Training courses are also available from the American Association of Airport Executives (AAAE). These courses are endorsed by the Federal Aviation Administration and cover a number of topics from basic and recurrent aircraft fire fighting, to hazardous materials and emergency management training. AAAE can be contacted at:
American Association of Airport Executives
601 Madison Street, Suite 400
Alexandria, VA 22314
Telephone: (703) 824-0504
Fax: (703) 820-1395
http://www.aaae.org/

In Arizona, aircraft fire fighting training is offered in Mesa.
Boeing - Mesa Fire Protection
5000 East McDowell Road
Mesa, AZ 85215
Contact: Keith Berthiaume, Training Officer

FAA ARFF Contacts

FAA Office of Airports
Marc Tonnacliff
ARFF Specialist
Federal Aviation Administration
800 Independence Ave. SW
Airport Safety and Standards, AAS-300, Room 618
Washington, DC 20591
(202) 267-8732
Fax (202) 493-1416

FAA Technical Center
Keith Bagot
ARFF Research Program Manager
ANG-E621, Bldg 296
Atlantic City International Airport, NJ 08405
(609) 485-6383

- Airport Technology Research & Development Branch
- FAA Aircraft Rescue & Fire Fighting Research Program
- Airport Safety Research Published Papers & Technical Notes

CONCLUSION

Even without formal ARFF training, Fire Fighters can do much to improve the quality and response of aircraft rescue fire fighting. The first step is to contact your local airport manager, or the designated airport liaison in your city, town, or county offices. He or she can work with your fire fighting team and airport users to create an aircraft emergency response plan that meets the needs of your local airport and the surrounding community.

FAA ADVISORY CIRCULARS

The Federal Aviation Administration maintains an on-line library of Advisory Circulars pertaining to airport design, maintenance and management. A complete list of these Series 150 circulars is available at: https://www.faa.gov/airports/airport_safety/aircraft_rescue_fire_fighting/. Many of these Series 150 circulars provide guidance for airport managers and emergency response personnel on planning and executing crash-fire rescue operations. A partial list of the most commonly referenced Advisory Circulars is provided here with direct links to FAA pdf documents.

50/5200-12	First Responders' Responsibility for Protecting Evidence at the Scene of an Aircraft Accident/Incident
150/5200-31	Airport Emergency Plan
150/5210-5	Painting, Marking, and Lighting of Vehicles Used on an Airport

150/5210-6	Aircraft Fire Extinguishing Agents
150/5210-7	Aircraft Rescue and Fire Fighting Communications
150/5210-13	Airport Water Rescue Plans and Equipment
150/5210-14	Aircraft Rescue Fire Fighting Equipment, Tools and Clothing
150/5210-15	Aircraft Rescue and Firefighting Station Building Design
150/5210-17	Programs for Training of Aircraft Rescue and Firefighting Personnel
150/5210-19	Driver's Enhanced Vision System (DEVS)
150/5210-23	ARFF Vehicle and High Reach Extendable Turret (HRET) Operation, Training and Qualifications
150/5220-10	Guide Specification for Aircraft Rescue and Fire Fighting Vehicles
150/5220-17	Design Standards for an Aircraft Rescue and Firefighting Training Facility
150/5220-26	Airport Ground Vehicle Automatic Dependent Surveillance - Broadcast (ADS-B) Out Squitter Equipment
150/5230-4	Aircraft Fuel Storage, Handling, and Dispensing on Airports

BALLISTIC RECOVERY SYSTEMS

BRS Site
https://brsaerospace.com/wp-content/uploads/2018/02/First_Responders.pdf

OTHER REFERENCES

Accident Reporting Rules
https://ecfr.io/Title-49/Part-830
International Fire Service Training Association (IFSTA)
http://www.ifsta.org/
American Association of Airport Executives
http://www.aaae.org/

Aviation Safety Advisory Group of Arizona
P.O. Box 20645
Phoenix, AZ 85036