ONLINE LEARNING COMPANION #3
A Look at Airport Firefighters

By Jim Anderson

I recall a statement made by an ill-informed relative at my son’s graduation party after many intense weeks at the Sacramento Fire Academy. The statement posed to him was “So, will you be responding to real emergencies?” Needless to say, this person is totally in “left field” when it comes to knowing the world of aircraft fire protection. The term used is ARFF, an acronym for Aircraft Rescue and Fire Fighting.

Air travel is very safe, thanks to strict regulations and competent engineering. Most of our responses are medical in nature, along with the usual smattering of vehicle fires and hazardous materials incidents.

When you fly commercially, you almost never see the airport fire vehicles, although they are strategically staged at quick response locations. This is because when providing aircraft escort to parking after the emergency landing, they will follow the airplane in such a way that the passengers are unable to see the fire apparatus.

Airport fire crews respond to emergency landings, which may include anything from an engine that is shut down to hydraulic or electrical problems. These specialized firefighters may be assigned to fire departments belonging to cities, counties, port authorities, airport authorities, federal, civilian, or military authorities, or aircraft companies such as Boeing.

Unfortunately, some “old-fashioned” fire departments have used their airport fire stations as dumping grounds for the “old timers” who just wanted to quietly rust away. Modern fire departments realize the challenges posed by the complexities of aircraft fire suppression and rescue. An airplane poses many hazards within a confined area. These progressive fire departments may offer incentive pay, as this specialty requires FAA certification and a workforce that is fast-thinking and aggressive.

A commuter airplane such as the Embraer 120 can routinely carry 30 persons on board. A mid-sized aircraft carries over 130 persons; the larger aircraft easily carry more than 250 persons. The new Airbus 380 can carry over 550 people in a normal configuration, while the capacity can be over 800 people in an all-economy configuration. In the event of a crash landing, anyone who has survived the impact is likely to survive a post-crash fire provided that the fuselage is intact and ARFF crews are positioned quickly and applying extinguishing streams.
These airport firefighters are training in how to use baggage conveyors for removal of patients in the event of a HAZMAT incident.

Response time is most critical: Human beings are strapped inside a long hollow tube with large quantities of fuel and secondary systems that include high-pressure hydraulic systems, electrical cables, and cargo in the lower hold. It is not uncommon for an aircraft to have improperly declared cargo on board. Many shippers violate the law by
deliberately refusing to declare the true contents of parcels that may be shipped, whether	on a cargo airplane or passenger aircraft.

Accessing aircraft is difficult and specialized. It may be necessary to cut through the
skin of the aircraft, and structural frame components may hamper the cutting operation.
Look for marked cut-in areas or cut around window edges. Beware of fuel tanks and fuel
lines, electrical wiring, oxygen lines and cylinders, hydraulic lines and other tubing. Use
a power saw for cutting. When cutting through the fuselage, it is important to know the
aircraft interior. There are structural components such as bulkheads, framework, or
equipment inside the aircraft that would hinder entry.

Most military cargo planes haul cargo on pallets fastened to the aircraft floors.
Commercial cargo planes carry cargo either on pallets or in special containers called
“cargo cans.”

Because of these complexities, the ARFF firefighters are required to constantly train
on the various kinds of commercial, private, and military aircraft. The FAA evaluates
airport fire departments on a recurring basis. FAA regulations require regularly scheduled
live fire aircraft training for ARFF firefighters.

All aircraft by their very nature share some common hazards. Most aircraft can be
looked upon as flying potential hazardous materials incidents, which can be dangerous
for all response people at the scene. A closer look at these hazards will minimize your
likelihood of becoming hurt. This will also increase your ability to perform aircraft rescue
and firefighting tasks as the need arises.

Aircraft hydraulic systems on newer aircraft can hold hydraulic fluid within their tubing
with over 4,000 pounds of pressure. This can be the case even in aircraft that have
crashed. Anyone who cuts through a section of tubing containing hydraulic fluid under
pressure can be killed or seriously injured.

APU (auxiliary power unit) exhaust comes from a small jet engine turbine contained in
the airplane. Its purpose is to provide auxiliary or emergency power. The exhaust is very
hot and can result in burns. Turbine blade failure is similar to the hazards associated with
turbine blade failure of a jet engine.

Electrical system: Many aircraft can have DC as well as AC electrical systems. Batteries
can "off-gas" hydroxide gases if overheated or burning. Electrical wiring can shock you if
you cut through it. The best means to reduce the hazards presented by the electrical
system is to shut off the aircraft master switch, which is marked yellow or red and
positioned in an obvious place on the control panel. The most reliable way to shut off
electrical power to an aircraft is by disconnecting the battery. Batteries may be located
anywhere in an airplane. Some batteries have quick disconnects, while others have
connections similar to those in automobiles. Trained personnel know the location of the
electrical master switch and the auxiliary power switch. They will shut these off prior to
disconnecting a battery. It is important to remember that if a battery is disconnected while
there is an electrical load, there may be a spark, which could ignite fuel vapors. When
aircraft batteries are subjected to a fire, they can yield vapors that are toxic and explosive.

Halon is used in aircraft fire suppression systems and some flight line fire extinguishers.
Halon poses a health threat when used in a confined space. When halon is subjected to
fire, it liberates toxic byproducts such as halides, bromides, and other poisonous vapors.
Some European military aircraft use methyl bromide in their on-board fire extinguishing
systems.
Hot brakes: Airplane wheels have fuse plugs that melt and "pop out" to relieve tire pressure in the event of a fire or other “overheat” condition. These plugs have enough force to cause bodily harm. The situation can escalate to become a wheel assembly fire and can cause catastrophic wheel failure. When this happens, the fragments can travel 300 feet on either side of the wheel assembly. Exposed personnel can die or be seriously injured from flying fragments. Fuel tanks, fuel lines, hydraulic lines, etc. could become punctured.

Baggage hold below main floor

Voids may be created. In the event of a heavy impact, the main floor will buckle and can drop passengers into the lower baggage/cargo hold.

Jet engine intakes: Firefighters have been sucked in even while standing 90 degrees to the side of an intake. More distance is needed when encountering larger jets and high performance aircraft.

Jet engine exhaust is hot and can blow a person off his or her feet, while also posing a hazard from blowing debris.

Liquid oxygen: Certain military aircraft such as the C-130 use liquid oxygen converters. Liquid oxygen is very cold and can freeze human skin on contact. It may ignite when in contact with other materials. This will be discussed later in this book.

Oxygen may be stored in permanently mounted cylinders, or "walk around cylinders." This is true for general aviation aircraft, commercial aircraft, and military aircraft. Some commercial aircraft carry oxygen generators, which pose a flammability hazard. Remember that any pressurized vessel when subjected to fire or severe forces of impact may explode.
Aircraft Oxygen

Aircraft may carry pressurized cylinders such as oxygen (above) as well as nitrogen and fire extinguishers.

An aircraft can easily be considered a potential “flying HAZMAT.” Airplanes carry large amounts of fuel.

Radar: If left on, radar can pose a hazard up to a distance of least 75 feet at a radius 90 degrees on either side of the nose of the aircraft. Some types of aircraft radar can cause radiation hazard from the radar, often called a "radar burn."

Fuel is always a concern in all aircraft. Common sense tells us that the larger an airplane is, the larger fuel load carried will be. If you are involved in a firefighting effort, avoid standing below the wings. The fuel load adds weight to the wing. If the wing structure becomes weakened due to fire or impact, it may collapse upon rescuers.

The “silver” firefighting clothing worn by ARFF Firefighters is only 90 percent heat reflective. It is not uncommon for these crews to sustain steam burns while combating large (and hot) fuel fires.
Boeing 767

Wing surface: If you walk on a wing for any reason such as rescue, entry, etc. consider the following: A wing is usually curved in shape. The leading edge is rounded, like the front of a teardrop, and the trailing edge tapers to a very thin edge. If you get too close to the edge you are more prone to fall off. This is especially likely if the wing is wet from water, foam, fuel, hydraulic fluid, ice, or snow. Another reason to avoid standing on control surfaces such as flaps or ailerons is they can bend down or even break off.
Burning Materials

Airplanes are made of many different materials. They carry anything: cargo, cattle, people, baggage, weapons, and equipment. Obviously there is a wide spectrum of different products of combustion contained in the smoke. Aircraft interiors contain various forms of plastics, which yield different forms of toxic byproducts in the smoke.

The most common toxic vapors include hydrogen chloride, hydrogen sulfide, hydrogen cyanide, carbon monoxide, and a long list of other gases too numerous to list. These materials can be controlled easily using water or foam. All aircraft carry some form of fuel, which is a petroleum product such as jet fuel or avgas. Use the same firefighting techniques as you would in any fire involving a large volume of fuel. Class B firefighting foam is your best choice for extinguishing these fires.

The combined effects of multiple toxic vapors from cargo and baggage are not predictable. Some toxins are absorbed through the skin.

Metals: Many aircraft contain metals, with magnesium, titanium, and aluminum being the most common. Magnesium is found throughout the structure of many aircraft, including the wheels. It burns with intense heat and an extremely bright light. ARFF firefighters are equipped with helmets that have gold-covered reflective face shields. The purpose of a gold shield is not to reflect heat, but rather to minimize the chance of retina burns due to the intense bright light of some burning metals. The firefighters are trained to avoid looking directly at burning metals. Magnesium and some other metals, which are commonly used in aircraft construction, will react with water. Because it burns so hot, it will break water down into its basic elements: hydrogen and oxygen. Hydrogen gas is highly flammable and has wide explosive limits. It is able to burn with an invisible flame under the right conditions. It poses an inhalation hazard due to hydroxides and other toxic vapors.

A growing concern in the emergency response community is the increasing use of advanced composite materials. These pose tactical firefighting, health, and environmental concerns, which need to be addressed. Their use is spreading to other modes of transportation as well as sporting goods, bridges, and building structural components.

Baggage & carry-on items: Every year, millions of people fly on commercial aircraft. Many of these folks are carrying some form of dangerous materials in their luggage. Either they don’t know the items are dangerous, or they do not care.

Even a material as common as fingernail polish remover can be dangerous inside the confined cabin of an aircraft. Items including fireworks, propane cylinders, white gas, and mercury have been found in baggage. Aerosol spray cans such as hair spray or paint can take off like a rocket in a fire environment or if punctured. We all have heard stories about HAZMAT incidents caused by careless passengers.
Military combat aircraft pose hazards from various kinds of explosive munitions and weapons systems. Fighter, attack, and bomber aircraft are equipped with ejection seats and hatches, canopies, and external stores such as auxiliary fuel tanks that can be jettisoned.
F-18 Danger Zones

Case Studies

The following incidents are taken from a previous issue of the ARFFWG News Magazine.

During a routine flight, a passenger airplane with 120 passengers, and a total crew of 6 encountered a fire on board while in flight. A light haze of smoke began to fill the main cabin. A short time later, passengers saw smoke rising up at the location where the carpet joins the aircraft interior wall panel. The flight attendant noticed that this smoke had an irritating smell. Additional passengers described the smoke to be like “an acid reaction or burning plastic.”

At the proximity of rows 15 through 18, the floor was found to be extremely hot and melting in certain areas. As the floor began to sag down slightly in the middle, the urgency of this emergency became more intense and the crew needed to land the aircraft in a hurry. The aircraft landed safely, but intense heat was coming out of the floor. As firefighting vehicles were positioned by the stricken aircraft, passenger evacuation was in progress. As this was going on, entry was made into the main passenger cabin, which had become very hot. When firefighting hose streams were directed inside the baggage compartment, steam was observed. A firefighter wearing full turnouts and SCBA began unloading the compartment, as well as completing total extinguishment of the flames. Toward the rear of this compartment, he found some charred boxes and a fiber drum which was observed to be on its side. It contained a white powder as well as plastic bottles. Everything near the drum was extremely hot. Some of the nearby cargo and baggage was charred.

The aircraft sustained fire damage to the aft third of the mid cargo compartment. This included damage to the roof of the compartment as well as five lateral aluminum floor
beams for the main cabin. There was charring of electrical cables, and soot deposits were found along the auxiliary fuel tank vent line. Flight control, engine control, and hydraulic actuation cables run along the ceiling of this compartment. Cable guides and cables were subjected to thermal damage. In the interest of safety, 20 flight control, 18 engine control, 18 hydraulic system actuation, and 7 environmental system control cables were replaced. The fiberglass-nomex composite floor panel by rows 17D and 18D sustained heat damage.

In this emergency, two firefighters were injured as well as three airline employees and nine passengers: There were assorted minor injuries from evacuation and smoke inhalation.

The four flight attendants were transported to a hospital, treated for smoke inhalation and eye irritation, and then released.

The cause of this fire was leakage and spontaneous ignition due to undeclared hazardous materials contained in a fiberboard overpack drum. Inside were 5 gallons of 65% hydrogen peroxide solution, (an oxidizing agent), 25 pounds of sodium orthosilicate-based mixture, which is a solid corrosive material, 25 pounds of laundry booster, and 24 ounces of liquid brightener. There were no markings, declarations, or proper shipping papers, which are required by law before air transport. Shipping of hydrogen peroxide greater than 50% by aircraft is forbidden; 35% solution is restricted to a maximum of one quart per container on passenger aircraft.

The hydrogen peroxide and sodium orthosilicate are incompatible and should not have been packed together.

Under certain conditions, hydrogen peroxide under 65% may cause fires because the concentration may increase as this chemical evaporates. Under the right conditions it may also detonate or spontaneously ignite when it comes in contact with organic materials. The fire could have sustained itself without oxygen.

There were no package orientation labels on the shipping drum to advise handlers the proper storage and handling of the contents, which would minimize risk of spilling.

*Here is the scary part:*

The fire breached the cargo compartment, threatening the airworthiness of the airliner while it was in flight.

An airport fire department responded to a reported HAZMAT involving a passenger-carrying aircraft located on a parking ramp. The firefighters encountered a suspicious powder inside the aircraft cargo hold and on the parking ramp. The material was so corrosive that it was actually "eating into the concrete." The fire department immediately secured the area. After size-up, a HAZMAT unit was requested. After donning the appropriate PPE, the unit performed further recon. Inside the baggage/cargo hold, mixed in with other assorted passenger suitcases and checked luggage, they found a duffle bag with several 1-gallon plastic jars containing the powdered substance. Apparently one of the screw-on lids had come loose and leaked the powder out of the duffel bag. They determined that the material was a strong base, with a pH of 14.

The authorities were able to identify the baggage and summoned the owner to the Incident Command Location. The owner said it was sodium hydroxide, used in jewelry cleaning and other manufacturing processes after dilution. A "passenger/courier" obtained the chemical and was transporting it illegally in his personal luggage.
The remaining powder had to be cleaned out of the baggage-loading conveyor and inside the belly of the aircraft. Decontamination of all exposed materials was necessary.

The FAA grounded the aircraft until it could be verified that no structural damage had occurred from the spill. Conversation with the FAA representative revealed that this is a common problem occurring at MIA (and other airports).

The baggage crew employed by the airline was vigilant and acted according to the airport Standard Operating Procedures.

An incident involving military aircraft poses additional hazards. Combat aircraft are equipped with ejection seats as well as a wide variety of dangerous weapons systems (including lasers) and explosive munitions.

Photograph by Jim Anderson
The ARFF vehicle above is equipped with a specialized piercing tip which can quickly punch a hole and deliver firefighting agent inside a burning aircraft.
Quicker night responses  
Jim Anderson
The ARFF vehicle above is equipped with a GPS monitor enabling the apparatus operator to pinpoint his exact location in darkness and fog. A screen above displays night vision using FLIR.

Composite Test Burn  
Jim Anderson
These airport firefighters are participating in test burns involving carbon fiber composite materials.
The Future

Aviation is constantly changing. Aircraft are being constructed out of newer-generation materials, which may have unusual burning characteristics. This may require changes in tactics such as selection and application of extinguishing agents.

As firefighters, we will never know all there is to learn about the complexities of our trade. It is best to prepare before an incident occurs. If there is an airport close to you, make contact with the fire department assigned there and arrange a visit. You will discover an interesting aspect in the world of fire protection and rescue, and you will become more aware of the hazards inherent in the aircraft firefighting environment.