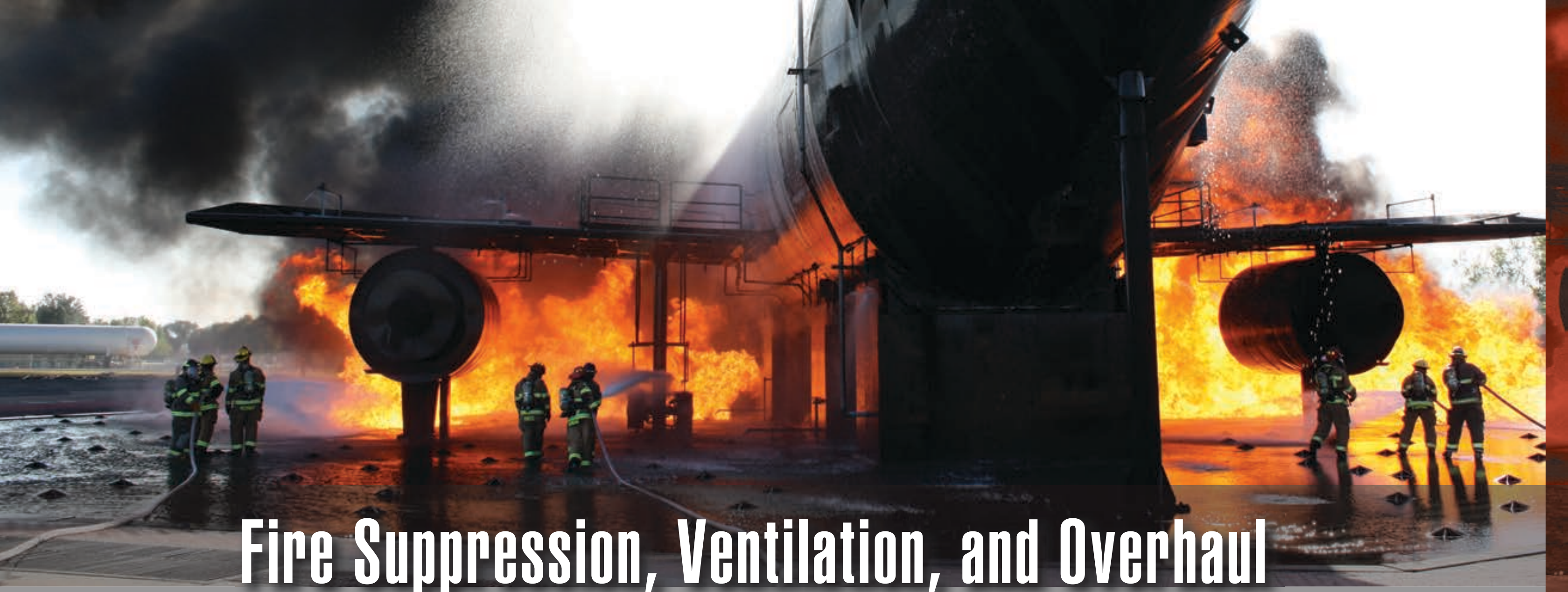


Fire Suppression, Ventilation, and Overhaul

Chapter Contents

Key Terms

NFPA® Job Performance Requirements

This chapter provides information that addresses the following job performance requirements of NFPA® 1003, *Standard for Airport Fire Fighter Professional Qualifications (2015).*

4.1.1.3	**4.3.4**	**4.3.10**
4.1.1.4	**4.3.5**	**4.4.1**
4.3.1	**4.3.6**	**4.4.2**
4.3.2	**4.3.7**	
4.3.3	**4.3.9**	

Fire Suppression, Ventilation, and Overhaul

Learning Objectives

After reading this chapter, students will be able to:

1. Identify fire suppression techniques. [NFPA® 1003, 4.1.1.3, 4.1.1.4, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 4.3.5, 4.3.6, 4.3.10, 4.4.1]
2. Describe methods of ventilation in an aircraft fire. [NFPA® 1003, 4.3.7]
3. Describe overhaul operations after an aircraft incident/accident. [NFPA® 1003, 4.3.10]
4. Explain the importance of evidence preservation during overhaul operations. [NFPA® 1003, 4.3.9]
5. Secure fuel sources. [NFPA® 1003, 4.3.3, 4.4.2; Skill Sheet 9-1]
6. Extinguish a fuel spill using an ARFF vehicle turret. [NFPA® 1003, 4.3.2, 4.3.9, 4.3.10; Skill Sheet 9-2]
7. Deploy and operate an ARFF vehicle handline to extinguish a fuel spill fire. [NFPA® 1003, 4.3.1, 4.3.9, 4.3.10; Skill Sheet 9-3]
8. Extinguish a three-dimensional fuel fire with handline(s). [NFPA® 1003, 4.3.3, 4.3.9, 4.3.10; Skill Sheet 9-4]
9. Attack an interior fire. [NFPA® 1003, 4.3.4, 4.3.7, 4.3.9, 4.3.10; Skill Sheet 9-5]
10. Extinguish an APU/EPU or engine fire. [NFPA® 1003, 4.3.5, 4.3.9, 4.3.10; Skill Sheet 9-6]
11. Extinguish a wheel assembly fire with a handline. [NFPA® 1003, 4.3.6, 4.3.9, 4.3.10; Skill Sheet 9-7]

Chapter 9
Fire Suppression, Ventilation, and Overhaul

Case History

ARFF crews responded to an engine fire on a cargo aircraft. The pilot reported heavy black smoke in the fuselage. Response crews, using ARFF apparatus turrets, cleared a rescue path and attacked the engine fire with AFFF. They quickly knocked down the fire, and moved in with handlines to fully suppress it. One crew assisted with occupant evacuation, while another crew ventilated the aircraft using the personnel and cargo doors. With the occupants and smoke out of the aircraft, fire crews started overhaul on the interior of the fuselage. Firefighters found few hidden fires and immediately extinguished them. ARFF crews made efforts to preserve any vital evidence throughout their operations. Examination of the aircraft showed that the engine was the only part of the aircraft to experience significant fire damage. There was minimal smoke damage to the fuselage.

Following an aircraft accident, fire and products of combustion can threaten the lives of aircraft and ARFF personnel. A crash can bring sources of fuel and ignition together to start a fire. Fires involving aviation fuels can quickly generate sufficient heat to burn through the skin of an aircraft. Such fires can enter the aircraft through open exits and impact-created openings. These same fires can impede the escape of passengers from the aircraft's interior.

Aircraft fires are inherently hazardous, and may include significant amounts of fuel and personnel. When combating an aircraft fire, ARFF personnel must always follow safety protocols. This chapter will provide information regarding:

- Fire suppression
- Ventilation
- Overhaul
- Evidence preservation

Fire Suppression

At an aircraft emergency, the potential for fire may exist, or fire may be present but not visible. ARFF personnel may encounter a situation where no fire is present, so they must take actions to prevent ignition. If a fire is present, ARFF personnel should use extinguishing agents to create a rescue path for occupant evacuation, as well as fully extinguish the fire **(Figure 9.1, p. 358)**.

Figure 9.1 Airport firefighters apply extinguishing agent during a live-fire training exercise.

ARFF personnel need to be trained in aircraft fire suppression techniques to include regular participation in live fire training exercises. All ARFF live fire training must meet the requirements of NFPA® 1403, *Standard on Live Fire Training Evolutions*.

NOTE: Local ARFF agencies need to meet the recurring proficiency training requirements set by the regulations or standards the agency is governed by. See **Appendix D** for additional information.

Aircraft Accidents without Fire Involvement

ARFF personnel may encounter situations where fuel has spilled from an aircraft but has not ignited. This is commonly referred to as a fuel spill. To prevent ignition, these fuel spills may be washed away from the aircraft and ignition sources, cleaned up, or covered with foam. Spark prevention efforts should be practiced to prevent igniting exposed fuels. Aircraft electrical systems must be de-energized to reduce the spark hazard. A firefighter should stand by with a charged handline during all cutting operations around fuel liquids and vapors to control any incipient fires.

To prevent an increase in the volume of fuel spilled, the fuel source should be secured. This may be accomplished by shutting down the fuel pump(s), closing the fuel valves, and plugging the leaking fuel line or tank. The steps for completing these tasks are listed in **Skill Sheet 9-1**.

Aircraft Accidents with Fire Involvement

An aircraft crash can release large quantities of fuel. The resulting fire can quickly surround the aircraft, impinge upon the aircraft's skin, and prevent occupant evacuation. Upon arrival, the Incident Commander (IC) has two basic attack methods to choose between **(Figure 9.2)**:

- Total extinguishment
- Maintain escape/evacuation areas

Fire Penetration into Aircraft Fuselage

Whenever a fire is present at a plane crash, ARFF personnel must remember that people remaining inside an aircraft have up to three minutes survival time when an exterior fire is impinging on the aircraft fuselage. As highlighted in NFPA® 402 and ICAO Part 1, this is due to the one minute or less burn-through time for the aluminum skin when directly exposed to fire. These facts should be taken into consideration when deciding whether to use a total extinguishment or maintain escape/evacuation areas.

In the total extinguishment method, all efforts are directed toward extinguishing all fires surrounding the aircraft. Total extinguishment can be resource intensive requiring large quantities of water and other fire fighting agents.

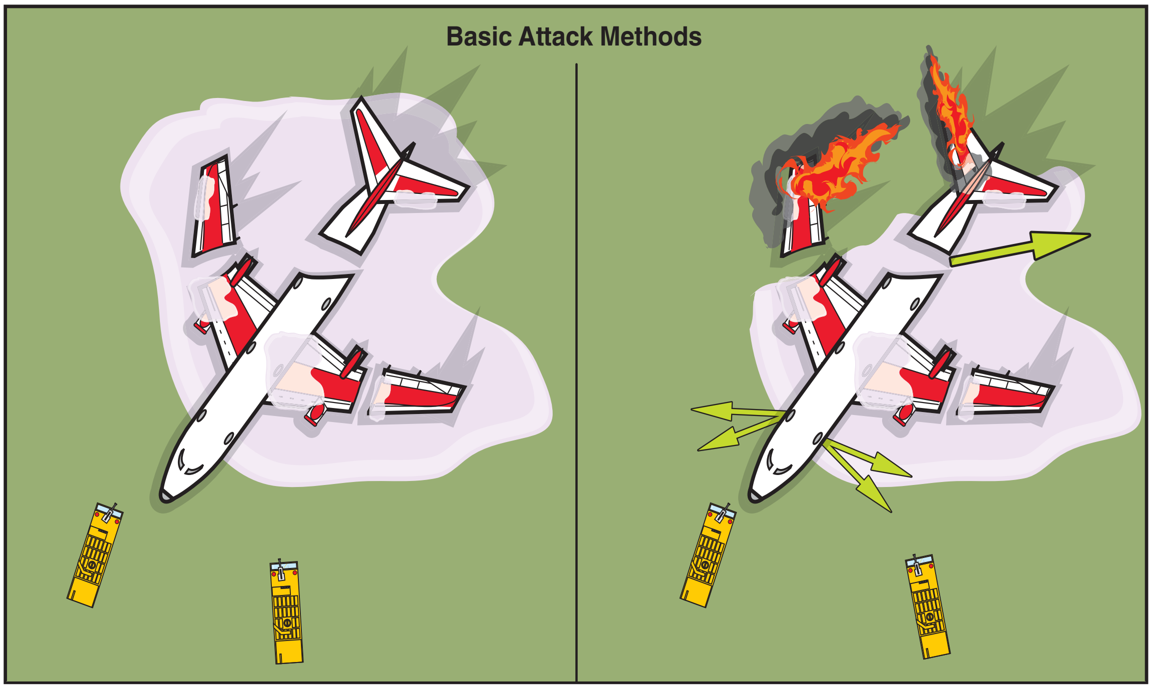


Figure 9.2 The two basic ARFF attack methods: Total Extinguishment and Maintain Escape/Evacuation Areas.

The maintain escape/evacuation areas method is a resource conserving alternative where only those fires in evacuation routes are extinguished. Based upon changing conditions, the IC may change from one method to the other.

For large aircraft fires, ARFF personnel should attempt fire suppression using an apparatus turret and foam. Using copious amounts of water and foam is effective on fires; however, turret operators should practice agent conservation techniques. This will prevent the apparatus from running out of agent(s) prior to total extinguishment.

For small aircraft fires, ARFF personnel can use foam handlines or dry chemical fire extinguishers to extinguish the fire. When selecting a fire extinguisher, ARFF personnel should select the proper extinguisher type and size.

ARFF personnel may use a foam blanket to extinguish or prevent a fuel spill fire. When doing so, firefighters must consider that foam can become contaminated and flammable. All foam breaks down differently based the type of foam and level of contamination. Splashing fuel during foam application may lead to the fuel reaching an ignitable fuel-air mixture. Firefighters should maintain the foam blanket by applying foam in a pattern that does not disrupt the existing blanket. Foam handlines are useful when performing this operation.

Following extinguishment of any aircraft or fuel spill fire, ARFF personnel should back away from the fire's location while keeping the nozzle pointed in the direction of the fire in the event of reignition. Firefighters should always maintain situational awareness and look for signs of reignition.

ARFF personnel may encounter incidents that involve fire warning indicators. During these incidents, the flight crew should stop the aircraft at an approved, remote runway location. With the aircraft in a controlled location, ARFF personnel can visually inspect the aircraft for signs of fire

Figure 9.3 An airport firefighter visually checking an aircraft compartment.

(Figure 9.3). Throughout this process, ARFF personnel should maintain constant communication with the flight crew to ensure all personnel are aware of the changing conditions.

NOTE: Thermal Imagers (TI), Forward Looking Infrared (FLIR), or simple heat guns can be useful in finding hidden fires during the inspection process.

WARNING!

While ARFF personnel inspect an aircraft following a fire warning indication, the aircraft may still have one engine running to provide electrical power to the aircraft systems. ARFF personnel must exercise caution when working around the air intakes of operating turbojet engines and the propellers of reciprocating and turboprop engines.

Attack Techniques

Whenever possible, ARFF apparatus should approach an aircraft fire from upwind, uphill, and upstream, if applicable. The wind will assist by improving fire stream reach and by blowing heat and smoke away from the fire fighting operation. An uphill, upwind, and/or upstream approach can prevent burning fuel from running down slope toward the ARFF apparatus **(Figure 9.4)**.

NOTE: Turret operators working on opposite sides of an aircraft must avoid pushing burning fuel under the aircraft to the other side.

Turret streams should be directed along the fuselage's length. This action will help:

- Push the fire away from the fuselage
- Cool the fuselage
- Protect evacuating occupants
- Aid rescue team entry

The first fire streams, using foam or a combination of foam and complementary agent, should be directed to those areas where evacuation is underway to protect those evacuating the aircraft. Three-dimensional or flowing fires can be extinguished with a combination of primary (foam) and complementary (dry chemical or clean) agents. Foam should be applied after the fire is extinguished to prevent reignition.

Foam handlines should be used for a direct interior attack if the fire has entered the fuselage. Complementary agents can be useful in reaching fires that foam cannot, such as using a clean agent to extinguish a fire inside a concealed electronics and electrical bay.

ARFF personnel should use foam or water spray to protect exposures. Caution should be taken to ensure water spray or runoff doesn't damage the foam blanket within the critical fire area. Fuel spills at an aircraft accident should

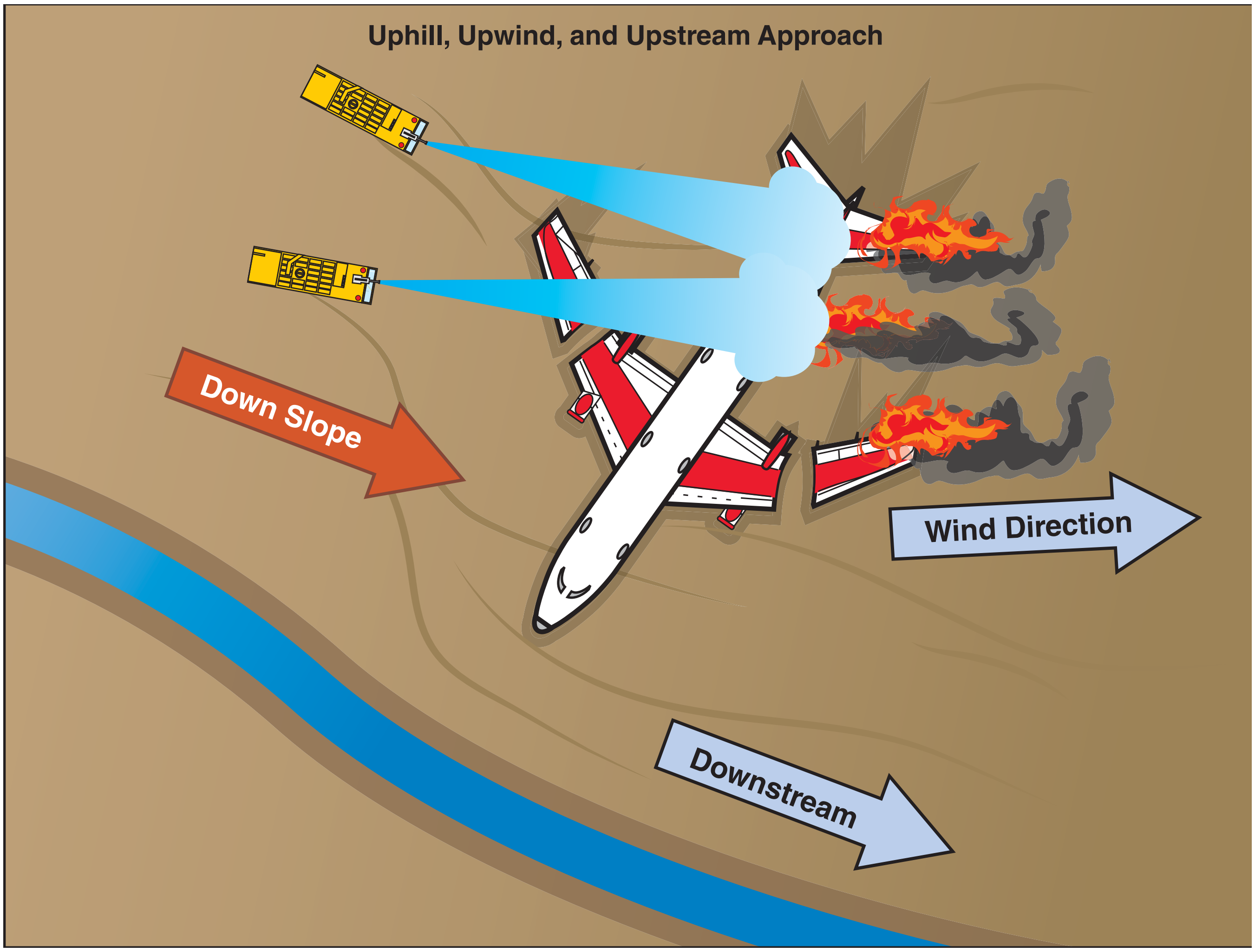


Figure 9.4 Illustrating an uphill, upwind, and upstream approach for ARFF apparatus to an aircraft accident.

be covered by a blanket of foam while every effort is made to eliminate ignition sources such as the aircraft electrical system components and hot engines. After extinguishing the fire, the aircraft fuselage and components must be cooled evenly.

Agent Application Methods

In aircraft rescue and fire fighting, there are four basic methods used when applying foam. The sections that follow describe the roll-on, deflection or bank-down, base-of-the-fire, and rain-down (rainfall) methods.

Roll-on method. The roll-on method directs the foam stream on the ground near the front edge of a burning liquid pool. The foam then rolls across the surface of the fuel. ARFF personnel continue to apply foam until it spreads across the entire surface of the fuel and the fire is extinguished **(Figure 9.5, p. 362)**. It may be necessary to move the stream to different positions along the edge of a liquid spill to cover the entire pool. This method is used only on a pool of liquid fuel (either ignited or unignited) on the ground or pavement.

Figure 9.5 Airport firefighters practicing the roll-on method of foam application.

Deflection or bank-down method. The deflection or bank-down method may be employed when an elevated object is near or within the area of a burning pool of liquid or an unignited liquid spill **(Figure 9.6)**. These objects may include the following:

- Fuselage
- Wall
- Tank shell
- Wing
- Engine

ARFF personnel direct the foam stream at the object, allowing the foam to run down or deflect onto the surface of the fuel. As with the roll-on method, it may be necessary to direct the stream off various points around the fuel area to achieve total coverage and extinguishment of the fuel.

Base-of-the-fire method. AFFF can be applied with the use of a zero-degree, base-of-the-fire agent delivery angle to maximize agent effectiveness and minimize extinguishment time **(Figure 9.7)**. The foam stream is usually applied through a High Flow Bumper Turret or Low Attack Nozzle with high flow capability; however, a handline can also be effective in delivering foam using the base-of-the fire method.

CAUTION

Take care not to agitate standing or pooled fuel and potentially increase the fire magnitude or affected area.

Figure 9.6 Applying foam using the deflection or bank-down method.

Figure 9.7 Airport firefighters applying foam using the base-of-the-fire method.

Rain-down (Rainfall) method. The rain-down (rainfall) method directs the stream into the air at a 40 degree angle above the fire or spill and allows the foam to float gently down onto the surface of the fuel **(Figure 9.8)**. This method extends the reach of the foam stream during initial approach and application.

The rain-down method is the primary manual application technique used on aboveground storage tank fires. On large fires, it is effective for ARFF personnel to direct the stream at one location to allow the foam to take effect there and flow over the fuel from that point. On small fires, firefighters sweep the stream back and forth over the entire surface of the fuel until the fuel is completely covered and the fire is extinguished.

NOTE: Firefighters must consider the effect of wind when using this method.

CAUTION

Avoid plunging the foam stream down into the fuel.

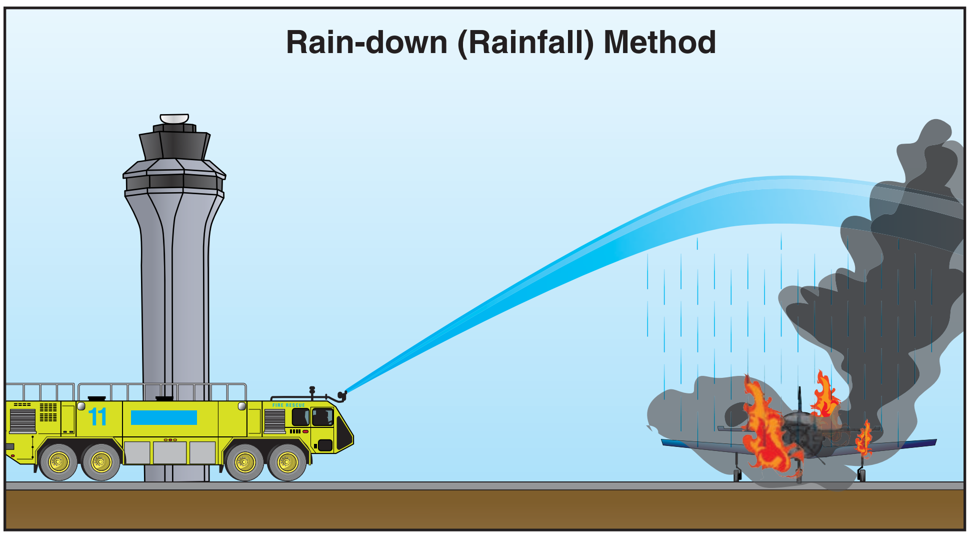


Figure 9.8 Applying foam using the rain-down (rainfall) method.

Turret Operations

ARFF apparatus turrets provide a means to apply large quantities of foam and other agents from a distance, during approach, and setup and while the apparatus is in motion. When a turret's discharge can no longer effectively reach a fire, ARFF personnel should move the apparatus to provide a better angle of attack or they should deploy handlines. Turret discharges should be utilized to push fuels and fire away from the aircraft and provide an escape route for aircraft occupants.

When operating turrets, ARFF personnel should use the wind to their advantage whenever possible. A tailwind can help extend the effective range of a turret stream. Crosswinds and straight-on winds will reduce the effective range of a turret discharge by disrupting the stream and breaking up its pattern **(Figure 9.9)**.

ARFF personnel should operate the turret or turrets as the apparatus approaches the aircraft fire. Normally, the pump will be engaged with the turret swung into position and set on straight stream. **Skill Sheet 9-2** lists the steps for extinguishing a fuel spill fire using an ARFF vehicle turret.

NOTE: ARFF turret operators must carefully monitor onboard water and foam supplies during fire fighting operations to avoid running out of agent.

Handline Operations

With the main body of the fire extinguished, ARFF personnel should deploy handlines **(Figure 9.10)**. Handlines can be effective on small fuel spill, aircraft wreckage, and interior fires. The steps for using a foam handline to extinguish a fuel spill fire are listed in **Skill Sheet 9-3**. These handlines should be positioned at strategic locations to:

- Continue fire control
- Maintain the foam blanket
- Keep the rescue path open
- Extinguish any spot fires
- Conserve agent by limiting agent flow
- Protect ARFF personnel

CAUTION

When operating handlines, ARFF personnel should avoid walking through fuel spills. If this is unavoidable, personnel must avoid breaking the foam blanket and agitating the fuel.

Water Application

Many procedures for applying water in aircraft fire fighting have been explored. ARFF personnel have been most successful when they have used fog and spray streams. The smaller the water particles become, the more heat the stream

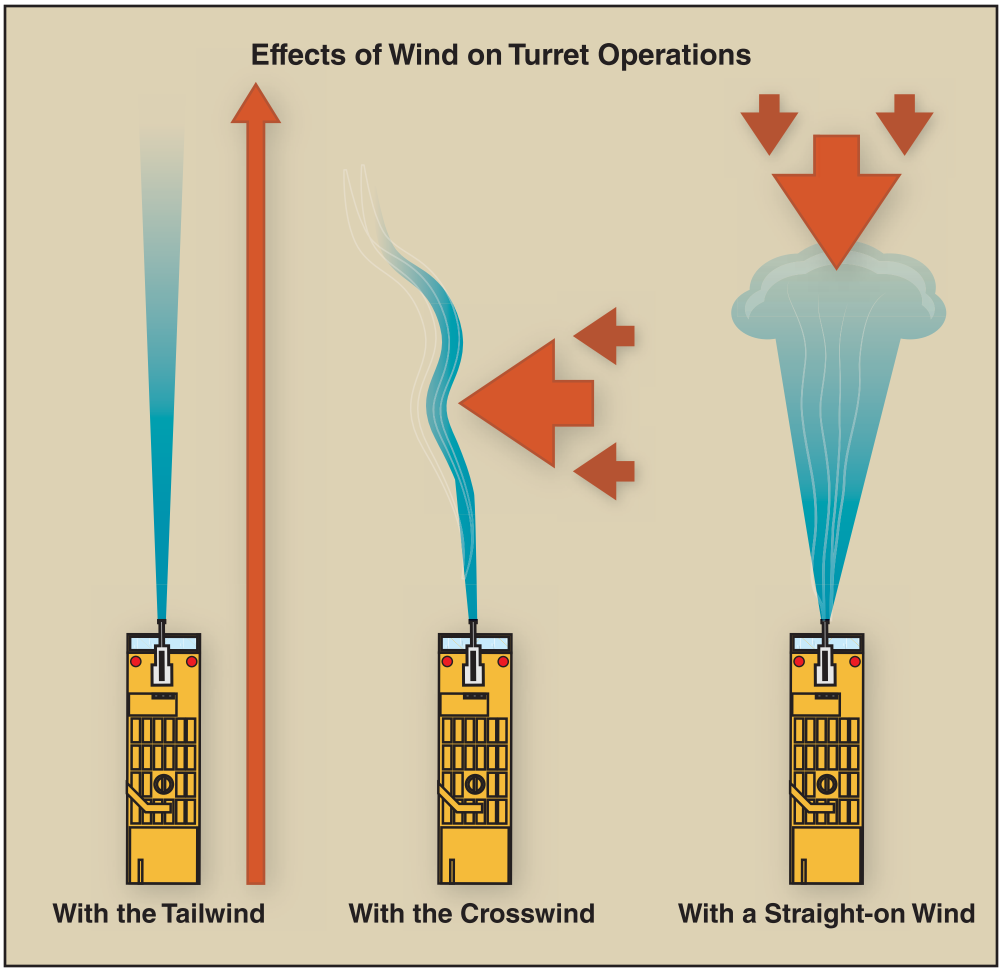


Figure 9.9 The effects of the wind on turret streams.

Figure 9.10 Airport firefighters deploying a handline from an ARFF apparatus.

absorbs. However, the more finely divided the stream becomes, the more it is subject to the effects of wind and thermal column updrafts; as a result, it may be more difficult to reach the seat of the fire.

When using water to combat a fuel spill fire, firefighters should use a minimum 1½-inch (38 mm) handline and apply the water in a fog pattern. Firefighters should avoid using straight streams because they tend to churn and splash the fuel, causing the flammable liquids to spread the fire to other exposures.

NOTE: While structural fire fighting apparatus usually does not carry as much water as ARFF vehicles, its water supply may last long enough for ARFF personnel to effect rescue if the water is judiciously applied.

A straight stream may be the best nozzle pattern to use in well-involved, unventilated aircraft interior fires. Compared to a fog stream, a straight stream will not upset the thermal layering as much, will generate less steam, and will have better reach to knock down the main body of a fire. Recent fire behavior studies have shown that short applications (approximately 30 seconds) of a straight stream applied in a side-to-side motion into the super-heated products of combustion overhead can inhibit flashover conditions **(Figure 9.11)**.

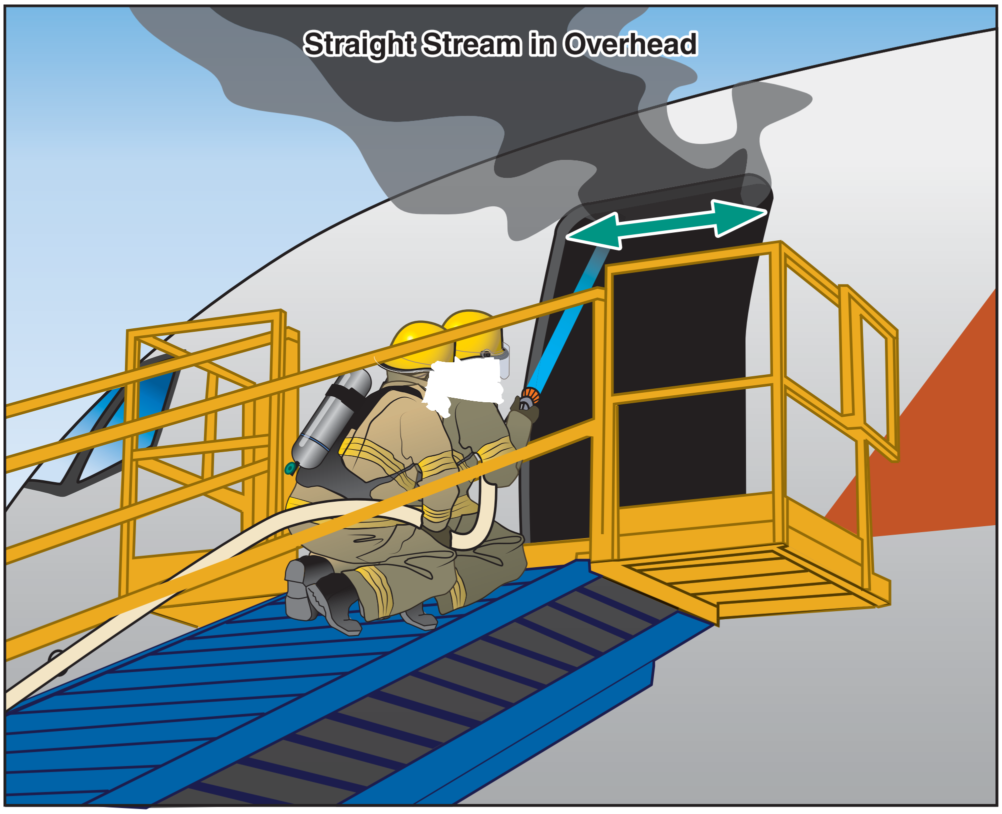


Figure 9.11 Application of a straight stream into the heated overhead of the aircraft interior is beneficial.

Foam Application Techniques

Airport firefighters may be required to operate a foam turret, handline, or master stream on a fire or spill. It is important to use the correct techniques when manually applying foam. Using incorrect techniques, such as plunging the foam into a liquid fuel, reduces the effectiveness of the foam.

CAUTION

Avoid plunging the foam stream down into the fuel.

Correct application of any extinguishing agent can be as important as the type of agent selected. Approach at the site and application of foam should begin at the farthest reach of a turret at large exterior fires. The principle of "insulate and isolate" explains the general tactics. The initial foam application should insulate the fuselage and protect the integrity of the aircraft skin. Insulating the fuselage will assist in protecting the occupants who may be self-evacuating. The next consideration should be to try to separate (isolate) the fire from the fuselage. While these techniques may have to be modified for any given circumstance or situation, the general principle remains.

Foams can be applied using a variety of nozzles to include water spray, air aspirating, and turrets. These agents can be applied with straight streams or variable patterns depending upon the distance to the fire and wind conditions.

A **nonaspirating foam nozzle** can give a turret greater reach, helping to control and extinguish a fire faster. AFFF or FFFP discharged from a non-aspirating nozzle expands less and drains faster, generating a less stable foam blanket with a lower burn back resistance.

Nonaspirating Foam Nozzle — Nozzle that does not draw air into the foam solution stream. The foam solution is agitated by the nozzle design, causing air to mix with the solution after it has exited the nozzle.

When applying foam, the objective is to create a foam blanket that suppresses the flammable vapors given off by the fuel. Foam is not permanent and must be re-applied when necessary until the fuel vapor hazard has been mitigated. Straight streams must be used carefully to avoid disturbing the existing foam blanket or churning up the underlying fuel. Straight streams may be deflected off available surfaces to avoid disturbing the existing foam blanket. After the main body of the fire has been extinguished, turrets can be shut down and kept in standby mode in the event of a rekindle.

Foam can be applied by handlines using the same methods used when applying foam with a turret. ARFF personnel must exercise caution while operating handlines to avoid disturbing the foam blanket with the handline streams or with their boots if they must walk into it.

Apparatus Placement and Repositioning

Tactically, driver/operators should also consider the correct placement and repositioning of apparatus. It is vitally important to know the effective reach of the turret. Application should begin at the effective reach of the turret. Achieving the accurate distance may be difficult for the driver to judge, having only a limited "one-dimensional" view of the accident. The application may be overshooting, landing short, or not effectively controlling the fire.

To determine whether an apparatus is properly positioned, the turret operator should use the "short burst" application technique, described in the following steps:

Apparatus Placement and Repositioning (cont.)

- Apply foam for five to ten seconds.
- Momentarily stop and assess fire conditions.
- If the application is missing the fire:
  — Change the stream pattern.
  — Reposition the apparatus.
- If the fire has been successfully controlled:
  — Shut down turret.
  — Move the apparatus to attack another area of fire **(Figure 9.12)**.

If available, an officer or other apparatus, placed at a 45-degree angle can view the effectiveness of the turret's reach. At this point, instructions can be given to the driver regarding positioning for turret effectiveness.

Drivers should also reposition apparatus as necessary to apply the agent to the correct areas. ARFF apparatus are built with pump and roll capability specifically for this purpose. When repositioning apparatus, a ground guide should be utilized to watch for aircraft debris, luggage, and/or aircraft occupants who may have been thrown from the aircraft.

Care should also be taken to conserve agent. Turret operators should periodically shut down and evaluate the efficient and effective application of extinguishing agent. ARFF personnel should also remember to use a low flow rate application to conserve agent whenever possible.

Figure 9.12 An ARFF apparatus pumping and rolling as it discharges agent.

Once the foam concentrate and water have been mixed together to form a foam solution, the foam solution must be mixed with air (aerated) and delivered to the surface of the fuel. With low-energy foam systems, the aeration and discharge of the foam are accomplished by a fog nozzle or a foam nozzle, sometimes referred to as a foam maker. Low-expansion foams may be discharged through either handline nozzles or master stream devices. While standard fire fighting nozzles can be used for applying some types of low-expansion foams, it is best to use nozzles that produce the desired result (such as fast-draining or slow-draining foam). This section highlights portable foam application devices.

NOTE: Foam nozzle eductors and self-educting master stream foam nozzles are considered portable foam nozzles, but they are omitted from this section because they are covered in Chapter 7, Extinguishing Agents.

Figure 9.13 Examples of roof and bumper turret nozzles.

Turret nozzles. Turret nozzles are large, pre-plumbed master stream appliances connected directly to a pump that is mounted on a pumper, a trailer, or airport rescue and fire fighting apparatus. They are capable of sweeping from side to side and designed to deliver large volumes of foam or water **(Figure 9.13)**. Turrets may be either aspirating, nonaspirating, or a combination of the two, any of which can be used with great success. As with any other type of nozzle, better reach and penetration are achieved with nonaspirating turrets, whereas aspirating types produce better-quality foam. Because either type of turret can perform satisfactorily, the type of turret selected is simply a question of preference and local need. Some ARFF apparatus are equipped with turret nozzles that can discharge both primary (water/foam) and complementary (dry chemical or clean agent) agents.

Figure 9.14 An airport firefighter using an automatic fog nozzle.

Handline nozzles. IFSTA defines a handline nozzle as "any nozzle that one to three firefighters can safely handle and that flows less than 350 gpm (1 400 L/min)." Most handline foam nozzles flow considerably less than that figure. The two most common types of handline nozzles used by ARFF firefighters are standard fog nozzles and air-aspirating foam nozzles.

Either fixed-flow or automatic fog nozzles can be used with foam solution to produce a low-expansion, short-lasting foam. It is often referred to as non-aspirated foam. This nozzle breaks the foam solution into tiny droplets and uses the agitation of water droplets moving through air to achieve its foaming action **(Figure 9.14)**. Its best application is when it is used with regular AFFF, AR-AFFF, or FFFP. Some nozzle manufacturers have foam aeration attachments that can be added to the end of the nozzle to increase aspiration of the foam solution.

Venturi Effect — Physical law stating that when a fluid, such as water or air, is forced under pressure through a restricted orifice, there is an increase in the velocity of the fluid passing through the orifice and a corresponding decrease in the pressure exerted against the sides of the constriction. Because the surrounding fluid is under greater pressure (atmospheric), it is forced into the area of lower pressure.

Aspirating versus nonaspirating nozzles. Air aspirating nozzles can be effective in applying fluoroprotein foam over large areas using straight or dispersed patterns. Air-aspirating nozzles provide foam that restricts reigntion and burnback. These nozzles inductair into the foam solution by the **Venturi Effect** and provide maximum expansion of agent. Aspirating nozzles are designed to produce quality foam with good properties such as:

- Bubble size
- Uniformity
- Stability
- Water retention
- Heat resistance

The foam is agitated inside the foam nozzle, which causes a loss of energy and velocity, therefore the reach of the stream from air-aspirating foam nozzles is considerably less than that of a standard fog nozzle. However, these nozzles are the most effective appliance for generating low-expansion foam. An expansion ratio of 6:1 to 10:1 is commonly associated with low-expansion air-aspirating equipment.

Nonaspirating nozzles offer some practical advantages over aspirating nozzles. These nozzles provide benefits such as the following:

- Greater foam stream reach
- Ability to cover large areas with conventional variable stream nozzles
- Generates a wide fog pattern that can be used for personnel protection

In some instances, extinguishing the fire may be quicker with nonaspirating nozzles than with conventional low-expansion devices. There are less air bubbles in the foam, so it is denser than aerated foams. This allows the foam to better penetrate the fire's thermal updraft or chimney effect, as well as produce the aqueous film faster. The foam produced is largely a function of the following:

- Foam solution properties
- Nozzle design
- Selected nozzle setting
- Droplet size
- Impact of the stream on the fuel surface

Nonaspirating devices have some disadvantages, which are often realized only after laboratory and field testing. They do not mechanically draw in the air leaving them with a low-expansion ratio of 2:1 or 3:1. This low-expansion ratio limits the foam's ability to seal a fire surface after the fire is out and reduces the foam's effectiveness against reignition and burnback.

Firefighters will determine which type of nozzle to use based on the nozzle's compatibility with the varieties of foam. The application of protein or fluoroprotein foams requires air-aspirating nozzles. Only film-forming foams are suitable for nonaspirating application. AFFF is compatible with either type of nozzle.

NOTE: Attachments are available for some non-aspirating nozzles to quickly change them into the aspirating type.

Dry Chemical Agent Application

ARFF personnel use dry chemical agents to suppress aircraft-related fires. The sections that follow address applying dry chemical agents using fire extinguishers and apparatus mounted units.

CAUTION

Dry chemical can be a minor respiratory irritant; therefore, ARFF personnel should always wear SCBA when applying them. Do not aim dry chemical agents directly at escaping passengers.

Extinguishers

Dry chemical extinguishers come in two basic designs: stored-pressure and cartridge-operated. Stored-pressure extinguishers contain a constant pressure of about 200 psi (1 400 kPa) in the agent storage tank. Cartridge-operated extinguishers employ a pressure cartridge connected to the agent tank. The agent tank is not pressurized until a plunger is pushed to release the gas from the cartridge.

Both extinguisher designs use either nitrogen or carbon dioxide as the pressurizing gas. Cartridge-operated extinguishers usually use a carbon dioxide cartridge unless the extinguisher is going to be subjected to freezing temperatures; in such cases, a dry nitrogen cartridge is used.

Larger dry chemical extinguishers at airports are typically wheeled units **(Figure 9.15)**. These extinguishers are either stored-pressure as described above, or contain a pressurizing gas which is stored in a cylinder. Firefighters apply the dry chemical agent from wheeled units in the same way as handheld extinguishers. Operational considerations for wheeled units are similar to handheld extinguishers with the following additions:

- Stretch the hose out completely prior to charging the line.
  - — A charged hose can be difficult to remove.
  - — Dry chemical powder can pack in sharp hose bends.
- Allow a few seconds to fully pressurize tank from external gas supply before opening nozzle.

Figure 9.15 An example of a wheeled dry chemical extinguisher on an airport ramp.

CAUTION

Point the top of the extinguisher away from the firefighter or other personnel when pressurizing the unit. Because of the size of the nozzle, the firefighter should be prepared for a significant nozzle reaction when it is opened and may need assistance.

Wet Chemical Fire Extinguishing System — Extinguishing system that uses a wet chemical solution as the primary extinguishing agent; usually installed in range hoods and associated ducting where grease may accumulate.

Apparatus Mounted Units

Some ARFF apparatus are equipped with dry chemical or **wet chemical fire extinguishing systems**. These could be skid-mounted units for pick-up trucks or built into larger ARFF apparatus. These systems are usually composed of the following:

- Dry chemical storage tank
- Tank containing a pressurizing gas to expel the dry chemical from its storage tank
- Valves and piping to route agent to a discharge
- Sufficient hose and a nozzle for discharging the agent

Dry chemical is dispensed in three different ways. The most common method of application is to dispense using a handline stored at some position on the vehicle. Other popular ways include piggybacking and water stream injection. On piggyback systems, the manufacturer has mounted an independent dry chemical nozzle directly over the water/foam nozzle on the roof or bumper turret. Water stream injection systems work by injecting the dry chemical directly into the water/foam stream of the main turret. This allows the dry chemical to stay inside the water stream of the turret, greatly extending the effectiveness of the agent.

A dry chemical handline is required to have at least 100 feet (30 m) of hose. It must flow at least 5 lb/sec (2.5 kg/s) and have a range of at least 25 feet (7.5 m). These handlines must have a minimum burst pressure rating of three times the system working pressure. Dry chemical turrets should discharge at 16-22 lb/sec (8-11 kg/s) with a no wind range of at least 100 feet (30 m). The discharge rate for dry chemicals on an extendable turret is 12-22 lb/sec (6-11 kg/s) with at least a 100 foot (30 m) range.

Firefighters often use dry chemical on three-dimensional fires on aircraft engine nacelles or for running fuel fires **(Figure 9.16)**. This makes water stream injection effective by applying the dry chemical to fight the fire and also by supplying the water/foam solution to stop the spill fires associated with three-dimensional fires.

NOTE: Operators should blow down the entire dry chemical system after each use to ensure removal of all residual agent.

Figure 9.16 Airport firefighters applying dry chemical to a three-dimensional fire during a training exercise.

Clean Agent Application

Firefighters should use clean agents, such as halons and Halotron, in short bursts followed by observation of the agent's effect on the fire. ARFF personnel should make use of the wind to increase the range of clean agent discharge. While clean agents have great penetration capability, the agent cloud may impede visibility during fire fighting and rescue operations.

Dual Agent Attack

A dual agent attack involves the use of a primary agent (foam) with a complementary agent (dry chemical or clean agent). It is vital that the two agents be compatible with each other and that ARFF personnel apply the agents in a coordinated manner to achieve maximum effectiveness. Properly executed dual agent attacks are effective for fighting three-dimensional fires.

Three-Dimensional Fuel Fire Fighting

A three-dimensional fuel fire involves fuel flowing, spraying, or pouring from an aircraft creating a pool upon the ground or tarmac. Three-dimensional fires are difficult to extinguish because of the continuing nature of the fuel flow. A dual agent attack that addresses both the burning fuel from the aircraft and the burning fuel puddle is a must. Foam should be applied to blanket the pool fire blocking flammable vapors from burning. The complementary agent cloud should encapsulate the burning fuel coming from the aircraft to reach extinguishment. After the fire is extinguished, ARFF personnel should close fuel system valves or plug fuel lines or tanks to stop the leak and continue to monitor situation for reignition. **Skill Sheet 9-4** lists the steps for extinguishing a three-dimensional fuel fire with handline(s).

Aircraft Interior Fire Attack

ARFF personnel should utilize handlines to conduct interior fire attack operations. Prior to entering the aircraft interior, ARFF personnel should attempt to determine the location of any fire. Clues to interior fire locations may include:

- Reports from flight crew and/or passengers
- Flames visible through aircraft windows
- Smoke behavior indicating the location of a fire
- Buckled aircraft skin or blistered paint
- Use of TI, FLIR, or heat guns

Foam or water spray may be used to extinguish interior fires. ARFF personnel may need to remove debris or interior panels to access the seat of the fire. Water fog/foam is effective for extinguishing upholstery, cargo, or other combustible materials. The steps for extinguishing an interior fire are listed in **Skill Sheet 9-5**. If the interior fire cannot be extinguished immediately, ARFF personnel may need to use foam or water spray to cool and protect external exposures.

CAUTION

Interior fire fighting operations should not interfere with the evacuation of aircraft occupants.

Baggage and cargo areas should be checked for fire. Fire in these areas can weaken the floor supports for the passenger compartment above, leading to a collapse which endangers the lives of aircraft occupants and ARFF personnel. Baggage and cargo may need to be pulled apart to expose any hidden fire. Water or foam may be used to extinguish fires in the baggage and cargo areas.

Engine and APU/EPU Fire Suppression

In the event of an engine or auxiliary power unit/emergency power unit (APU/EPU) fire, the flight crew may make the first attempt to extinguish the fire by using onboard extinguishing systems. At other incidents, fire personnel may deal with an aircraft that is unoccupied; therefore, airport firefighters must be familiar with aircraft shutdown procedures and the location of external shutdown devices.

When dealing with an engine or APU/EPU fire, directing a stream of water or AFFF into the air inlet will not always extinguish the fire. Although some of the agent will go into the core of the engine or APU/EPU, the fire very likely involves the accessory section around the outside core of the engine.

Clean, gaseous extinguishing agents are the agents of choice when fighting engine or APU/EPU fires. Foam may be used if a clean agent is not available. The use of clean agents and foam may allow for an engine to be repaired and reused at a later date. Dry chemical may be used at the discretion of the local ARFF department but may result in engine damage.

The preferred method of extinguishment is to operate the engine or APU/EPU fire shutdown system from the flight deck/cockpit or, where provided, from an external fire protection panel **(Figure 9.17)**. Large-frame aircraft usually have easily identifiable engine and APU/EPU fire shutoff handles in the cockpit. Many also have external APU/EPU fire protection panels in the forward wheel well, in the main wheel wells, on the belly, or in the tail. In addition to arming the extinguishing agent bottles, these systems simultaneously deactivate the power plant's fuel, hydraulic, electrical, and pneumatic connections.

NOTE: The variety of locations for engine and APU/EPU shutdown controls emphasizes the need for ongoing aircraft familiarization training.

If unable to access or use the aircraft's fire protection system, or if it fails to extinguish the fire, responders may be tasked with opening the engine cowlings or APU/EPU access panel doors in an effort to fully extinguish the fire. Airport firefighters need to be trained to identify the correct panel or panels

Figure 9.17 APU/EPU shutdown procedures can be accomplished from the flight deck/cockpit or an external fire protection panel. *External image courtesy of Doddy Photography.*

to open and have the proper tools to do so. Because of the potential of residual fuel to pool in the area of an engine or APU/EPU during an emergency, the engine or APU/EPU cowling should be opened from the lowest point to highest point. Due to the location and configuration of these access panels, firefighters must exercise extreme caution when performing this task. Hot and burning fluids or engine parts may be trapped inside these areas. These could fall onto firefighters when the panels are opened.

If firefighters are unable to safely access the internal components, personnel may want to consider using a piercing tool to apply extinguishing agent prior to opening. If a piercing tool is not available, an opening may be created using an available forcible entry tool. The engine should be deactivated and the fuel, electrical, hydraulic, and pneumatic supply removed before using any of the engine fire control techniques discussed in this section.

The key to piercing an engine housing is to know where to penetrate and access the accessory compartment. Piercing the wrong location may miss the compartment and hit another engine component immediately behind the housing. Some aircraft are equipped with fire extinguishing access ports or knock-in panels, which can be used to apply agent directly to the engine.

Other means of applying extinguishing agent may include the use of access panel doors around the engine or APU/EPU. Doors used to check oil levels or hydraulic levels may also be utilized to gain access into the inner section of the engine.

A tail pipe fire occurs when too much fuel is injected into the engine during start-up, causing fuel and fuel vapor to be emitted through the engine. High temperatures in the tail pipe assembly cause the fuel and fuel vapor to ignite. Usually, pilots will shut off the fuel and spool-up or rev the engine. This action will blow out the excess burning fuel from the back of the engine, at which time restart procedures can be conducted. Often, the fire department is not called unless the pilot is unsuccessful in extinguishing the fire. On occasion, burning fuel may drip out onto the ground from the tail pipe.

An uncontained engine failure or disintegration occurs when fan or compressor blades in the engine separate or the turbine section disintegrates. When this happens, fragments may tear through the engine cowling and can penetrate other areas of the aircraft. A similar problem can occur with propeller-driven aircraft when a propeller blade separates. The resulting imbalance can cause disintegration of the engine and loss of control of the aircraft. If the engine shrapnel stays inside the engine housing or cowling, it is a contained engine failure or disintegration.

The worst-case scenario involves fragments of engine components piercing the fuselage and/or wing structure, causing injuries to occupants, puncturing fuel tanks, severing fuel and hydraulic lines, starting an interior fire, or damaging the flight-control system. Due to the location and configuration of fuel tanks and lines, this type of incident may result in a three-dimensional flowing fuel fire. This may make it necessary for the flight crew to immediately evacuate the aircraft. Firefighters may be forced to make an aggressive interior fire attack in order to support evacuation procedures. Unless the integrity of the passenger compartment has been compromised, an uncontained engine failure can be handled like a normal engine fire. **Skill Sheet 9-6** lists the steps in extinguishing an engine or APU/EPU fire.

Figure 9.18 Airport firefighters attacking a simulated wheel assembly fire.

Wheel Assembly Fire Suppression

If the wheel assembly is on fire, the safest approach is to use large amounts of water from a distance using turrets. This application keeps the firefighters out of the hazard zone and allows for extinguishment and rapid cooling. Once the fire is out, cooling efforts should be maintained to minimize damage to other components. Handlines can also be used in place of turrets as long as firefighters approach from a 45-degree angle fore or aft of the wheel assembly as described in Chapter 4, Safety and Aircraft Hazards **(Figure 9.18)**. If water is not available, any available agent should be used to extinguish a wheel assembly fire. **Skill Sheet 9-7** lists the steps in extinguishing a wheel assembly fire with a handline.

NOTE: If magnesium or titanium is suspected, applying large amounts of water from a distance is an effective initial extinguishing technique, however, if the fire is not extinguished, appropriate Class D extinguishing techniques should be deployed.

Wheel assembly construction materials have evolved. Older generation wheel assemblies contained small amounts of magnesium or titanium in their construction. These metals cause hazardous issues for emergency operations. Fortunately, these metals are rarely found in today's commercial and military aircraft. New generation wheel assembly materials are lighter weight, more resistive to natural elements, and pose less of a hazard. Examples of these materials include the following:

- Cerametalic
- Carbon
- Aluminum alloy

NOTE: Fire departments should consider the wheel assembly materials when developing local SOP/Gs.

Wheel assemblies may overheat due to hydraulic failures involving an aircraft's flight control systems. When this failure takes place, pilots may have to stop the aircraft using more brake power than normal.

Fires around the hydraulic fittings near the wheel are possible if the landing gear hydraulic system contains petroleum-based fluids. Firefighters should immediately control these fires utilizing appropriate extinguishing agent(s). Failing to control the fire could allow conducted heat to impinge on the fuselage, allowing the fire to spread to the aircraft interior.

NOTE: When ignited, Skydrol® (aviation hydraulic fluid), thermally decomposes at high temperatures and produces toxic vapors.

CAUTION

Wear full protective clothing and SCBA regardless of the suspected hazard during a fire involving wheel assemblies.

Exposure Protection

During aircraft fire fighting operations, airport firefighters must prevent the spread of fire to uninvolved, exposed properties such as other aircraft and structures. The best approach to protecting exposures is to extinguish the aircraft fire as quickly and effectively as possible, limiting its spread to other properties. Exposure protection must be prioritized based on the conditions found at the emergency scene, particularly when resources are limited. If time and resources allow, exposed aircraft may be towed from the danger area.

Caution must be taken during fire fighting operations to avoid pushing any burning fuel toward uninvolved exposures. Additional personnel and equipment may be needed to provide exposure protection by applying cooling streams of water spray on the exposures. ARFF personnel must also prevent fire, fuels, and other contaminants from entering underground facilities, waterways, drains, and sewers.

Rocket Engine Fires

Some aircraft are equipped with auxiliary rocket engines to provide additional thrust during takeoff. These rockets may be mounted in nacelles, the aircraft's tail cone, or the aircraft's belly or sides. Fires in areas around these rockets should be approached with caution. Do not attempt to extinguish the rockets themselves if ignited. Water spray or foam should be used to control fires around the rocket motors.

If an aircraft equipped with rockets crashes and the rockets have not ignited, qualified personnel should remove the igniters and ignition cables as soon as possible. ARFF personnel should perform safety standby operations during such work.

Military aircraft may carry rocket-equipped missiles. For safety purposes, ARFF apparatus should be positioned at a 45-degree angle to the longitudinal axis of the rocket/missile at the front and rear as described in Chapter 4, Safety and Aircraft Hazards. The same extinguishing guidelines for rocket engine fires apply to rocket-equipped missiles.

Runway Foaming Operations

While runway foaming operations seldom occur in North America, runway foaming is still practiced in some other countries. Runway foaming with protein foam was once thought to be useful in emergency landings involving aircraft with wheels-up or defective landing gear problems. The idea was to mitigate aircraft damage and reduce the risk of fire following impact.

Runway foaming effectiveness has not been fully substantiated by the evidence gathered. In some runway foaming operations, the aircraft either under-shot or over-shot the foam blanket. In incidents where runways were not foamed, the aircraft involved received only moderate damage and no major fires occurred. Runway foaming operations may be provided by the local airport authority and training on the operations should be considered to be locality training. ICAO Part 1 describes the procedures for conducting runway foaming operations.

Ventilation

Proper ventilation, coordinated with an interior attack, should be part of a planned and coordinated operation. Removing the heat and toxic gases through ventilation will increase the likelihood of victim survivability. Personnel should establish ventilation as soon as ventilating is deemed safe.

Initial ventilation may be accomplished by opening as many doors and hatches as possible. Side windows may be able to be knocked in. Firefighters should take advantage of the positive pressure ventilation provided by opening doors, hatches, and windows on the side of the aircraft with the prevailing wind **(Figure 9.19)**. Hydraulic ventilation may be possible by discharging a fog stream out of an opening in the aircraft.

In some cases, vertical ventilation openings can be made in the top of the aircraft. Airport firefighters should perform this operation while working from an aerial platform, and should never stand on top of the aircraft itself. A rescue, rotary, or cutoff saw with a 16-inch (400 mm) cutting blade will be needed to cut all the way through most commercial aircraft hulls. Any cuts should be cooled with water spray or foam during the cutting operation in order to lubricate the cut and prevent molten aluminum from fouling the cutting edge of the blade. ARFF personnel should avoid opening up roof areas that slope toward the nose or tail as these areas are highly reinforced and may not access the main cabin area.

ARFF personnel should read the rivet lines to locate suitable ventilation locations. Heavily riveted areas should be avoided. If the interior ceiling and luggage bins are intact, vertical openings in the top of the aircraft will only

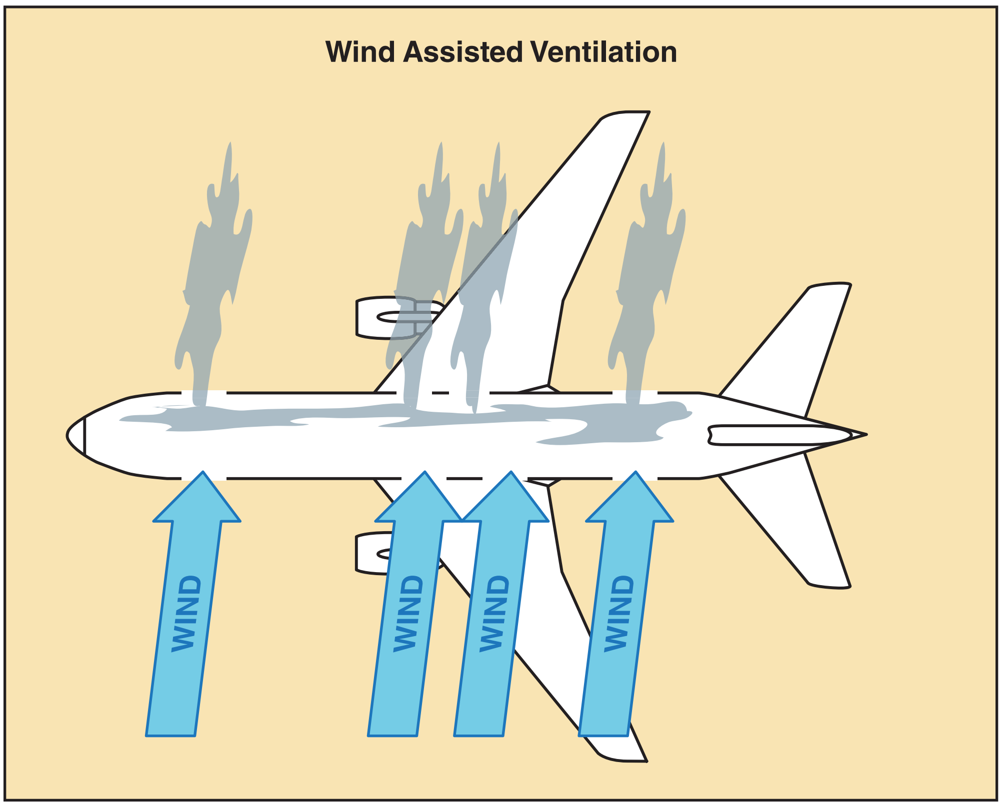


Figure 9.19 The wind can assist with ventilating smoke and other products of combustion from an aircraft fuselage.

ventilate the overhead access area, which in large body aircraft may contain a crew rest area.

NOTE: Portable lighting can be used to light the interior of the aircraft during ventilation operations.

WARNING!

Never discharge hoseline or turret streams into a hole, either burned or cut into the top of an aircraft. This will interrupt the vertical ventilation process and push the fire and products of combustion horizontally through the aircraft.

Overhaul

After every aircraft incident/accident, a thorough overhaul inspection must be conducted, whether fire was apparent or not. As always, the on-scene investigating authority should be consulted before overhaul operations begin.

During overhaul, ARFF personnel must make sure that all fire is completely extinguished. This phase of aircraft interior fire fighting is one of the most difficult and is also one of the most hazardous. Because toxic gases and fumes are concentrated and other hazards may be present, firefighter safety is a major concern. To protect themselves, ARFF personnel shall wear SCBA until the atmosphere in which they are working has been checked with the appropriate gas and particulate detectors and declared safe. In addition, a charged handline must be kept close at hand **(Figure 9.20)**.

Figure 9.20 ARFF personnel should continue to wear their personal protective clothing and SCBA during overhaul operations.

ARFF personnel should exercise extreme caution when performing overhaul operations on the interior of an aircraft. Aircraft are configured in ways that provide void spaces that may contain hidden fires. Firefighters may need to remove the following to access deep-seated, concealed fires:

- Carpeting
- Wall panels
- Partitions
- Ceiling coverings

NOTE: Personnel should watch out for any fire that has extended into the void space over the ceiling panels. These fires can extend and come down behind personnel.

Care should be taken to preserve as much of the interior in its original configuration as is reasonably possible. This process will assist in determining the origin and cause of the fire and will facilitate the investigation. If ARFF personnel must remove wall panels or disturb other items, they should make descriptive notes or take photographs to indicate the original position of the items. If the incident involved a fire somewhere on the aircraft, determining the cause is extremely important. Before overhaul is conducted, the point of origin needs to be identified and protected during overhaul operations.

Firefighters may have to open some parts of the wreckage for complete extinguishment. Whenever the skin of the aircraft is penetrated, however, ARFF personnel should consider the potential hazards of cutting into high-pressure hydraulic lines, compressed gas cylinders, pneumatic lines, and unexploded ordnance on military aircraft. All hot spots should be cooled until extinguishment is complete and reignition no longer occurs.

Salvage and Property Conservation

Salvage and property conservation operations involve those actions that recover and protect items such as mail and passenger luggage. Cautious application of fire fighting agents by ARFF personnel during extinguishment and overhaul operations can limit property damage.

Evidence Preservation

Bloodborne Pathogens — Pathogenic microorganisms that are present in the human blood and can cause disease in humans. These pathogens include (but are not limited to) hepatitis B virus (HBV) and human immunodeficiency virus (HIV).

During overhaul, personnel should avoid disturbing any evidence that may aid investigators in determining the cause of the accident or the extent of damage while ensuring personal protection against **bloodborne pathogens**. Overhaul personnel should move only those parts of the aircraft that are essential to complete fire extinguishment. If the aircraft or its parts and controls must be moved because they present a direct hazard to human life, every effort must be made to preserve physical evidence and record the original condition and location of whatever was moved.

ARFF personnel should be familiar with their fire department's SOPs/SOGs that cover this area of operations. The FAA furnishes general guidance for preservation of evidence in Advisory Circular 150/5200-12, *Fire Department Responsibility in Protecting Evidence at the Scene of an Aircraft Accident*. Also, the National Transportation Safety Board (NTSB) provides general guidelines for handling civil aircraft accidents with which ARFF personnel should be familiar.

Only authorized personnel should remove bodies that remain in wreckage after a fire has been extinguished. Prematurely removing bodies may interfere with identifying them and may destroy evidence required by the medical examiner, coroner, or other investigating authority. If it is absolutely necessary to remove a body prior to the arrival of the medical authority, ARFF personnel should tag each body with a number or secure a stake to note where the body was found. They should note on the tag the location from which the body was removed and also record that information on a drawing of the aircraft accident site in their incident report. This information will be critically important in the accident investigation.

Chapter Summary

During an aircraft accident, ARFF personnel must be prepared to prevent flammable liquids and combustibles from igniting and suppress fires that have already started. Fire suppression requires ARFF personnel to use the extinguishing agents and systems on their apparatus in a trained and coordinated fashion. Ventilation can aid in the rescue of passengers and crew. Removing the products of combustion from the aircraft interior can increase the survivability factors for those inside the aircraft and improve visibility for firefighters. Overhaul is critical for ensuring that all fires are extinguished thus preventing the re-ignition of flammable and combustible materials. Throughout fire suppression, ventilation, and overhaul operations, ARFF personnel must preserve evidence found at the accident.

Review Questions

1. Identify the two basic attack methods for an aircraft accident with fire involvement. *(p. 358)*
2. What technique can ARFF personnel utilize to locate suitable ventilation locations? *(p. 378)*
3. During overhaul operations, what materials may need to be removed to access concealed fires? *(p. 379)*
4. Why should overhaul personnel move only parts of the aircraft that are essential to completing fire extinguishment? *(p. 380)*

Shut Down Fuel Pumps

Step 1: Gain access to fuel pump controls.

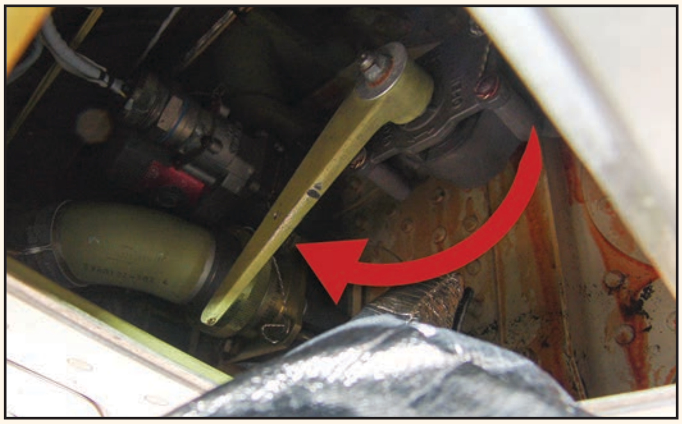
Step 2: Deactivate fuel pump.

Step 3: De-energize fuel pump controls.

Close Fuel Valves

Step 1: Identify leaking fuel line.

Step 2: Gain access to fuel valve for that line.



Step 3: Close fuel valve.

Plug Leaking Fuel Line or Hole in Tank

Step 1: Identify leaking fuel line fuel or hole in tank.

Step 2: Identify appropriate size/type of plug or appropriate plugging material.

Step 3: Insert plug/plugging material into fuel line or hole in tank until leak stops.

Step 1: Deploy the turret as the ARFF apparatus approaches fire.

Step 2: Activate the agent pump(s) as required.

Step 3: Aim the agent stream above fire.

Step 4: Begin discharging agent when the apparatus is within turret range.

Step 5: Operate the turret at appropriate pressure and flow using prescribed techniques until fire is extinguished.

a. Adjust the turret pattern as necessary for distance and fire/fuel conditions.

b. Interrupt the agent discharge as needed to determine fire/fuel conditions.

NOTE: Practice agent conservation.

Step 6: Stop discharging when the fire is extinguished.

SKILL SHEETS

9-3
Deploy and operate an ARFF vehicle handline to extinguish a fuel spill fire.

Step 1: Access the handline.

a. Unlock the hose reel, if necessary.
b. Remove security netting/open hoseline compartment.

Step 2: Pull the handline .

a. Fully deploy the handline.
b. Properly position the handline to avoid kinking or knotting.

Step 3: Charge the handline.

Step 4: Open the nozzle to bleed air from the handline.

CAUTION: Open the nozzle slowly to reduce nozzle reaction.

Step 5: Test hose stream pattern.

Step 6: Close the nozzle.

CAUTION: Close the nozzle slowly to reduce water hammer.

Step 7: Advance the handline toward the fire maneuvering around obstacles, as needed.

Step 8: Approach the fire

Step 9: Operate the nozzle at appropriate pressure and flow using prescribed techniques until fire is extinguished.

NOTE: Practice agent conservation.

Step 10: Back away, maintain situational awareness.

9-4
Extinguish a three-dimensional fuel fire with handline(s).

Step 1: Deploy and charge the handline(s).

Step 2: Approach the fire.

Step 3: Operate the nozzle(s) using primary and secondary agents at appropriate pressure and flow using prescribed techniques until fire is extinguished.

NOTE: Practice agent conservation.

Step 4: Secure fuel source.

Step 5: Back away, maintain situational awareness.

Direct Method

Step 1: Gain access to aircraft interior.

Step 2: Advance the handline toward fire maneuvering around obstacles, as needed.

Note: Both firefighters should be on the same side of the handline.

Step 3: Ensure proper nozzle pattern for fire/fuel conditions prior to opening the nozzle.

Step 4: Open the nozzle slowly to avoid nozzle reaction.

Step 5: Aim the agent stream at the base of the fire.

Step 6: Sweep the agent stream from side-to-side extending beyond the edge of the fire to each side.

Step 7: Adjust the nozzle pattern as needed based upon fire/fuel conditions.

NOTE: Practice agent conservation.

Step 8: Maneuver the handline and nozzle as necessary.

Step 9: Stop discharging when the fire is extinguished or the fuel surface has been covered with a foam layer.

Step 10: Shut off the nozzle slowly to reduce water hammer.

Step 11: Ventilate the fuselage to remove heat and other products of combustion.

Step 12: Back away from the fire. Always maintain situational awareness of area for signs of reignition.

Indirect Method

Step 1: Gain access to aircraft interior.

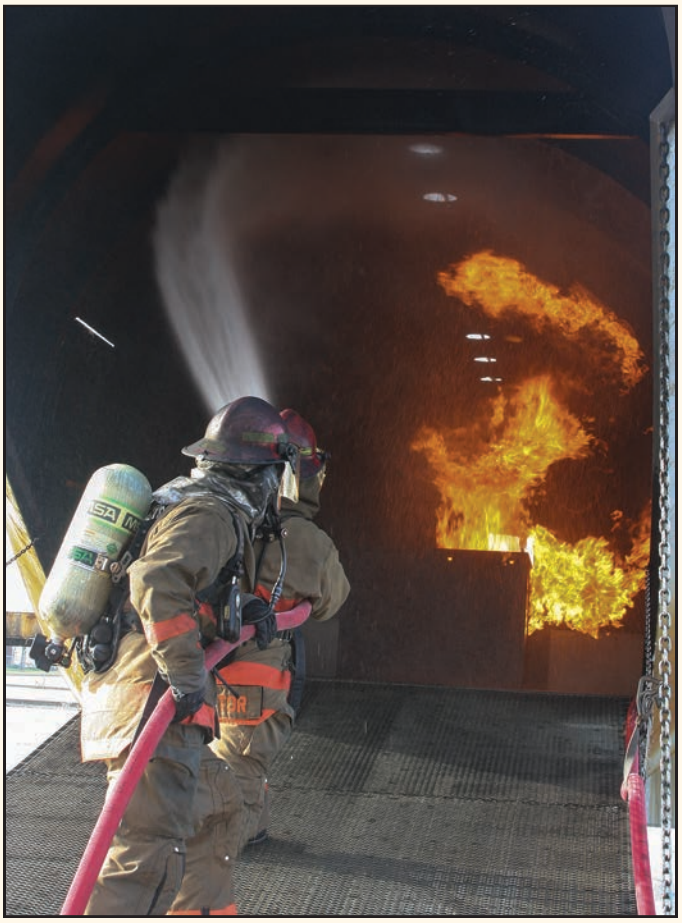
Step 2: Advance the handline toward fire maneuvering around obstacles, as needed.

NOTE: Both firefighters should be on the same side of the handline.

Step 3: Ensure proper nozzle pattern for fire/fuel conditions prior to opening the nozzle.

Step 4: Open the nozzle slowly to avoid water hammer.

Step 5: Aim the agent stream above the fire or deflect it off of aircraft surfaces.



Step 6: Sweep the agent stream from side-to-side extending beyond the edge of the fire to each side.

Step 7: Adjust nozzle pattern as needed based upon fire/fuel conditions.

NOTE: Practice agent conservation.

Step 8: Maneuver the handline and nozzle as necessary.

Step 9: Stop discharging when the fire is extinguished or the fuel surface has been covered with a foam layer.

Step 10: Shut off the nozzle slowly to reduce nozzle reaction (water hammer).

Step 11: Ventilate the fuselage to remove heat and other products of combustion.

Step 12: Back away from the fire. Always maintain situational awareness of area for signs of reignition.

Combination Method

Step 1: Gain access to aircraft interior.

Step 2: Advance the handline toward fire maneuvering around obstacles, as needed.

NOTE: Both firefighters should be on the same side of the handline.

Step 3: Ensure proper nozzle pattern for fire/fuel conditions prior to opening the nozzle.

Step 4: Open the nozzle slowly to avoid nozzle reaction.

Step 5: Open the dry chemical nozzle, if so equipped.

Step 6: Aim the agent stream(s) at the base of the fire.

Step 7: Sweep the agent stream(s) across the fuel's surface to one side.

Step 8: Then raise and aim the agent stream(s) above the fire or deflect it off of surfaces while sweeping to the other side of the fire.

Step 9: Sweep the agent stream(s) back across the base of the fire then back above.

a. Repeat as necessary.

b. Adjust nozzle pattern as needed based upon fire/fuel conditions.

NOTE: Practice agent conservation.

Step 10: Maneuver handline and nozzle as necessary.

Step 11: Stop discharging when the fire is extinguished or the fuel surface has been covered with a foam layer.

Step 12: Close the nozzle(s) slowly to reduce water hammer.

Step 13: Ventilate the fuselage to remove heat and other products of combustion.

Step 14: Back away from the fire. Always maintain situational awareness of area for signs of reignition.

NOTE: Some aircraft APU panels may take special tools such as wrenches to access. Be familiar with aircraft in your jurisdiction.

Step 1: Approach aircraft. Size up fire conditions.

Step 2: Activate external controls to deploy on-board extinguishing systems (if applicable).

NOTE: Ensure on-board extinguishing has been deployed by activating the external controls or by confirming deployment by communication with the flight crew, if possible.

Step 3: Identify correct access panel location.

Step 4: Open access panel, using a pike pole or other tool.

WARNING: Do not stand directly under hatch. Burning fuel may drop causing injury or death.

Step 5: Apply agent at appropriate pressure and flow using prescribed techniques.

NOTE: Practice agent conservation.

Step 6: Stop discharging when the fire is extinguished.

Step 7: If extinguishing with a handline, back away from the fire.

Step 8: Maintain situational awareness of area for signs of reignition.

NOTE: When dealing with military aircraft, responders should assume hypergolic fuels may be involved, which will necessitate a hazardous materials response.

9-7
Extinguish a wheel assembly fire with a handline.

CAUTION: High temperature may cause fusible plugs to blow, creating a fragmentation hazard.

Step 1: Deploy and charge the handline.

NOTE: Practice agent conservation.

Step 2: Approach the wheel assembly from a 45-degree angle.

Step 3: Operate the nozzle using water at appropriate pressure and flow using prescribed techniques until fire is extinguished.

NOTE: If magnesium or titanium is suspected, large amounts of water from a distance is an effective initial extinguishing technique. However, if the fire is not extinguished, appropriate Class D extinguishing techniques should be deployed.

Step 4: Back away, maintain situational awareness.