FIRE INVESTIGATION REPORT

Aircraft Cabin Fire
Atlanta, Georgia
June 8, 1995

Prepared by
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National Fire Protection Association
ABSTRACT

At approximately 7:10 p.m. on Thursday, June 8, 1995, a mechanical failure in an engine caused a fire aboard a DC-9 passenger jet at Atlanta’s Hartsfield International Airport. The failure occurred after the aircraft had begun its take off acceleration. The aircraft was able to stop on the runway, and all 57 passengers and five crew members escaped while flames spread through the aircraft’s cabin. Five passengers, two air crew members, and two fire fighters were injured. One of the air crew members sustained serious injuries.

Airport fire fighters responded with ten vehicles. Upon arrival, fire fighters found most passengers outside the aircraft and the last few escaping. One fire fighter used the roof turret on his vehicle to suppress the fire in the engine on the left side of the fuselage. However, turrets could not be used initially against the fire spreading inside the passenger cabin because the aircraft’s fuselage was still intact. In order to mount an attack against the fire inside the cabin, fire fighters advanced hose lines up to the aircraft, but severe heat prevented them from entering the cabin.

Several minutes after the fire fighters arrival, the fire burned a hole through the fuselage skin at the forward end of the passenger cabin. Fire fighters using roof-mounted and boom-mounted turrets discharged foam into this opening and extinguished most of the flames inside the aircraft. After the interior fire was knocked down, fire fighters advanced hose lines into the passenger cabin to extinguish remaining hot spots.

The survival of passengers and crew, in this incident, was directly related to their ability to react and to the egress provisions that were available to them. Before the arrival of fire fighters, passengers faced an immediate and severe threat from the rapidly spreading fire in the cabin. Using the door and over-wing exits, all were able to escape.

This incident highlights one of the most severe challenges facing airport fire-fighting personnel: i.e., a rapidly spreading cabin fire. The fire threatened passengers and crew aboard the aircraft despite the fire fighters quick and unimpeded response with numerous aircraft rescue and fire-fighting (ARFF) and structural vehicles. Moreover, the fire fighters attempts to extinguish the fire using both interior and exterior fire attacks were thwarted by the magnitude of the fire inside the cabin and by the obstruction afforded by the aircraft’s fuselage.
I. Introduction

The National Fire Protection Association (NFPA) Fire Investigation Department, with the cooperation of the Atlanta Fire Department, documented this fire as part of NFPA's on-going program to study technically significant fires. It was not NFPA's intention that the investigation and resulting report pass judgment on, or fix liability for, injuries and the loss of property. Rather, the NFPA intends that its report present the findings of the NFPA data collection and analysis efforts and highlight factors that can reduce losses during aircraft accidents.

The National Transportation Safety Board (NTSB) has the authority and responsibility to investigate and report on the probable cause of aircraft accidents and to make recommendations to prevent reoccurrence. As a result, the NFPA did not focus on this aspect of the aircraft accident during its 2-day on site investigation. Instead, the NFPA investigation studied fireground operations, preincident planning, performance of ARFF vehicles and equipment, and many other issues that are addressed by NFPA codes and standards. The NTSB provided the NFPA with information regarding fire cause and origin, fire development, and crew and passenger actions.

NFPA's Fire Investigation Department thanks the Atlanta International Airport Fire Department and the National Transportation Safety Board for their cooperation and assistance that made this report possible.
II. Background

The Aircraft

The aircraft involved in this fire was a 26-year-old McDonnell Douglas DC-9 series aircraft. It had been operated by another major air carrier based in the United States until February 1994 when it was bought by the air carrier that owned and operated it at the time of the fire. This aircraft had two engines mounted to the rear fuselage — one engine on each side. The engine mounted to the left side of the aircraft was the Number 1 engine, and the one mounted to the right side was the Number 2 engine. In March of 1995, the aircraft underwent a routine airframe inspection, and its Number 2 engine was replaced by a 24-year-old engine that had been owned, operated, maintained, and repaired by a foreign air carrier.

The aircraft was configured with 108 passenger seats. However, only 57 passengers (38 male and 19 female) were on board the aircraft at the time of the accident. Three of these passengers were children whose ages were 9 years, 8 years, and 24 months. None of the passengers were known to be mentally or physically challenged. The passengers were seated throughout the aircraft cabin.

In addition to the passengers, there were five crew members aboard the aircraft. During take off, the captain and first officer were in the cockpit, two flight attendants (Flight Attendants 1 and 2) were seated in the forward cabin, and a third flight attendant (Flight Attendant 3) was seated in the aft.

Seven exits were available to the passengers and crew. The exits included two forward doors (one on each side of the aircraft, L-1 & R-1), four over-wing exits.
(L-2, L-3, R-2, & R-3), and a tail cone emergency exit. The two forward doors were equipped with automatic inflating slides. These slides could also be manually inflated if necessary.

The weight and balance record for this flight listed the aircraft as having 24,100 pounds (10,931 kg) of Jet A fuel before take off. This is equivalent to approximately 3550 gallons (13,438 L). In addition to this fuel, the passenger cabin contained many combustible materials such as carry on luggage, wire insulation, and interior finish materials. According to a Federal Aviation Administration representative, fire blocking materials had been installed in the aircraft’s seats.

The National Transportation Safety Board (NTSB) selected samples of the aircraft’s carpet, side wall panels and seat covers and performed fire tests on those materials. Due to the age of the aircraft, the NTSB had the samples tested in accordance with the Federal Aviation Administration (FAA) standard that was in effect before 1985. In 1985, the FAA passed a regulation requiring interior finish materials used in all new aircraft and aircraft receiving a “general retrofit” of their cabin interior meet new and more rigorous fire test criteria. The (pre-1985) FAA standard required that samples be exposed to a bunsen burner flame with a minimum temperature of 1500°F (815°C) for 60 seconds. All of the interior finish samples passed that test.

The Fire Department

The Atlanta Hartfield International Airport Fire Department is a division of the City of Atlanta Fire Department. The airport fire department has four fire stations, eight major aircraft rescue and fire fighting (ARFF) vehicles, and three structural pumpers. A general description of the airport’s eight ARFF vehicles and three structural pumpers has been provided in the table on the next page.

The airport division has 142 suppression and 10 administrative personnel. The suppression personnel were divided into three shifts with 45 personnel assigned to A-shift and B-shift and 52 personnel assigned to C-shift. The suppression personnel worked a schedule of 24 hours on-duty and 48 hours off-duty. All ARFF personnel had been assigned to a structural station at some time before being assigned to the airport division.

The primary water supply for all the major ARFF vehicles was the water that each carried. This capability was complimented by the airport municipal water distribution system. This system had 5,000,000 gallons (18,926,720 L) of stored water and had 20-inch (508-mm) mains carrying the water. The water distribution system had fire hydrants regularly spaced through out the airport property. Seven of these hydrants were close to the accident scene. (See Figure 2, for the location of the hydrants.) The fire department had a standard operating procedure (SOP) which stated that ARFF vehicles were to reservice at the closest hydrant. The SOP also stated that the incident commander could order responding engine companies to lay supply lines if the water demand required that type of water supply.

<table>
<thead>
<tr>
<th>Vehicle Number</th>
<th>Model /Year</th>
<th>Vehicle Type</th>
<th>Staffing</th>
<th>Water 2 Gal (L)</th>
<th>AFFF Foam Gal (L)</th>
<th>Turrets gpm (L/min)</th>
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<tbody>
<tr>
<td>Y-1</td>
<td>M4000/1979</td>
<td>Oshkosh</td>
<td>3</td>
<td>4000 (15,140)</td>
<td>515 (1950)</td>
<td>1: 1800 (6813) 2: 900 (3406) 3: 300 (1135)</td>
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<td>Oshkosh</td>
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<td>4000</td>
<td>515</td>
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<td>2: 900 (3406) 3: 300 (1135)</td>
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<td>4000 (15,140)</td>
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<td>Spartan</td>
<td>4</td>
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<td>200 (756)</td>
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<td>1000 (3785)</td>
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<tr>
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<td>K-15/1994</td>
<td>Colet</td>
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<td>1500 (5678)</td>
<td>100 (378)</td>
<td>1: 800 (3028) 2: 400 (1514) 3: 300 (1135)</td>
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<td>Spartan</td>
<td>4</td>
<td>1500 (5678)</td>
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<td>N/A</td>
</tr>
<tr>
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<td>Ford</td>
<td>3</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
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<td>F-350/1989</td>
<td>Ford</td>
<td>2</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

2 The quantities in this column reflect vehicle capability and not the quantity used by the vehicle during the actual fire-suppression operation.

3 1 equals the primary (roof) turret high-flow rate; 2 equals the primary turret low flow rate; 3 equals the secondary (bumper) turret flow rate.
**Airport Emergency Program**

Airport administrators developed written plans for managing events such as in-flight emergencies aboard aircraft intending to land at their airport, aircraft accidents and incidents (on and off airport), bomb threats, sabotage, pilferage/theft, and structural fires. These plans were approved by the Federal Aviation Administration in 1988 and established the roles and responsibilities for the various on-airport organizations including the fire department, airport operations and security. The administrators also developed plans for coordinating activities with the county’s emergency management organization, off-airport law enforcement agencies, and hospitals. In addition, the airport fire department established mutual-aid agreements with fire departments in neighboring communities and established policies for the combined use of fire-suppression resources.

**Weather Conditions**

The incident occurred approximately 1 1/2 hours after sunset. At that time, the skies had scattered clouds, the ceiling was 5500 feet (1676 m) and visibility was 12 miles (19.3 km). Ambient temperature was 93°F (34°C), and the winds were from the west (290 degrees) at 9 mph (14.5 km/h).
III. THE FIRE

Crew and Passenger Response

On the evening of June 8, 1995, Flight 597 was leaving Atlanta’s Hartsfield International Airport with a destination of Miami International Airport. Shortly before 7:08 p.m., the aircraft was cleared for take-off on Runway 27R. The crew taxied to that runway and began the take-off roll. When the aircraft reached a speed of approximately 30 knots (34.5 mph/55.5 km/h), the flight crew heard a loud thump and felt a surge in cabin pressure. At the same time the fire warning light and alarm bell operated. The captain immediately closed the throttles and applied the brakes. When the aircraft came to a stop, the captain set the brakes, completed the engine failure checklist items, discharged the Halon 1301 fire-extinguishing system for the Number 2 engine, and made an announcement for passengers to evacuate through the forward part of the cabin.

The first officer began performing his emergency functions at the same time as the captain. These functions included verifying that brakes were set, setting control surfaces into emergency positions, and discharging the Halon 1301 fire-extinguishing system for the Number 1 engine. Before the first officer could complete the rest of his emergency functions, “plastic-smelling” smoke that was accumulating in the cockpit began to burn his eyes. The smoke became so thick and suffocating that the first officer was forced to leave his seat. When he reached the door to the main cabin, the first officer could not see due to the thick smoke, but, as he stood near the cockpit door, he could feel people passing by him. He could also hear the flight attendants shouting evacuation instructions to passengers. The first officer waited until he could no longer feel people passing him and evacuated through the main cabin door (L-1 door).

When the first officer stood up to leave, the captain could only see him from the chest down. As soon as he could, the captain also left the cockpit. Instead of standing up, the captain got down to floor level where the air was much clearer. Smoke was within three to four inches (76 mm to 102 mm) off the floor, and he could see a glow at the rear of the passenger cabin. When the captain was satisfied that no one remained in the aircraft, he left through the L-1 door and was followed by the flight attendant who had been assisting passengers out the same door.

Flight Attendant 1 was seated at the front of the cabin and was closest to the L-1 door. She heard a bang, and Flight Attendant 2, who had a clear view of the aircraft cabin, immediately turned to Flight Attendant 1 and said there was a fire. When Flight Attendant 1 looked down the aisle, she saw that passengers were already getting out of their seats and the cabin was filling with smoke. From her position, it appeared that the passengers were opening the over-the-wing exits even though the aircraft was still moving. She felt conditions further back in the cabin had to be bad at that time. She opened the cockpit door so they could inform the captain. After telling the captain she attempted to open the L-1 door, but the door did not
immediately open all the way. Flight Attendant 1 believed that a problem with the slide pack or the girt bar may have prevented the door from opening freely. A passenger came to her position and helped her open the door. Once the door was open, she inflated the slide and began instructing passengers who were evacuating. This flight attendant also stated that she believed the emergency path lights in the cabin floor did not operate. Smoke quickly reached their position in the cabin making breathing difficult. This smoke eventually forced the flight attendant to leave the aircraft.

Flight Attendant 2, seated in the forward part of the aircraft, had a clear view of the cabin during takeoff. When she heard what she described as a loud bang, she looked to the rear of the cabin and saw flashes, smoke, and flames at the feet of the flight attendant sitting in the seat at the rear of the cabin. After telling Flight Attendant 1 that there was a fire, both flight attendants got out of their seats. Flight Attendant 2 also reported the fire to the captain after Flight Attendant 1 opened the cockpit door. When the aircraft came to a stop, Flight Attendant 2 opened the R-1 door and secured it against the fuselage. The slide did not automatically inflate so she had to manually inflate the slide. Before the slide was inflated, smoke was filling the cabin at her position and she could not see anyone from the waist up. Flight Attendant 2 yelled instructions at passengers to keep them moving out of the aircraft. At one time, she had to get partially out of the door to get fresh air and then came back in to continue instructing passengers. Shortly after this, the smoke became so hot that she thought the fire had reached her position and she left the aircraft.

Flight Attendant 3 was seated at the rear of the passenger cabin. She heard an explosion-like noise and realized that she was in the middle of the fire. She also recalled getting herself out of the seat and moving forward in the aircraft. She saw one or two men in front of her as she headed toward the over-wing exits. After leaving the aircraft through one of the left-side over-wing exits, the flight attendant jumped off the forward edge of the wing, and two people assisted her to a safe area.

All 62 people aboard the aircraft evacuated before fire fighters began their fire-suppression operations. NTSB reported that passengers used the following means for escape:

<table>
<thead>
<tr>
<th>Door/Exit</th>
<th>Passengers</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-1, boarding door</td>
<td>12</td>
</tr>
<tr>
<td>R-1, service door</td>
<td>9</td>
</tr>
<tr>
<td>L-2, window exit</td>
<td>2</td>
</tr>
<tr>
<td>R-2, window exit</td>
<td>6</td>
</tr>
<tr>
<td>L-3, window exit</td>
<td>7</td>
</tr>
<tr>
<td>R-3, window exit</td>
<td>6</td>
</tr>
<tr>
<td>Tail cone exit</td>
<td>0</td>
</tr>
<tr>
<td>Unknown exit point</td>
<td>15</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>57</strong></td>
</tr>
</tbody>
</table>

Once outside the aircraft, at least one crew member went to the aid of Flight Attendant 3 who had sustained burn injuries. The other members of the flight crew attempted to account for the passengers on the aircraft. After feeling confident that

* A girt bar is a device that initiates the automatic inflation of an egress slide. The girt bar is connected to the slide mounted in the cabin floor. Flight attendants will secure it to the cabin door when the door is closed before takeoff. During emergencies the cabin door will be opened with the girt bar still attached and this action should inflate the slide.
all passengers and crew members had escaped, the captain told the incident commander that everyone was off the aircraft.

**Fire Department Response**

At approximately 7:08 p.m. the air traffic control tower notified the fire department, airport operations, security, and other agencies of the aircraft fire on Runway 27R. The fire department responded with all eight ARFF vehicles and the three structural pumpers to the aircraft which was at a location approximately 1/4 mile (0.4 km) from the main fire station.

Approximately one minute after leaving the fire station, Battalion Chief 7 arrived on scene first. He established a command post on Taxiway M, a taxiway that was parallel with the right side of the aircraft. The battalion chief directed all fireground operations from this position. The pilot of the aircraft went to the Battalion Chief and reported that all passengers and crew were off the aircraft.

Upon leaving the station, the crew of Yellow 11, a major aircraft rescue and fire fighting (ARFF) vehicle, saw smoke in the air and knew that they had an actual fire. Using an access road between Fire Station 35 and the aircraft’s location, this unit arrived at approximately 7:10 p.m., just under a minute after leaving the station. As they approached the plane from the right rear they saw flames coming from the forward part of the Number 2 engine. This appeared to be the only fire area at that time. In addition, they saw the over-wing exits on the right side of the aircraft were open, the R-1 door was open with its slide deployed, and many people (apparently passengers) standing outside the aircraft. They drove to a position that was proper with respect to the prevailing winds, and, at approximately 7:11 p.m., began discharging Aqueous Film Forming Foam (AFFF) onto the engine fire. *(See Figure 3, next page.*) They depleted their water supply while extinguishing the fire involving the Number 2 engine.

Yellow 6, a structural pumper equipped with a nozzle mounted on the end of a boom and preconnected 1 3/4-inch (44 mm) handlines, approached from the right (north) side of the aircraft and arrived shortly after Yellow 11. Since the aircraft’s right engine was on fire, Yellow 6 positioned on the left side of the aircraft. As they prepared to make entry into the aircraft, the last few people aboard the aircraft came down the slide at the L-1 door. Not knowing that all passengers and crew were off the aircraft, the fire fighters advanced two handlines to the aircraft with the intention of controlling the cabin fire and rescuing anyone still on the aircraft.

Yellow 12, another major ARFF vehicle, arrived almost immediately after Yellow 11. Yellow 12 approached the nose on the left (north) side of the aircraft and saw a large number of people outside the aircraft and standing in a grassy area. As they drove closer to the aircraft they observed a few “stragglers” still leaving the area, and they could see fire starting to come out of the L-1 door. Recognizing that their turrets would be ineffective against this fire, they did not use their turrets. Instead,
one fire fighter left the vehicle and went to assist the crew from Yellow 6. Similarly, a fire fighter from Yellow 3 (a third major ARFF vehicle that arrived) also assisted the Yellow 6 crew.

After the fire fighters placed a ladder against the aircraft, one handline was brought to the L-1 door. By the time the fire fighter attempted to enter the aircraft through this door, the fire had become so severe that it prevented him from going more than a couple of feet into the cabin even though the fire fighter was discharging agent from his handline. Other fire fighters placed a ladder on the leading edge of the left wing and brought a second handline over the wing to the open emergency window exits. But, before the fire fighter could discharge with this handline, the hose broke injuring the leg of a fire fighter who was helping to move that handline. The broken section was removed, the handline was reassembled, and it was advanced a second time to the over-wing exits. Similar to the fire fighters’ attack at the L-1 door, the fire attack through the over-wing exits was not effective.

Approximately two to three minutes after the fire fighters arrived on the scene, the fire burned through a section of the fuselage’s roof in an area just behind the forward doors. At this point all of the handlines were withdrawn, and four ARFF vehicles (Yellow 2, 3, 10, & 12) discharged their turrets into the hole. Since the hole was on the top of the fuselage, the roof-mounted and bumper turrets could not effectively place agent into the passenger cabin. Following this attack, Yellow 13, a major ARFF vehicle with an extendible primary turret, was positioned so that its turret was above the hole in the fuselage and discharged directly into the aircraft’s cabin. This successfully knocked down the fire. Then, Yellow 6 crew members
and other fire fighters entered the aircraft with two handlines from Yellow 1 and suppressed small fires that the vehicle-mounted turrets could not reach.

The fire was considered “under control” at approximately 7:21 p.m., 11 minutes after the arrival of Yellow 11. Fire extinguishment was declared approximately three minutes later (7:24 p.m.). However, fire apparatus remained on standby for another 5 1/2 hours. During the standby, Yellow 11 used its extendible primary turret to reach inside the passenger cabin and flood it with agent one last time before the aircraft was towed to a hanger. This agent application was a precaution intended to cool any hot spots that could potentially reignite while the aircraft was being towed.

Y-11 was the only major ARFF vehicle that depleted its entire water supply before the fire was extinguished. As each crew approached the end of their respective water supply, the crew was replaced by another crew with a fully serviced ARFF vehicle. The vehicle that was low on water was then allowed to return to the fire station to reservice. Approximately 13,750 gallons (52,050 L) of water and 1000 gallons (3785 L) of foam concentrate were used during the extinguishment and subsequent operations.

In addition to the crews already mentioned, several other airport fire department crews responded to the scene and supported the fire suppression operations. For example, Yellow 5 connected to Yellow 6 and provided additional water after that crew’s hose broke causing the loss of some water. Medical personnel from Echo 1 and 2 established a triage area at the scene. In this area, the medical units performed a primary evaluation of injuries and initiated the care of the injured.

Other Responses

The airport’s operations management personnel received notification of the DC-9 fire at the same time as the fire department. Airport operations vehicles were equipped with emergency warning lights that helped them to respond quickly. Operations managers and other operations personnel arrived on scene shortly after the fire department personnel.

Upon arrival, the operations manager observed fire suppression was already in progress and passengers were collecting in areas where they could be injured by vehicles responding to this accident, affect fireground operations, and interfere with the movement of other aircraft in the area of the accident site. The manager immediately met with the fire department’s incident commander, and they shared a common concern for the safety of the evacuated passengers and flight crew who were in the area. The commander asked the operations manager to get buses for these people. When the manager relayed the request to her control center, she was informed that several buses from another major airline were already en route to the scene.
The aircraft stopped in an area that was very close to one of the airport’s operations maintenance facilities. As a result, many operations maintenance personnel responded to the scene. With permission from the incident commander, the operations manager used maintenance workers to establish a site perimeter and to ensure that all passengers and aircraft crew members were brought to a designated safe area at the fire scene. Before the buses arrived, maintenance personnel began to transport passengers to one of the airport fire stations that was being used as a second triage area.

Many other airport personnel and resources also mobilized to support the emergency operations. Security personnel, many of whom were on the opposite side of the airport, responded and relieved the maintenance personnel securing the fire scene’s perimeter. Airport administrators established a liaison for handling media issues. Representatives of the airline quickly assembled a passenger manifest and provided it to the incident commander so an accurate accounting of those on the aircraft could be made. The buses that were used to gather the survivors at the scene were also used to transport them to the secondary triage area or to the terminal building where many got other flights to reach their destinations. Trailers with lighting equipment were brought from the maintenance facility to illuminate the scene after dark, and airline representatives provided equipment to secure the aircraft and a tug to pull the aircraft away from the scene.

**Injuries**

According to the NTSB report regarding this accident, one crew member, seven passengers, and one fire fighter were injured during this incident. The most severely injured person was the flight attendant who was sitting in the crew seat at the very rear of the plane. She suffered second-degree burns over 15 percent of both legs and on her left arm. She also had two puncture wounds near her left knee. This flight attendant was transported to a hospital and admitted for treatment. The seven injured passengers were also transported to hospitals. Their injuries included minor lacerations, contusions, an ankle injury, smoke inhalation, a back injury, and an injured right foot. A fire fighter also sustained a back injury and a smoke-related injury and was transported to the hospital where he was treated and released.

The NTSB Survival Factors Group report did not include three individuals as part of their injury statistics for this fire. One of the individuals was the fire fighter who sustained a minor leg injury when the hoseline broke. He was treated on the scene and did not have to be transported to the hospital. The NTSB report mentioned the two flight attendants who were sitting in the forward cabin. These individuals were exposed to smoke and were transported to the hospital with the injured survivors. Both crew members were treated and released. Though the NTSB report recognized that the crew members suffered from smoke inhalation, it did not consider crew members’ conditions as injuries and did not include them in the injury statistics.

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5 National Transportation Safety Board, Office of Aviation Safety, Survival Factors Division, Survival Factors Group Factual Report of Investigation, December 13, 1995
Aircraft Damage

The aircraft’s Number 2 engine was damaged by the mechanical failure and the subsequent fire. The engine’s front nacelle (streamlined enclosure covering the engine) had a large rip going along its circumference. (See Figure 4.) The rip involved approximately 3/4 the circumference of the engine nacelle. Looking in a forward direction, the rip extended from about the 9 o’clock position and continued in a clockwise direction to approximately the 6 o’clock position. This rip was aligned with one of the engine’s forward turbine compressor blades. The tear was most severe on the out-board side of the nacelle. There was significant soot staining on the outside of the nacelle in the area of this tear.

The right aft side of the fuselage had a total of nine puncture holes in its skin, and these holes were essentially aligned with the rip in the engine nacelle. These holes ranged in size from a 3/8-inch by 1/8-inch (9.5-mm by 3.2-mm) hole to one that was 11 inches by 4 inches (280 mm by 100 mm) in proximity to the tear in the engine cowling. The shrouded fuel line located inside the fuselage at the location of the largest puncture hole was approximately 80 percent severed.

The entire passenger cabin was damaged by the fire. However, the most severe fire damage occurred in the forward part of the cabin in an area where a large hole was burned through the fuselage skin. This hole was approximately 15- to 20-feet (4.6-m to 6.0-m) long and almost the full width of the cabin. According to the NTSB report, most of the seat upholstery and cushions were consumed in this area. In addition, the interior finish panels, plastic overhead luggage compartments, and the contents of those compartments were consumed. Toward the rear of the cabin, the doors to the majority of the luggage storage compartments were consumed. The compartments and their contents were damaged by heat. The frames for seats at the rear of the aircraft were intact, but the cushions on the seats were blackened by flames and heat.
IV. ANALYSIS

Fire Cause & Development

The NTSB determined that the probable cause of the accident was the failure of personnel in a foreign maintenance and inspection facility to perform a proper inspection of the 7th stage high-compressor disk. This failure allowed a detectable crack to grow to a length at which the disk ruptured, under normal operating conditions. Fragments from the ruptured compressor disk were not contained and penetrated the fuselage. The fragments severed a right engine main fuel line and pressurized fuel was released into the cabin. The NTSB also determined that sparks most likely ignited the fire that quickly engulfed the cabin area.

The fire inside the DC-9 in Atlanta was initially fueled by Jet A fuel, so from the very beginning of the incident, the fire was intense. The Jet A fuel-fed fire quickly ignited the aircraft’s passenger seats and interior finish materials causing the cabin to fill with smoke. The fire spread through the cabin rapidly and had almost reached the L-1 door when fire fighters brought their handlines to this location. As a result the fire fighters encountered an interior fire that was being fed by both jet propulsion fuel and the combustible materials in the cabin.

According to the NTSB, the aircraft involved in this accident was not required to meet nor did it meet the current regulations regarding flammability standards used in interiors of transport-category airplane cabins.\(^6\) At the conclusion of their investigation of the February 1, 1991, collision between a B-737 and a Metroliner at Los Angeles International Airport, NTSB issued Safety Recommendation A-91-116.\(^7\) This recommendation asked the FAA to “Prohibit the use, after a specific date, of cabin materials in all transport-category airplanes that do not comply with the improved fire safety standards contained in 14 CFR 25.853.” In March 1992, the FAA responded that it had evaluated the safety issue and had determined that in the case of the Los Angeles accident, it was unlikely that improved materials would have improved survivability.

The NTSB concluded that the June 8, 1995 aircraft cabin fire in Atlanta illustrated the merit of the NTSB recommendation. The NTSB also concluded that the accident demonstrated the importance of the current standards and the need for existing aircraft to be brought up to these standards as quickly as possible. The Safety Board believes that the FAA should prohibit the use of cabin materials in all transport-category airplanes that do not comply with fire safety standards contained in 14 CFR 25.853. Furthermore, the Board believes that the FAA should amend 14 CFR Part 121 to prohibit the operation of airplanes with cabin materials that do not meet the requirements of 14 CFR 25.853. The Board recommends that this prohibition be enforced by January 1, 2001 or upon transfer of the aircraft from one certificate holder to another, whichever occurs first.


\(^7\) NFPA prepared a summary fire investigation report regarding the collision. The NFPA report is entitled, Aircraft Collision and Cabin Fire, Los Angeles International Airport, February 1, 1991.
Emergency Egress

All passengers and crew evacuated the aircraft without the assistance of the fire fighters. Everyone interviewed by the NTSB investigators recalled the loud bang and many saw the fire involving the flight attendant at the rear of the aircraft. As a result, passengers and crew members immediately understood the severity of the situation.

Some passengers began responding even before the aircraft came to a stop. A passenger at the rear of the cabin moved forward and helped another passenger who was having difficulty opening one of the right over-wing (R-3) exits. The passenger who came from the rear of the aircraft then moved to the next over-wing exit (R-2) opened it and exited the aircraft. These men and other passengers escaped through the right over-wing exits. Some passengers also opened the left-side over-wing exits and many escaped through these exits.

The smoke spread quickly through the cabin obscuring vision. Some passengers used the emergency path lights in the cabin floor to locate the exits. Some passengers reported that the emergency lighting system stopped operating approximately 45 seconds into the incident. NTSB investigators determined the cockpit crew was unable to complete their in-cockpit emergency procedures because of the rapidly spreading smoke. One of the steps missed required the emergency lighting system control switch to be placed in the “on” position rather than the “armed” position it is in during normal flight. When the aircraft lost its primary electricity, the emergency lights initially operated. However, the public address system stopped operating when the primary electricity was lost. The captain manually turned “on” the aircraft’s emergency power system to get power to the public address system, and then he made his evacuation announcement. Since the emergency lighting system had not been turned to the “on” position, it shut down when the emergency power system was turned on.

The NTSB stated that several factors affected the timely and successful evacuation. Perhaps the most important was the ratio of exits to occupants. Six of the seven emergency exits (two floor-level exits at the front of the cabin and four over-wing exits) were opened quickly and used by all 57 passengers. Additionally, the airplane had about half of its full complement of passengers, and except for the aft flight attendant, no occupants were injured or incapacitated, which would have slowed the evacuation. Finally, the cabin interior remained intact and no debris hampered access to exits.

The NTSB Survival Factors Group report included the following statement regarding the performance of crew members:

“All passengers praised the flight attendants for their professional manner and many recalled hearing their commands as well as PA commands made by the captain.”

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Fire Suppression

When reflecting back on the fire suppression operations, fire officers felt that many factors were in their favor. Other than being hot, the weather did not hamper fire-ground operations. Since the closest airport fire station was approximately 1/4 mile away from the location where the aircraft stopped, the ARFF vehicles were able to reach the scene in about a minute. The fire department was able to respond with enough vehicles and agent capacity so that no vehicle had to be resserviced in order to suppress the fire. Except for the hndline that ruptured, all equipment operated according to design. All of these factors contributed to the success of the fire suppression operations.

Like many fire suppression operations, some activities provided better results than others. One of the first fire crews to arrive at the aircraft was on a structural pumper. These fire fighters advanced handlines to the forward cabin door and over-wing exits while an ARFF vehicle attacked the fire in the Number 2 engine. The cabin fire had become so severe by this time that the fire fighters could not enter the cabin even with operating handlines. Interior operations had to be postponed until the heat inside the cabin was reduced. This occurred after the fire burned the large hole creating large ventilation openings and providing additional access points for the application of agent.

One vehicle used its turrett to effectively attack and quickly suppress the fire in the Number 2 engine. Several other ARFF vehicles attempted to attack the cabin fire by using their roof-mounted turrets to discharge agent into the large hole that the fire created in the roof of the forward cabin. These efforts proved unsuccessful because the roof-mounted turrets discharged most of their agent over the fuselage rather than into the hole. The agent being discharged over the fuselage detracted from the suppression operation in several ways. For example, the agent from ARFF vehicles on one side of the aircraft covered ARFF vehicles on the opposite side of the aircraft and obscured the vision of operators in the vehicles being covered. In addition, the ineffective application of agent caused a large percentage of the discharged agent to be wasted. Agent waste is a serious concern to ARFF fire fighters since their vehicles carry only a finite quantity of agent. The effectiveness of the attack improved when Yellow 13, a vehicle with an extendible turret, was used. This vehicle was able to place its turrett directly above the hole and discharged down into the cabin.

Noise was another detrimental factor that some fire fighters discussed in interviews with the NFPA investigator. They stated that normal aircraft operations that continued at other airport areas created a high ambient noise level. This noise overlaid the loud sounds of multiple ARFF and structural vehicle engines running at high speeds. Though the fire fighters did not have specific examples of missed communications, some acknowledged that the high noise levels on the fire ground made face-to-face and radio communications difficult and occasionally impossible.
Incident Management & Role of Other Agencies

The Hartsfield International Airport administrators had developed formal plans and programs for managing aircraft and other emergencies that could affect the safety of people and operations at the airport. Departments such as airport operations, security, and fire were well versed in the plan.

During this accident response, the various departments cited in the airport’s emergency plan assumed their respective roles. The combined efforts of these agencies contributed to the successful outcome of the operation. For example, after meeting with fire department officials, operations personnel coordinated the care for the passengers and the crew of the aircraft while the security personnel quickly established a perimeter for the incident site. These kinds of activities allowed fire officers and personnel to focus on fire suppression operations and other activities in areas too hazardous for non fire department personnel to enter.

Code Analysis

NFPA has several ARFF standards addressing aspects of airport fire protection and disaster management. It is not the intent of this code analysis to examine the standards, manuals, and guides that were being enforced at Atlanta Hartsfield International Airport. Rather, the analysis will highlight and discuss current NFPA requirements and recommendations that have particular relevance to this accident and could have potentially affected the outcome of this accident.

The NFPA 1003, Standard for Airport Fire Fighter Professional Qualifications, 1994 edition, recognizes that significant interior fires may not be extinguishable using external aircraft fire-fighting tactics alone. NFPA 1003 requires the airport fire fighter candidate to meet the requirements for Fire Fighter I as defined in Chapter 3 of NFPA 1001, Standard for Fire Fighter Professional Qualifications. NFPA 1003 also provides requirements for the proper application of agent using an ARFF vehicle and the attack of a fire on the interior of an aircraft. Though the severe fire in the aircraft prevented the Atlanta fire fighters from successfully operating inside the aircraft, the fire fighter attempted an interior attack. Thus they had an opportunity to use their structural fire-fighting skills, and this opportunity reinforces the NFPA requirements for ARFF to be proficient in structural fire-fighting procedures.

NFPA 1003 is not the only NFPA standard that addresses interior fire-fighting operations aboard aircraft. Chapter 9 of NFPA 402M, Manual for Aircraft Rescue and Fire Fighting Operations, 1991 edition, provides guidance for ARFF personnel who encounter interior aircraft fires in both parked, unoccupied aircraft, and aircraft with passengers and crew. It recognizes that an interior aircraft fire, when passengers and crew are on board, creates a major problem for ARFF personnel and that the ability for ARFF personnel to enter the aircraft to suppress the fire may be delayed until the evacuation of the aircraft is complete. However, once ARFF personnel make entry into the aircraft, a direct attack using foam handlines is usually effective. The success of the direct attack is because the fires normally involve
ordinary combustibles like upholstery, paneling, carpeting, refuse, electrical insulation, and carry-on materials. The chapter also recognizes that interior aircraft fire situations can differ widely so specific guidance regarding extinguishment techniques is not possible.

NFPA 403, *Standard for Aircraft Rescue and Fire Fighting Services at Airports*, 1993 edition, is a third NFPA document that discusses interior fire-fighting operations. Appendix Section A-6-1.4 states that ARFF personnel should have a sound knowledge of fire behavior and lists several instructional opportunities to develop and reinforce this knowledge. One of the listed instructional activities is live-fire exercises. These exercises should include, but are not limited to, exterior fuel fires, interior fires, engine fires, wheel fires, and fires involving on-board power units. This appendix section, again, recognizes that ARFF fire fighters need to be proficient at interior fire fighting which supports the need for them to have Fire Fighter I certification.

Finally, new requirements were included in the 1995 edition of NFPA 414, *Standard for Aircraft Rescue and Fire Fighting Vehicles*, that can make major ARFF vehicles more effective against interior fires aboard aircraft. One of the new requirements, Paragraph 414.2-16.5.7, addresses extendible-type primary turrets. The following is one of the paragraph’s many design and functional requirements:

The extendible turret shall be capable of applying agent to the interior of aircraft through cargo bay openings, passenger doorways, and emergency exits on the type of aircraft being protected while the aircraft is in either the gear up or gear down landing position.

The code recognizes that the extendible turret is a recent development for aviation fire protection and recognizes that tactics, procedures, and training must be developed in order for extendible turrets to be most effective during fire suppression operations. ARFF personnel intending to use extendible turrets for interior fire-fighting operations may have to establish tactics and procedures for aircraft with passengers and crew aboard.

The Hartsfield Airport Fire Department stated in its report that one of their “lessons learned” was that an interior cabin fire can be controlled by placing a boom inside the aircraft. They recognized that the fire aboard the aircraft in Atlanta was too intense for fire fighters to enter the fuselage. They also realized that no occupants would have been placed at risk by a turret discharge inside the aircraft since all the passengers and crew had escaped. The fire department believed that a turret discharging several hundreds of gallons of agent inside the aircraft cabin would have more quickly controlled the fire.
V. Discussion

An NFPA study of vehicle fires from 1989 to 1993 revealed that an average of 260 aircraft fires causing 70 deaths, 56 civilian injuries, and $38.4 million in direct property loss occurred each year. Aircraft fires account for approximately 0.1 percent of the vehicle fires in the United States annually. The NFPA report on vehicle fires also stated that over half of the aircraft fires began in the engine, running gear, or wheel area. Among causes, mechanical failure was the leading ignition factor for aircraft fires (over 1/4 of all causes were attributed to mechanical failure). Only 20 (6.5 percent) of the fires originated in the passenger area of the aircraft making aircraft cabin fires a small part of the aircraft fire problem.

When a fire does occur in an aircraft cabin, it poses a severe threat to passengers and crew aboard and remains as a significant challenge to ARFF personnel. Fortunately, all aboard the aircraft in Atlanta were able to escape in the brief time that they had before the fire swept through the cabin. Fire fighters were able to respond with numerous ARFF and structural vehicles, and their response was quick and unimpeded. Despite this, the fire fighters’ attempts to extinguish the cabin fire using both interior and exterior fire attacks were thwarted by the magnitude of the fire inside the cabin and by the protection afforded by the aircraft’s fuselage.

NFPA has documented ten other aircraft cabin fires including the June 6, 1983, aircraft fire in Cincinnati; the December 3, 1990, fire in Detroit; and the February 1, 1991, fire in Los Angeles. (See Section VI. Additional Information for a listing of all the incidents documented by NFPA.) During each of these incidents, the fires involved the interior of the aircraft cabin, and airport fire fighters could not readily extinguish those fires using the traditional ARFF tactic of exterior fire fighting. Fire fighters ultimately had to enter the fuselage of each aircraft in order to suppress the fire.

Though a relatively rare occurrence, an aircraft cabin fire presents such unique challenges to ARFF personnel that they need to specifically prepare for the event. NFPA standards provide training and proficiency requirements that will help ARFF personnel prepare themselves for interior fire-fighting operations aboard aircraft. NFPA standards also contain information regarding equipment and tools that ARFF fire fighters will need to effectively suppress aircraft cabin fires.
VI. ADDITIONAL INFORMATION

Since 1965, NFPA has prepared the following reports or journal articles as a result of NFPA investigations of other aircraft fires:

NFPA Fire Investigation Reports

• Los Angeles, CA, February 1, 1991.
• Cincinnati, OH, June 2, 1983.
• Jamaica, November 12, 1975.

NFPA Journal & Fire Journal Articles

• “Aircraft Cabin Fire on the Ground,” Fire Journal, March/April 1970
VII. NFPA CODE SECTIONS


Chapter 9 Interior Aircraft Fires

9-1 General.

402M:9-1.1 The recommendations contained in this chapter are provided for the guidance of RFF personnel encountering interior aircraft fires occurring in both parked, unoccupied aircraft and aircraft with passengers and crew aboard.

402M:9-1.2 The occurrence of interior aircraft fires where passengers and crew are onboard presents a major problem for RFF personnel. An acute life safety hazard exists in these instances, and the ability to enter the aircraft and extinguish the fire might have to be delayed until evacuation has been completed. Because forcible entry and rescue are discussed in detail elsewhere in this manual, they will not be covered here, and instead emphasis will be on the procedures and techniques of attacking and extinguishing interior aircraft fires.

402M:9-1.3 Aircraft passenger cabin fires normally involve ordinary combustibles such as upholstery, paneling, carpeting, refuse, electrical insulation, and carry-on materials. Generally, a direct attack on the fire with water streams, using structural fire fighting techniques, is effective.

402M:9-1.4 RFF personnel should understand the structural characteristics of an aircraft fuselage. The absence of fire stops at the floor, behind wall panels, and above ceiling areas permits fires to spread undetected and unchecked through combustible materials once fire has entered those areas. RFF personnel should always assume, until it is proven otherwise, that fire has moved away from its origin via these concealed spaces. Sections of flooring, wall panels, and ceilings should be removed where fire travel is suspected so that complete extinguishment can be accomplished.

402M:9-1.5 Since the burning of aircraft interior materials creates a toxic atmosphere, RFF personnel should wear positive pressure self-contained breathing apparatus whenever working inside the fuselage both during the fire fighting stage and later, while overhauling. Additionally, the entire fuselage should be ventilated as quickly as possible by whatever means available. Smoke ejectors can expedite horizontal ventilation, which is usually the only choice of methods since aircraft have no designed vertical openings. [See Figure 9-5(b).]
401M:9-1.6 Interior aircraft fire situations can differ widely; therefore, explicit guidance regarding extinguishment techniques is not possible. Points of entry and methods of attack should be dependent upon an evaluation of conditions and assessment of resource capability by the RFF officer in charge.

402M:9-1.7 An interior aircraft fire location and its intensity can to some degree be determined by observation through cabin windows, smoke concentrations, or aircraft skin that shows buckling or paint blisters.

402M:9-1.8 In the event that an interior aircraft fire cannot be immediately extinguished, foam or water spray should be applied to wing and fuselage fuel tank areas that might be exposed to heat.


403:A-6-1.4 A carefully organized training program should be developed to meet the qualification requirements of NFPA 1003, Standard for Airport Fire Fighter Professional Qualifications. The following guidelines are offered for structuring such a program.

The objectives of a training program for aircraft rescue and fire fighting personnel at airports should be to:
(a) Teach the safe application of recognized practices and procedures;
(b) Develop and maintain the confidence and competency of all personnel assigned ARFF duties;
(c) Instill the concept of professionalism;
(d) Serve as a source of accurate technical information whereby the lessons gained from aircraft accidents or incidents are properly analyzed and the information disseminated to others concerned with ARFF operations; and
(e) Enhance the esprit de corps of aircraft rescue and fire fighting personnel by creating an appreciative awareness of the hazards and dangers they may face in carrying out ARFF operations.

Control and Planning.
The complete training and educational program for aircraft rescue and fire fighting personnel should be under the direction of one officer of the airport fire department for planning, development, and supervision.

Resources for Training.
Training material resources for a training program oriented specifically to meet the needs of aircraft rescue and fire fighting personnel should take into consideration providing suitable amounts of extinguishing agents, such as foam concentrate, dry chemical, and Halon 1211; and fuel for training fires.

Phases of Training.
Training of aircraft rescue and fire fighting personnel should include seven phases. Training in all phases should be conducted for support personnel used as auxiliary
fire fighters and for full-time aircraft rescue and fire fighting personnel. Because of the factor of time availability for schooling, the depth into which subjects are covered will vary, but the scope should not be reduced for auxiliary fire fighters.

**Indoctrination.**
Indoctrination training should include the following:
(a) The rules and regulations applicable to ARFF services;
(b) Knowledge of the basic duties and responsibilities and those of co-workers;
(c) Emergency response procedures;
(d) The command structures for administration and operations; and
(e) The importance of practicing occupational safety.

**Operating ARFF Equipment.**
All aircraft rescue and fire fighting personnel should be capable of effectively handling fire and rescue equipment under varied conditions of terrain and weather. The aim of training should be to ensure that every fire fighter is so well versed in handling all types of appliances and tools used in ARFF operations that under stressful conditions individual fire fighters can take effective action without the need for specific direction. Among the items that should be covered are:
(a) Complete knowledge of each tool and piece of equipment;
(b) The location of each piece of equipment and tool carried on each vehicle;
(c) The method of using each piece of equipment and tool, with emphasis on personal safety factors;
(d) Special handling precautions for the use of power tools;
(e) Knowledge of, and training in, the use of breathing apparatus and other protective equipment;
(f) The techniques employed in utilizing the available communication equipment;
(g) Knowledge of the apparatus, its built-in equipment, including the pump and its performance capabilities, the agents carried and their delivery systems;
(h) Actual operation of all vehicle controls and behind-the-wheel driver training under circumstances including negotiating obstacles and muddy or snow-covered soil conditions. This is done to provide a degree of assurance that the vehicle will not get bogged down or damaged during emergencies.
(i) Knowledge of departmental policies on positioning of apparatus for tactical service at accidents/incidents under the variety of possible conditions to be encountered; and
(j) Recordkeeping to document the efficiency and effectiveness of the various vehicles utilized by the airport fire department.

**Fire Behavior and Fire Suppression.**
Aircraft rescue and fire fighting personnel should possess a sound knowledge of fire behavior.
Instruction in this phase should include:
(a) The principles of combustion, with emphasis on the types of aircraft fuels;
(b) How fire propagates through the effects of heat conduction, convection, and radiation;
(c) The influence of fuel distribution on heat production;
(d) The principles of fire suppression by the various types of agents utilized in aircraft rescue and fire fighting operations;
(e) Live fire exercises that include but are not limited to exterior fuel fires, interior fires, engine fires, wheel fires, and fires involving on-board auxiliary power units; and
(f) The effects of heat exposure on individuals.
Training should be given covering the advantages and disadvantages of each fire extinguishing agent employed. Every opportunity should be taken to use the agents on realistic training fires. Each routine equipment test should be used as a training exercise to provide experience in the proper handling of the equipment and to establish the proper technique of application of each agent available.

Rescue and Fire Fighting Procedure.
Care should be taken to ensure that aircraft rescue and fire fighting personnel fully understand that to achieve the objective of safeguarding the lives of those involved in an aircraft accident requires that fire in the practical critical area be controlled quickly and that this area be kept secure. Strict discipline should be maintained to ensure that fire suppression agents are not expended on fire outside the PCA until it is positively established that the immediate and long-term security of the PCA will not be jeopardized.
Personnel should be given thorough instructions in the following subject areas:
(a) The standard operating procedures (SOP) to be expected from the aircraft crew members under specified circumstances;
(b) The locations within aircraft where victim concentration may be anticipated under accident conditions of various types;
(c) Behavior patterns of individuals involved in major disasters;
(d) Means of preventing or minimizing panic;
(e) Means of gaining entry through normal aircraft openings;
(f) Locations most suitable for forcible entry into the aircraft;
(g) Requirements of setting up triage and treatment areas that should be part of the Airport/Community Emergency Plan (see NFPA 424M, *Manual for Airport/Community Emergency Planning*); and
(h) Methods of carrying injured persons (one-person and by teams).

Familiarization with Local Terrain.
A thorough knowledge of the terrain of the airport and its immediate vicinity is essential. The existence of any areas that may from time to time become impassable because of weather or other conditions (tides, growth of brush, etc.) should be known to all crew members. Training should include actual ARFF vehicle operations over primary and secondary travel routes on the airport and runway overrun areas. Familiarization with areas outside the airport boundary to which the on-airport ARFF equipment might be authorized to respond can be accomplished with other vehicles. Personnel should also receive training during periods of diminished visibility.
The instruction program should include:
(a) Locations of obstacles both temporary and permanent;
(b) Locations of exit points (gates and/or frangible sections) in the security fence;
(c) Location of rendezvous points for mutual-aid apparatus as planned in the airport/community emergency plan;
(d) Areas that might become impassable in inclement weather;
(e) Availability of helicopters, boats, swamp buggies, air-cushion vehicles or other off-road conveyances; and
(f) The operation of each ARFF vehicle and its capability to negotiate the existing terrain under the various conditions that may be anticipated.

**Aircraft Familiarization Training.**
Aircraft rescue and fire fighting personnel should be familiar with:
(a) Locations of phone jacks on different types of aircraft;
(b) The availability and method of operation of aircraft escape devices;
(c) The location of aircraft batteries, and means of disconnection;
(d) The amount and type of aircraft fuel carried and the fuel storage locations in each aircraft;
(e) The location and quantity of oxygen carried;
(f) Access to wheel wells, engine accessory compartments, and other areas of critical concern; and
(g) The fire behavior characteristics and locations in the aircraft of combustible metals (magnesium, titanium), plastics (cabin liners, seating), combustible insulation (for electrical wiring and sound deadening), hydraulic fluids, lubricating oil, rubber, and similar combustibles and flammable materials.

**Emergency Medical Training.**
Every member of the airport ARFF services should be given initial and recurrent training in emergency medical procedures.

**NFPA 414, Standard for Aircraft Rescue and Fire Fighting Vehicles, 1995 edition.**

414:2-16.5.7* If the primary turret is of the extendable type, it shall meet the following design and functional requirements:

(a) It shall comply with NFPA 1901, *Standard for Pumper Fire Apparatus*, Section 8-5, 8-5.2, and 8-5.3, and shall meet the requirements of 2-2.1.3 and 2-2.1.4 of this standard while in the stowed position. It shall achieve a 20-percent side slope with the extendable turret fully elevated and the nozzle rotated uphill at maximum horizontal rotation while discharging at maximum flow rate. The vehicle shall be provided with an interlock or warning system and placards in full view of the driver/operator to provide the operational limitations during all phases of operation.

*Exception: Flow rates shall be in accordance with Table 2-16.5.2 for major vehicles.*

(b) The extendable turret shall function without the use of outriggers or other ground contact stabilizers.

(c) The primary turret shall achieve the elevation and reach needed to service the highest tail-mounted engine for the aircraft being protected.

(d) The extendable turret shall function as a conventional roof turret in accordance with 2-16.5.2 for major vehicles.
(e) The extendable turret shall be capable of applying agent to the interior of the aircraft through cargo bay openings, passenger doorways, and emergency exits on the type of aircraft being protected while the aircraft is in either the gear up or gear down landing position.

414:A-2-16.5.7 The development of the extendable turret for aviation fire protection is a recent development. As such, the design and functional requirements, as well as the tactics and procedures for its use, are not well developed. Training curricula also need to be developed. The intent of the requirements of 2-16.5.7 is to provide minimum performance criteria so that there is no degradation in the basic turret performance, while allowing individual flexibility for specific user needs. These needs can be affected by the type of aircraft being protected, the ability to access the aircraft interior, and the ability to access shielded fires.

As now envisioned, the extendable turret can be used for primary agent application as part of a first-arriving vehicle. As such, the vehicle should be capable of applying agent quickly without the need to deploy supporting outriggers. In the future, other design features or functions might be incorporated. For example, man-rated devices for use in accessing the interior cabin after fire knockdown might be incorporated. These devices might or might not require stabilizing devices; depending on the function of the vehicle, the time to deploy such devices may be permitted. In any event, there should be a maximum time for total deployment of the boom/tower device. A maximum of 30 seconds is recommended. The requirements do not prohibit the development of an advanced device or a unit with a different function, recognizing that the primary turret performance should not be compromised.

It is not recommended that agent be applied from a vertically extended position before knockdown of the exterior exposure fire, unless the fire cannot otherwise be accessed. Preliminary data from demonstrations of extendable turrets, plus data from earlier turret testing, suggest that AFFF discharged at a low level is the most effective technique. The extendable turret should be designed to extend below the roof level of the cab to take advantage of low-level AFFF application. Extension of the extendable turret below the cab level also should provide advantages in accessing shielded/obstructed areas such as wheel-well incidents and “gear down” scenarios. To improve operator efficiency, the movement of the boom/tower should be accomplished with a single lever located within the cab. Elevation/azimuth indicators are not needed if the turret is in the line of sight of the operator.

Where specified, the extendable turret should be fitted with the appropriate tools/devices needed for a driver/operator to perform interior aircraft and tail-mounted engine fire-fighting functions remotely. These could include a skin penetrator/agent applicator for penetration of the fuselage to access interior fires from outside the aircraft. Tactics and procedures for these evolutions are not well developed and should be given careful consideration, preplanning, and training, particularly for situations where surviving passengers/crew might still be in the aircraft. Where a penetrator/agent applicator is used, a minimum flow equal to two handlines (as specified in 2-16-6.4.3) is recommended. Airports planning to use the device for indirect attack with a skin penetrator should preplan appropriate access locations on aircraft served and the conditions under which the device is to be used.

1003:1-3.1* For certification as an airport fire fighter, the candidate shall meet the requirements for Fire Fighter I defined in Chapter 3 of NFPA 1001, Standard for Fire Fighter Professional Qualifications; first responder operational level defined in Chapter 3 of NFPA 472, Standard for Professional Competence of Responders to Hazardous Materials Incidents; and the job performance requirements for airport fire fighter defined in Chapter 3 of this standard. Airport fire fighters who drive aircraft rescue and fire fighting (ARFF) vehicles shall meet the requirements of Chapter 7 of NFPA 1002, Standard for Fire Department Vehicle Driver/Operator Professional Qualifications.

1003:A-1-3.1 Due to the improvements in the design and construction of modern aircraft, resulting in increased structural integrity, the potential exists for significant interior fires that cannot be extinguished using external aircraft fire-fighting tactics. Extinguishing aircraft interior fires is an essential task of the airport fire fighter. This is one of the primary reasons for the FFI requirement in this document. The basic fire-fighting skills and knowledge required for Fire Fighter I in NFPA 1001, Standard for Fire Fighter Professional Qualifications, are essential to the airport fire fighter.

The requirement for first responder at the operational level (in NFPA 472, Standard for Professional Competence of Responders to Hazardous Materials Incidents) was included based on the airport fire fighter’s potential for frequent exposure to a wide variety of hazardous materials. The potential exposure frequency is significantly greater than anticipated for the Fire Fighter I.

1003:3.3.4 Extinguish a 5000-ft2 (464.5-m2) aircraft fuel fire, given ARFF vehicle turrets and appropriate agents, so that the agent is applied with proper technique and the fire is extinguished.

1003:3.3.4.1 Prerequisite Knowledge: Operation of ARFF vehicle agent delivery systems, the fire behavior of aircraft fuels in pools, physical properties and characteristics of aircraft fuel, use of protective clothing, agent selection, agent management, and agent application rates and densities.

1003:3.3.4.2 Prerequisite Skills: Effective application of fire-fighting agent using ARFF vehicle turrets.

1003:3.3.6* Attack a fire on the interior of an aircraft, given an ARFF vehicle handle(s) and appropriate agent, so that the lines are properly advanced and positioned and the fire is extinguished. (See Appendix B.)

1003:A-3.3.6 This requirement can be met by using a structural burn facility configured to simulate the interior layout and dimensions of an aircraft fuselage containing mannequins to simulate victims. The mock-up should include at least three metal seats and training dummies to simulate victims.