NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, DC 20594

SURVIVAL FACTORS

SPECIALIST'S FACTUAL REPORT

February 28, 2017

I. ACCIDENT

Operator	:	British Airways
Airplane	:	Boeing 777-200 [G-VIIO]
Location	:	Las Vegas, NV
Date	:	September 8, 2015
Time	:	1627 Pacific daylight time (PDT)[1]
NTSB #	:	DCA15FA185

II. SURVIVAL FACTORS SPECIALIST

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III. SUMMARY

On September 8, 2015, about 1627 Pacific daylight time (PDT), British Airways flight 2276, a Boeing 777-200ER, equipped with two GE90-85B engines, registration G-VIIO, experienced a #1 engine uncontained failure during takeoff ground roll on runway 7L at McCarran International Airport (LAS), Las Vegas, Nevada. The #1 engine, inboard left wing, and a portion of the left and right fuselage sustained fire damage. Resulting fire was extinguished by aircraft rescue and firefighting. The 157 passengers, including 1 lap child, and 13 crewmembers evacuated via emergency slides on the runway. The airplane was substantially damaged. The flight was operating under the provisions of 14 Code of Federal regulations (CFR) Part 129 and was en route to London – Gatwick Airport (LGW), Horley, England.

[1] All times are reported in local time unless otherwise noted.

IV. DETAILS OF THE INVESTIGATION

1.0 Airplane Configuration

The Boeing 777-200ER was configured with 283 passenger seats. The seats were divided into 3 seating class zones with (fore to aft) 40 "Club World" (first class) seats, 24 "World Traveller Plus" seats, and 219 "World Traveller" seats. The dual-aisle airplane had 8 floor-level door exits. Four entry doors, identified as 1L, 2L, 3L, and 4L, were located on the left side of the airplane. Four service doors, identified as 1R, 2R, 3R, and 4R, were located on the right side of the airplane.

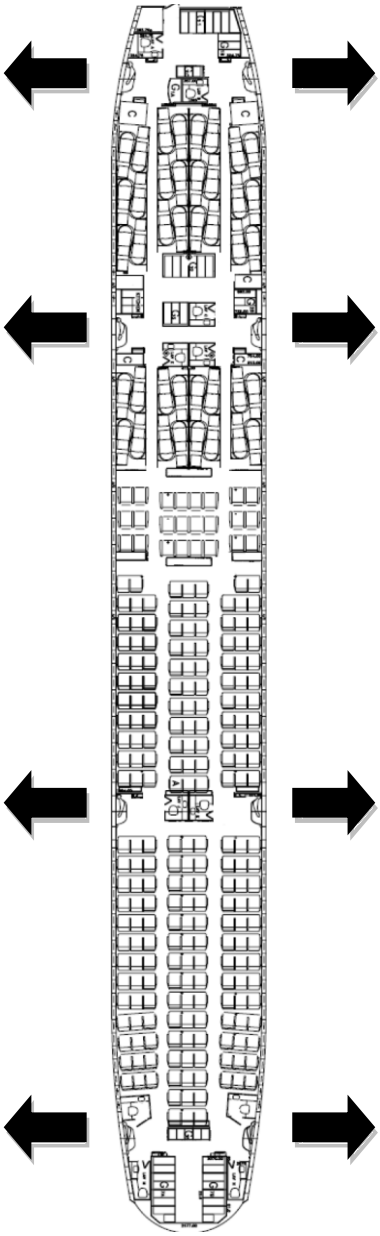

Figure 1. Interior Configuration of G-VIIO

2.0 Cabin Crew Information

Flight 2276 was operated with 10 flight attendants. The table below provides their position, location, date of hire, and last B777 recurrent training with British Airways.

Position	Jumpseat Location	Date of Hire	Last B777 Recurrent
1 - Cabin Manager	1L (aft-facing)	2/12/85	11/14
2	2L (aft-facing)	4/11/12	3/15
3	3L (aft-facing)	1/23/15	N/A
4 - Purser	4L (forward-facing)	3/4/06	11/14
5	1R (aft-facing)	3/12/15	2/15
6	2R (forward-facing)	9/11/98	3/15
7	3R (aft-facing)	2/17/97	2/15
8	4R (forward-facing)	7/17/06	1/15
9	1L (forward-facing)	4/12/97	2/15
10	Center jumpseat (near door 3L)	1/21/08	8/15

Table 1. Flight attendant positions, dates of hire, and last recurrent training.

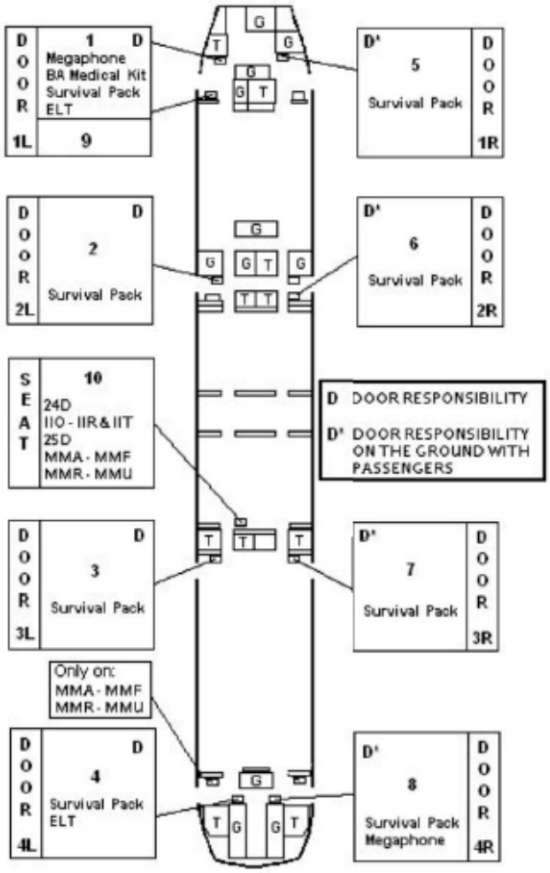

Figure 2. Flight attendant locations and door responsibilities.

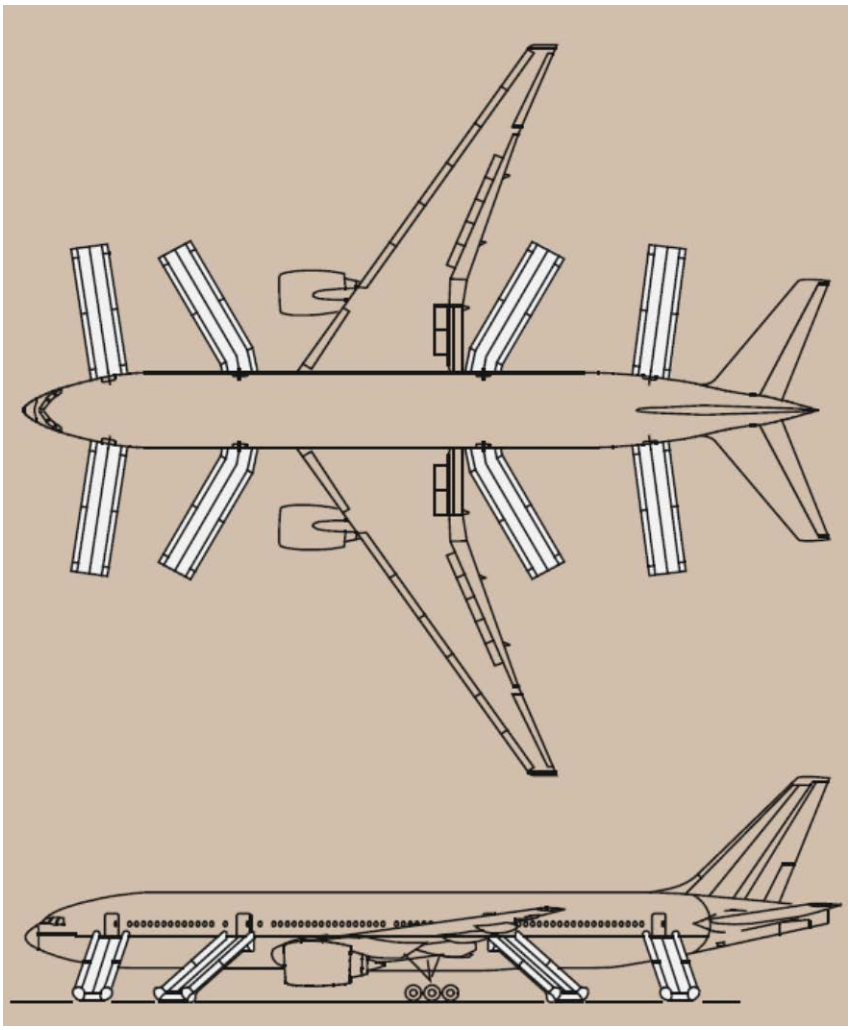

Figure 3. B777 slide/rafts and their orientation to airplane when inflated.

2.1 Evacuation Summary

A summary of the activity in the cabin after the uncontained engine failure was produced using 1) written statements provided by the flight attendants (attachment 1) and 2) a review of the cabin crew's recorded debriefing provided by UK Air Accidents Investigation Branch (AAIB).

During the takeoff roll the cabin crew heard a sound described as a loud "thud," "bang," or "pop," followed by feeling the airplane swerve to the left. Many commented about a "bumpy" sensation and hard braking. Most initially felt they had experienced a blown tire. The F/A #1 (the cabin manager), who was seated on an aft-facing jumpseat at door 1L, saw nothing unusual in the cabin or outside door 1L after the airplane came to a stop. The "Heavy[2]" crewmember came out of the cockpit to assess the situation and had difficulty getting down the left aisle because some passengers were out of their seats.

[2] An additional first officer was in the cockpit at the time of the accident and was referred to by the cabin crew as the "Heavy."

F/A #1 made a public address (P/A) announcement to instruct passengers to remain seated. F/A #9, seated at door 1L across from F/A #1, recalled a P/A announcement from the flight crew for passengers to remain in their seats prior to the heavy crewmember coming into the cabin.

F/A #5 was seated in an aft-facing jumpseat at door 1R and heard the flight crew's P/A to remain seated but reported multiple passengers were standing in the back of the cabin. As the heavy crewmember entered the cabin, F/A #5 noted the presence of thick, black smoke outside door 1R.

F/A #2, seated at door 2L, also heard the flight crew's command to remain seated and await further instructions, but immediately saw smoke billowing from the left engine. Passengers began to shout at her that "we need to get off" but she reported a second P/A from the flight crew to "remain seated." She then saw flames coming out of the engine and had picked up the interphone to notify the flight crew when the "Heavy" arrived at door 2L. She notified him of the visible fire and stated that he looked at the window and said, "we need to evacuate." He returned to the cockpit and passengers continued to shout for her to open the exit. Across the cabin, F/A #6 at door 2R heard the flight crew's announcement to remain seated and await further instructions. She noted some passengers getting up out of their seats in her area and could not see anything outside of door 2R because of the smoke which she considered a hazard.

F/A #3 at door 3L initially saw no hazards outside when the airplane came to a stop. Passengers immediately got out of their seats and, after the flight crew's announcement, she stood up to command passengers to remain seated. She then looked out door 3L again and saw "orange flames and thick black smoke." F/A #10 in the center jumpseat near door 3L told her that he saw flames as well.

F/A #7 at door 3R and F/A #8 at door 4R both heard the flight crew's announcement to remain seated. F/A #7 stated she initially saw "fumes" outside door 3R and F/A #8 saw a small amount of smoke which dissipated quickly.

F/A #4 at door 4L saw "debris… flying past" the window as the airplane decelerated. Once it stopped he saw a "tiny strip of fire on the runway." He reported that passengers immediately got up out of their seats prior to the flight crew's "remain seated" command. He got out of his jumpseat, walked 4-5 rows into the cabin and commanded them to sit.

In the front of the airplane, F/A #1 reported hearing someone say "fire on the right" but was unsure whether it was a passenger or crewmember. She was about to report that information to the flight crew in the cockpit when the heavy crewmember returned from door 2L Shortly after he returned to the cockpit the flight crew made a P/A to "evacuate, evacuate" and the evacuation alarm sounded.

F/As #1 and #9 assessed the conditions outside door 1L and both decided it was safe to open. F/A #1 stated that the door opened easily. She used the commands "wait,

wait, slide inflating" followed by "unfasten seatbelts, come this way" but after about 5 passengers had evacuated F/A #9 noted flames on the runway. They immediately began redirecting passengers to door 1R. At door 1R, F/A #5 commanded "unfasten your seatbelt and come this way" while assessing the conditions. She saw thick black smoke outside; however, she heard F/A #6 at door 2R redirecting passengers to door 1R. She was also confronted with passengers shouting loudly for her to open the door. She called across the cabin to F/A #1 and asked whether there was a hazard on the left which F/A #1 confirmed. F/A #5 assessed door 1R again and did not see any flames so she opened it and pulled the manual inflation handle, which was a normal procedure. During this time she "reported being "pushed" by a passenger and had to "quickly" grab the assist handle by the door and block it, as the slide/raft was still inflating. Once the slide/raft was fully inflated she began evacuating passengers.

Both F/As #2 and #6 blocked doors 2L and 2R and redirected passengers to door 1R. F/A #3 was about to initiate an evacuation via a button at her communications panel when the flight crew commanded the evacuation over the P/A. She blocked door 3L and redirected passengers to doors 3R, 4L, and 4R. F/A #7 saw no hazards outside door 3R and opened it. She stated it was "a bit hard" and a passenger from row 26 HJK assisted her. She reported that the slide/raft deployed and inflated correctly but was not in a usable attitude. She redirected passengers to door 4L. Similarly, F/A #4 opened door 4R and the slide/raft deployed and inflated but was not in a usable attitude. She reported that it was "twisted in stature, almost being whipped around by the wind, and was a high distance off the ground." She blocked the exit and redirected passengers to door 4L.

F/A #4 reported that door 4L opened easily after he grabbed his assist handle and pulled the manual inflation handle he noted passengers were right behind him. He commanded "wait, wait, slide inflating" and began evacuating passengers once the slide/raft was inflated. He reported that passengers "just kept coming and coming and coming." He recalled that one woman stopped to take her shoes of and was pushed down the slide/raft. After the evacuation command F/A #10 knew that door 3L could not be opened and redirected passengers to the back of the airplane. He saw an elderly woman stumble and fall in the aisle and passengers "walked over her." He picked her up and told her to continue to the exit, which she did. He reported that passengers were moving "fairly quickly." He also noted flames licking up at door 3R and knew that it could not be opened.

Ultimately, only doors 1R and 4L were used for the entire duration of the evacuation, which lasted approximately 2 minutes and 32 seconds, based on observations from two videos posted to YouTube. (see attachments 2 and 3 and section 4.0 for a detailed timeline of events)

When asked, during a group debriefing by an AAIB investigator, whether passengers retrieved carry-on baggage, the flight attendants replied that some passengers had retrieved baggage but most of retrieval happened after the airplane came to a stop and before the evacuation was ordered. They did not believe that baggage retrieval slowed the evacuation because the flight attendants were being so assertive with their

commands. F/A #4 at door 4L reported that passengers had very little baggage with them at his exit. F/A #5 at door 1R noted passengers with bags once she was outside the airplane but did not recall seeing them while passengers were evacuating. In summary, the flight attendants agreed that carry-on bags were not a problem during the evacuation.

The flight attendants estimated that approximately 50-55 passengers evacuated through door 1R meaning approximately 100-105 passengers evacuated through door 4L.[3] Five flight attendants evacuated through door 1R and 5 evacuated through door 4L. All three flight crewmembers evacuated through door 1R.

2.2 Cabin Crew Procedures and Training

British Airways provided a copy of a current flight attendant manual as well as initial and recurrent training materials and instructors' notes. Additionally, sections from the British Airways Operations Manual – Part B (OM-B) were contained in the British Airways investigation report for the accident. Pertinent sections are shown below:

OM-B – General Procedures

3.5.2 Initial Evacuation Procedure
WARNING: Only open exits not affected by fire or other hazard.
Once the aircraft has come to a complete stop and the evacuation announcement has been made:
- RELEASE Harness;
- "UNFASTEN YOUR SEAT BELT – COME THIS WAY";
- CANCEL Horn;
- CHECK No hazard or fire outside your door;
- CHECK Door prepared for emergency use;
- OPERATE Door in accordance with type-specific instructions;
- OPERATE manual slide inflation device;
- "WAIT, WAIT SLIDE INFLATING";
- MOVE to assist space;
- DIRECT passengers through door.

Figure 4. Sections 3.5.2 of British Airways OM-B describing F/A evacuation procedures.

OM-B – General Procedures

3.5.3 Maintaining Evacuation Flow
Use strong, loud positive commands.
Use whatever physical force is necessary to keep passengers moving.
CAUTION: *Stand to the side of the doorway in the 'assist space' so that none of the available exit area is blocked. DO NOT stand partially in the doorway.*
- GRAB a firm hold on the assist handle.
- MAKE PHYSICAL and/or verbal contact with the approaching passengers as far back in the cabin as possible.
- MAINTAIN CONTACT only to the point where you are sure they have made a positive commitment to jump.
- ORDER the first able-bodied passengers to wait at the bottom of the slide, to help passengers to their feet, and away from the aircraft.

CAUTION: *Do not attempt to remove items of hand baggage at this stage, unless it is of a size that would impede the flow.*
WARNING: Should a passenger sit down at the door, DO NOT bend down. Use your foot or knee in their backs to tip them on to the slide.

Figure 5. Sections 3.5.3 of British Airways OM-B describing evacuation flow procedures.

[3] These figures were estimates disscussed in the group AAIB debriefing and do not include the 5 passengers that were reported to have evacuated from door 1L.

Once the aircraft has come to a halt the Captain will assess the situation. If an immediate evacuation is not required, the Captain will make the announcement

"Passengers and crew remain seated and await further instructions"

This call is intended to signal to the cabin that the situation has been/is being assessed and that the Flight Crew believes that there is no immediate threat to the aircraft. ***(OM B GEN B.3.1.1.c.)***

How would the Captain order an evacuation?

By making the PA "**This is an Emergency, Evacuate, Evacuate**".

Followed by the evacuation alarm when fitted. He/she may also warn about 'hazards' outside. E.g. Hazard, fire on the left hand side.

Cabin Crew **must** still check the area outside

On hearing the PA/Evacuation Alarm what should the crew do?

Commence an immediate evacuation by shouting, "**Unfasten your seatbelts, come this way**" (unfastening your own seatbelt at the same time).

Keep shouting commands to motivate passengers towards the doors whilst completing your door drill.

Figure 6. Excerpt from BA initial training instructor's notes.

The only situation when the Cabin Crew will initiate an evacuation is when the situation is clearly catastrophic. In a clearly catastrophic situation the evacuation of passengers must be initiated without delay immediately the aircraft has finally come to rest

Catastrophic – Evacuation Initiated by Cabin Crew – **B.3.5.10.**

'A catastrophic situation exists whenever:
• It is probable that the pilots have been incapacitated following an aircraft accident on land or water, or
• When the physical conditions inside the cabin are unmanageable and pose an extreme and immediate threat to life.'

Figure 7. BA policy of F/A evacuation initiation.

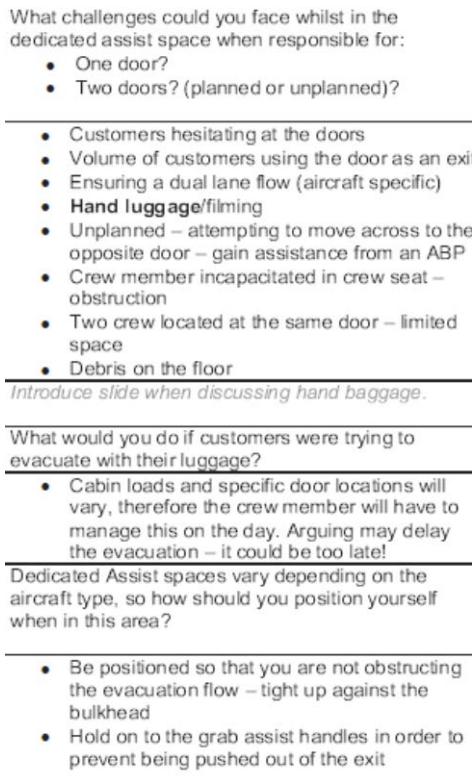

Figure 8. Excerpt from BA 2015-16 recurrent training instructor's notes on evacuation techniques and crowd control.

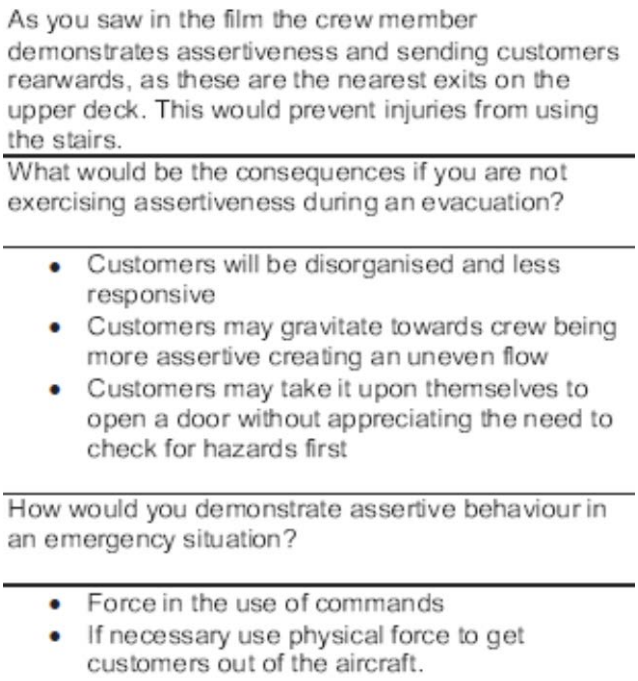

Figure 8. Excerpt from BA 2015-16 recurrent training instructor's notes on evacuation techniques and crowd control.

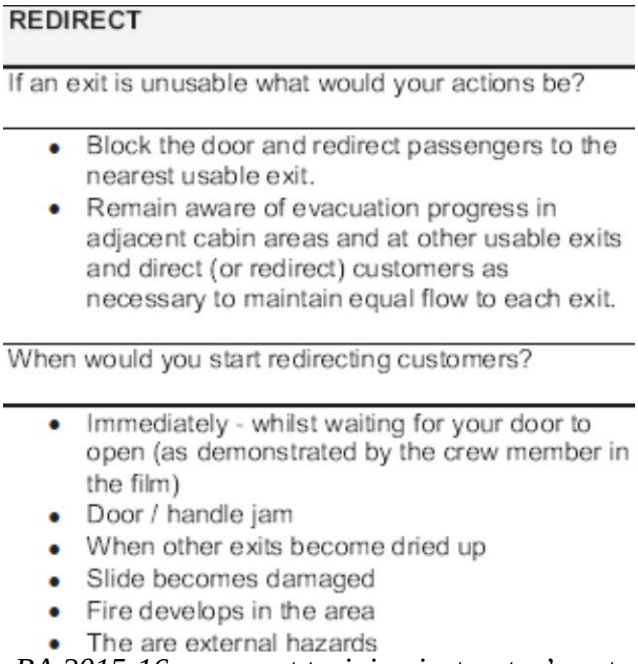

Figure 9. Excerpt from BA 2015-16 recurrent training instructor's notes on evacuation techniques and crowd control.

3.0 Emergency Response

The FAA certified LAS as a 14 CFR Part 139 airport with Index E aircraft rescue and firefighting (ARFF) capabilities.[4] The airport had one fire station, Station 13, that was located approximately 0.40 miles from the accident site on runway 7L near the intersection with taxiway A6. (see figure 10) Station 13 housed three Clark County Fire Department (CCFD) ARFF vehicles identified as Red Dog (RD) 41, RD42, and RD44 as well as a medical unit (R13).

After stopping the airplane on the runway, the flight crew contacted the LAS air traffic control tower at 1613:19 and requested ARFF vehicles respond to their location. Statements from ARFF personnel similarly indicated the time of dispatch was 1613. Internet videos showed ARFF vehicle RD41 arriving on scene at the left engine about 1 minute and 59 seconds later (see section 4.0) and discharging agent onto the fire from both the bumper and roof turrets. RD41 was followed closely by RD44, an ARFF vehicle equipped with a high reach extendable turret (HRET), and RD42. An airport-based medical unit (R13) and a command vehicle also responded from Station 13. Additional mutual aid fire and medical personnel from four CCFD stations also responded in support of the airport units. In total, 41 emergency response personnel were assigned to the accident and 16 additional personnel were placed on standby.

[4] An Index E airport was required to have a minimum of 3 ARFF vehicles. One was required to carry either 500 pounds of sodium-based dry chemical, halon 1211, or clean agent; or 450 pounds of potassium-based dry chemical and water with a commensurate quantity of AFFF to total 100 gallons for simultaneous dry chemical and AFFF application. Two vehicles were required to carry an amount of water and the commensurate quantity of AFFF so the total quantity of water for foam production carried by all three vehicles was at least 6,000 gallons

After RD41 positioned near the left wing, RD44 arrived and positioned to the right side of the nose "to protect passengers exiting from both sides of the aircraft." The vehicle discharged agent from the HRET which initially impacted the area near the 1R door and slide/raft. The vehicle's stream was unable to reach the fire from its location and repositioned closer to the airplane's nose about 45 seconds later. The HRET was elevated and agent was discharged onto the fire side of the airplane aiding the fire attack.

RD42 arrived on scene about 20 seconds after RD44 and positioned close to the airplane, near the 1L slide/raft and the nose. RD41's attack had already changed the color of the smoke from black to white by this time. RD44 discharged agent directly onto the area of smoke/fire with its bumper turret and, along with the two streams from RD41, provided three simultaneous attacks on the fire. Shortly after RD42's attack began, the white smoke dissipated. It was estimated, based on lack of smoke, that the fire was likely extinguished by 16:17:44 – about 2 minutes and 26 seconds after the beginning of RD41's initial attack – if not before.

CCFD provided statements from firefighters and an event summary that is included as attachment 4.

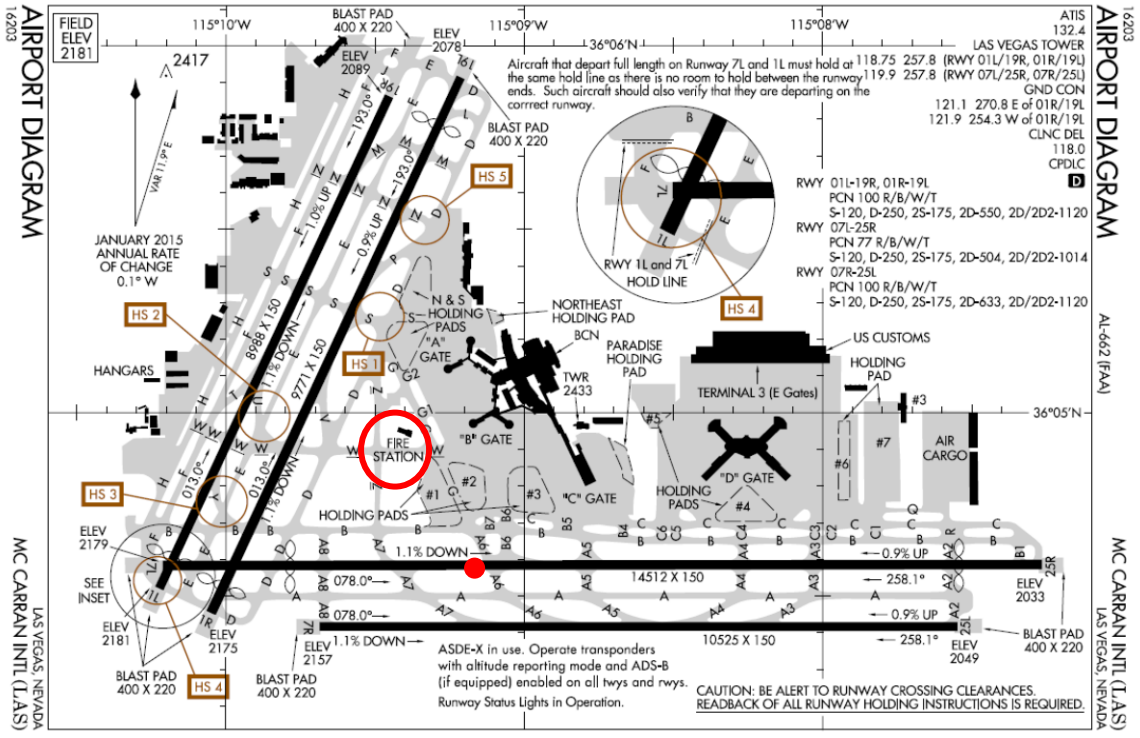

Figure 10. LAS airport diagram showing the location of Station 13 and the accident site

4.0 Timeline of Events

Two videos were identified on YouTube that showed the evacuation from two different angles. Video #1 (attachment 2) shows of view of the airplane from the airport terminal and began prior to the start of the evacuation. Video #2 (attachment 3) was taken by a passenger on a taxiing Southwest Airlines airplane and also shows the left side of the accident airplane. Video #2 began after the start of the evacuation. The videos were synced with one another through a common event viewed by both cameras – namely, the first application of agent by RD41. The events observed on the videos were then placed on a common timeline with events from the Cockpit Voice Recorder and Flight Data Recorder by correlating the sounds of the initiation of the evacuation from within the cabin to the external observations of the airplane doors opening and slide/rafts deploying and inflating. The following table summarizes the significant events surrounding the evacuation. Times based on video observations should be considered approximate.

Time (Local)	Event
1612:51	Uncontained engine failure
1613:05	Airplane parking brake set
1613:19	Flight crew requested ARFF response
1614:16	Start of video #1 (attachment 2)
1614:23	Flight crew commanded evacuation via P/A
1614:30	Doors 1L/4L open
1614:37	1L/4L fully deployed and inflated
1614:41	1R fully deployed and inflated
1614:42	Start of video #2 (attachment 3)
1615:06	Fuel cutoff
1615:18	RD41 arrived, first extinguishing agent applied to left engine
1615:52	RD44 arrived
1616:05	RD42 arrived
1616:29	Two occupants in white shirts exited door 4L
1616:55	Occupant assisted at bottom of 1R slide/raft; end of evacuation
1617:44	Minimal smoke observed from left engine; fire extinguished

Table 2. Timeline of events.

5.0 Medical and Pathological Information

British Airways reported 19 passengers sustained minor injuries and one occupant sustained a serious injury during the event. F/A #1 reported that the 1R slide/raft was wet and slippery from the extinguishing agent being applied to the airplane. She fell upon reaching the end of the slide/raft and fractured her left radius (forearm). She also suffered a compression fracture of the 1st lumbar vertebra in her lower back. The Clark

County Fire Department reported that 3 passengers were transported to local area hospitals.

Injuries	Flight Crew	Cabin Crew	Passengers	Other	Total
Fatal	0	0	0	0	**0**
Serious	0	1	0	0	**1**
Minor	0	0	19	0	**19**
None	3	9	138	0	**150**
Total	**3**	**10**	**157**	**0**	**170**

Table 3. NTSB injury classifications.

6.0 Photographs

A Google search for images of the accident was performed and selected images taken during or immediately after the evacuation are shown below.

Photo 1. Flames and smoke surround the airplane prior to the evacuation.

Photo 2. Passengers evacuating out door 4L with fire visible beneath left engine.

Photo 3. Passengers evacuating out door 4L with RD41 discharging agent.

Photo 4. Passengers evacuating out door 4L with RD41 discharging agent.

Photo 5. Passengers evacuating out door 1R prior to the arrival of RD44.

Photo 6. Passengers evacuating out door 1R after the arrival of RD44.

Photo 7. Passengers on the right side of the airplane after extinguishment of fire.

Photo 8. Left side of the airplane after fire extinguishment.

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Survival Factors Investigator

Attachments

1.) British Airways flight attendant statements
2.) YouTube video #1 “Fire and evacuation of BA2276, showing emergency slide deployment” (Aron Meltzner channel)
3.) YouTube video #2 “Fire Plane British Airways #2276 - Las vegas” (Jck Midia channel)
4.) Clark County Fire Department statements and event summary