The Manchester Accident — The Final Chapter

The author relates the firsthand accounts of crew members and passengers involved in the British Airtours Boeing 737 accident in Manchester, England, explores the cause of the accident and describes corrective actions that have been taken to prevent similar accidents.

by

Sharon Barthelmess, M.S.

The fair weather conditions in Manchester, England on August 22, 1985, gave no hint of what was to come. A British Airtours Boeing 737 was about to "make headline news in the United Kingdom, and around the world, and give rise to detailed and searching examinations of the equipment and procedures employed by many airlines." (1) The event was also to be marked by brave deeds that resulted in six awards of the Queen's Gallantry Medal and four Flight Safety Foundation Heroism Awards.

The Boeing 737, carrying 131 passengers and six crew on board began accelerating down the runway. Approximately 30 seconds later a loud bang was heard and the Number One engine erupted into a fireball. The captain immediately ordered "Stop." The aircraft came to an abrupt halt just off the active runway with its left wing pointed directly into a seven-knot wind.

Crew Members' Accounts

The following is an account of the captain's immediate impressions of the incident: (2)

"The takeoff ... was normal to about 123 knots, when a muffled explosion or bang was heard by us both [captain and first officer]. Later, when comparing our impressions, we had both thought that there had been a tyre failure. I called 'Stop,' closed the throttles, and then selected reverse thrust; meanwhile, the copilot was applying very heavy braking, and I remember saying 'Don't hammer the brakes,' so that damage would not occur to the undercarriage. I had decided that I would clear the runway, evaluate the situation and maybe taxi to the stand...

"I transmitted to the tower that we were abandoning takeoff. Halfway through the transmission to the tower the fire warning bell on Number One engine sounded, and I added this information in my transmission to the tower. The tower confirmed that there was a fire, and I asked them if it was necessary to evacuate the passengers. The tower confirmed 'Affirmative, starboard side.'

"At this time, the copilot was slowing the aircraft to turn onto the taxiway. My thoughts were to communicate to the cabin crew and I remember looking at the crew call button. Deciding this was too slow, I called on the cabin address "Evacuate, starboard side," as the aircraft came to a stop. We were carrying out the fire drill on Number One engine, when the purser entered the flight deck and asked me to confirm that I wanted an evacuation starboard side. I replied in the affirmative, and the purser left the flight deck, closing the door behind him. I then asked the copilot for the evacuation drill. About halfway through the drill, I looked out of the port window and saw flames from spilt fuel creeping up the port side. Behind me, I could hear noises from the cabin. We had nearly completed all the 15 items of the evacuation drill, and I told the copilot to evacuate through the starboard cockpit window. I followed him out of that window and remember immediately being hit in the face by very cold foam.

"When on the ground, the scene behind us was horrific. We could not have imagined that in such a short time the aircraft could become such a complete wreck. Both the copilot and myself went around to the front of the aircraft to assist the passengers. There appeared to be so much ground support that the management of the scene was taken from us."

Details From Inside the Cabin

The purser of British Airtours Flight 328 described the scene inside the cabin.

"We had almost reached the takeoff speed when I heard a muffled bang. I thought it was a nose-wheel burst, although I have never experienced this before. From my position sitting with my back to the flight deck and looking rearwards I thought the bang came from either underneath or behind,

which is why I thought it was a nose-wheel burst. There was then a rapid deceleration and a very loud and extended reverse thrust. There was a lot of vibration.

"When the aircraft came to a positive halt there was a pronounced jolt. Just prior to the aircraft coming to a stop, after the noise, I had looked inboard, in that I had leaned to my left side and looked into the body of the aircraft. I had seen people starting to stand out of their seats. I grabbed the P.A. and told people to remain seated with their seat belts fastened.

"As the aircraft came to a stop, I unbuckled my seat belt and went about three rows down into the cabin. I immediately noticed that a band all around the center of the cabin was glowing with an orange color. I can only describe it as a dayglow orange like a vivid sunset. I saw no smoke or flames. I looked out of the window on the port side and saw that the whole of the port wing was ablaze. The passengers on the port side could see this. (They had probably seen it for sometime already). I have no recollection of walking further ahead to the rear of the aircraft. I do not remember seeing beyond the orange.

"I ran back to the P.A. to order an evacuation, because I considered this a catastrophic situation. At this time, I hear over the P.A. the captain order 'Evacuation on the starboard side.' This is the sort of order you are always warned about but never experience in practice. I, therefore, flung open the cockpit door to confirm with Captain Terrington what he had said. He confirmed 'Evacuate starboard.' I closed the flight deck door and then went straight to the P.A. system and ordered 'Evacuation, Evacuation, stay calm and don't panic.'"

Problems Opening the Starboard Door

"I was the nearest crew member to the starboard front door, although opening this door was at the time the responsibility of Number Four crew member. I went straight to the door, looked outside the window, saw that it was clear, took hold of the handle and very quickly rotated it through 180 degrees.

"The bustle housing came away quickly before the door was properly open, and the slide began to drop down at the back, therefore, jamming the door. My main concern was that the slide might deploy in the cabin. Thankfully, the slide had not come out sufficiently. I pulled the door to as best I could, enough for the handle to be locked. I had made about six or so attempts to open the starboard door without success.

"I crossed the galley to open the port door instead, having abandoned my attempts with the starboard door. Since I could not open the starboard door, I had no choice but to try the port door, despite the fire which I knew had caught hold on that side. During this time, I was considering mentally how to overcome the fault on the starboard door. I remember saying to Stewardess Toff something like 'Guard the door' when I first went across to the starboard door. I wanted her to bar that door against passengers, given that there was a fire on that side.

"Before attempting to open the front port door, I looked out of the port door window. There were one or two whiffs of smoke, but the wind was blowing it away. I, therefore, decided that it was safe to open this door and deploy the slide and start an evacuation on this side."

Using Both Methods of Inflation

"I opened the door carefully in the same way as the starboard door. I was taking no chances, and, therefore, pulled the manual handle as well. Both methods of inflation take only a few seconds. Although I opened the door manually, I only opened it a little way at first — in case I had to close it quickly due to fire. As the door opened, I saw fire on the wing, and I saw fuel spillage from the wing underneath the aircraft running away on the ground. The whole profile of the wing was ablaze. The fuel which had not ignited was creeping towards the door.

"I decided in the circumstances we could evacuate at least some passengers before the fire caught up, and, therefore, told Stewardess Toff to take charge of this. I told her to make sure that passengers ran to the right to avoid the fire on the left-hand side. As soon as I had opened the door, foam had come into the cabin from outside.

"I then crossed the galley back to the starboard door again. All this would have taken ten seconds or so in total, no more. I put my hand under the slide and managed with difficulty to put it back into the bustle housing and then eased the door open and deployed the slide manually. I kept my foot on the bustle housing this time to ensure that the slide did not deploy prematurely. This time it worked.

"Due to my position in the forward galley areas, I have no recollection of any smoke in the cabin at this time nor did I see any fire inside the aircraft. By this time, passengers were evacuating through the port door under the guidance of Stewardess Toff. I began directing some through the starboard door once it was open. I could smell burning and smoke in the air, but the smoke was not a hazard at this point."

Evacuating the Passengers

"I kept grabbing people and shoving them out of the aircraft as quickly as possible. There was no mad scramble but simply a steady flow of people. The nearest description I can give is that the passengers were like a whole load of penguins shuffling out. You must remember that the aisle is fairly narrow, and that they were being funnelled through the aisle out of the door. I remember actually pushing people out onto the slide. The whole time I was shouting at them,

telling them to jump onto the slide, to stay calm and not to panic.

"I was then aware of smoke coming into the galley. This smoke became denser and darker and towards the end of this period was worsening and becoming very, very bad. I could not see the port door nor Stewardess Toff. On my side, I could not even see the slide. By the end, I was in total darkness working by touch only. The smoke was extraordinarily dense and thick.

"Three or four people came out of the cabin in a bunch together. This released a fair amount of thick, acrid smoke which had been piling up behind them. The people had been acting almost as a plug for the aisle exit. I took a good lung full of this acrid smoke. I felt I could not take more than one or two more or I would have passed out. Visibility was then about two or three inches. I felt around in total darkness in the area immediately surrounding me and could not trace anybody. I could not shout due to smoke inhalation."

Purser Bradbury then left the aircraft safely, and described the scene outside as almost a total white-out due to the foam being sprayed by the emergency services.

Recollections of Stewardess Toff

The following are portions of an interview given by Stewardess Joanna Toff, the Number Four cabin crew member at the forward passenger door.

Managing the Evacuation Procedures

Q. Can you tell us your impressions of the evacuation, and where you were standing?

A. By door Number One left, by the port side first of all, and as the slide deployed all the foam was shot straight into the aircraft, up the slide, onto the slide and on the galley floor, and, so, it made it a very slippery area. I fell, and I presumed people would start to slip about, but passengers were actually jammed into the aisle between the two galleys and it was like a bottleneck. Nobody could get out because there were so many, maybe four people, jammed into that little area.

Q. How did you get them out then?

A. Well, there was a little boy who was a little bit further forward than the others. I was pulling at him and when I managed to free him and push him down that slide, the flow started to become a lot easier then. Passengers seemed to tumble out of the area then, and we could pull them out and throw them out either door until they were able to get out.

Q. So, you actually needed to pull the passengers out from that area?

A. Yes, you had to really hold them by their clothes and really pull hard to free the first person. Others had to be pulled to guide them, because they were confused, quite panicked. It wasn't easy to [pull them]. They weren't, they couldn't make up their own minds. They had to be shown everything, and really had to be pulled and thrown into the light because it was starting to get quite dark, and there was a lot of confusion.

Q. And, so, you were pulling people out and throwing them onto the slide, and then at what stage did you have to start going into the cabin to retrieve people?

A. After about seven or nine passengers, because after that the flow more or less stopped, there didn't seem to be anybody coming out of the cabin. So, I went into the cabin and found a man who was seated on the edge of the seat and pulled, but he struggled against me because his family was still on board, and I really had to struggle to pull him to get him to the door.

Q. Did he actually say anything to you?

A. Well, I really don't remember him saying anything, because you think you look quite normal, and you think you are thinking quite normally, but it turns out at the end of it that you are all black and your voice isn't as normal anyway. So, you probably seem to be speaking to them normally, but all the time you can see the alarm on their faces, you don't know what that is because of until a lot later. But, there were people in the area who were more or less resting before they were caring to come to the door, they weren't rushing to the door at this time. So, although I had the impression of a few people coming past me, it must have been quite a lot because there was only a few at a time. I found out later that more people came out of the two doors.

Crawling Through the Cabin

Q. When you went into the cabin did you stay standing up, or did you go in crawling?

A. No, you couldn't really [stand], because the first few passengers who were in the bottle-neck effect were holding back the smoke. As soon as they came out, the smoke came rolling behind them towards the flight deck door . . . so, it was very black and smoky. But, on the ground . . . there was about six inches of clear air space and you could breathe there, if you crawled on your hands and knees you could breathe. It wasn't as bad, you could feel the smoke and you knew, and the heat, but it wasn't as bad, it was breathable down there. And, on the ground you could pull passengers along and guide them that way, and they could breathe.

"By shouting to the passengers to stay low, they managed to crawl towards the door, I think. So, the first people came out standing up, and after the first few people you went down on your hands and knees and pulled people to keep them low. There was a girl on the floor straight away, but she had been

knocked there. It wasn't because of the smoke or anything, but she was down low anyway and almost trampled upon. We had to lift her out, and I had to lift her away to stop people standing on her.

Q. As you told me, you ended up almost with pulled shoulder and arm muscles?

A. In training, you know, when they say to people "stand on top of the slide and jump," it wasn't like that at all. What happened was you ended up pulling the passengers and throwing them down the slide head first, or whichever, just to really get them out with any kind of speed. There is no "jump and sit." There was nothing like that. You just say to people to go down the slides and run to your right which is away from the fire. Those were the only instructions I remember shouting, other than just to stay calm. It wasn't textbook but it worked for those people.

Entering the Cabin for the Last Time

Q. So, you went back again, I believe?

A. Yes, back again, and by this time it was getting really quite bad. And the conditions by now, it was quite quiet in the cabin, there were no real sounds in the cabin, and I went down quite a way. Then, I felt something hit me, and that was a passenger, a young girl, and I found out later she was just 13 and very little. She felt about 200 pounds. I could hardly pull her, and I pulled her up the aisle, and brought her to the door where it is light, bright light. I looked at her face and I thought she was probably dead, but she did survive later. There was nothing I could do for her there, a fireman just shouted to throw her down.

Q. Did he then say to you —?

A. Yes, he was shouting at me to come down again. It didn't feel that bad, so I went back inside, checked all around and the galley. There was nobody. It turned out that people came up later after that, but I couldn't see anybody for three or four rows.

Q. And the only way you could see at that stage was on your hands and knees?

A. No, you couldn't see, it was just by touch. In the cabin then, it was just by touch. I couldn't feel anybody, but you could feel the metal on the bottom of the seats was hot. So, I knew the conditions were getting quite bad inside the cabin.

Q. So, how did you find your way back to the door?

A. Well, I was almost a full-length away and I knew it was behind me, and when I got near the door there was a bright light. There was foam on the galley floor and all down the slides. It was all over the passengers who were the first to get out, but the firemen were pointing the foam straight up the slides as the people were evacuating, just to stop anybody from catching fire, because they needed to be damped down because there was a lot of fuel about.

Dangerous Fuel Spillage

Q. Yes, I understand your whole uniform was covered in fuel?

A. Everything, really right down to my underwear, my shoes soaked, and I was soaked in fuel. I didn't think there was any danger of catching fire, but my uniform scorched when I went under the wing to pull a passenger from under the wing. I thought it would catch fire eventually but fortunately it didn't.

Q. When you eventually crawled back to the door did you just tumble onto the slide?

A. I say I went onto the slide, a fireman said he had to pull me. I thought I jumped, but he said I was pulled. I think I probably jumped. I don't know, really.

On August 6, 1987 it was announced that Purser Arthur Bradbury, Stewardess Toff and two firemen of the Manchester Airport fire Brigade had been awarded the Queens Gallantry Medal. The award was also given posthumously to the two stewardesses in the aft section of the aircraft who died in the fire: Jacqueline Urbanski and Sharon Ford.

Passengers' Accounts

According to survivors, the engine explosion that occurred during takeoff sounded like a shotgun blast. The passengers seated on the left side of the aircraft were terrified as they watched the Number One engine erupt into a huge fireball. Smoke began to penetrate the cabin just before the aircraft came to a halt, as intense heat from the burning wing and engine melted the aft-left windows (see photograph). Smoke and toxic fumes then quickly traveled forward in the cabin along the ceiling.

Graphic not available

Intense heat from the Boeing 737's burning wing and engine melted the aft-left windows and surrounding structure. (Photo courtesy of U.S. NTSB)

Listening to the Passengers

The following are detailed accounts of some of the surviving passengers.

Seat 3D. Doctor said by the time he reached the exit area, smoke had traveled the full-length of the cabin and had an extremely toxic smell.

Seat 5B. Female passenger was delayed in the aisle, pushed into a seat row and disorientated by smoke.

Seat 5D. Male recalls the thick, black smoke coming forward along the ceiling, but then remembers nothing associated with getting forward to an exit and slide.

Seat 6B. Male passenger recounts the penetration of the smoke. "I then, saw a roll of thick, black smoke, clinging to the cabin ceiling, making its way rapidly to the front area. When I reached the front area it seemed to swirl around and return to the rear. All the time it was getting heavier and moving lower. About this time, I was aware that the front doors were open. People began to exit from the plane, and a crowd of people began to move forward. I then breathed a gulp of the smoke and immediately began to choke. After that, I became anxious to get out into the fresh air. I think I managed to climb forward over the seats in front of me, some of which I remember had collapsed forward. Somehow I was standing close to the right door and I think a stewardess instructed me to jump into the escape chute." (3)

Seat 7A/7B. Female passenger in 7A and male passenger in 7B both said they could not see and had to feel their way to the exit.

Seat 7E. Young, female passenger, stated she went to the end of her seat row and waited to get into the aisle. She took off her shirt and held it against her mouth, but she still inhaled smoke which was burning her throat and she could not breathe. She could not get into the aisle, so climbed over seat backs to the exit.

Seat 8B. Male passenger, age 31, rescued by fireman after 33 minutes. Died six days later in the hospital.

Mother and Child Escape

Seat 11D. Female passenger with two-year-old son. "The next thing I can remember is looking to my husband and he told me to 'get out.' I remember that two girls were seated on my right and one of them was trying to open the overwing exit. A man behind me shouted to the girl to kick the exit in. (The right overwing exit was removed, only to fall on a female passenger and block the egress path until the door could be moved by another passenger). I then stood up with Daniel (infant), and I was preparing to escape through the exit. I saw a woman in front of me holding a small baby in her arms. She was shouting to other passengers to take her baby. I then climbed through the overwing exit still holding Daniel in my arms and found myself standing on the wing." (4) Note: 27 passengers, including two infants, would ultimately escape through this overwing exit.

Seat 12D. Young boy, age 14, dragged out of right overwing exit five and a half minutes after aircraft had stopped. He was on a respirator for several days and subsequently released from the hospital.

Seat 18C. Male passenger stated that after a few seconds the windows at the rear of the aircraft began to melt, forming honeycomb until finally, they looked like honey. He moved forward, he could not see and held his breath. He said he felt like lying down and going to sleep. He made one last effort and dived towards the door, tripped, hit the wall to the right of the door, spun around and fell out backwards. His legs were still inside the aircraft, and he was lying on the wing. He was able to free himself and slide down the wing to the ground.

Another Cabin Crew Arrives to Help

Another British Airtours aircraft had just arrived in Manchester, England from New York, U.S., and the cabin crew were disembarking at the time the accident occurred. The crew members, led by Purser Hilary Cox, recognized the critical situation and directed the coach (bus) driver to proceed to the accident area. At some risk to themselves, they provided instant medical aid, as did many ground personnel who rushed to the scene. Without their help the death toll would have been far greater, according to Brian Furnish, Superintendent in charge of Safety Equipment and Procedures Training for British Airways.

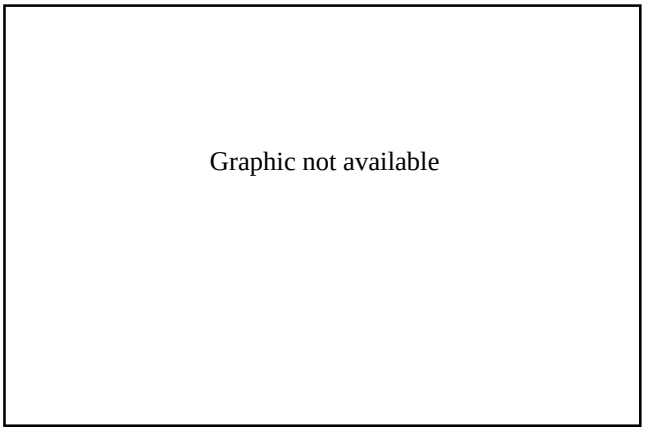
Pathological examination of the 54 people who died aboard the British Airtours Boeing 737 indicates that 45 people, that is 85 percent, perished as a result of having been incapacitated by the effects of toxic gas and smoke inhalation, thereby eliminating any chance of escape from the aircraft. Nine passengers died from the thermal effects of the fire. One person rescued by firemen died some days later in the hospital.

The exits used during the evacuation were as follows:

Exit	Number of Persons
Right Forward	34 - 36
Left Forward	15 - 17
Right Overwing	27 (including 2 infants)

Accident Causes and Lessons Learned

Examination of the Number One engine revealed that a crack in the combustion can had caused it to rupture. A piece of the combustion can was propelled by the explosion outward through the fixed engine cowl, carrying with it a 3-inch by 3-inch piece of the outer bypass duct. This projectile weighed about four pounds and was propelled directly at the left wing fuel tank access panel creating a 6-1/2 by 8-1/2 inch hole (see photograph).



When the left engine combustion chamber failed, a four-pound section penetrated the wing fuel access panel. Fuel poured over the engine and ignited, spreading fire beneath the fuselage that melted windows and entered the cabin. (Photo courtesy of U.S. NTSB)

Penetration of the fuel tank access panel allowed fuel to pour from the left wing fuel tank into the engine casing. A fireball could be seen forward of the fuel fire on the tarmac and beneath the wing. The fireball was the result of fire "blowing" out the hole in the access panel. Burning fuel spread along the fuselage, causing windows to melt and fire to enter the cabin. Flames spread over the top of the aft section of the fuselage, and a portion of the left wing surface was destroyed in the explosion.

Failure of the Number One engine's combustion chamber resulted in U.K. Civil Aviation Authority (CAA) issuance of an Airworthiness Directive which required more rigorous inspections of combustion chambers, repeat inspection of critical vibration frequencies and limitations on repairable crack lengths. The CAA also actively pursued improvements in inspection methods involving radiographic and borescope techniques. The improvements included revised techniques and training programs.

Penetration of Wing Tank Access Panels

The Manchester accident highlighted the vulnerability of Boeing 737 access panels to penetration by foreign objects. The access panel is constructed of cast aluminum, while the surrounding wing is constructed of a much stronger tempered aluminum. It is possible that the fragment would have bounced off the access panel instead of penetrating it had the fuel tank access panel been constructed of tempered aluminum. The U.S. Federal Aviation Administration (FAA) published Airworthiness Directive (AD) Number 86-NM-175-AD requiring the replacement of the fuel tank access panels, immediately adjacent to the engine, with new panels of increased strength, by February 1988.

In May 1988, the FAA issued a Notice of Proposed Rulemaking (NPRM) to require impact and fire resistant fuel tank access panels on all newly manufactured U.S. transport category airplanes. In addition, all fuel tank access covers on existing aircraft must be designed to minimize penetration and deformation by tire fragments, low energy engine debris or other likely debris, if the access panel is located in an area where service experience indicates a strike is likely. Existing fuel tank access covers must also be shown by analysis or tests to be fire resistant. If the proposed rule is adopted, a two-year compliance period would allow operators and manufacturers time to redesign and produce improved fuel tank access panels with a minimum of disruption to fleet schedules or to production lines. (5)

Problems With the Opening of the Forward Right-Hand Door

The purser on British Airtours Flight 328 experienced difficulty opening the forward right-hand door during the emergency evacuation. Apparently the "escape slide stowage cover, attached to the inside of the door, detached prematurely and wedged between the door and the door frame. The resulting door obstruction was cleared by pulling the door inboard, repositioning the cover and pushing the door and slidepack out together." (6)

After the accident, the problem with the escape slide stowage cover "was reproduced on other aircraft and confirmed as a design weakness associated with aggressive and rapid door opening." (7) Boeing developed a series of modifications that were introduced by Service Bulletin (SB) Number 737-25-A1182 and FAA Airworthiness Directive (AD) 85-19-04 and 85-25-04.

Access to and Opening of Type III and Type IV Emergency Exits

Accident investigation reveals that mid-cabin Type III exits can, in some cases, become a major escape route. This is especially true in accidents where pairs of exits at one end of the cabin become unusable. In the Manchester accident, the two rear exits were never opened and 27 passengers, including two infants, escaped through the right overwing Type III exit.

In an effort to improve the use of Type III exits, the CAA issued Airworthiness Notice (AN) Number 79 in January

1986, requiring improved access to and opening of all Type III exits for all aircraft on the UK register certified to carry 20 or more passengers. The new requirements were implemented on all affected UK aircraft by July 1986.

The more significant aspects of Airworthiness Notice (AN) Number 79 are as follows:

1. There shall be no outboard seat adjacent to the Type III exit, thus creating two access routes to the exit from the cabin aisle. Alternatively, there shall be a single access route between seat rows from the aisle to the exit of a sufficient width and located in such a way that no part of any seat that is beneath the exit extends beyond the exit center line and a vertically projected space of 10 inches.

2. The seat backs of each seat, which forms the boundary of the access route to each such exit, shall be restricted in movement to ensure that the minimum width access route from the aisle to the exit is maintained, and that seat backs remain in essentially the upright position.

3. Pictorial instructions similar to those found on the Passenger Safety Card clearly showing the method of operation of the exit and disposal of the hatch, shall be located at eye-level in front of each passenger occupying a seat which forms the access route to the exit.

4. While the improved floor level access should minimize the chance of passengers either kneeling or standing on seats in order to reach the exit, it is also considered necessary to ensure that the seat pan and lower back rest suspension of all seats bounding the access route(s) from the cabin aisle to the exit shall be free from any gaps that might entrap a foot or other part of a person standing or kneeling on the seat.

This Airworthiness Notice was reissued in March 1987, and extended the requirements to include the smaller Type IV exits, with an effective compliance date of December 1987, for all UK-affected aircraft.

Disposal of the Exit Hatch

The CAA recommended that the standard procedure for disposal of the Type III exit should be such that the exit hatch does **not** remain inside the aircraft. It was concluded that the exit hatch is potentially a more significant hazard inside the aircraft and could, in some circumstances, become an obstruction. This is not necessarily the case with the smaller and more lightweight Type IV exit hatch, and, therefore, no standard procedure for disposal of this exit has been established by the CAA.

Seat Allocation and Briefing of Passengers at Type III and Type IV Exits

Given the fact that many "self-help" exits are heavy, some in excess of 60 pounds, the CAA felt it was prudent to allocate the seats which form the access route from the cabin aisle to the exit, only to passengers who appear physically capable of operating and/or assisting with the operation of the exit.

The CAA issued a notice to public transport operators in May 1986, reminding them of the importance of correct seat allocation at self-help exits and listed the categories of passengers who must not be seated close to overwing exits.

In a further notice to operators, issued in July 1986, it was recommended that operators include a discrete briefing of the passengers seated in the seat rows leading to self-help exits, drawing their attention to the exit operating information provided on the seat back instruction placard.

Galley Vestibules

When panic occurs, as it did in the Manchester accident, passengers will not only proceed to the exits along the aisle but may also climb over seat backs. Where galleys and lavatories are located in vestibule areas, further progress to the exit is only possible along the aisle, and congestion can develop. Current minimum aisle widths are based upon evacuation demonstration tests and related information. A literature search by the CAA did not reveal any test data in which panic or a competitive attitude between passengers had been reproduced or represented by government or industry. This raises the question of whether increased aisle widths in areas where floor to ceiling restrictions are present, such as that created by two galleys, might reduce the potential for congestion. The results of a CAA test program designed to evaluate a range of conditions to determine whether the effects of panic can be minimized will be discussed later.

Passenger Protective Breathing Equipment

According to N.J. Butcher of the CAA, "There is no doubt that in the Manchester accident, as in many other accidents where there is fire, a great number of the deaths were caused by inhalation of toxic fumes." We know that in the post-accident fire environment, the irritant and toxic smoke and fumes together with the high inhalation temperatures can incapacitate passengers. In such conditions, it is argued that passenger smoke hoods could be of benefit by extending the time available to escape while delaying the onset of panic.

The debate on the value of smoke hoods started in 1969 when the FAA first proposed the introduction of a simple hood. The proposal was eventually withdrawn on the basis that the concept of a simple air bag created many of its own hazards, not the least of which was the dangerous build up of carbon dioxide within the bag.

More recently, we have seen filtration elements, carbon dioxide absorption elements and a compressed gas supply

added to such hoods to give greatly improved duration of protection. [It has been reported to FSF that a passenger recently was denied boarding by one airline because of the gas cannister attached to his personal smoke hood.]

In September 1986, the CAA hosted a 'Four Authority' meeting on passenger smoke hoods. The other participants were the FAA, Transport Canada and the French DGAC. The four authorities agreed to undertake a study program to assess the safety benefits and any likely offset due to possible delays in evacuation time induced by the use of such equipment.

In December 1987, the CAA concluded that unless a smoke hood meets all the essential requirements in terms of protection against fire gases, resisting fire, performance duration, weight, ease of donning and availability at the moment of crisis, it could not be relied upon in the full range of circumstances that experience has shown might reasonably be expected to occur. A less than fully adequate smoke hood might not only fail to provide protection against foreseeable danger, but it could also encourage a false sense of security in the passengers, and in some cases even delay evacuation, thereby putting lives at risk.

The CAA decided not to make passenger smoke hoods a mandatory UK requirement. This decision was shared by the aviation authorities of the United States, France and Canada, and it was agreed that further work is needed in order to produce an internationally agreed standard for passenger smoke hoods. In support of an international specification, the FAA has proposed a research program to assist in the development of performance specifications, certification standards and test methods for passenger protective breathing equipment. The program is expected to be completed by May 1990.

Effect of Wind Direction on Aircraft Fire

If, as happened in the Manchester accident, the aircraft is brought to a stop with the fire on the upwind side of the fuselage (the left wing was pointed directly into a seven-knot wind) the fire will be driven against the fuselage and will rapidly penetrate the aircraft skin. Fire penetration of the fuselage skin can occur very quickly with times ranging from 20 to 60 seconds. This has been demonstrated in various tests by NASA and the FAA during the 1970-1980 period and was a subject of discussion by the SAFER committee (7a).

However, if the aircraft is stopped with the fire on the downwind side of the fuselage the situation will be very different. In such cases the fire will not necessarily be driven against the fuselage, and, as a consequence, the potential for the fire to directly penetrate the fuselage will be significantly reduced. If fire penetration does occur, it will probably happen at a much later stage.

In October 1986, the CAA issued a notice to public transport operators, on the effect a crosswind might have on the chances of survival when an aircraft is on fire on the ground. CAA Notice Number 4/86 advised operators that in cases where an external fire has been identified, it is recommended that the aircraft be stopped with the fire on the downwind side of the aircraft if this does not delay the evacuation. In other situations, it is advisable to try and halt the aircraft heading into the wind, if this can be done within the confines of the runway or taxiway and without causing undue delay to the evacuation of the aircraft.

Passenger Behavior in Emergency Evacuations

Passenger behavior in precautionary evacuations is reasonably well documented and this, together with the video recordings of the 90 second evacuation demonstration for certification, provides much information on how passengers behave in a noncompetitive situation. We know that such evacuations are mainly conducted in an orderly manner with people waiting to enter an aisle and queuing to use an exit. However, less is known about the way passengers behave in panic situations and how competitive behavior affects evacuation flow rates.

Information from a literature study regarding human behavior, indicates that where there is a serious threat to life and only a limited opportunity for escape, it is human nature for individuals to compete with each other in order to survive. The behavior reported by passengers in the Manchester evacuation and other similar accidents support this theory.

In order to learn more about competitive behavior in aircraft emergencies, the CAA, in association with the Applied Psychology Unit of the Cranfield Institute of Technology, UK, conducted a series of evacuation exercises. The tests were designed to determine the effects of various bulkhead configurations and overwing seating configurations on passenger behavior and evacuation flow rates.

For both ethical and practical reasons, it is not possible to put volunteers in a situation of fear and threat for the purpose of research. However, a well-established research technique used in behavioral science is to offer an incentive payment to subjects. This is done in an attempt to influence the motivation and performance of subjects either individually or in groups. In these tests, an incentive payment (i.e., monetary reward) is given to the first 30 test subjects (out of 60 subjects total) to evacuate the aircraft. According to the CAA, they have not been disappointed with the degree of motivation that has been generated!

According to Dr. Helen Muir of the Cranfield Institute of Technology, UK, the volunteers were not given any infor-

mation regarding the cabin configuration or exits to be used prior to each evacuation. In order to introduce as much realism as possible, the trials took place on a Trident aircraft parked on the airfield at Cranfield. The volunteers were physically fit men and women between the ages of 20 to 50 years old.

Upon boarding the aircraft the volunteers "were given a standard pre-flight briefing by cabin staff, they heard taped noise of the engine start up, taxi down the runway and finally the sound of an aborted takeoff, followed by the voice of the captain telling them to undo their seat belts and get out. The doors to be used were opened by the cabin staff or members of the research team. This was to ensure that the evacuation times would not be influenced by the variable time taken for passengers to open doors.

"Ramps were mounted at the doors for passengers to walk onto, in order to ensure that the hesitation time to go down the slides was not a compounding variable and to remove the risk of passenger injuries from using the chutes. The behavior and evacuation times of the volunteers were recorded using video cameras [with time bases] mounted inside and around the exits from the cabin." (8) [Ed. note: FSF visited Dr. Muir at Cranfield in 1987 as tests were in their beginning phase. We were highly impressed with the care taken to establish, for the first time, baseline data of high quality on group competitive behavior in aircraft-like surroundings.]

Figure 1 illustrates the vestibule configurations used in the evacuation trails. The Boeing 737 involved in the Manchester accident had a vestibule configuration of 23 inches between the bulkheads in the forward cabin. According to the Number Four cabin crew member at the forward passenger door, "Passengers were actually jammed into the aisle between the two galleys and it was like a bottleneck. Nobody could get out because there were so many, maybe four people, jammed into that little area."

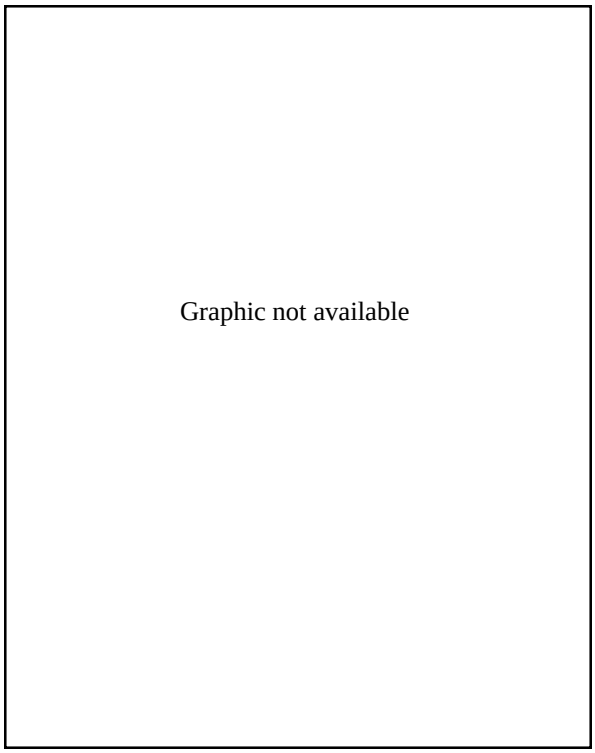


Figure 1. Vestibule configurations used in the evacuation trials at the Cranfield Institute of Technology, U.K.

In response to the question "How did you get them out then?" the cabin attendant responded, "Well, there was a little boy who was a little bit further forward than the others. I was pulling at him, and when I managed to free him and pushed him down that slide, the flow started to become a lot easier then.

"Passengers seemed to tumble out of the area then, and we could pull them out and throw them out either door until they were able to get out." (9)

This "bottle-neck" effect was clearly evident on the video recordings of volunteers attempting to evacuate through the narrow vestibule area between the bulkheads in the forward cabin. In contrast, the wider vestibule areas allowed a smoother flow of passengers without the "bottle-neck" effect.

Evacuation flow rates were also studied using a variety of seating configurations adjacent to Type III exits. The CAA determined that the seating configuration around the Type III overwing exits on the Boeing 737 involved in the Manchester accident, "allowed insufficient space for the passenger seated near the exit to stand up 'square' to the exit such that the heavy (about 22 kilograms/48.5 pounds) hatch could be removed and disposed of. In the accident, and generally in the tests, the passengers had difficulty in removing the hatch and then found that they tended to fall back in the seat with the hatch on top of them." (10)

Preliminary test results indicate that increased minimum spacing between the overwing seat rows and no overlap of the exit centerline **or** the removal of the seat adjacent to the exit (alternatives required by CAA Airworthiness Notice Number 79) have a significant effect on the ease with which passengers can evacuate a Type III exit.

More than 1,100 subjects have taken part in the evacuation tests described above. Of the total amount, 68.4 percent of the subjects were male and 31.5 percent were female. The mean age of the participants was 29.1 years. Dr. Muir noted that since the volunteers in the trials do not represent a cross-section of the traveling public (no young, elderly or disabled volunteers are included), it must be argued that in a real emergency, the problems highlighted by these tests (i.e., bottleneck at galley vestibules and difficulty removing Type III exit hatch and evacuating in overwing area) would only be exacerbated.

Significant safety improvements in design, equipment and

procedures of major air carriers worldwide have resulted from that fateful day in August 1985, when 54 individuals (eventually 55) succumbed to the effects of toxic smoke and fire. ♦

References

(1) Furnish, B.H., "Manchester, The Analysis of an Accident," Proceedings from the USC Fifth Annual International Aircraft Cabin Safety Symposium, February, 1988, page 11.

(2) Ibid.

(3) Trimble, E.J., Senior Inspector of Accidents (Engineering), Accidents Investigation Branch, Department of Transportation, Letter, "Manchester Accident, Passenger/Evacuation," December, 1985.

(4) Ibid.

(5) "Design Standards for Fuel Tank Access Panels," Notice of Proposed Rulemaking (NPRM) issued in Federal Register Volume 53, Number 99, May 23, 1988, pages 18526-28.

(6) Butcher, N.J., "United Kingdom Civil Aviation Authority Policy On Cabin Safety," Proceedings from Fifth Annual International Aircraft Cabin Safety Symposium, February 1988, page 21.

(7) Ibid., page 23.

(7a) Special Aviation Fire and Explosion Reduction (SAFER) Advisory Committee, FAA-ASF-80-4 June 26, 1978 through June 26, 1980.

(8) Muir, H.C., Ph.D., "The Influence of Competitive Behavior on Evacuation Flow Rates," Paper presented at Sixth Annual International Aircraft Cabin Safety Symposium, Long Beach, Ca., January 1989.

(9) Furnish, B.H., "Manchester, The Analysis of an Accident," Proceedings from Fifth Annual International Aircraft Cabin Safety Symposium, February 1988, page 15.

(10) Ashford, R., "Cabin Safety Research in the UK and European Collaboration," Paper presented at Sixth Annual International Aircraft Cabin Safety Symposium, Long Beach, Ca., January 1989.

About The Author

Sharon Barthelmess is president of Free to Fly, a company that organizes and conducts seminars designed to help persons overcome their fear of flying. The San Diego, Calif., U.S., company also conducts seminars over a wide range of aviation issues. A college instructor, she also lectures and writes about aviation safety.

A former cabin safety specialist with the U.S. Federal Aviation Administration, Barthelmess was responsible for the development, management and evaluation of the FAA's Aircraft Cabin Safety Program. During her FAA tenure, she also reviewed and evaluated existing regulations, and proposed regulations related to cabin safety.

Before joining the FAA, Barthelmess, who has an M.S. in psychology, spent seven years as a United Airlines flight attendant.

Reports Received At FSF

Regulations:

MEL Amendment Numbers 43-30 and 91-206.

The U.S. Federal Aviation Administration has issued a final rule revising the FAR to permit certain aircraft, for which an approved Master Minimum Equipment List (MMEL) has not been developed, to be operated with inoperative instruments and equipment not essential for the safe operation of the aircraft.

Amendment Numbers 43-30 and 91-206 permit rotorcraft, nonturbine-powered airplanes, gliders, and lighter-than-air aircraft, for which an approved MMEL has not been developed, to be operated with inoperative instruments and equipment not essential for the safe operation of the aircraft.

These amendments also permit general aviation operators of small airplanes, gliders, and lighter-than-air aircraft, for which a MMEL has been developed, the option of operating under the minimum equipment list concept or in accordance with the provisions of this final rule.

The pilot-in-command, owner, or operator will be required to identify the inoperative instruments or equipment, consult the aircraft's approved flight manual or owner's handbook, and review FAR 91.30[d](2). After the pilot-in-command ensures that an inoperative instrument or equipment is not required, the aircraft may depart provided:

• The inoperative instrument or item of equipment is deactivated or removed, the cockpit control of the affected instrument or item of equipment is placarded with the word "Inoperative," and the discrepancy is recorded in the aircraft's maintenance records. If the inoperative instrument or item of equipment is being removed from the aircraft or if deactivation requires maintenance, a certified and appropriately rated maintenance person will be required to accomplish the removal and maintenance task; and

• At the next required inspection, the inoperative instrument or item of equipment is repaired, replaced, removed, or inspected as appropriate.

New Books:

The United States Government Manual. 1988/1989. Office of the Federal Register. 896p.

Provides comprehensive information on the agencies of the legislative, judicial, executive branches, and the quasi-official agencies and international organizations of the U.S. government.

Code of Federal Regulations. Title 14, Aeronautics and Space. Revised as of January 1, 1988. Office of the Federal Register. 3 volumes. Parts 1-59, 60-139 and 200-1199.

Acronyms, Initialisms & Abbreviations Dictionary 1989. 13th ed. Gale Research, Inc. 3 volumes, 3,300p. ISBN 0-582-2581-0.

More than 450,000 definitions of a wide variety of acronyms, initialisms and abbreviations.

Countries of the World and Their Leaders. Yearbook 1988. Gale Research, Inc. 2 vol., 1,660p. ISBN 0-582-2343-5.

Provides information fr
om the U.S. State Department ("Background Notes") and other government sources on 170 countries. Details include basis social, political, and economic data, plus services offered to U.S. business overseas, embassy information, climate, world health information, QAU, NATO, OECD, UN and ASEAN.

Handbook of the Nations. 7th ed. Gale Research, Inc. 290p. ISBN 0-582-1593-9.

Originally compiled and published by the U.S. Central Intelligence Agency as The World Factbook - 1987. A brief guide to the economy, government, land, demographics, communications and national defense establishments of each of 223 nations and other political entities.

Encyclopedia of Associations 1989**.** Volume 1, National Organizations of the U.S. 23rd ed. Gale Research, Inc. 3 parts, 2,700+p. ISBN 0-582-2587-X.

Detailed entries describing over 22,000 active associations, organizations, clubs and other non-profit groups in many subject areas. Provides sources that can be contacted for further information.

Encyclopedia of Associations 1988. Volume 4. International Organizations. 22nd ed. Gale Research, Inc. ISBN 0-582-2694-9.

Details on more than 4,000 international nonprofit organizations whose headquarters are located outside of the United States.

Statistics Sources 1989. 12th ed. Gale Research, Inc. 2 volumes, 3,045p. ISBN 0-582-2586-1.

International coverage, by country, on where to get statistics for the country on a variety of subjects.

Experimental Guidelines for the Design of Turbine Rotor Fragment Containment Rings. Final Report. James T. Salvino, et al. Naval Air Propulsion Center. Report No. NAPC-PE-144. Contract No. DOT-FA71NA-AP-98.

Results of experimentation to determine design guidelines for turbine rotor fragment containment rings are reported, including an investigation of the containment characteristics of cloth rings and determining the engine casing thickness required for single and triple blade containment.

Statistical Summary of Commercial Jet Aircraft Accidents. Worldwide Operations 1959-1987. Boeing Company. Undated. 36p.

Presents accident statistics for worldwide commercial jet operators for aircraft heavier than 60,000 pounds maximum gross weight. Turboprop aircraft, Russian-manufactured/operated aircraft and military operators of commercial-type aircraft are excluded.

Business Jet Statistics. Aviation Information Services Limited. 1987. 100p.

The purpose is to supply aviation insurers with an independent source of information as an aid in assessing the specific risks that business jets represent in insurance terms.

Accidents to UK aircraft and to large jet and turboprop transport aircraft worldwide in 1987. Civil Aviation Authority. CAA Paper 88003. 23p. ISBN 0-86039-346-1.

This report presents provisional accident statistics for the year 1987 pertaining to all UK aircraft and all jet and turboprop fixed-wing aircraft of more than 5,700kg and all rotary wing of more than 4,500kg worldwide. The data in this paper is made available on the understanding that it is only to be used for the purposes of flight safety.

Civil Aviation Statistics of the World. 1987. 13th edition — 1988. ICAO Statistical Yearbook. International Civil Aviation Organization. ICAO Doc 9180/13. 176p.

Statistics on aircraft, pilot licenses, safety, fleets, traffic, finance. World, region and state and commercial air carriers.

International Federation of Air Line Pilots Associations. Report of the 43rd conference. Acapulco, Mexico, May 19-24, 1988. Volume 1. (Reports of the Opening Ceremony, the Agenda and the Awards Ceremony.)

32nd Annual Air Traffic Control Association Conference Proceedings. Fall 1987. Anaheim, CA. ISSN 0192-8740. 364p.

Proceedings of AEEC's International Conference on TCAS Implementation (Traffic Alert and Collision Avoidance System). Aeronautical Radio, Inc. ARINC Report 618. December 16, 1987. 350p.

Includes papers presented at the TCAS conference, including transcripts of the question and answer sessions. The conference explored the technical problems to be overcome before the airborne TCAS can be implemented.

Federal Aviation Regulations:

Federal Aviation Regulation. Part 25 — Air Taxi Operators and Commercial Operators. Change 27, eff. April 23, 1988.

Incorporates Amendment 25-63, Standards Governing the Noise Certification of Aircraft, and Amendment 25-64, Improved Seat Safety Standards.

Federal Aviation Regulation. Part 135 — Air Taxi Operators and Commercial Operators. Change 27, eff. April 23, 1988.

Incorporates Amendment 135-25, Smoking Aboard Aircraft.

Aviation Statistics

Progress and Difficulty of Commuter Air Carriers: A Summary and Discussion of the Report of FAA Inspection Program of Commuter Air Carriers

A one-year inspection program of U.S. commuter air carriers, launched by the U.S. Federal Aviation Administration (FAA) in March 1988, uncovered serious problems in both operational and airworthiness areas, including inefficient management control, inadequate training and poor maintenance procedures. Problems also were identified with check airman programs, crew coordination, flight and rest time, and aircraft weight and balance. The inspection report was issued in December 1988 and has been distributed to all commuter air carriers.

Background

Since the deregulation of airlines in 1978, the commuter air carriers have played an increasingly important role in meeting the nation's air transportation needs. In a 10-year period from 1978 to 1987, the passenger traffic on commuter air carriers has grown, more than doubling from 13 million to 27 million. In 1978, the first year of airline deregulation, the accident rate in terms of 100,000 aircraft hours flown for commuter air carriers was 4.685 accidents per 100,000 aircraft hours, which is 14 times higher than 0.332 accidents per 100,000 aircraft hours flown for the airlines operating under CFR 14 Part 121, i.e., the major air carriers. The differences during the past years are six times higher in 1984 and four times higher in 1986, and jumped back up to six times higher again in 1987. The accompanying graph shows a comparison of accident rates and trends for commuter air carriers vs. the major airlines for the decade. The commuter air carriers, after recording record-low numbers of accidents and accident rates in 1986, recorded 58 fatalities in 1987, which was the highest number since 66 fatalities were recorded in 1979. Of the 34 accidents involving commuter air carriers in 1987, 12 of them were fatal which was also the highest since 15 fatal accidents recorded in 1979. Note that the trend of the safety performance of commuter air carriers during this period is very encouraging while that for major air carriers has been at a standstill. However, a series of commuter air carrier accidents occurred in late 1987. FAA analysis of findings generated from nationally directed inspections revealed that commuter air carriers in numerous areas were either in noncompliance with or nonconformance with Federal Aviation Regulations. The results prompted the FAA to initiate a special inspection program in March 1988, which was designed to evaluate

commuter air carrier's compliance with safety rules and regulations and establish corrective programs, as necessary.

Special Inspection Program

The special inspection is a one-year program to be performed in the following three phases:

Phase 1, which was completed April 30, 1988, involved the analysis of safety related historical data, the identification of safety related problems and inspection focus areas and selection of a representative sample of commuter air carriers for on-site, in-depth inspection.

Phase 2, which was completed September 1988, involved the execution of on-site inspections of 35 commuter air carriers. A report, documenting the results, was prepared for each inspection.

Phase 3 involved the publication of the report and a follow-up program to brief the results to each individual operator.

At the end of Phase 1, 35 out of 173 commuter air carriers were selected for on-site inspection. FAA inspection teams spent an average of nine days at each location to conduct in-depth checks on the following focus areas:

Airworthiness	Operations
Management	Management
Training	Training
Airworthiness Directives	Check Airmen
Maintenance Inspection Programs	Crew Coordination
Minimum Equipment Lists	Flight and Rest Time
Service Difficulty Reports	Weight and Balance
Weight and Balance	

The program began in May and ran through September. The inspection report was published on December 1, 1987.

The results of the inspection program reflect the wide spectrum of operations within the commuter industry. A total of 1,284 findings of practices and procedures, with 53 percent involving airworthiness and 47 percent related to operations, were discovered to be in noncompliance or nonconformance with the Federal Aviation Regulations or were contrary to written FAA guidance material or written company policies. The following provides a summary and discussion of the issues identified during the inspection:

Operation Focus Area	Number of Findings	% of Commuters Inspected With Findings
Management	283	100%
Training	165	94%
Check Airmen	39	43%
Crew Coordination	17	40%
Flight & Rest	50	70%
Weight & Balance	51	45%
Total	605	

Airworthiness Focus Area	Number of Findings	% of Commuters Inspected With Findings
Management	233	94%
Training	38	49%
Airworthiness Directives	54	54%
Maintenance Inspections	217	89%
Minimum Equipment Lists	87	60%
Weight & Balance	36	57%
Service Difficulty Reports	14	20%
	679	

Of the total findings, 936, or 73 percent, occurred in areas of management and training as well as maintenance inspection programs; and 456, or 35 percent, of the total were considered serious enough to warrant the preparation of an Enforcement Investigation Report (EIR) and could lead to civil penalties against the carriers. All 35 commuter operators inspected had management problems involving inadequate or inexperienced supervision or control of operations by top management. In addition, 33 of the 35 inspected were found to have a lack of management control in procedures. However, the FAA emphasized that safety problems uncovered during the inspection have been corrected.

Management Problems

Every commuter air carrier inspected had management problems. The typical problem area in management was the failure to fill required management positions or that they were filled with inexperienced or unqualified people. The report noted that manual material was often outdated, unavailable for use or was incomplete. The problems encountered in the airworthiness area are similar to those in operations. Managers are often not familiar with regulatory material governing maintenance.

Training Problems

The training programs in both operations and maintenance areas are inadequate or inefficient. The report reveals that the training programs did not include required items, pilots did not complete required competency checks, training records were incomplete or nonexistent, recurrent training was not given, and testing standards were obsolete.

Maintenance Problems

The findings in this area indicate that some maintenance personnel were not knowledgeable of more complex maintenance requirements associated with 10 or more passenger aircraft. Other maintenance problems were incomplete inspections, deferred maintenance items that were not repaired during inspections, the absence of special tools and test equipment required for maintenance, and many aircraft prematurely approved for a return to service. Some maintenance programs were inadequate, and many commuters were not reporting operational interruptions caused by mechanical problems and mechanical reliability problems as required.

Other Problems

In addition to the above findings, the inspection also revealed that some check airmen conducted checks that were not authorized by the FAA. A majority of operators inspected provided insufficient rest for crew members prior to their flight assignments. Many commuters were found not providing procedures for determining actual passenger and baggage weights. As a result, many aircraft operated over weight or out of the center-of-gravity range.

A Follow-up Program

The inspection report was sent to every commuter air carrier last December. In connection with the execution of Phase 3 of the inspection program, the FAA commuter air carrier safety inspectors, "will be visiting all commuter air carriers to share the inspection program results, to work with individual operators to effectuate necessary corrective actions and improvements and to assist in the implementation of self-evaluation programs." These visits will be completed by March 31, 1989.

Reaction of the Industry

The commuter industry appears to disagree with FAA's findings. The Regional Airline Association (RAA) first called the findings misleading, then it said that at least 40% of the most serious (Class 1) findings had been dropped by the FAA prior to the publication of the report. The RAA also contended that there were cases incorrectly interpreted by FAA inspectors as violations on procedures previously approved by the agency.

Impact of the Inspection Program

In 1988 commuter air carriers were involved in two fatal accidents: one on January 19 another on February 19. Therefore, the fatal accident rate measured either by aircraft miles flown, or hours flown for by number of operations, is the lowest since the 1970s (see table on "Accidents, Fatalities and Rates"). The results of the special inspection program will provide the commuter industry with valuable information as a starting point for improving safety performance demanded by the traveling public.

Accidents, Fatalities and Rates
U.S. Air Carriers Operating Under 14 CFR 135
All Scheduled Service
(Commuter Air Carriers*)
1978 - 1988

	Accidents		Fatalities		Aircraft	Aircraft	
Year	Total	Fatal	Total	Aboard	Miles Flown#	Hours Flown#	Departures#
1978	61	14	48	48	226,187,000	1,302,136	1,995,728
1979	52	15	66	66	192,493,000	1,169,921	1,883,705
1980	38	8	37	37	192,200,000	1,175,588	1,776,999
1981	31	9	34	32	193,001,000	1,240,764	1,835,144
1982	26	5	14	14	222,355,000	1,299,748	2,026,691
1983	17	2	11	10	253,572,000	1,510,908	2,328,430
1984	22	7	48	46	291,460,000	1,745,762	2,676,590
1985	21	7	37	36	300,817,000	1,737,106	2,561,463
1986	15	2	4	4	321,629,000	1,738,239	2,663,327
1987	34	12	61	58	350,649,000	1,953,746	2,719,476
1988P	20	2	21	21	363,335,000	2,018,000	2,800,000

P Preliminary data.
Source of estimate: FAA
+ Rates are based on all accidents including some involving operators not reporting traffic data to RSPA.
* Includes accidents involving all-cargo air carriers when those accidents occurred during scheduled 14 CFR 135 operations. All-cargo air carriers no longer meet the RSPA definition for "Commuters". May also include accidents involving carriers whose FAA operating specifications permit scheduled revenue operations under 14 CFR 135, but who have not received an RSPA fitness determination.

Accident Rates

	Per Million Aircraft Miles		Per 100,000 Aircraft Hours		Per 100,000 Departures	
Year	Total	Fatal	Total	Fatal	Total	Fatal
1978	0.270	0.062	4.685	1.075	3.057	0.701
1979	0.270	0.078	4.445	1.282	2.761	0.796
1980	0.198	0.042	3.232	0.681	2.138	0.450
1981	0.161	0.047	2.498	0.725	1.689	0.490
1982	0.117	0.022	2.000	0.385	1.283	0.247
1983	0.067	0.008	1.125	0.132	0.730	0.086
1984	0.075	0.024	1.260	0.401	0.822	0.262
1985	0.070	0.023	1.209	0.403	0.820	0.273
1986	0.047	0.006	0.863	0.115	0.563	0.075
1987	0.097	0.034	1.740	0.614	1.250	0.441
1988P	0.055	0.006	0.991	0.099	0.714	0.071

Accident/Incident Briefs

Emergency Landing

Poland - November

Antonov An-24: Aircraft destroyed. Fatal injuries to one, non-fatal injuries to five.

The Polish An-24 with 25 passengers and four crew members on board was approaching Rzeszow after a scheduled flight from Warsaw when the pilot attempted an emergency landing in fields near the destination airport. Unconfirmed reports said the aircraft had struck an eagle and lost power.

The late morning weather was good when the airplane landed with its undercarriage up in a field just minutes before its expected arrival time at the airport. Before it stopped, the airplane hit an irrigation ditch and caught fire. Most passengers were reported to have evacuated the airplane before the fire began. Some survivors quickly left the scene by walking to a nearby road and getting rides from passing motorists.

The official news agency PAP said that the engines of the airplane failed near the city of Rzeszow and the pilot made an emergency landing.

Impala Stops Jumbo

Kenya - October

Boeing 747: Damage limited to tires. No injuries.

During the takeoff run at the beginning of a flight from Nairobi Airport, a Boeing 747 with more than 200 persons aboard was forced to abort when it hit an animal.

A passenger reported that the tires of the large jet blew when the pilot slammed on the brakes. The passengers deplaned without incident but had to walk about 100 yards back to the terminal. The crew identified the animal the airplane hit as an impala.

Punch in the Nose

Canada - November

Boeing 747: Damage to radar nose cone. No injuries.

The Boeing heavy with 269 passengers aboard was on a flight from New York's John F. Kennedy International Airport to London. Passing through 33,000 feet, the aircraft experienced turbulence and there was a jolt from forward of the cockpit as if something had hit the radome. As a precautionary measure, the pilot landed without further incident at Gander, Newfoundland, and the passengers continued to London on a relief airplane.

Upon investigation, a two-foot dent was found in the fiberglass nose cone. Initial conjecture about the cause included a change in air pressure, lightning, hail, ice, a meteorite, space debris and even a high-flying bird. The damaged nose cone was to be inspected by the manufacturer.

Rotation Aggravation

United Kingdom - Date not reported

Boeing 747: Minor damage to rear lower fuselage. No injuries.

The widebody was taking off on a scheduled flight from London Heathrow bound for Anchorage with the copilot flying the airplane. As the aircraft was rotated, the rear fuselage contacted the runway surface and was damaged. The captain and some members of the cabin crew later reported that they felt, and heard, a thump during rotation, but the flight crew considered the cause to be a main landing gear tire problem.

The control tower was requested to have the runway inspected for tire debris but none was reported. Considering the takeoff to have been normal in other respects, the flight crew decided to continue on to the intended destination.

Upon their arrival at Anchorage, the flight crew requested that emergency services stand by during the landing roll to inspect the landing gear and tires immediately after touchdown. There was no problem during the landing or taxi-in and the emergency services reported that their inspection revealed no damage as they followed the airplane while it taxied to the ramp.

Accident/incident briefs are based upon preliminary information from government agencies, aviation organizations, press information and other sources. The information may not be accurate.

During the normal preflight inspection prior to the next flight, however, the rear drain mast was seen to be damaged, as were the forward bulkhead and aft frame of the APU compartment, the APU access doors, and the fuselage skin just forward and aft of the APU doors.

No further damage was discovered after a full inspection was made of the structure from the APU tailcone to the rear pressure bulkhead. Temporary repairs were made to the damaged areas and the airplane was ferried back to London.

Cause of the incident was considered to be too early and rapid a rotation during takeoff. Although investigators were not entirely certain, they considered the cause of the premature rotation to be attributable to the "rotate" command being made by the captain when the airplane's indicated airspeed was 149 kt (V1) rather than the proper 167 kt (VR), and the copilot's failure to cross-check the airspeed indicator immediately prior to rotating the aircraft. The higher-than-normal speed of the rotation itself was considered to be because the copilot had relatively low time in type; he was flying his first operational leg after checking out in the 747.

Low on Fuel

Egypt - December

Boeing 707: Aircraft destroyed. Fatal injuries to 10; serious injuries to four.

The freighter with eight crew members aboard and a cargo of fruit and flowers was bound from Dar es Salaam to Brussels. The pilot had attempted to land at Cairo for refuelling but was turned away because of bad weather. The aircraft was directed to fly to Luxor Airport some 450 miles to the south.

When he was about 40 miles short of Luxor, the 707 pilot radioed controllers there that he was running low on fuel after which contact with the airplane was lost. The pilot attempted an emergency landing in a field near the village of Karm Omram about 405 miles south of Cairo. The airplane overshot the intended landing area and collided with six houses and a school building. The houses and three classrooms of the school were destroyed. All eight crew members aboard the aircraft were killed as was a woman on the ground. Another woman and her four children were seriously injured; one of the children was reported to have died later in the hospital.

Runway Overrun

United States - No date

McDonnell Douglas MD-80: Minor damage. No reported injuries.

The air carrier was landing at Pensacola, Florida, in VFR weather with 10 miles visibility and winds at 5 kt or less. The captain had 350 hours in the left seat and the first officer 150. The runway was not equipped with VASI.

The airplane ran off the end of the runway and stopped in mud.

According to the pilot, the aircraft had landed in the touchdown zone but the brakes were not effective enough to stop it on the runway surface. According to the digital flight data recorder, the aircraft passed over the end of the runway at a height of 462 feet above the surface and touched down 2,900 feet beyond the beginning of the runway. Brakes and anti-skid system were later checked and found to be operative.

Unsuccessful Go-Around

Fiji - November

Beechcraft Queen Air B80: Aircraft heavily damaged. Serious injuries to onecrew member and two passengers;minor injuries toseven passengers.

The commuter aircraft was attempting a landing at Matei, Taveuni after a flight from Nadi and crash-landed less than a mile past the runway. Early reports noted that a go-around had been attempted but that the airplane struck a tree. After the impact, the airplane caught fire.

Approach in Fog

Finland - November

Embraer EMB-110P Bandierante: Aircraft heavily damaged. Fatal injuries to five, serious injuries to two.

The turboprop commuter liner with 10 passengers and two crew members aboard was approaching Ilmajoki Airport at Seinajoki after a flight from Helsinki when it crashed just before landing. The crash occurred in heavy fog in a forested area near the airport.

Both crew members and three of the passengers died in the accident and two passengers were reported to have been seriously injured. The rest of the passengers escaped without injury and were immediately released from local hospitals in Seinajoki after check-ups.

Approach in Weather

United States - November

Piper PA-28 Cherokee: Aircraft destroyed. Fatal injuries to four.

The air taxi airplane had left Brunswick, Ga., under visual flight rules but poor weather at its destination forced the pilot to make an in-flight change to an instrument clearance for the approach to Jacksonville International Airport in Florida.

The Jacksonville control tower lost radio and radar contact with the airplane about 9:40 p.m. local time. The wreckage, with no survivors, was found in a swampy area about a mile and a-half off the runway the next morning.

Emergency Landing

South Africa - November

Fairchild Metro II: Aircraft extensively damaged. Minor injuries to three.

Shortly after a mid-morning takeoff from Jan Smuts Airport in Johannesburg on a flight to Nelspruit in eastern Transvaal Province, the left powerplant of the twin-engine aircraft failed. The commuter liner made an emergency landing in a refuse dump near Benoni, eastern Transvaal.

The airplane was damaged extensively but remained intact. There were only minor injuries reported to some of the 10 passengers and two crew members aboard, with three people being treated for back injuries.

Crash After Takeoff

France - November

Cessna 441: Aircraft destroyed. Fatal injuries to seven.

The Cessna Conquest II had taken off from the airport at Toussus-le-Noble, 13 miles southwest of Paris, heading for Montlucon in central France. On board were the pilot and six passengers, five of them automotive journalists on the way to see tests of a new automobile.

Ten minutes after takeoff, the airport control tower lost contact with the pilot. The airplane crashed in fog into a field near the town of Saclay, approximately 30 miles southeast of Paris. The airplane was destroyed in the mid-morning accident and all aboard were killed.

Tornado Alley

United States - November

Beechcraft King Air E90: Aircraft destroyed. Fatal injuries to seven.

The aircraft had taken off from Orange, Tex., and was making its second approach to the airport at Batesville, Ark., in rain and fog. It did not complete the maneuver, crashing three and a-half miles west of the nearby town of Locust Grove on a highway. There were no survivors.

A state police official noted that, in addition to the rain and fog, there were tornadoes reported in the area of the country in which the accident occurred.

Unexplained Spiral

Australia - December

Mitsubishi MU-2: Aircraft destroyed. Fatal injuries to 10.

The twin-engine turboprop was on a flight from Bellevue Goldmine to the mining town of Kalgoorlie with a pilot and nine passengers aboard. It crashed in the outback near Leonora, 375 miles east of Perth in Western Australia. Later, unconfirmed reports noted that the airplane had flown into an electrical storm, but a ground witness stated that the airplane had been in clear air when it suddenly spiralled into the ground.

Key Word is 'Cleared'

United Kingdom - October

Piper PA-23 Aztec: No damage. No injuries.

The twin-engine aircraft was approaching the Manchester air traffic zone at 3,000 feet and the pilot contacted Manchester ATC. The controller told the pilot that his present flight level was not acceptable but said he could offer the pilot 6,000 feet or special VFR with Liverpool Control.

The pilot told the controller he would accept the 6,000-foot level. The controller then instructed the pilot to squawk 4330.

Shortly, the Aztec's squawk appeared inside controlled airspace climbing through 3,500 feet — without a clearance. The controller had only given the pilot a transponder setting, he had not cleared him either to transit the controlled airspace or to climb. The pilot was instructed to turn and

remain clear of controlled airspace — the controller already had cleared two other aircraft that were departing from Liverpool on courses that conflicted with the Aztec.

In the Trees

United Kingdom - September

de Havilland Tiger Moth: Aircraft extensively damaged. Minor injuries to one of two.

With a passenger in the front seat of the biplane, the pilot took off parallel to the left of runway markers that separated powered aircraft operations from sailplanes.

At an altitude of about 300 feet and a speed of 55-60 kt, the pilot felt the aircraft was drifting towards the glider area and banked to the left. At this point, the pilot sensed a drop in power, although there was no decrease in rpm and no vibration. He lowered the nose slightly and checked the position of the fuel valve by moving it approximately half-way towards the closed position. At this point, the airplane seemed to be losing altitude and was heading toward some trees.

The pilot now felt there was no choice but to land in the trees, so he closed the throttle, switched off the magnetos and tried to stall the airplane into them. However, the right wing was caught by a large branch and the airplane was turned 90 degrees and dropped to the ground. Although the fuel tank was badly damaged, there was no fire. The pilot helped the passenger, who had experienced facial, knee and back injuries, out of the airplane.

Ground observers noted that the airplane had seemed to climb at an unusually nose-high attitude and that its ground track had seemed proper, which would have made the left turn unnecessary. There was no explanation given as to why the pilot had partially closed the fuel valve as a means of checking its position.

Water, Water Everywhere

United Kingdom - October

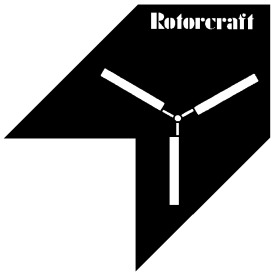
Mooney M20J: Belly and propeller damage. No injuries.

The aircraft had been stored outside for a couple of weeks while maintenance work had been performed on a magneto and a coil. Heavy rain had fallen on two days during that time and no fuel had been loaded.

The pilot came to pick up the airplane after the work had been completed and, with a passenger, taxied out to return the airplane to its home base. The Mooney was seen making a lengthy power check and the control tower asked the pilot if he was having difficulties, to which the pilot replied in the negative.

The airplane took off. Almost immediately after the gear was retracted, the engine stopped. The pilot decided to land straight ahead on the runway, with the gear still up. The airplane suffered damage to the underside of the fuselage and propeller but the two occupants evacuated without further incident.

Later, when the airplane was raised on jacks to lower the gear, the fuel drains were checked. The left tank had a large amount of water in it but there was no water in the lines from the right tank. The fuel strainer bowl was found to contain almost no fuel, but plenty of water, and the injector lines also had water in them. No problems were found with the engine.



That Sinking Feeling

United Kingdom - October

Sikorsky S-61N: Substantial damage to helicopter. No reported injuries.

The rotorcraft was carrying out a search and rescue mission over water at the southeast corner of Handa Island, off the northwest coast of Scotland. Having searched an hour for two members of a sailing dingy that had been reported as overdue, the helicopter crew was informed that one survivor had been picked up and the other was considered drowned. The helicopter crew made another search pattern of rocks in the area and was preparing to return to their base.

The pilot was bringing the aircraft to a hover when the winch operator informed him that the helicopter was moving backwards at what he considered an unacceptable speed. While he was trying to bring the helicopter into a hover or to forward flight, the pilot noticed that a high rate of descent had become established. Realizing that they were about to hit the surface of the sea, he tried to recover but was unsuccessful, and the helicopter hit the water and rolled to the right, slightly nose-down. It was later thought that the right-hand sponson broke off at this time.

The Sikorsky became inverted and began to sink in a nose-down attitude. Three of the crew members were able to evacuate quickly but the winch operator was unable to get out until the others opened the rear left emergency exit from the outside.

Another rescue helicopter was dispatched after radio communications were lost with the downed rotorcraft, and the four crew members were shortly picked up unhurt from the rubber raft they had boarded after escaping from the sinking aircraft.

Running Stop

United States - October

Hughes 269C: Substantial damage. No injuries.

After a local flight, the pilot was performing a running landing in the personal helicopter. He noticed that his airspeed was too high and raised the nose of the helicopter to slow down.

The aft end of the rotorcraft dropped too low and the tail rotor hit the ground.

No Joy Ride

United States - November

Bell 47G2: Aircraft destroyed. Fatal injuries to one.

A maintenance check was being performed on the helicopter by a mechanic who was a private pilot but was rated only for fixed-wing aircraft.

During the course of testing the engine, the rotorcraft "became airborne." It climbed to 100 feet, maneuvered over an industrial park for a number of minutes and hit the guy wire of a power transmission pole.

The rotorcraft descended out of control and collided with telephone cables before it hit the ground, destroying the aircraft and killing the mechanic.

No Gas, No Go

United States - November

Robinson R22: Aircraft substantially damaged. No injuries reported.

The student pilot and instructor were flying the helicopter to a refuelling point when the low fuel light flickered. The instructor took control of the aircraft and began an immediate descent.

As the helicopter was at about 150 feet above the ground, the low rpm horn sounded, following which the rate of descent increased. The rotorcraft landed heavily on its right skid, which collapsed, resulting in extensive damage.

Low Viz, Low Alt

United States - October

Bell 206L: Aircraft destroyed. Fatal injuries to two.

The helicopter was being used on a news-gathering mission with a pilot and one passenger aboard. According to witnesses, the visibility was poor in the area. The helicopter collided with powerlines and hit the ground, killing both occupants.

Seeing the Sights

United States - August

Bell 206B: Aircraft substantially damaged. No reported injuries.

The aircraft was on a sightseeing flight when the pilot pitched the nose down so the passengers could take photographs. However, when the aircraft was put into the nose-low attitude, the engine stopped and the engine-out horn sounded. The pilot successfully accomplished an autorotation into a plowed field. Upon touchdown, however, the helicopter rocked forward abruptly and the main rotor struck the tail boom, incurring extensive damage. The passengers and pilot evacuated the aircraft unhurt.

Checks of the helicopter after the accident revealed that there were about nine gallons of fuel aboard and that the boost pump was inoperative.