BLINDSIDED

BY LINDA WERFELMAN

The pilots of an Airbus A340 did not anticipate the 'severe deterioration' of weather as they approached the runway threshold at Toronto.

The Air France Airbus A340-300 was high and fast when it crossed the threshold of Runway 24L at Toronto/Lester B. Pearson International Airport during a thunderstorm, with heavy rain and lightning strikes that significantly reduced visibility before the touchdown 3,800 ft (1,159 m) down the 9,000-ft (2,745-m) runway. The crew selected reverse thrust 12.8 seconds after touchdown and full reverse 16.4 seconds after touchdown but was unable to stop the airplane before it departed the far end of the runway at 80 kt, crossed two roads, plowed into a ravine and burned.

The airplane was destroyed in the crash at 1602 local time Aug. 2, 2005, and 12 of the 309 occupants received serious injuries during the crash and subsequent evacuation.

The Transportation Safety Board of Canada (TSB) said in its final report on the accident that, "in hindsight, the risk presented by the rapidly deteriorating weather conditions was greater than most pilots would deem acceptable. However, when the [pilots] assessed the available weather information and the traffic flow into the airport, they did not expect that such a severe deterioration in the weather was imminent."

Among the causes of the accident and the contributing factors, the TSB cited the approach and landing during the thunderstorm, with greatly reduced visibility, lightning strikes and shifting winds — including a 10-kt tailwind component for part of final approach and a crosswind that, because the runway was contaminated by water, exceeded the airplane's landing limits.

Transportation Safety Board of Canada

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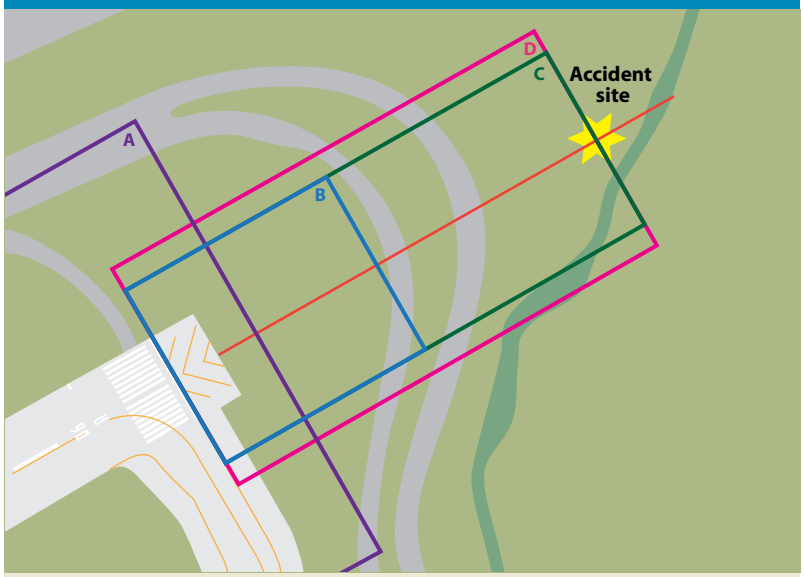
Other factors included the absence of Air France procedures for distance required from thunderstorms during approach and landing; the crew's belief, as the airplane neared the runway threshold, that a go-around was no longer an option; and the crew's delays in selecting the thrust reversers and applying full reverse thrust.

The crew did not calculate the landing distance required and "consequently, they were not aware of the margin of error available … [or] that it was eliminated once the tailwind was experienced," the TSB said. In addition, "there were no landing distances indicated on the operational flight plan for a contaminated runway condition" at the airport, and although the first 500 ft/150 m beyond the departure end of the runway complied with Transport Canada (TC) standards, "the topography of the terrain beyond this point, along the extended runway centerline, contributed to aircraft damage and to the injuries to crew and passengers," the TSB said (Figure 1).

Runway 24L Safety Areas, Actual and Recommended



FAA = U.S. Federal Aviation Administration; ICAO = International Civil Aviation Organization; RESA = runway end safety area; RSA = runway safety area

Notes:

A. Runway strip: Area extending 200 ft/60 m from end of runway, 500 ft/150 m from either side of centerline. Transport Canada standard, in place at Runway 24L.

B. RESA: Area extending 300 ft/90 m from end of runway, twice runway width. ICAO standard, TC recommendation, not in place at Runway 24L.

C. RESA: Area extending 1,000 ft /300 m from end of runway, twice runway width. ICAO recommendation, not in place at Runway 24L.

D: RSA: Area extending 1,000 ft/300 m from end of runway, 250 ft/75 m either side of center line. FAA standard, not in place at Runway 24L, not applicable outside U.S.

Source: Transportation Safety Board of Canada

Figure 1

Eight-Hour Flight

The crash occurred after an eight-hour flight from Charles de Gaulle International Airport in Paris. Before leaving Paris, the flight crew obtained a weather forecast for Toronto that included possible thunderstorms; as a result, additional fuel was added to the tanks to allow for an extra 23 minutes of holding time in Toronto.

About seven hours into the flight, the pilots made their initial contact with the Toronto Area Control Centre (ACC), asked about the weather, and told Air France operations personnel in Toronto that, because of thunderstorms near their alternate airport — Niagara Falls (New York, U.S.) International — they were designating Ottawa Macdonald-Cartier International Airport as their new alternate.

Soon afterward, the crew discussed the weather with air traffic control (ATC). The crew subsequently was told to reduce speed because of landing delays at Toronto. They requested and received vectors to avoid weather and also received an aviation routine weather report, which included information about thunderstorms and

Airbus A340

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The Airbus A340, first flown in 1991, is a large-capacity, widebody, medium/ultra long-range airliner. It is closely related to the A330. The A340-300 began service in 1993.

The A340-300 can seat as many as 440 passengers; the accident airplane was configured to seat 291 passengers. It has four CFM 56-5C2 turbofan engines and a maximum operating speed of 0.86 Mach. Typical standard range with fuel reserves is 12,223 km (6,600 nm). Maximum standard weights are 257,000 kg (566,582 lb) for take-off and 186,000 kg (410,056 lb) for landing.

Source: *Jane's All the World's Aircraft*

heavy rain. They briefed the wind shear approach, planning to conduct a missed approach if they encountered wind shear.

At 1528, they were cleared for the Simcoe 2 arrival to Toronto; at the time, they had 9.3 metric tons (10.3 short tons) of fuel remaining, and the airplane was 137 nm (254 km) from Toronto. Having determined earlier that, with Ottawa as their alternate, a diversion would require 7.3 metric tons (8.0 short tons), with 14 minutes of fuel for holding at Toronto, they reviewed company procedures on when to declare minimum fuel.

At 1533, automatic terminal information service (ATIS) information indicated that Toronto had reduced visibility in thunderstorms and heavy rain, and rapidly changing weather conditions. After reviewing weather reports from possible alternate airports, they selected Ottawa — a decision that meant they would have fuel for six minutes of holding in Toronto.

They conducted a briefing for the instrument landing system (ILS) approach to Runway 24L but did not discuss runway length, missed approach procedure or landing distance calculations for a wet or contaminated runway, the report said.

Around 1540, some pilots on the same radio frequency told ATC that they were proceeding to alternate airports, but by 1549, when the accident crew requested and received a deviation because of weather on the approach, airplanes were landing.

'Pretty Bad' Weather

At 1553, "the number one aircraft on approach [the accident airplane was number three] was asked by ATC about their likelihood of being able to land," the report said. "The reply was that the weather was to the north and looking pretty bad."

The two airplanes ahead of the accident airplane were landed without incident.

At 1558, the report said, the accident airplane was "at the approach speed on final approach. The previous aircraft had reported that braking action was poor, the tower wind instruments were not functioning because they were knocked off line during thunderstorm activity, the last wind available in the tower was 230 degrees at 7 kt, and there was lightning all around the airport."

The crew of a regional jet landing ahead of the accident airplane reported winds from 290 degrees at 15 to 20 kt and said that braking action was poor until the airspeed decreased to less than 60 kt.

The crew of the accident airplane delayed the pre-landing checklist because the landing memo had not yet been displayed on the electronic centralized aircraft monitor (ECAM), and although they had acted on all items on the challenge-and-response checklist, the checklist itself was not completed before landing.

For the remainder of the approach, weather conditions fluctuated, but portions of the approach were conducted in "very dark clouds, turbulence and heavy rain," the report said.

"The runway was covered with water, producing a shiny, glasslike surface," the report added. "There was lightning on both sides and at the far end of the runway."

The airplane's navigation display indicated a right crosswind of 70 to 90 degrees at 15 to 20 kt. Autopilot and autothrust were engaged during the approach, and the airplane was stabilized on the localizer and glideslope at the targeted airspeed of 140 kt. At 1601, as the airplane descended through 323 ft above ground level (AGL), the first officer — the pilot flying (PF) — disengaged the autopilot and autothrust and increased engine thrust from about 42 percent of N1 (engine compressor speed) to 82 percent of N1 "because he sensed that the airspeed was decreasing and the aircraft was sinking," the report said.

"The aircraft then began to deviate above the glideslope, [and] the wind direction shifted, changing from a 90-degree crosswind component to an increasing tailwind component of up to 10 kt."

The airplane was 40 ft above the glideslope when it crossed the runway threshold and entered an area of heavy rain and lightning strikes; visual contact with the runway environment was "severely reduced," the report said. The PF began the flare when the airplane was 40 ft above the runway (Figure 2).

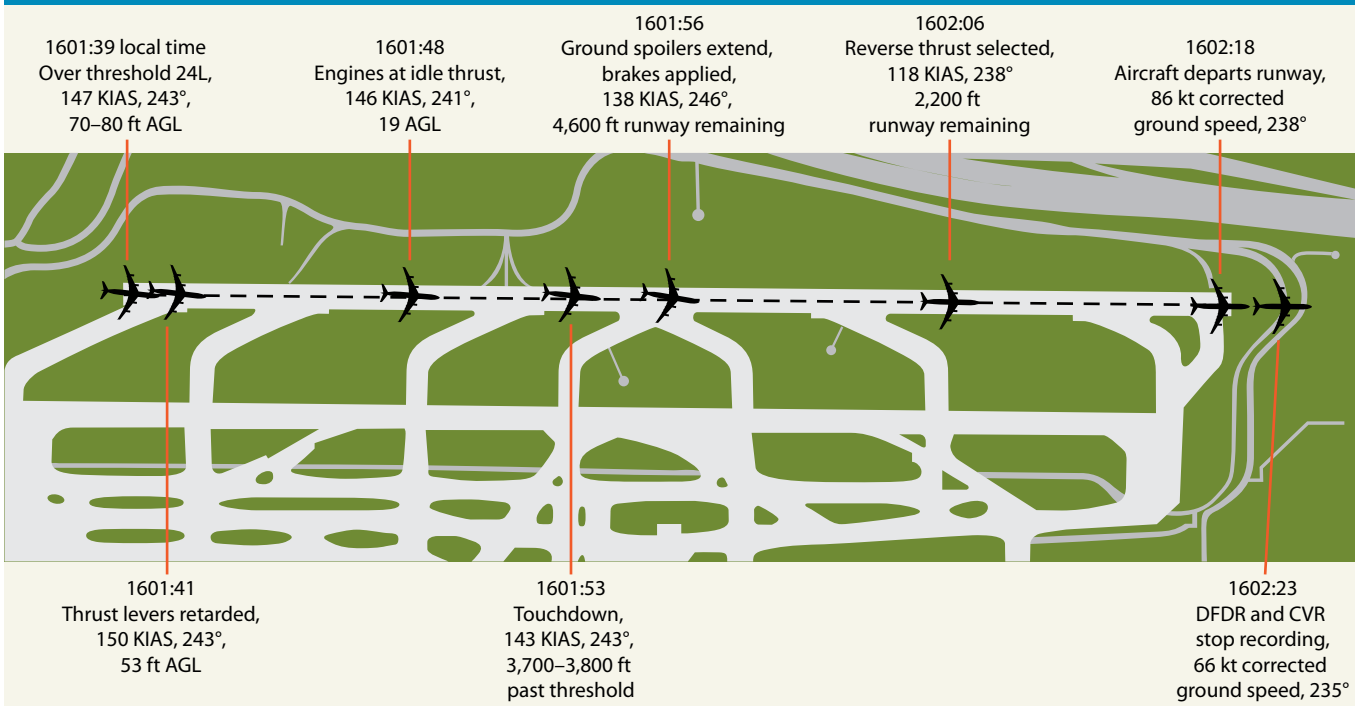
"From this point to touchdown, there were numerous and sometimes significant pitch inputs made on the PF side stick, and the aircraft leveled off at approximately 25 ft for a period of 2 ½ seconds," the report said. "There were also regular and sometimes large inputs in roll on the PF side stick. Combined, these inputs would indicate that significant workload and attention were required on the part of the PF to control the aircraft."

Throttle levers were moved to the idle position when the airplane was 20 ft above the runway.

After touchdown, the captain did not make the standard callouts for deployment of spoilers and reversers. The airplane was traveling at a groundspeed of 80 kt when it departed the end of the runway. Within seconds after the airplane stopped in the ravine, the cabin crew saw flames and ordered an evacuation.

Both flight crewmembers had airline transport licenses and Class 1 medical certificates. The captain had 15,411 flight hours, including 1,788 on

Key Events in Landing Sequence



AGL = above ground level; CVR = cockpit voice recorder; DFDR = digital flight data recorder; KIAS = knots indicated airspeed

Source: Transportation Safety Board of Canada

Figure 2

type, and had been employed since 1997 by Air France, where he had a "good reputation for being easy to fly with," the report said.

The first officer had 4,834 flight hours, including 2,502 on type. He was hired by Air France as a cabin crewmember in 1985; he became a pilot for the company in 1997 and was considered "solid and competent," the report said.

The accident airplane was built in 1999. Total airframe time was 28,426 hours. The investigation found that all aircraft systems were working as intended and that weight and balance at the time of the accident were within normal limits.

Investigators calculated required stopping distances for Runway 24L using the environmental conditions present at the time of the landing and determined that, "for the actual touchdown speed of 143 KIAS [knots indicated airspeed], with a 10-kt tailwind and the actual deployment of thrust reverser time of 16.4 seconds, the aircraft would have stopped in 6,674 ft (2,034 m) after touchdown. … With full reverse thrust selected after touchdown in accordance with the AFM [aircraft flight manual] and the aircraft touching down at the recommended speed, the aircraft would have used 5,574 ft (1,699 m) of runway." From the point that the accident airplane touched down, however, only 5,200 ft (1,586 m) of runway stopping distance remained.

Analysis of weather radar data found that, although there had been a downburst about eight km (five mi) northeast of Runway 24L at the time of the accident, wind conditions at the time were not those typically associated with microburst. Conditions precluded any significant upward wind component at the runway, the report said. Numerous lightning strikes occurred just before touchdown, including nine cloud-to-ground strikes at the end of the runway that were recorded in just one second.

Departures had been halted by a "red alert" — a warning of numerous lightning strikes at or near the airport …

'Red Alert'

At the time of the accident, Runway 24L was in use because other flight crews had refused to operate on Runway 23 — at the far end of the airport terminals, more than 3,500 ft (1,068 m) to the northwest — citing storms on the approach. Lightning strikes had rendered the ILS for Runway 24R and other runways unserviceable at various times in the hours before the accident. Departures had been halted by a "red alert" — a warning of numerous lightning strikes at or near the airport typically accompanied by operators' discontinuation of ground activities to protect ground personnel from lightning.

"During the course of the investigation, it was determined that a perception existed among

both the occurrence pilots and other pilots that airports could be closed if weather conditions were too severe to allow approaches and landings to be conducted safely," the report said. "ATC may restrict the flow of aircraft into a particular airport due to weather conditions, but the ultimate decision to conduct an approach or landing rests with the pilot."

The report said that, although there have been numerous reports and studies on runway overrun accidents and many recommendations on how best to avoid them — including the Flight Safety Foundation *Approach and Landing Accident Reduction (ALAR) Tool Kit* — and although Air France recognized the potential for overrun accidents and took steps to prevent them, this accident "essentially fits the pattern of the accident these programs and training procedures were aimed at preventing."

The report said that only after the airplane was on very short final — when the airplane encountered intense precipitation and reduced visibility and departed from the glideslope — were there clear indications to the crew that a landing was unadvisable.

"The crew had two courses of action with potentially undesirable outcomes: proceed with an approach that was becoming increasingly difficult or conduct a missed approach into potentially dangerous conditions," the report said. "At that moment, although Air France procedures called for a go-around any time the ideal trajectory is not maintained up to thrust reverser deployment, the captain, doubting that a go-around could be conducted safely, committed to continue with the landing."

At the time, Air France procedures said that only the captain could call for a missed approach; after the accident, procedures were changed to allow either pilot to make the call.

Although Air France had guidelines about the distance required from convective activity during cruise flight, the airline — like many others — had no such guidelines for approach and landing, the report said. Air France had considered such guidelines after an earlier accident but concluded that their adoption would be "contrary to the goal of enabling crews to make decisions based upon each specific situation," the report said.

"However, some companies do provide such guidelines and, in some cases, directives related to approaches around thunderstorms. Previous accident investigations have recognized their value to assist crews in making decisions in situations where the choices before them are less than obvious."

After the accident, Air France revised sections of its operations manual that discussed thunderstorms. The TSB recommended that TC establish standards to restrict approaches and landings during thunderstorms and that TC and other civil aviation authorities require flight crews to "establish the margin of error between landing distance available and landing distance required before conducting an approach into deteriorating weather."

More Training

Another recommendation called for TC and other civil aviation authorities to require air transport pilots to undergo training "to better enable them to make landing decisions in deteriorating weather."

The report added, "Crews need to be more acutely aware that an approach near convective weather is a hazardous situation. … They must acquire a better understanding of all the conditions that they may expect to be faced with on final approach. They must be ready to conduct a missed approach at any time one of these conditions escapes their control or understanding. They must not get themselves into a situation where the missed approach option is no longer available."

The asphalt blast pad and grassy area beyond the departure end of Runway 24L extend for 200 ft/60 m, the minimum length required by TC but shorter than the 1,000-ft/300-m runway end safety area (RESA) recommended by the International Civil Aviation Organization (ICAO), the report said. If the Runway 24L RESA had been constructed in accordance with the ICAO recommendation, "an obstacle-free overrun area, free of hazardous ruts, depressions and other surface variations, would have extended to … approximately 75 m [246 ft] beyond Convair Drive [about the point where the accident airplane stopped]. Similarly, if the requirement had been the same as those established by the U.S. Federal Aviation Administration (FAA) — calling for either a 1,000-ft /300-m RESA or a 600-ft/200-m engineered materials arresting system (EMAS) — "the damage to aircraft and injuries to the passengers may have been reduced," the report said.

After the accident, TC said that, after a review of RESA specifications and related information, it would require all airports to construct RESAs. The TSB issued a safety recommendation calling on TC to require construction of a 1,000-ft/300-m RESA at the end of all runways longer than 2,400 m (7,874 ft), or an alternative means of "stopping aircraft that provides an equivalent level of safety." ●

This article is based on TSB Aviation Investigation Report A05H0002, "Runway Overrun and Fire, Air France, Airbus A340-313 F-GLZQ, Toronto/Lester B. Pearson International Airport, Ontario, 02 August 2005."