FLIGHT OPS

Continued Takeoffs

Two flight crews suddenly had little or no runway to spare.

by Wayne Rosenkrans | August 1, 2013

A business jet accident and a serious incident involving a large commercial jet had in common the flight crews' decisions to continue takeoffs after they suddenly became aware of non-normal circumstances, according to the final reports issued in early 2013 by accident investigation boards.[1,2] In each case, the exact circumstances fell outside some generic lists of predominant risks and causal factors previously emphasized by safety specialists (see "Guidance on Rejected Takeoff Considerations"), such as U.S. Federal Aviation Administration (FAA) analysis of rejected takeoff (RTO) events.

"The infrequency of RTO events may lead to complacency about maintaining sharp decision making skills and procedural effectiveness," the FAA *Takeoff Safety Training Aid* says. "In spite of the equipment reliability, every pilot must be prepared to make the correct go/no go decision on every takeoff — just in case.

"For optimum crew effectiveness, [pilots] should share a common perception — a mental image — of what is happening and what is planned [based on] communications, situational awareness, workload distribution, cross-checking and monitoring. … A review of actions for a blown tire, high-speed configuration warning or transfer of control are examples of what might be appropriate for before-takeoff (or before–engine start) review. … Meaningful communication, however brief, regarding a non-normal situation during takeoff and RTO can often mean the difference between success and disaster."

GUIDANCE ON REJECTED TAKEOFF CONSIDERATIONS

Flight Safety Foundation, as coordinator, and the International Air Transport Association published in July 2009 the findings and recommendations of the Runway Safety Initiative (*ASW*, 8/08, p. 12) based partly on excursion data from 1995 through March 2008.[1] Only about one-fourth as many excursions occurred during takeoff — 63 percent of them overruns — as occurred during landing. Turboprops accounted for 41 percent of these takeoff excursions, jet transports for 36 percent, business jets for 17 percent and other fleets for 6 percent. The most common risk factor in takeoff excursions was a rejected takeoff (RTO) initiated at a speed greater than V_1 (see definition in "Continued Takeoffs," Note 3). Loss of directional control by the pilot was the next most common risk factor, followed by rejecting the takeoff before V_1.

Other takeoff risk factors ranked as significant by the initiative were: The flight crew fails to consider rejecting the takeoff; the crew performs an RTO with inadequate time to avoid a veer-off; premature rotation occurs (that is, prior to reaching V_R); rotation is not attempted; no rotation occurs because V_R is not reached; the pilot is unable to rotate the airplane; rotation occurs above $V_{R;}$ piloting technique fails to counteract crosswind; the flight crew fails to comply with standard operating procedures; improper checklist use occurs; the pilot-in-command fails in supervision of the first officer; a failure of crew resource management occurs; the aircraft weight calculation is incorrect; sudden engine power loss occurs; degraded engine performance occurs; tire failure occurs; and/or thrust asymmetry occurs.

Earlier insights about when and how to safely conduct RTOs were based on data from airline operations compiled by the U.S. Federal Aviation Administration (FAA).[2] For the period 1959–2003, the FAA's estimates from the available data were that 143,000 RTOs occurred in worldwide airline operations — 6,000 a year — and that in 97 cases, or about four per year, the outcome was an accident or incident. The conclusion was that RTOs were uncommon, with typical operations resulting in one RTO per 3,000 takeoffs and one runway overrun accident or incident during takeoff per 4.5 million takeoffs.

Notes:

1. *Flight Safety Foundation. "Reducing the Risk of Runway Excursions: Report of the Runway Safety Initiative." May 2009.*
2. *FAA. "Pilot Guide to Takeoff Safety." Section 2,* Takeoff Safety Training Aid, *1994 (last update February 2008). The other sections include "Takeoff Safety Overview for Management," "Example Takeoff Safety Training Program," "Takeoff Safety Background Data" and an optional video.*

Tailwind Incident

In Australia, the first officer was the pilot flying during the takeoff of a Qantas Airways Boeing 737-800 on

Runway 06 at Perth Airport, Western Australia. Late in the takeoff run, the wind direction and speed suddenly changed to a tailwind that caused the airplane to become airborne near the end of the runway without the margin of safety expected from prior calculation

of the takeoff distance required. An Airservices Australia fact sheet lists the Perth Airport Runway 06/24 length as 2,163 m (7,096 ft). No damage or injuries were reported when the event occurred at about 1618 local time on Dec. 4, 2012. The captain was the pilot monitoring.

"Approaching the takeoff reference speeds[3] of V_1 and V_R [rotation speed], the airspeed stopped increasing and did not start increasing again for several seconds," said the report by the Australian Transport Safety Bureau. "The captain noticed that the wind vector on the navigation display was showing a tailwind of about 20–25 kt. The captain disconnected the auto-throttle and 'fire-walled' the thrust levers [selected maximum thrust].

"During the initial climb, the first officer performed a wind shear escape manoeuvre. … Just after the aircraft became airborne, the wind was recorded at 282 (degrees true) and 25 kt. No wind shear warnings were recorded. Recorded latitude, longitude and radio altitude data showed that the aircraft passed over the end of Runway 06 (threshold of Runway 24) at a height of about 10 ft above ground level. … As the performance calculations had assumed nil [zero] wind for takeoff, the aircraft failed to achieve the predicted takeoff performance."

Analysis of quick access recorder data for the flight "showed that the airspeed stagnated at 134 kt for 3-4 seconds just below the V_1 speed of 137 kt, the auto-throttle was disconnected and maximum thrust was set."

Investigators determined that at the time of the takeoff, cumulonimbus cloud activity was present about 20–30 nm [37–56 km] north of the airport, and also found there were "no indications of an impending wind change before takeoff." The flight crew during climb advised air traffic control (ATC) about the tailwind component that they had seen displayed. "Takeoffs were then temporarily suspended from Runway 06 and aircraft departed using Runway 03," the report said.

The flight crew had monitored the current automatic terminal information service message, issued about five minutes before lineup for takeoff. It reported wind from 060 degrees magnetic at 8 kt — that is, a direct headwind. Before lining up for takeoff, the captain observed that windsock 1 indicated a headwind component. The first officer told investigators that windsock 2 also had indicated a headwind component. Neither pilot was able to observe any of the airport's three windsocks from the Runway 06 threshold (Figure 1).

The temperature was 37 degrees C (99 degrees F), and visual meteorological conditions prevailed. "The anemometer experienced a significant wind change at 1618 that would have resulted in tailwind conditions at least near the northern part of Runway 06," the report said. Investigators' computations showed that the crew otherwise should have been able to safely conduct a takeoff on Runway 06.

A reactive wind shear–detection system, incorporated in the 737's ground-proximity warning system, began at rotation to detect whether it was actually experiencing wind shear. A predictive wind shear–detection system, incorporated in the airplane's weather radar system, began scanning when the thrust levers were set for takeoff. "New warnings were inhibited after the aircraft reached 100 kt until it was over 50 ft above ground level," the report said. "This incident serves as a reminder to pilots that significant wind changes can occur during takeoff, can be difficult to predict, and can occur in the absence of thunderstorm activity. The wind conditions at each end of a runway may differ significantly so that headwind conditions can exist at one end and tailwind conditions at the other end. Although it did not assist in this case, it is important to monitor the available windsocks before takeoff as it is the final opportunity to detect wind changes before the takeoff roll begins."

The report recommended review of one briefing note on wind shear <flightsafety.org/files/alar_bn5-4-windshear.pdf> from Flight Safety Foundation's *Approach and Landing Accident Reduction (ALAR) Tool Kit* as a resource for relevant takeoff-safety advice.

Airborne After Overrun

In Switzerland, a copilot was conducting the takeoff of a Cessna Citation C525 on Runway 07 at Grenchen Regional Airport when the airplane failed to reach V_1 at the normally expected point along the 980-m (3,215-ft) runway. The Citation struck a runway-end identifier light, overran the runway, crossed a grass-covered meadow and a small perpendicular stream bed, then became airborne. It subsequently landed safely at a different airport.

The commander of this ferry flight under instrument flight rules (IFR) was the pilot monitoring when the takeoff occurred at 0853 local time on Feb. 16, 2011. There were no injuries to the two professional pilot–occupants. The aircraft operated by Swiss Private Aviation was described as "badly damaged, a runway end light was damaged and minor damage to nearby grassland was found," said the report by the Swiss Accident Investigation Board (SAIB).

The current Grenchen Regional Airport weather report (and investigators' determinations for the accident vicinity) included wind from 080 degrees at 6 kt, visibility 300 m (0.2 mi), fog and possibly light rain, cloud vertical visibility 200 ft above the ground, temperature and dew point 2 degrees C (36 degrees F), and poor visibility conditions due to fog.

A Grenchen ATC officer (controller) cleared the flight crew for takeoff from Runway 07 while the aircraft was parked at a stand. "The taxi checklist was completed on the short route to the Runway 07 holding position via Taxiway W," the report said. "This included, among other things, testing the functionality of the brakes, which was carried out by both crewmembers. No anomalies were found."

The fog precluded visual contact with any aircraft positioned along the line of sight between the tower and the end of Runway 07, so the ATC officer arranged for a runway inspection.

The ATC officer saw the Citation entering the runway and amended the initial clearance, instructing the crew to hold on the runway for takeoff clearance because the runway inspection was still in progress. "In view of the expected delay, the commander then set the parking brake," the report said. At 0853:43, the takeoff clearance was issued, updating wind data to 060 degrees at 6 kt.

"The commander then switched on the pitot heater and landing lights, pushed the thrust levers forward and handed control over to the copilot. He instructed the copilot, in view of the reduced visibility, to carry out a so-called standing takeoff. At a power setting with a low-pressure compressor speed N1 of approximately 90 percent of the rated speed, the copilot took his feet off the brake pedals, set takeoff thrust and steered the aircraft on the runway centerline. The set takeoff thrust was checked by both crewmembers."

The commander "had the impression that the aircraft's acceleration was lower than usual," the report said. "[The Citation] attained a speed of 80 kt before Taxiway E1 … i.e., rather late, but still within a framework which seemed acceptable to the commander. On reaching [V_R], in the copilot's estimation approximately 250 m [820 ft] before the end of the runway, the commander called out 'Rotate,' whereupon the copilot pulled on the control column.

"Both crewmembers immediately noticed that the nose of the aircraft was not lifting. After a repeated callout by the commander, he, too, pulled on the control column. On overshooting the end of the runway, the right main landing gear … struck a light, which was perceived by the crew as a distinctly noticeable impact."

Leaving the runway pavement, the landing gear wheels continued to roll on the meadow. "The copilot, according to his statement, had the feeling that it was no longer possible to continue the takeoff and briefly reduced power," the report said. "But at approximately the same time, the copilot noted that [the Citation] had already lifted off and applied full power again.

"At the same time, he asked the commander whether the takeoff process should continue. The [commander] answered the copilot's question in the affirmative, with the consideration that they would perhaps still have a chance to get the aircraft into the air."

Investigators' analysis of this stage determined that "a few seconds" had elapsed from the point of runway overrun — then more than 100 m (328 ft) across the meadow and stream bed — to the liftoff (Figure 2).

"The [ATC officer] heard a click on the radio frequency as [the Citation] approached the end of the runway," the report said. "She took up the binoculars and was still able to see the aircraft's strobe lights. Then she made sure on the radar screen that [the airplane] had actually lifted off."

Following normal climb procedure, the commander next reduced power to the maximum continuous thrust setting and retracted the flaps. "Then the crew realised that the parking brake was still set," the report said.

During his attempt to retract the landing gear, however, the commander observed a red gear-warning light. Extending the gear again resulted in three green indicator lights, so the crew left the gear extended for the remainder of the flight. After being handed off to an approach controller at about 3,500 ft, the flight crew requested and received IFR clearance to Zurich, their IFR alternate airport, where they landed uneventfully.

"Structural damage was found in the area of the nose gear and main gear, as well as to both rear wing spars," the report said. "Also, a certain asymmetry was ascertained in the dimensions of the aircraft."

Investigators used the accident airplane's flight management system to replicate the pilots' calculated takeoff field length for the conditions at Grenchen, obtaining 2,808 ft (856 m) as the result. "It is apparent that with 124 m [407 ft], the crew basically had a small safety margin available," the report said. "There is no evidence of the existence of any technical defects or limitations which could have caused or influenced the accident."

longer aware of the set parking brake. Possibly, also, the delay due to the runway inspection may have played a part in this."

Because of their significant experience, both pilots had a mental picture of the normal acceleration of the accident airplane at Grenchen, the report said, noting, "On a takeoff on a relatively short runway, preconceived decisions and thus the willingness to abort takeoff roll early at the merest hint of a failure or adverse [effect] is essential."

The SAIB's safety recommendations in part addressed the need for a retrofit technical solution to warn flight crews when the takeoff roll is initiated with the parking brake set.

NOTES

1. ATSB. "Significant wind change during takeoff involving Boeing 737, VH-VZL Perth Airport, Western Australia, 4 December 2012." ATSB Transport Safety Report, Aviation Occurrence Investigation AO-2012-168, May 17, 2013.

2. Aviation Division, SAIB. "Final Report No. 2156 of the Swiss Accident Investigation Board SAIB concerning the accident involving the C525 aircraft, registration HB-VOV on 16 February 2011 at Grenchen regional airport (LSZG)." April 25, 2013.

3. V_1 means the maximum speed in the takeoff at which the pilot must take the first action (e.g., apply brakes, reduce thrust, deploy speed brakes) to stop the airplane within the accelerate-stop distance. V_1 also means the minimum speed in the takeoff, following a failure of the critical engine at V_{EF} , at which the pilot can continue the takeoff and achieve the required height above the takeoff surface within the takeoff distance.

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