When A Rejected Takeoff Goes Bad

The pairing of relatively inexperienced flight crew members was merely the first in a chain of events that ended with a runway overrun that resulted in passenger fatalities and extensive aircraft damage.

by
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On September 20, 1989, a U.S. domestic air carrier Boeing 737-400, on an "extra section" passenger flight to replace a regularly scheduled, but canceled flight from New York's La Guardia Airport to Charlotte, North Carolina, ran off the end of La Guardia's Runway 31 into Bowery Bay. Instrument conditions prevailed, the runway was wet and the aircraft was being flown by the first officer.

The U.S. National Transportation Safety Board (NTSB) Aircraft Accident Report, AAR/90/03, states that as the first officer began the takeoff, the airplane drifted to the left and the captain used the nosewheel steering tiller to correct the drift. Later in the takeoff run, the flight crew heard a "bang" and a rumbling noise. The captain then took over control from the first officer and rejected the takeoff but was unable to prevent the overrun. As a result, two of the 57 passengers on board sustained fatal injuries, and 15 sustained serious or minor injuries. Both pilots and four cabin crew members sustained minor injuries. The NTSB listed 26 items in its conclusions, and this report will focus upon those which are germane to this discussion (items 3-18) and will concentrate on aircrew performance and behavior.

The NTSB Conclusions

As numbered in the NTSB report:

3. Rudder trim moved full left while the airplane was parked with engines off at La Guardia.

4. The captain could have detected the mistrim rudder condition during taxi, during the flight control freedom-of-movement check and during the response to a checklist challenge. He failed to do so.

5. The captain did not use the autobrake system during the takeoff roll, as recommended by the aircraft manufacturer and airline management. His failure to do so delayed the onset of maximum braking and extended the airplane's stopping distance.

6. Both pilots were relatively inexperienced in their respective positions. The captain had about 140 hours as a Boeing 737 captain. The first officer was conducting his first non-supervised line takeoff in a Boeing 737 and his first takeoff after a 39-day non-flying period.

7. Early in the takeoff attempt, the first officer inadvertently disarmed the autothrottle. He then manually advanced the throttles. The resultant delay and the slightly low thrust set on the left engine lengthened the airplane's ground roll and added to the directional control problem.

8. The captain's use of the nosewheel steering tiller during the takeoff roll was not

proper and may have masked the initial directional control problem created by the mistrimmed rudder.

9. Because of poor communication between the pilots, both attempted to maintain directional control initially and neither was fully in control later in the takeoff, compounding directional control difficulties.

10. Neither pilot was monitoring indicated airspeed and no standard airspeed callouts occurred.

11. The captain should have been aware of the directional control problem and should have initiated an RTO (Rejected TakeOff) before accelerating to high speed.

12. Unusual noise and vibration from the cocked nosewheel, and the leftward veer, led the captain to reject the takeoff.

13. Computed V_1 speed was 125 knots and action by the captain to reject the takeoff began at 130 knots.

14. After initiating the RTO, the captain used differential braking to steer the airplane. This delayed the attainment of effective braking until 5.5 seconds after the takeoff was rejected.

15. Braking during the RTO was less than the maximum braking achievable on the wet runway; the airplane could have been stopped on the runway.

16. The airplane departed the end of the runway at about 34 knots.

17. The pilots did not submit urine samples for toxicological testing until 44 hours after the accident. They refused to submit blood samples upon the advice of their attorney, in spite of requests to do so by the NTSB.

18. U.S. Federal Aviation Administration (FAA) requirements for post-accident toxicological testing were not in effect at the time of the accident and the flight crew was not required to provide specimens for such testing. However, the FAA rules later adopted are inadequate to determine impairment from drugs and alcohol because they permit up to 32 hours for specimen collection and do not include requirements for alcohol tests.

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Flight Safety Foundation Articles Offer Relevant Information

Since this accident involved an inexperienced flight crew with the first officer at the controls (initially) and a runway overrun, two Flight Safety Foundation publications pertaining to those situations should be reviewed. *Flight Safety Digest*, Vol. 7 No. 8, August 1988, contains "Who Is Flying The Aircraft," a discussion of first officers at the controls during catastrophic accidents. *Accident Prevention*, Vol. 47 No. 9, September 1990, "Facing the Runway Overrun Dilemma," discusses rejected takeoffs.

Aircrew Experience Is a Factor

The captain, age 36, received his initial flight training in the U. S. Air Force in 1979. His first military line flying assignment was in the USAF reserve Lockheed C-130 cargo aircraft. In 1987, he upgraded to aircraft commander in the C-130 and held the rank of major at the time of the Boeing 737 accident. He failed his first C-130 aircraft commander check ride, in part, because of poor checklist usage.

In July 1984, the captain was hired by an airline that was subsequently merged into the one he was employed by at the time of the accident. He served as a flight engineer until August 1985, when he completed Boeing 737-200 flight training with 34 simulator hours and 1.7 hours in the aircraft. He subsequently completed "differences" flight training in the Boeing 737-300 in September 1986 and ground training in the Model 400 in May 1989. He said he believed he had "between five and 10 RTOs" in the Boeing 737 simulator, all after simulated engine anomalies. He had experienced one low-speed RTO in the Boeing 737 after a takeoff warning system alarm had sounded.

He completed training for captain in June 1989 with 22 flight hours plus four hours of line oriented flight training (LOFT) in July. His initial operating experience in the Boeing 737-300/400 consisted of 14 hours with 11 takeoffs and landings followed by a 9.2-hour, FAA-observed line check with six takeoffs and landings.

Supervisory pilots described his upgrade training as "average." The pilot who supervised the captain's initial operating experience said the captain had no problems making decisions. The captain had no formal training in cockpit resource management.

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The captain had a total estimated flying time of 5,525 hours, about 1,500 hours of which were in the USAF and USAF Reserve with 97 hours as pilot-in-command of the C-130. He had about 2,625 hours in all models of the Boeing 737. His total flying time as a Boeing 737-400 captain was about 140 hours. Prior to the flight on September 20, he had flown on September 3, the last leg of a three-day trip.

The first officer, 29, was also hired by the merged airline. He completed Boeing 737 training in August 1989 with 24 hours in the simulator and 1.1 flight hours. His initial operating experience consisted of 14.2 flight hours and the observation of 12 landings from the jump seat. His line check consisted of 3.1 flight hours and three takeoffs and landings on August 12, which was the last time he flew prior to the flight on September 20. He had 3,287 flying hours, 8.2 hours of which were in the Boeing 737-300/400. He had flown 8.3 hours during the previous 90 days and 0.9 hours during the previous 24 hours. He had no formal instruction in cockpit resource management, and his prior experience was in light and turboprop commuter aircraft.

This then was the pilot complement for the subject flight. By most standards, this crew could be called relatively inexperienced, a fact which the NTSB pointed out, for among the NTSB recommendations to the FAA were these two items:

"Issue an Air Carrier Operations Bulletin directing all Principal Operations Inspectors to urge air carriers to schedule newly-trained captains and first officers on regular trip schedules immediately following completion of training, until they accrue a prescribed amount of line operating time in their respective positions in order to consolidate their recently-acquired training (Class II, Priority Action) (A-90-107)."

"Amend CFR 121.385 to specify a combined experience level for initial pilot-in-command and initial second-in-command pilots which would preclude the pairing of two pilots, each of whom has relatively low experience in his or her respective position (Class II, Priority Action) (A-90-108)."

In view of the number of accidents that have occurred as a result of pairing inexperienced pilots, this airline's crew scheduling practices can rightfully be taken to task.

Accident analysts can go beyond crew pairing and question why the captain, who had only 140 hours as captain, allowed the first officer, who had only 8.2 hours in the Boeing 737, to make the takeoff during instrument weather conditions (estimated 500 feet overcast, five miles visibility, light rain and fog, and at night).

The NTSB determined that the first officer was on his first trip after obtaining initial operating experience, and that the captain had never flown with the first officer before. The captain had flown the first segment of the flight and, according to NTSB, the first officer was to be the flying pilot on the next segment, which was the accident flight. The NTSB pointed out that no company or federal regulations govern flying pilot choices.

As in other accidents where the first officer was flying the airplane, the decision as to who would fly gave minimal consideration to the first officer's qualifications and experience or to extenuating weather conditions.

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Most airlines have a policy which allows pilots to alternate flying the airplane but the first officer usually does not move from the right to the left seat. This policy does not normally call for mandatory compliance. It appears that it is the captain's prerogative to make the choice as to who should fly the airplane if there is a concern with extenuating circumstances. The question to be asked in this instance is, given the circumstances, was it prudent for this captain to allow this first officer, who had only 8.2 hours in the Boeing 737 to make this takeoff?

Troubling Events Prior to the Flight

At 1400 hours, the crew reported to the airline's operations department at Baltimore-Washington International Airport to make a scheduled flight to La Guardia with departure at 1510 hours. However, inbound traffic to La Guardia caused the takeoff to be delayed until 1935. The aircraft had held on the taxiway for 1.5 hours and was required to return to the terminal area for additional fuel. It landed at La Guardia at 2040.

While on the ground at La Guardia, the captain went to the airline operations department and then returned to the aircraft expecting to fly to Norfolk, Virginia. However, the airline dispatcher decided to cancel the Norfolk leg, unload the passengers and send the flight to Charlotte without passengers. Several minutes later, the dispatcher told the captain that the airplane would carry passengers to Charlotte. According to a passenger service representative, this seemed to upset the captain who expressed concern for the passengers because more delays would cause him and the first officer to exceed crew duty time limitations before the end of the trip. While the passengers were boarding, the captain visited the airline's ground movement control tower to ask about how decisions were made about flights and passengers.

The captain returned to the cockpit as the last passengers were boarding and the entry door was closed. After the jetway was retracted, the passenger service representative told the captain through the open cockpit window that he wanted to open the door again to board passengers. The captain refused and the airplane left the gate at 2252.

Although the NTSB does not dwell on the aforementioned incidents, it is quite possible that stress factors may have influenced the captain's attitude and behavior. For instance, two minutes after the pushback, the ground controller told the crew to hold short of taxiway GOLF GOLF. However, the captain failed to hold short of that taxiway and received modified taxi instructions from the ground controller.

What follows is an excerpt from the cockpit voice recorder (CVR) tape during taxiing:

"CAM-I (the captain). Time is really gettin' ** (unintelligle words) bad. We were due out at sixteen fifty five, right.

CAM-2 (the first officer). Ah. originally.

CAM-1. That's seventeen hundred; that's five o'clock.

CAM-2. You're loo- comin' up six hours late, yes sir.

CAM-1. See we're runnin' out of time, too. We couldn't wait a minute longer. We might not even get to Lansing.

CAM-2. Naw, not at this rate

CAM-1. We might get to Lansing.

CAM-2. (sound of laugh) Gotta think positive.

CAM-1. We're gunna be # haulin' # (# indicates expletives deleted)."

The CVR conversation could give emphasis to the captain's concerns about the duty day.

Cockpit Visitors and Rudder Trim

Because the rudder trim setting was of concern, it is interesting to consider what went on in the cockpit while the captain had been absent to check with the operations department on how flights were scheduled is of interest.

The first officer was in his cockpit seat and said he placed new pages for an en route chart/approach plate holder on the center pedestal, then put the pages into the holder on his lap. Meanwhile, a captain from another airline, who was flying as a non-revenue passenger, entered the cockpit and sat down facing crosswise on the auxiliary jump seat behind the captain's seat. This captain said another person from the airline entered the cockpit and gave the crew a weather chart that was eventually placed on the center pedestal. Several other persons were also in the cockpit at various times before departure. The rudder trim control and indicator are grouped at the top rear of the center pedestal.

Many reports described the inadvertent setting of rudder trim by the foot of a jump seat occupant behind the captain's seat.

In the analysis section of the accident report, the NTSB said it had collected about 90 reports of rudder trim anomalies for the Boeing 737-300/400 series aircraft. Many reports described the inadvertent setting of rudder trim by the foot of a jump seat occupant behind the captain's seat. The reports imply that casual visitors to the cockpit did not strap in, and that they sat sideways and used the aft end of the center pedestal as a footrest for their right foot. This allowed their shoe sole to push the trim knob counter-clockwise and apply left rudder trim. The airline captain who had visited the cockpit before the departure of the accident flight said that he did not rest his foot on the center pedestal at any time.

Other reports showed that placing objects on the center pedestal can inadvertently turn the rudder trim knob. While the other airline captain said that he believed the first officer placed his chart holder on the pedestal during prestart activities, the first officer did not recall having done so.

Many pilots reported rudder trim knobs sticking out of neutral after intentional activation. A knob with debris underneath or a mechanical anomaly found later on some airplanes can keep applying trim after release, in spite of it being spring-loaded to the neutral position.

Enter the Flight Sequence

After receiving taxi clearance at 2256, the captain then briefed takeoff speeds at V_1, 125 knots; V_r, 128 knots; and V_2, 139 knots. As the pilot flying, the first officer's departure briefing consisted of his reciting to the captain his turn and altitude clearance and the La Guardia 3 departure clearance.

About two minutes later, the first officer announced "stabilizer and trim" as part of the before takeoff checklist. The captain responded with "set" and then corrected himself by saying: "Stabilizer trim, I forgot the answer. Set for takeoff." According to the airline normal procedures checklist, "set for takeoff" was the correct response, although the captain's words "stabilizer trim" failed to restate the correct challenge. (In the public hearing, the captain said that he had no specific recollection of checking trim settings on the accident flight but his normal procedure would be to do so. The first officer said that he did not check the trim settings himself while he was running the checklist during taxi-out and the airline procedure did not require him to do so.

The last item on the before takeoff checklist was "auto-brake." When challenged on this item, the captain responded "is off," and the first officer called the checklist complete.

About 18 seconds after beginning the roll, the CVR recorded a "bang" followed by a loud rumble.

The flight was cleared into position on the runway and received takeoff clearance at 2320:05. The CVR disclosed the sound of increasing engine noise, and shortly thereafter the first officer pressed the autothrottle disengage button instead of the takeoff/go around (TO/GA) button. (He later said that he then pressed the TO/GA button but noted no throttle movement). He then advanced the throttles manually to a "rough" takeoff power setting. The captain then said, "Okay, that's the wrong button pushed" and nine seconds later, "All right, I'll set your power." (The captain later said he thought he had rearmed and reengaged the autothrottles and had advanced the throttles to the N1 target setting of 95 percent while depressing the TO/GA button. The first officer later explained that "I'll set your power" meant to him that the captain was "fine-tuning" the setting to takeoff power. Both crew members agreed that the airplane then began tracking to the left during the takeoff roll).

About 18 seconds after beginning the roll, the CVR recorded a "bang" followed by a loud rumble. (The captain later said that during this time the airplane continued tracking to the left and that he was becoming concerned about the unidentified bang and rumble. The first officer said he believed he had stopped the leftward tracking and the airplane "began to parallel the runway centerline.").

At 2320:53, the CVR recorded the captain saying "got the steering." (The captain later testified that he had said, "You've got the steering." The first officer said that he thought the captain had said, "I've got the steering.") When the first officer heard the captain, he said, "Watch it then" and began releasing force on the right rudder pedal but kept his hands on the yoke in anticipation of the V_1 and rotation callouts.

At 2320:58.1, the captain said, "Let's take it back then" (which he later testified meant that he was aborting the takeoff). According to the captain, he rejected the takeoff because of the continuing left drift and the rumbling noise. He said that he used differential braking and nose wheel steering to return toward the centerline and stop. The sound of throttle levers hitting their idle stops was recorded at 2320:58.4. The digital flight data recorder (DFDR) indicated airspeed at that time was 130 knots. The sound of engine noise decreasing was recorded at 2321:00.9. The first officer then advised the tower of the rejected takeoff. (Later, the first officer said he was unaware of the reason for the captain's decision to abort).

Increasing engine sound indicating employment of reverse thrust was heard on the CVR almost nine seconds after the abort maneuver began. The airplane did not stop on the runway but crossed the end of the runway at 34 knots ground speed. It came to rest in the water supported by the pier that holds Runway 13's approach lights. The sound of impact was recorded at 2321:21.9.

Both pilots agreed that the farthest the airplane tracked to the left during the rejected takeoff was about halfway between the centerline and the left side of the runway. Both said that during the rejected takeoff they thought the airplane could be stopped on the remaining runway. Neither pilot could recall noting the airspeed at initiation of the rejected takeoff and the CVR recorded no standard airspeed callouts.

NTSB Accident Analysis

In general, the NTSB found that the flight and cabin crew were qualified to perform their duties under FAA and company regulations. There was no evidence suggesting that pre-existing structural discrepancies or flight control system or engine anomalies contributed to the accident. The evidence indicated to the NTSB that the takeoff attempt with full left rudder trim precipitated the accident. The NTSB's investigation also showed that the airplane was controllable with full left rudder trim and could have been flown with the appropriate operation of available flight controls. And, the investigation showed that the airplane could have been stopped on the runway after the takeoff was rejected.

Activation of Rudder Trim

Data from the DFDR showed that the rudder trim on the airplane was neutral after arrival at La Guardia. The DFDR was shut down, but when it was re-powered after engine start, showed that the rudder had moved to the full left trim position. Power was available during the intervening period to change the rudder trim position, if commanded. The time required to run the trim from neutral to full left is about 30 seconds, so momentary knob rotation would not have produced full left trim.

The NTSB concluded that a person or object inadvertently moved the rudder trim knob while the airplane was between flights ...

The design of the knob and its unguarded location at the rear edge of the center pedestal made it vulnerable to inadvertent actuation by a person in the jump seat who could have pushed the knob counterclockwise with a foot. Although the visiting captain said that he did not use the center pedestal as a foot rest, either he or other individuals not identified had the opportunity to rotate the knob inadvertently. Also, an object placed on the center pedestal could have wedged against and rotated the knob to drive the trim out of neutral. Although the visiting captain said that the first officer may have had a chart binder on the console, the first officer disagreed.

It is possible that the rudder trim knob was momentarily moved and jammed out of neutral either because of debris underneath or an internal malfunction, but the NTSB did not consider that either occurrence was likely because the knob operated satisfactorily after the accident.

The NTSB concluded that a person or object inadvertently moved the rudder trim knob while the airplane was between flights and that the crew failed to note the mistrimmed condition during preparations for the departure.

Mistrimmed Rudder Goes Undetected

The NTSB stated that the captain could have noticed the misset rudder trim almost immediately after engine start, even before he began taxiing away from the gate because the rudder pedals were offset from each other by 4.25 inches. He did not mention the offset to the NTSB until two days after the accident. After the DFDR evidence indicated the trim anomaly, the captain said that he had noticed the offset pedals, adding that the offset did not bother him because he was used to taxiing with offset pedals in the C-130. The NTSB noted that the C-130 rudder control system is reversible, or subject to feedback from the rudder surface, because air loads acting on the rudder surface will cause rudder movement that will feed back through the control system to move the rudder pedal. It would be normal, when taxiing a C-130, for the rudder pedals to move as a crosswind or jet blast acts on the rudder. However, said the NTSB, the Boeing 737 control system is irreversible — air loads on the rudder will not cause rudder or rudder pedal movement. Given the captain's relative inexperience, the NTSB thought that he should have been aware of these different aircraft characteristics.

Since the captain had only 140 hours in the left seat of the Boeing 737-400, and taxiing is performed only from the left seat, his taxi experience was somewhat limited. However, the full rudder trim would also have turned the nose wheel about four degrees left, requiring the captain to make a constant correction with the nosewheel steering tiller to keep the aircraft straight on a taxiway. The NTSB did not understand the captain's failure to react to those cues.

The captain checked rudder control during the before takeoff checklist. The Boeing 737 rudder trim is designed so that the full 26 degree rudder deflection is always obtainable regardless of trim setting or airspeed. Boeing estimated that full deflection of the rudder left and right with full left trim in the system would have required about 56 pounds of force on the left pedal and 71 pounds on the right. At zero trim, full rudder deflection forces are equal at approximately 68 pounds. The DFDR showed that the flight control check included full rudder deflection left and right and, therefore, full pedal travel in both directions. Again, said the NTSB, the captain apparently did not notice or consider significant the different pedal deflections or the different forces required during the control check.

The before takeoff checklist also required the captain to look at the trim indicators for the stabilizer, the rudder and the aileron in response to the first officer's challenge, "Stabilizer and trim." This step is intended to detect misset trim. Although the captain said he looked at all three indicators during taxi out, his response, "Stabilizer trim, I forgot the answer. Set for takeoff," suggested to the NTSB that not only was he unfamiliar with the memory response but that he may have also been unfamiliar with what items to check. The words "stabilizer trim" instead of "stabilizer and trim" suggested that he looked at the stabilizer trim only instead of all three settings. Certainly, said the NTSB, this was a critical opportunity to notice the misset rudder trim but the captain failed to do so. The procedures in effect at the time did not require the first officer to verify the rudder trim position as he called out the checklist.

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The NTSB believed that the captain should have noticed the mistrimmed rudder when he first rested his feet on the offset pedals during taxi, when he had to move the rudder pedals or nosewheel steering tiller to correct the left turning tendency, or during the rudder control freedom-of-movement check.

The first officer would have been unlikely to notice the offset pedals until he took control for the takeoff run. He did notice the pedal offset, while on the runway, and applied more right pedal to maintain runway heading. The CVR did not record either pilot's mention of the pedal offset. The NTSB thought that the first officer's inexperience in the Boeing 737 would explain his failure to recognize and act on the anomaly in time to change the outcome.

Directional Control Becomes Difficult

According to the NTSB, full rudder trim during takeoff does not make an accident inevitable, because pilots are trained to maintain directional control during takeoff under adverse conditions such as a yaw from an engine failure. Furthermore, said the NTSB, rudder trim on the Boeing 737 can be overpowered by the pilot. Upon reaching a speed at which the rudder is aerodynamically effective, the rudder pedals alone can be used to keep the airplane rolling straight. At lower speeds, the nosewheel steering must be used.

According to the Boeing 737 airplane flight manual (AFM), use of the nosewheel tiller after receiving takeoff clearance is only for alignment of the airplane with the runway. After alignment, rudder pedal steering should be used to maintain directional control during takeoff. On the Boeing 737, rudder pedals give the nosewheel up to seven degrees of steering to assist during the early part of the takeoff roll. However, the captain testified that he tried to use the steering tiller to maintain runway alignment until he rejected the takeoff.

The DFDR confirmed that the first officer applied some force on the right rudder pedal while the airplane accelerated for takeoff, but this pedal force became insufficient as the rudder became more aerodynamically effective. At 91 knots, the nose veered left. At 106 knots, the CVR recorded the captain saying, "got the steering." (He later testified that he had said, "you got the steering" advising the first officer to correct with right rudder. The first officer thought the captain said, "I got the steering" and that he expected the captain to take control of the rudder.) The first officer then said "okay" and, at 110 knots, relaxed force on the right pedal gradually to prevent rapid veering to the left. The rudder deflection changed from about one degree left to eight degrees left, consistent with the first officer's statement that he relaxed force on the pedal.

The first officer testified that he never felt the captain overpower his rudder pedal force. At 119 knots and fewer than three seconds after the captain commented "got the steering," the DFDR lateral accelerations showed that the airplane swerved to the left. Apparently, neither pilot was fully in control of the airplane because both of them seemed to expect the other to steer.

The captain testified that he tried to halt the leftward track of the airplane by using both rudder pedal and the nosewheel steering tiller prior to rejecting the takeoff. The DFDR refuted such an occurrence because it indicated a maximum rudder deflection of only one degree right during the 4.5 seconds that elapsed from "got the steering" to the captain's signaling his rejection of the takeoff by saying, "let's take it back." Although one degree nose-right rudder required about 58 pounds of force on the right pedal, neither pilot applied the 71 pounds of force required for full right rudder.

Apparently, neither pilot was fully in control of the airplane because both of them seemed to expect the other to steer.

When the captain took control of the airplane to initiate the RTO, he faced an unknown and complicated directional control situation. The first officer had been reacting to the nose-left tendency by depressing the right pedal, but the captain did not remember the first officer's warning about this. Therefore, said the NTSB, the need for a large amount of force on the right rudder pedal probably was a complete surprise to the captain at a critical time in the takeoff. His testimony, DFDR rudder data, the rumble sound on the CVR indicating extreme nosewheel deflection, and the physical evidence on Runway 31 indicate that the captain was relying on the nosewheel steering tiller for directional control instead of the rudder pedals. The combination of the captain's use of the tiller, and his failure to detect the first officer's rudder commands apparently led the captain to falsely believe that the tiller was effectively maintaining directional control. Instead of applying force to the right rudder pedal, the captain continued to depend on the nosewheel steering tiller and the airplane veered to the left, complicating the captain's subsequent actions to stop the airplane.

The Takeoff Is Rejected

The NTSB stated that most of the RTOs that have previously resulted in runway overrun accidents have been initiated for reasons other than engine failure. In many cases, the RTOs were not necessary, because the airplanes could have made the takeoff safely. As awareness of these occurrences increased, the airline industry has been emphasizing the philosophy that after reaching high speeds (generally accepted as 100 knots), pilots should reject takeoff only when an engine fails before V_1 or there are clear indications that a condition exists that will significantly affect the safety of flight. In this instance, the airline provided such guidance in its training program and the airline's

Boeing 737-300/400 Pilot's Handbook.

The NTSB said the captain of this flight had several indications of a problem during the takeoff roll before the airplane reached 100 knots. First, he must have been aware of the first officer's difficulty in maintaining runway heading as more and more nosewheel steering commands were applied by the tiller. Second, the sound of the "bang" occurred at 62 knots and the subsequent rumble was heard at 91 knots.

It was the NTSB's belief that the captain should have decided to reject the takeoff immediately. Having failed to do so, he must have been aware that the airplane was accelerating and rapidly approaching the V_1 speed, even though he failed to make the 80 knots and V_1 callouts. With such awareness, said the NTSB, the captain should have given his total attention to control of the airplane with the rudder pedals and continued the takeoff.

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Since either pilot was physically able to but did not use substantial rudder control, the NTSB concluded that because the pilot had full rudder authority, a safe takeoff was possible and that the pilots could have corrected the mistrim condition after lifting off. The NTSB's research turned up four successful takeoffs with full rudder trim and five with partial rudder trim from Boeing 737-300/400 pilots.

The NTSB found that the captain had not experienced a tire failure or non-critical event at high speed during takeoff in either simulator training or line flying operations. The board found that this airline was not unique in this regard and that most airlines present only engine failure situations during simulator training.

Braking Performance Scrutinized

Calculations by Boeing showed that a Boeing 737-300/400 should have stopped after an RTO initiated at a 125-knot V_1 speed using 4,050 feet on a dry runway and 5,670 feet on the "1/2 dry" runway involved in the accident, both without consideration for reverse thrust. That the accident flight failed to stop on a 7,000-foot runway was of concern to the NTSB. An extrapolation of DFDR acceleration data when the airplane left the runway shows that the flight would have used about 7,280 feet to come to a full stop, assuming that the deceleration was maintained.

In addition to variations in the runway friction, the NTSB also considered the distance used to accelerate the airplane, the RTO initiation speed, and the distance used, because of variations in pilot response times to apply maximum braking and to reconfigure the airplane.

Distance used for acceleration was the first factor that the NTSB considered. Although the airplane accelerated rapidly, the evidence showed that full takeoff thrust was not achieved and the thrust used was attained with some delay. NTSB studies showed that this flight would have reached the speed at which the RTO was initiated using 320 feet less runway had the thrust advanced normally with the use of the autothrottle. More significantly, said the NTSB, the captain delayed his action to reject the takeoff until the airplane had accelerated to, or beyond, the prescribed V_1 speed. DFDR data showed that the throttles were retarded to idle thrust at 130 knots, five knots above the speed for which the airplane flight manual stopping distance was based. Other factors notwithstanding, NTSB's study showed that the five knots of additional speed increased the required stopping distance by 494 feet.

In the view of the NTSB, the order of actions in a rejected takeoff are: full braking, throttle reduction, extending the spoilers and applying reverse thrust when available. Such actions are considered the full braking configuration. Wheel braking develops most of the decelerating force and full wheel braking at high speed depends on rapid spoiler deployment. Spoilers serve the purpose of increasing drag for deceleration and placing weight on the tires for braking by reducing wing lift. If the pilot does not extend the spoilers, they are automatically deployed during reverse thrust.

The DFDR data for this flight showed that the thrust reversers unlocked 5.5 seconds after the rejected takeoff started and about 4,800 feet from the beginning of the runway. The captain testified that he could not remember extending the spoilers or if the selection of reverse thrust automatically extended them. Spoiler position was not on the DFDR. The NTSB could not determine whether late deployment of the spoilers delayed the attainment of full braking force.

The NTSB stated that the captain should have used autobrakes ...

When the captain took control to reject the takeoff, he needed to correct the leftward tracking and apply maximum braking without delay. NTSB evidence showed that maximum braking was not achieved immediately. DFDR thrust and rudder position data indicate that the captain relied only on differential braking and nosewheel steering to correct the airplane's heading. The captain's testimony confirmed that he attempted first to correct the leftward track. As a result, DFDR data showed the maximum deceleration was not achieved until 5.5 seconds after the initial RTO action was taken, whereas the AFM data assumed an increment of only one second from brake application to achieve maximum deceleration. The NTSB assumed a reaction time of 2.5 seconds from brake application to achievement of maximum deceleration as being reasonable, and determined that the additional three seconds of delay added 786 feet to the theoretical stopping distance required.

Based on those calculations, the NTSB concluded that the airplane could have been stopped on the 7,000-foot runway had the captain taken more timely action to achieve maximum braking after his decision to reject the takeoff. Further, the NTSB observed that maximum braking would have been achieved sooner, regardless of the captain's actions or his directional control problems, if he had used autobrakes. The captain chose not to use the RTO feature of the autobrake system during the accident takeoff run despite recommendations from both Boeing and the airline.

The NTSB stated that the captain should have used autobrakes, and his failure to do so suggested that their use may not have been appropriately emphasized during line operations. The lack of autobraking was a factor in this accident. The captain believed steering the airplane back to the centerline was necessary prior to applying full brakes. Manually applying full brakes and full rudder is possible during a high-speed abort but borders on being an unnatural action because the pilot's feet are in slightly different positions for braking and for rudder. Use of the autobrake would have freed the pilot to concentrate on maintaining directional control with the rudder, while achieving maximum braking.

The NTSB believed that the captain either did not rearm the autothrottle after the inadvertent disengagement or he did not rearm and press TO/GA before 64 knots was reached. In either case, the autothrottles did not engage. The first officer did a "rough manual power set" but the captain did not make final adjustments to the left throttle. The left engine never reached its target N1 power setting, which explains the resultant substandard engine performance compared to a typical autothrottle thrust application.

"Bang" and Rumble Compel Reject Action

The tire marks on the runway suggested to the NTSB that the captain's continued attempt to steer using the nosewheel caused the "bang" and rumble noises that prompted the RTO. Rumbling began when the airplane reached 95 knots ground speed, 1,736 feet from the start of the runway. The "bang" was most likely caused by the left nosewheel tire suddenly coming off the rim allowing the air to escape violently.

The CVR showed that 23 seconds elapsed after the takeoff started before the rumble started. During this period, the rudder was deflected to the left much of the time. The NTSB stated that the airplane stayed on the runway instead of running off the left side because the captain was overpowering the rudder by commanding the nosewheel to steer right with the tiller. Erasure marks on the runway and damage to the nose wheel tires confirmed this.

Another Case for Applying Cockpit Resource Management

The NTSB viewed the absence of a comprehensive departure briefing, the absence of airspeed callouts, the failure of the first officer to clearly communicate his directional control problem and the non-assertive manner in which the captain communicated his intent to reject the takeoff, as indications of poor cockpit coordination. The flight crew's ineffectiveness as a team, said the NTSB, was probably the result, in part, of their lack of any formal training in cockpit resource management (CRM). Both pilots were hired and trained by the merged airline that did not provide formal cockpit resource management training to either pilot.

The NTSB listed the following crew coordination problems that were evident in the accident sequence:

1. the captain's failure to provide an extended briefing, or an emergency briefing before the takeoffs at Baltimore and La Guardia or at any time during the nine hours the crew members spent together before the accident

2. the decision of the captain to execute the takeoff at La Guardia with autobrakes disengaged, contrary to company and manufacturer recommendations

3. the failure of the crew to detect the improper rudder trim setting in response to the checklists

4. the failure of the crew to detect the improper rudder trim setting by means of rudder pedal displacement information during taxiing and holding for takeoff

5. the failure of the aircraft to hold at taxiway Golf Golf during taxiing as directed by ATC (This error, an obvious violation, had no effect on the accident sequence.)

6. the failure of the first officer to push the correct button to engage the autothrottles at the beginning of the takeoff roll

7. the failure of the captain, during the takeoff roll, to take control of the aircraft and transfer control back to the first officer in a smooth and professional manner, with the result of confusion as to whom was in control

8. the failure of the captain to make speed call-outs and to consult airspeed before initiating an abort

9. the failure of the captain to announce the abort decision in standard terminology, with the result of confusion by the first officer as to what action was being taken

10. the failure of the captain to execute the abort procedure in a rapid and aggressive manner.

The NTSB concluded that the captain's briefing on departure and emergency procedures was not adequate for the circumstances of this takeoff.

Emergency Procedures Briefing Considered Less than Adequate

The captain was aware that the first officer was on his first trip in the Boeing 737 and not having flown with him, could not have been fully aware of his capabilities. The NTSB concluded that the captain's briefing on departure and emergency procedures was not adequate for the circumstances of this takeoff.

At La Guardia, said the NTSB, the captain should have been even more aware that the first officer needed a discussion of emergency procedures, such as rejected takeoffs. This was to be the first officer's first non-supervised takeoff in line operational status in conditions that included darkness, low ceiling and a wet runway that was also relatively short with no appreciable overrun, having water at its end. These factors, according to the NTSB, should have categorized the takeoff as non-routine and should have prompted the captain to review emergency procedures. Good airmanship, said the board, should have dictated such a discussion, and the captain might even have made the takeoff himself.

Enter the Factors of Pilot Experience and Pairing

The circumstances of this accident reinforced the NTSB's conviction that the pairing of pilots with limited experience in their respective positions can, when combined with other factors such as an aircraft anomaly, be unsafe and is not acceptable. Although the pilots of this flight had previously demonstrated competence in their duties, compromises in the captain's decision making processes and management of the flight, and the first officer's improper operation of aircraft controls occurred as a result of inexperience in their respective positions.

...the pairing of pilots with limited experience can ... be unsafe ...

NTSB is of the opinion that the crew pairing minimum flight hour limitation should not be less than 150 hours and that operators should be required to pair not only a captain who has a relatively high level of experience with a first officer of relatively low level experience but also should require that a captain with a relatively low level of experience be scheduled with a first officer with relatively high level of experience.

Post-Accident Crew Availability Introduces Confusion, Consternation

The NTSB was concerned and upset that no federal investigators were allowed to speak to the pilots until almost 40 hours after the accident. Specific requests to the airline and to the Air Line Pilots Association (ALPA) to interview the pilots and to have them provide toxicological samples were made about 10 hours and again about 20 hours after the accident. The airline said they did not know where the pilots were. ALPA initially stated that it also did not know where the pilots were, but later stated that their location was being withheld so they could not be found by the media. This complicated the NTSB's investigative process to a great degree and in many respects, bordered on interference with a federal investigation. To the board, this was inexcusable.

More important to the NTSB is the fact that the pilots may have had safety-related information concerning the Boeing 737 that needed to be disseminated to all operators and the manufacturer. Although this was not the case in this accident, only the pilots and their union representatives were aware of the board's concern until it's representatives interviewed the pilots 40 hours later.

Author's Observations

There is much grist for the accident mill in all of the circumstances involved with this flight. In most accidents, there is a chain of events that can be traced and, usually, if one link in the chain is removed, the accident may not have occurred. In this particular accident, however, the series of events is linked together so strongly that the removal of one link may not have been enough to avoid the accident.

In the absence of federal regulations pertaining to crew pairings, airlines that are careless in their pairings, notwithstanding what numbers of captains and first officers are available for flight, show a disregard for the safety of their passengers and the value of their equipment.

If the pairings are out of alignment (i.e., a low-time captain with a low-time first officer), there is little to prevent the captain from using his very good judgment (NTSB calls it "good airmanship") in deciding who will fly the airplane. In this case, the pairings were very obviously out of line and the captain knew that his first officer had the very minimum of experience in the Boeing 737; plus it was his first flight in Boeing 737 line operations. Yet the captain, in what appears to be a very poor judgment call, allowed the first officer to make the takeoff.

... the cause for the accident is laid squarely at the feet of the captain ...

Crew coordination and cockpit resource management have been stressed over and over, and a little bit of such training would have gone a long way for both of the pilots involved in this accident. Given the fact that airlines can pair pilots who have not flown together before and, therefore, not know what the other's skills and weaknesses are, what prevents the pilots from talking to each other about experience levels and a review of what is expected in the cockpit?

The NTSB report provides sufficient information to consider two questions.

The first is that the flight itinerary, beginning with the delay at Baltimore, and the subsequent changes apparently vexed the captain because he went to the scheduling office at La Guardia to question how flight schedules were made. He expressed his concerns with the duty day. These concerns probably added stress factors which may have had a bearing on his conduct of the flight. Was the absence of a comprehensive emergency procedures briefing due to his push to conserve time and get on with the flight? The NTSB did not speak to this point.

The media has made much of the pilots' disappearance after the flight, and there has been much conjecture as to the whys and wherefores of that action. More speculation serves little purpose. However, the tone of NTSB comments eliminates any doubt as to the board's displeasure. If one assumes that NTSB investigators are dedicated and devoted to the principle of finding the cause of accidents in order to prevent another similar accident from happening, one can also assume that the pilots' actions immediately following the accident would lead to a intense and comprehensive investigatory process by the NTSB. There is an enormous amount of detail in the NTSB report and the cause for the accident is laid squarely at the feet of the captain.

Can a question be raised as to how much the post-accident behavior of the pilots had on the intensity of NTSB's investigation? ♦

About the Author

John A. Pope established John A. Pope & Associates, an aviation consulting firm located in Arlington, Va., U.S., after retiring in 1984 as vice president of the U.S. National Business Aircraft Association. He specializes in developing comprehensive operation manuals for corporate flight departments.

Pope, former Washington editor for "Aviation International News," is a frequent contributor to Flight Safety Foundation's publications.

He served as a command pilot in the U.S. Air Force and the Air National Guard. He retired as a colonel from the U.S. Air Force Reserve after 33 years of service.

Aviation Statistics

Worldwide Airline Fatal Accidents and Jet Transport Aircraft Hull Losses

by
Shung C. Huang
Statistical Consultant

Preliminary statistics have been compiled by Flight Safety Foundation for air carriers operating large aircraft during calendar year 1990. The data indicate that worldwide airlines recorded 27 fatal accidents that accounted for 792 fatalities that included 766 occupants of the aircraft involved and 24 persons on the ground. A total of seven jet transport aircraft were totally destroyed, two of which were manufactured in the U.S.S.R. The accompanying table provides a preliminary review of the 27 fatal accidents and jet transport aircraft hull-losses.

Troubles on the Ground

Of the 27 fatal accidents, four occurred on the ground at U.S. airports and involved U.S. airlines. Two of them were ground collisions between aircraft. The third fatal accident occurred on a ramp when a maintenance technician was fatally injured. The fourth occurred when a pedestrian was killed while crossing a runway. The preliminary descriptions of the four fatal U.S. ground accidents follow:

1. January 18, Hartsfield International Airport, Atlanta, Georgia — An airline Boeing 727 was involved in a ground collision with a general aviation aircraft on a runway. The general aviation aircraft had landed, and before it had completed a right turn onto a taxiway, the Boeing 727 landed on the same runway and struck the small aircraft. The right wing of the jetliner struck the area between the left wing and the tail cone of the small aircraft which was totally destroyed. The pilot of the small aircraft received fatal injuries and another occupant, in the right front seat, received serious injuries. There were no injuries to persons on the jet aircraft.

2. December 3, Detroit Metro Airport, Michigan — The airport was very foggy. Landings had been banned but takeoffs were allowed because the visibility on the runways was determined to be above the required quarter-mile minimum. A departing DC-9 left its gate and made a turn onto the wrong taxiway, then failed to turn right onto a second taxiway that would bring it back to the assigned takeoff point. When it continued to taxi past the second assigned taxiway, the DC-9 entered an active takeoff runway. A ground traffic controller in the control tower, unable to see the DC-9 because of heavy fog, called the crew on the radio in an attempt to locate the aircraft's position. He warned the crew to taxi the aircraft off the active runway immediately if it was on it. At that moment, a Boeing 727 that had been cleared for takeoff was moving down the runway at more than 100 miles an hour. By the time either flight crew could see the other aircraft, it was too late for either to take avoidance action, and the right wingtip of the 727 slashed almost the entire length of the DC-9, tearing off one of the DC-9's engines. A fire was ignited when jet fuel flowed from severed lines ruptured by the collision. Smoke and toxic fumes engulfed the cabin section

and eight of the aircraft's 44 occupants were fatally injured. There were no injuries to those aboard the Boeing 727.

3. January 31, Indianapolis Airport, Indiana — An airline Boeing 727 had been parked, awaiting a tug, with the wheels chocked. The flight engineer and pilot were aboard finishing their paperwork, while a mechanic/ramp employee brought a tug and towbar to the aircraft. The ground employee stopped the tug in front of the aircraft and disconnected the towbar from the tug which he connected to the nosegear of the aircraft. He reboarded the tug and moved it forward, closer to the tow bar for attachment. As he reached to insert an attachment pin, the tug continued to move toward the aircraft. The tug and the towbar jacknifed and the tug continued to move until it contacted the underside of the aircraft's nose section. The operator was crushed between the tug and airplane. He received serious injuries and subsequently died.

4. March 19, Phoenix Sky-harbor Airport, Arizona — An airline Boeing 727 struck a pedestrian on a runway during the takeoff ground run at night. The pedestrian received fatal injuries but the occupants of the jetliner were not injured. Night visual meteorological conditions prevailed at the time the accident occurred. The pedestrian was not authorized to be in the vicinity of the runway, but the circumstances in which he gained access to it were not known.

Since all four of the ground accidents occurred at U.S. airports and involved aircraft operated by U.S. airlines, they are under investigation by the U.S. National Transportation Safety Board (NTSB). Although the probable causes of the accidents have not been determined, the nature of the four ground accidents reflects continuing concerns relating to ground operational safety and security at U.S. airports. In addition to one fatal accident in 1977, two fatal accidents in 1979 and the above four in 1990, there have been hundreds of airport runway incursions recorded at U.S. airports. According to the U.S. Federal Aviation Administration (FAA), a report in the *Washington Post* newspaper stated that there were 179 airport runway incursions recorded in 1978, 223 in 1979 and about 250 in 1990. The FAA describes a runway incursion as an incident in which objects or people stray onto runway and calls it a serious problem.

It was also reported that the FAA has addressed these airport incidents with a variety of programs. For the past 15 years, the agency has been attempting to devise a radar system that would enable airport ground controllers to identify aircraft on the ground, as well as they are identified when they are airborne, in order to better separate the aircraft during taxiing operations. An existing ground radar system provides inadequate performance and fails to work properly in heavy rain, often a time when the ground controllers need help most. A newer version is being developed that is expected to overcome performance and image shortcomings of the older system.

Safety procedures during ramp operations have been emphasized from time to time, but despite preventive programs, many such accidents continue to occur. During a typical year, many personnel working on the ramp suffer injuries, and damage occurs to aircraft and ground support equipment.

Because of the continuing occurrence of incidents and accidents on the ground, airport security and safety will continue to be one of the greatest challenges to individuals and agencies concerned with airport safety. ♦

Worldwide Airline Fatal Accidents and Jet Transport Aircraft Hull Losses — 1990

Date	Location	Aircraft	Damage	Fatalities*	Phase	Remarks
1/13	Sverdlovsk, U.S.S.R.	TU-134	Subst.	23	Cruise	Emergency landing due to engine fire.

Date	Location	Aircraft	Damage	Fatalities*	Phase	Remarks
1/18	Atlanta, Ga., U.S.	B-727	Minor	1	Landing	Ground collision with Beechcraft.
1/25	New York, N.Y., U.S.	B-707	D	72 (161)	Approach	Lost all power; short of fuel in heavy fog approach.
1/25	Lombok, Indonesia	BAe-748	D	19	Approach	Crashed into high terrain on approach.
1/31	Indianapolis, Ind., U.S.	B-727	Minor	1	Parked	A ground service mechanic was fatally injured by a tug.
2/14	Bangalore, India	Airbus 320	D	91 (146)	Landing	Landed short of runway; fire after impact.
3/13	Phoenix, Ariz., U.S.	B-727	Minor	1	Takeoff	Struck a pedestrian on runway.
3/21	Tegucigalpa, Honduras	L-188	D	3	Approach	Descended too low; hit high ground on approach.
3/23	Santiago, Cuba	An-26	D	20	Takeoff	Takeoff aborted; crashed into a ditch.
3/27	Kabul, Afghanistan	IL-76	D	10	Approach	Crashed into high terrain.
4/12	Vaeroy, Norway	DHC-6	D	5	Takeoff	Crashed into sea during climb.
4/18	Panama	DHC-6	D	20	Takeoff	Crashed into sea due to engine birdstrike.
5/4	San Juan, Puerto Rico	L-1049	D	1	Cruise	Ditched in sea due to engine fire.
5/5	Guatemala City, Guatemala	DC-6	D	27	Takeoff	Crashed into residential area; 22 persons on the ground were fatally injured.
5/10	Mexico	FH-227	D	21	Approach	An engine failed; emergency landing short of runway.
5/11	Manila, Philippines	B-737	D	8	Taxiing	Explosion in fuselage on taxiing. Aircraft burned.
6/6	Altamira, Brazil	FH-227	D	23	Approach	Crash landed short of runway.
8/1	Nagorno-Karabakh, U.S.S.R.	YAK-40	D	30	En route	Crashed into mountain.
9/21	Phoenix, Ariz., U.S.	B-707	D	1	Takeoff	Crashed and burned.
10/2	Canton, China	B-737	D	127	Landing	A hijacker's bomb ex

Date	Location	Aircraft	Damage	Fatalities*	Phase	Remarks
-						ploded.
10/3	Atlantic Ocean	DC-9	None	1	Cruise	A passenger died as a result of in-flight turbulence injuries.
10/10	Siberia, U.S.S.R.	AN-12	Subst.	9	Approach	Crashed short of runway.
10/21	Siberia, U.S.S.R.	IL-62	D	176	Approach	Crashed in a ravine a few miles short of airport runway.
10/24	Antonio, Maceo, Cuba	YAK-40	Subst.	10(31)	Approach	Crashed short of runway.
11/15	Zurich, Germany	DC-9	D	46	Approach	Aircraft was on fire, hit a ridge on approach.
11/21	Koh Samui Ils, Thailand	Dash-8	D	38	Approach	Crashed into sea.
12/3	Detroit, Mich., U.S.	B-727 DC-9	Subst. D	None 8(44)	Takeoff Taxiing	B-727 struck DC-9 in heavy fog; near zero visibility.

Comparative Data on Accident Rates
U.S.S.R and ICAO Member States

Source: State Supervisory Commission for Flight Safety (Gosavianadzor), Council of Ministers, U.S.S.R.

Fatal Accidents per 100,000 Flight Hours

	Average for the period			Year			
	71-75	76-80	81-85	86	87	88	89
U.S.S.R.	0.24	0.17	0.09	0.12	0.05	0.08	0.03
ICAO (excl. U.S.S.R.)	0.26	0.17	0.14	0.09	0.12	0.12	0.14

Fatalities (Passengers and Crew Members)
Per One Million Enplanements

	Average for the period			Year			
	71-75	76-80	81-85	86	87	88	89
U.S.S.R.	4.6	3.2	2.6	2.4	0.16	0.6	0.3
ICAO (excl. U.S.S.R.)	2.4	1.3	0.9	0.5	0.9	0.7	1.0

*The figures in the parentheses indicate the total occupants aboard the aircraft

Reports Received at FSF Jerry Lederer Aviation Safety Library

Reference

Advisory Circular 25.807-1, 8/13/90, Uniform Distribution of Exits. — Washington, D.C. : U.S. Federal Aviation Administration, August, 1990. 17p. in various pagings.

<u>Key Words</u>

1. Aeronautics, Commercial — Law and Legislation — United States.
2. Aircraft Cabins — Design — United States.
3. Aircraft Cabins — Emergency Exits — United States.
4. Aircraft Cabins — Law and Legislation — United States.

Summary: This advisory circular (AC), applicable to transport airplanes, provides guidance material defining acceptable means, but not the only means, of demonstrating compliance with the requirements for distributing required passenger emergency exists uniformly. The AC addresses only those passenger-carrying airplanes, including mixed passenger/cargo ("combi") configurations, which are required to comply with [U.S. FAR Part] 25.807, Amendment 25-15 or later. This AC does not address airplanes with only one pair of required exits. There is no intent to impact existing certificated passenger/exit configurations or new models added to existing type certificates which have identical, or improved, passenger/exit configurations even if these configurations do not strictly meet the guidance material presented herein. The intent is to provide guidance for application to new airplane models, to prevent changes to derivative airplanes which would worsen already marginal configurations, and to prevent changes to existing airplanes that could result in undesirable passenger/exit configurations. Such changes could include, but not be limited to, the addition of fuselage sections between existing exits, and the addition of passenger seats in areas of the cabin beyond previously approved numbers. [purpose]

Report

Report of a Safety Study on VFR Flight into Adverse Weather / Transportation Safety Board of Canada. — Hull, Quebec : Transportation Safety Board of Canada; [adopted] November 13, 1990. Report No. 90-SP002. 35p. [Communique Number 12/90 scheduled for release 20 December 1990.] [FSF also has French edition.]

<u>Key Words</u>

1. Aeronautics — Accidents — Pilot Training.
2. Aeronautics — Accidents — Night Flying.
3. Aeronautics — Accidents — Visual Flight Rules
4. Aeronautics — Accidents — Weather.
5. Airplanes — Piloting — Safety Measures.

Contents: Introduction — VFR Flight — Night Visual Flight — Pilot Licensing — Industry Practices — Aircraft Equipment — Other TC [Transport Canada] Safety Measures — Conclusion — Annexes.

Summary: "Accidents involving continued VFR-into-IMC (Instrument Meteorological Conditions) account for a disproportionate number of fatalities each year. The causes of and contributing factors to the 333 accidents in the study have recurring themes. These include inappropriate pilot qualifications or proficiency for the conditions encountered, and serious shortcomings in the permissible weather minima for VFR flight, in pilot training, and in pilot license privileges. In some cases, current industry practices and limitations in aircraft equipment and weather briefing facilities exacerbated the circumstances leading up to the accidents. The Board believes that full implementation of the [26] recommendations made in the report will go a long way towards redressing the pervasive conditions leading to this type of accident which annually claims so many fatalities." [Conclusion]

Accident/Incident Briefs

This information is intended to provide an awareness of problem areas through which such occurrences may be prevented in the future. Accident/incident briefs are based upon preliminary information from government agencies, aviation organizations, press information and other sources. This information may not be accurate.

Air Carrier

Rapid Rotation Scrapes Tail

Boeing 757: Minor damage. No injuries.

A pilot trainee was making his first takeoff in the Boeing 737 with a training captain monitoring. During the preflight briefing, all aspects of local training flying procedures were covered and included a discussion on the proper rotation rate to use at liftoff.

During the takeoff, the aircraft made a normal ground run and the routine call for rotate was made. However, the trainee pilot rotated too quickly and raised the nose too far and the training captain did not respond in time to correct for the over-rotation. A bump was felt as the aircraft lifted off the runway but no unusual handling was experienced. The aircraft completed a traffic pattern and landed without incident. Inspection revealed damage to the underside of the rear fuselage where the tail had scraped the runway during the takeoff.

An analysis of the flight data recorder indicated that the aircraft's rotation rate had been 8.25 degrees per second compared with the recommended rate of three degrees per second. The aircraft also had rotated to an excessive deck angle of 16 degrees before the rotation was halted.

Training captains were advised of the incident and recommendations were made about care needed during early flight phases of flight training with inexperienced pilots.

Configuration Warning Saves the Day

Boeing 737: No damage. No injuries.

Taxi for takeoff involved a non-standard procedure to arrive at the runway. The aircraft eventually was positioned for takeoff and power applied.

When the power levers were advanced to takeoff power, a takeoff configuration warning occurred and the captain rejected the takeoff immediately; the aircraft had accelerated only to 10 knots.

A check of the aircraft configuration revealed that the flaps had not been set for takeoff. The oversight was corrected and the aircraft was repositioned for a subsequent takeoff with no further incident.

The cause of the incident was attributed to the flight crew's failure to properly set the flaps for takeoff. The normal taxi-out procedure requires the captain to call for takeoff flaps to be set prior to completion of the before-takeoff checklist. The flap position is to be checked again as part of the before-takeoff checklist which requires that the green light indicating extension of the leading-edge flaps is illuminated and that the flap position indicator agrees with the position of the flap lever. The takeoff configuration warning system operated as it was designed.

The failure to set takeoff flaps according to checklist procedures was discussed with the flight crew.

Engine Failure Demonstration Takes an Unexpected Turn

Pilatus Britten-Norman Islander: Extensive damage. No injuries.

The purpose of the flight was for the pilot taking a flight test to demonstrate compliance with a requirement to maintain directional control after sudden failure of a critical engine during the takeoff run before V_2 speed or, if the aircraft has become airborne below V_2, to "re-land without the display of undue skill …." The weather forecast had reported that the wind was at 17 knots but there were slight gusts that had not been reported.

The V_2 speed for the flight was calculated at 60 knots. The engine failure would be simulated by closing the low-pressure fuel valve at an airspeed that was expected to produce an engine power decrease at the V_2 speed, plus or minus five knots.

The simulated failure of the left engine was accomplished and the engine power run-down occurred at 63 knots. The pilot being tested kept the aircraft within a 10-foot divergence to the left of the runway centerline.

The demonstration was repeated but with a failure of the right engine. This time the engine power run-down occurred at 70 knots, just after the aircraft became airborne because of a wind gust, according to the pilot. The aircraft drifted to the right of the runway centerline further than the engine failure should have induced. By then, the aircraft had gained a height of almost 40 feet and was nearly 30 feet to the right of the centerline. The aircraft commander estimated that there was not enough available runway distance available to land, so he continued the takeoff, expecting the light weight of the aircraft to allow adequate climb performance. The airspeed decayed, however, possibly the result of the passing of the wind gust, and the aircraft began to sink. Full power was applied and flaps were retracted, but the aircraft descended in a nose-high attitude and impacted the ground beyond and to the right of the runway at a speed of 55 knots.

The crew exited the aircraft without injury. The aircraft was extensively damaged, with the tailplane, fuselage and right wing buckled, and the main landing gear broken.

Not Sure of Door? A Good Thump Is No Cure

Reims Cessna F406: Minor damage. No injuries.

It was a positioning flight and the pilot was the only occupant in the twin-engine Cessna. The aircraft was climbing out on a standard instrument departure, in instrument meteorological conditions at night.

Passing through 6,000 feet, the master warning light illuminated. Simultaneously, the crew door warning light came on.

The pilot suspected the problem was caused by a faulty door microswitch, so he thumped the door and wiggled the locking handle to assure himself that the door was secured. The warning lights went out. As the flight progressed, however, both warning lights continued to illuminate, but each time the pilot was able to put them out by thumping the door and wiggling the handle. The process was very distracting for the pilot, who was flying in instruments in the dark.

Approximately 20 nautical miles from his destination, at an altitude of 3,000 feet, a sudden loud roar engulfed the pilot and the door disappeared from sight.

The pilot noticed a slight pitch change, but otherwise had no control difficulty. He notified air traffic control of the problem, reduced power to lower the noise level from the open doorway, and landed the aircraft without further incident.

When the aircraft was inspected, it was found that the door had not departed the fuselage, but had hinged back over the roof of the cabin. No defects were found in the locking mechanism and the door was reinstalled for a flight to home base for further inspection, during which the door remained closed.

A notice in the flight manual cautions against touching the door in case the warning lights illuminate during flight, and recommends landing as soon as practical.

Two Warnings Were Not Enough

Cessna 340: Extensive damage. No injuries.

The pilot was landing in the late afternoon after an uneventful flight. A normal touchdown was made but, when the pilot applied brakes, the right main landing gear collapsed. The propeller struck the runway, stopping the engine, and the aircraft came to rest off to the right side of the runway in the grass. The pilot was not injured and secured the aircraft before he exited it.

No mechanical malfunction was found because of extensive damage to the locking mechanism. However, technicians suspected a problem in the downlock mechanism.

The pilot told investigators that landing gear unsafe indications had occurred on two previous flights which he had attributed to a faulty microswitch; no maintenance action had been recorded. A third such unsafe warning had occurred when the gear was lowered on the accident flight, but the pilot reported he recycled the gear and that three green lights showed all gear were down and locked.

Under the Clouds And Into a Tree

Cessna Citation: Aircraft destroyed. Fatal injuries to four.

The aircraft was approaching to land in the early evening, after an instrument flight of less than an hour, and was making a localizer approach in weather that was described as ceiling obscured at 100 feet and visibility of slightly more than one-tenth of a mile in fog. Aboard the business jet were two pilots and two passengers.

No problems had been reported by the pilot. However, an air traffic control radar controller had warned him that the aircraft was low prior to arrival at the outer marker but the pilot had responded that it was okay because he was "visual." The controller also notified the pilot that the aircraft was to the right of course and it appeared that the aircraft was correcting back to course.

When the aircraft reached the outer marker, it began a rapid descent and collided with a tree 90 feet above the ground approximately two and a half miles prior to the airport. It crashed in an open field. The aircraft was destroyed and both pilots and two passengers received fatal injuries. The minimum descent altitude was 1,160 feet higher than the tree hit by the aircraft.

There were no aircraft mechanical problems discovered. The pilot, an officer in the company that owned the aircraft, was type-rated but had fewer than 200 hours in the aircraft. He had received all of his pilot ratings in less than a year and had been given outstanding marks during training. The copilot was not type-rated but had previously flown in the right-hand seat of the aircraft.

Fuel Flows Downhill And Grounds Aircraft

Rockwell Commander 114: Aircraft destroyed. No injuries.

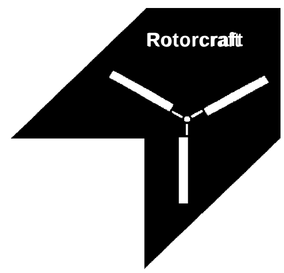
The low-wing, single-engine lightplane had been housed for some time in a hangar that had a floor with a pronounced slope, sufficient for the aircraft's left wing to be lower than the right wing. During the time the aircraft was stored there, the fuel selector had been left in the on position, a condition that would allow fuel to drain by gravity from the higher to the lower tank.

The pilot arrived for an early morning flight and noticed during preflight checks that the fuel gauge for the left tank indicated three-quarters full while the right-hand gauge indicated between one-quarter tank and empty. The pilot nevertheless continued preparations for a short-field takeoff from the 1,200-foot dry grass runway. This technique required 20 degrees of flaps, full power prior to brake release and liftoff at 66 knots.

On takeoff, the aircraft became airborne after about half of the takeoff distance available; however, as soon as it lifted off, the left wing began to lower. Although the pilot applied full right aileron and rudder, he was unable to prevent the left wingtip from striking the ground. With the stall warning sounding, the aircraft pivoted onto its nose and came to rest.

Fuel escaped from the damaged left wing and quickly ignited. The pilot grabbed the fire extinguisher and evacuated the aircraft, uninjured, from the right side door. He tried to extinguish the flames, but the amount of agent in the fire extinguisher was not enough and the aircraft was consumed by the fire.

The pilot admitted being under pressure to arrive at his destination in time for the start of business. He stated that this could have affected his judgment in recognizing the effect the fuel imbalance could have on the control of the aircraft, especially during a low-speed, high-performance takeoff.



Sent Helicopter On First Solo

Hughes 369D: Substantial damage. No injuries.

An external load mission had just been completed. The rotorcraft was landed on the roof of a parking structure so the pilot could reinstall the left front door before returning to the airport where the aircraft was based. Earlier, the door had been removed for better visibility during the lift operation and it was stored in the helicopter's passenger compartment.

After landing, the pilot exited the helicopter with the engine running at operating rpm. As he started to install the door, the rotorcraft began to lift off. According to reports from witnesses, the aircraft attained a height of between 10 and 15 feet and rotated to the right. It then fell back to the roof on its right side. The aircraft ended its short solo flight substantially damaged, but the absent pilot avoided injury. ♦