



During Three-engine Takeoff in DC-8, Captain Makes Premature Liftoff, Resulting In Stall and Collision With Terrain

Although the flight was legal under the regulations governing it, the accident flight crew would not have met the legal crew-rest requirements for a revenue flight, the official U.S. report said.

FSF Editorial Staff

The crew of the McDonnell Douglas DC-8-63 had been assigned to make a three-engine ferry flight from Kansas City International Airport (MCI), Kansas City, Missouri, U.S., to a company maintenance facility where repairs could be made to the No. 1 engine. The crew attempted two three-engine takeoffs at night in visual meteorological conditions (VMC). Their first attempt resulted in a rejected takeoff, after the captain (the pilot flying) applied high power on the asymmetric engine too quickly to maintain directional control.

As they taxied back to the runway for a second takeoff, the captain agreed to allow the flight engineer to increase the power on the asymmetric engine during takeoff, which was contrary to the published procedure for three-engine takeoffs.

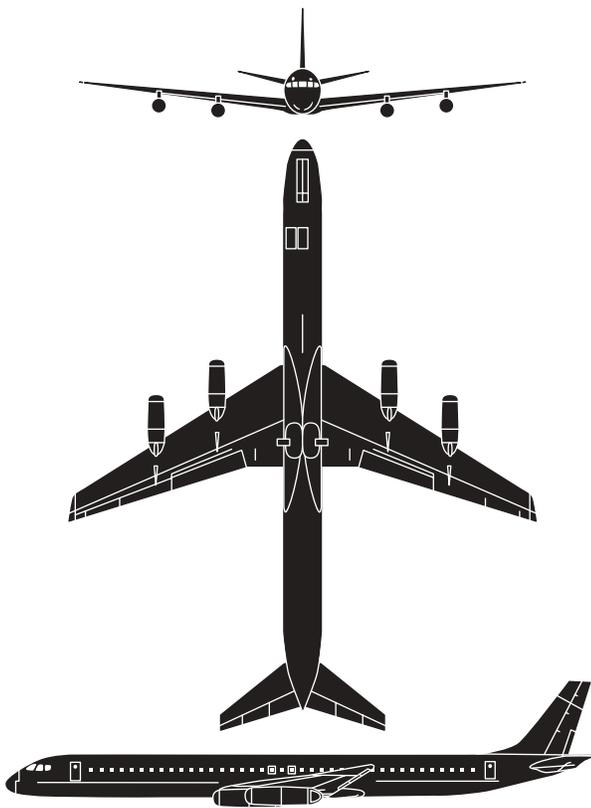
During the second takeoff, the flight engineer increased power too quickly on the asymmetric engine, and the airplane veered toward the left side of the runway. The captain was unable to maintain directional control and, instead of rejecting the takeoff, rotated the airplane below rotation speed (V_r). The airplane became airborne momentarily, rolled into a near 90-degree left bank, then hit the ground and exploded. All three flight crew members were killed in the Feb. 16, 1995, accident.

The U.S. National Transportation Safety Board (NTSB) concluded in its final accident report that the probable causes

of the accident were: "1) the loss of directional control by the pilot in command during the takeoff roll, and his decision to continue the takeoff and initiate a rotation below the computed rotation airspeed, resulting in a premature liftoff, further loss of control and collision with the terrain; 2) the flight crew's lack of understanding of the three-engine takeoff procedures, and their decision to modify those procedures; 3) the failure of the company to ensure that the flight crew had adequate experience, training and rest to conduct the nonroutine flight."

The report also concluded that contributing to the accident "was the inadequacy of the FAA [U.S. Federal Aviation Administration] oversight of ATI [Air Transport International, the owner and operator of the accident aircraft] and FAA flight- and duty-time regulations that permitted a substantially reduced flight-crew rest period when conducting a nonrevenue ferry flight under [U.S. Federal Aviation Regulations (FARs)] Part 91."

The accident aircraft landed at MCI after a regularly scheduled cargo flight from Denver, Colorado, U.S., the report said. After the aircraft was prepared for another trip, the crew attempted to restart the aircraft's engines, but was unable to start the No. 1 engine. "Local maintenance personnel examined the engine and determined that a No. 1 engine gearbox drive gear had failed, and that repairs could not be accomplished at MCI," the report said.



McDonnell Douglas DC-8

The McDonnell Douglas DC-8-63, which combined the stretched fuselage of the model 61 with aerodynamic and powerplant improvements, first flew in 1967. The model 63, equipped with four Pratt & Whitney JT3D-7 turbofan engines, has a maximum takeoff weight of 350,000 pounds (158,760 kilograms) and maximum cruising speed at 30,000 feet (9,150 meters) of 521 knots (600 miles per hour/965 kilometers per hour). The design range of the model 63 with maximum payload and normal reserves is 3,907 nautical miles (4,500 statute miles/ 7,240 kilometers).

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

ATI management decided that the aircraft should be ferried to Westover Municipal Airport (CEF), Chicopee, Massachusetts, U.S., where repairs could be made, and the cargo was then off-loaded, the report said.

Meanwhile, another DC-8 was scheduled to be ferried from Dover, Delaware, U.S. (DOV), to MCI by the captain, first officer and flight engineer who would later crew the accident flight. "This flight crew had completed a regular cargo flight from Germany and were on an off-duty rest break [at] DOV," the report said. "ATI flight crew scheduling personnel later assigned the captain and his crew to the three-engine ferry operation of [the accident aircraft] to be conducted from MCI to CEF. The ATI chief pilot was consulted about this assignment and gave approval for the flight, although flight crews more

experienced in three-engine takeoffs were available at MCI," the report said.

The chief pilot later said he had telephoned the captain and discussed details for the three-engine ferry flight, "including the weather forecast of possible adverse winds during the landing at CEF," the report said. "Additional discussions occurred concerning a landing curfew at CEF of 2300 [hours] eastern standard time (EST) and how this would impact the flight. If the captain was unable to arrive before the landing curfew, it was decided to use Bradley International Airport (BDL), Windsor Locks, Connecticut (about 17 nautical miles [31.5 kilometers] southwest of CEF), as an alternate," the report said.

The crew departed DOV and arrived at MCI at 1739 central standard time (CST), for a blocks-to-blocks time of 3.3 hours, the report said. An airframe and powerplant (A&P) mechanic prepared the accident aircraft for the ferry flight, while the captain prepared paperwork and discussed fuel requirements with the captain who had flown the aircraft from Denver to MCI. "The computer flight plan provided to the captain estimated an en route time of two hours and seven minutes for the flight from MCI to CEF," the report said. "Based on this estimated time, [the crew] would have had to take off prior to 1953, in order to arrive at CEF before the curfew."

The A&P mechanic who prepared the aircraft for the flight later said he was in the cockpit when the captain "reviewed the three-engine ferry procedures with the other two crew members with the aid of the flight manual," the report said.

There were some problems starting the No. 4 engine, but all three engines were operating at 2004 hours. The captain then said to the other crew members, "Okay, okay, what we are going to need to do is, ah, get as much direct as we can that will allow us to fly a little bit better than eight zero [Mach .80] if we can," the report said. The captain elaborated: "Yeah, because we got, we got two hours to make it to go over there for flight time ... and right now it's past," the report said. The first officer then commented, "Pushin'."

At 2007:39, the first officer called ground control, requested taxi instructions, and told the controller they would be making a three-engine takeoff, the report said. The crew was assigned Runway 01L, which is 10,801 feet (3,294 meters) long and 150 feet (46 meters) wide. After requesting the latest information about surface winds, the crew was told that the wind was from 240 degrees at four knots. "The flight crew then requested Runway 19R for departure, but due to conflicting inbound traffic, this request could not be approved," the report said.

The report discussed the performance data for the flight: "Takeoff data computed by the flight crew during flight planning (written on the laminated takeoff data card found in the wreckage) included a V_{mcg} speed [minimum control speed on the ground] of 107 knots [later determined to be miscalculated], a V_r speed of 123 knots, a V_2 [takeoff safety]



Photo: Pat Cariseo, U.S. National Transportation Safety Board

The airplane's fuselage broke into two large sections on impact.

speed of 140 knots, a stabilizer trim setting of 5.1 units nose-up and a maximum takeoff engine pressure ratio (EPR) setting of 1.9.”

V_{mcg} is the “minimum speed at which it is possible to maintain control of the airplane with an engine inoperative, using primary aerodynamic controls alone, and thereafter maintain a straight path parallel to that originally intended,” the report said. V_{mcg} is a function of the airport pressure altitude, airplane flap setting and ambient air temperature.

The report commented: “According to the ATI DC-8 three-engine takeoff chart, these speeds would be appropriate for a 220,000-pound [99,792-kilogram], 1,000-foot [305-meter] pressure altitude, 12-degree flap setting, 30 degrees C [86 degrees F] takeoff. The temperature at the time of the accident takeoff was 31 degrees F, or about zero degrees C. The correct speeds for a zero degrees C takeoff, under the same conditions, would be V_r — 121 knots, V_2 — 141 knots and V_{mcg} — 116 knots.”

At 2013:28, the captain conducted a pretakeoff briefing during which he told the first officer and flight engineer that maximum power would be set on the No. 2 and No. 3 engines, the report said. The captain then said he would “ease in” power on the No. 4 engine.

The accident flight was cleared for takeoff at 2019:07, the report said. The crew performed a static run-up while in

position at the end of the runway. The takeoff was commenced and, at 2020:31, the crew transmitted, “We’re aborting the takeoff,” the report said. After turning off the runway, the crew requested clearance to taxi back to Runway 01L for another takeoff.

The report said that during the aborted takeoff, “the power on the asymmetric engine was advanced so that full power on the asymmetric engine was obtained at around 100 knots, about seven knots below the stated but incorrect V_{mcg} speed of 107 knots. The [EPR] of 1.5 was called one second before the airspeed-alive (about 50 [knots] to 60 knots) call was made; followed by a call of 1.6 EPR, one second before the 80-knots call. Then, 90 knots was called, followed one second later by the 1.8-EPR [call] (the target EPR was 1.91). One hundred knots was called one second later, followed by the sound of decreasing engine power, indicating the start of the rejected takeoff.”

As they were taxiing back to the runway, the crew discussed the problems they encountered during the takeoff, the report said. The captain commented that the power on the No. 4 engine came up too quickly for him to maintain directional control of the aircraft. At this point, the flight engineer said, “If you want to try it again, I can try addin’ the power if you like,” the report said.

The captain agreed to allow the flight engineer to increase the power on the No. 4 engine during takeoff, the report said. This

procedure was contrary to the three-engine takeoff procedure in the aircraft manual, which specifies that the captain should control the throttles.

The crew also discussed the fact that time was “gettin’ tight” for reaching CEF by curfew time, the report said.

At 2024:28, the flight was again cleared for takeoff. As the captain taxied onto the runway, he said, “I’ll line up just a little right of the centerline here.” The captain was probably compensating for asymmetric thrust that would steer the aircraft to the left during the takeoff roll, the report said.

During the takeoff, “the power on No. 4 engine was increased by the flight engineer at a more rapid rate than on the first takeoff,” the report said.

The report described the takeoff: “Shortly after the first officer called airspeed alive, there was an abrupt turn to the left, followed quickly by a correction to the right. After the first officer called ‘90 knots,’ the airplane started to turn left again. Following the 100-knot call, the FDR [flight data recorder] revealed a pitch change, indicating that the pilot rotated the airplane about 20 knots before the target rotation speed of 123 knots.”

The report continued: “The left drift continued, and the first officer was heard calling, ‘We’re off the runway.’ A directional control correction was initiated, and the pitch attitude increased just as the airplane became airborne. The airspeed reached between 120 [knots] and 123 knots. This is just about V_{mca} (minimum control speed air) and is also about the stall speed for that airplane weight.”

A commercial pilot, who was standing on the ramp near the runway midpoint, observed the takeoff. The pilot said that, as the airplane rotated, “the tail dragged and it left quite a lot of sparks. It looked unusually nose-high after rotation,” the report said. “He also said that as the airplane passed by him, he could see something like ‘fire’ emanating from the left side of the airplane, about the location of the No. 2 engine. He stated that the airplane became airborne, but ‘it mushed into the air,’” the report said.

The pilot also estimated that the airplane reached an altitude between 50 feet and 100 feet (15.2 meters and 30.5 meters). “At this point, there was no more flame from the left side,” the report said. “[The commercial pilot] saw the airplane enter a slow roll to the left and reach ‘nearly a 90-degree bank.’ It then impacted the ground and exploded.”

At the time of the accident, the Kansas City Fire Department was holding a night exercise at the airport, “and arrived at the accident site about one [minute] to 1.5 minutes after the crash,”

the report said. “The fire was contained and extinguished shortly thereafter.”

All three crew members died from traumatic injuries, the report said. Toxicological specimens from each crew member tested negative for alcohol and other major drugs of abuse. The DC-8 was destroyed by the impact and postcrash fire, the report said. The airplane was valued at US\$12 million.

When the wreckage path of the accident airplane was examined, investigators found evidence that the airplane’s tail skid hit and dragged the runway beginning 3,779 feet (1,153 meters) from the runway threshold, and 29 feet (8.8 meters) left of the runway centerline, the report said. The aircraft exited the left side of the runway, and the dragging tail skid created a ground scar. “The ground scar ended 144 feet [44 meters] left of [the runway] centerline and 5,174 feet [1,578 meters] from the threshold,” the report said. “This was determined to be the takeoff point of the airplane.”

Another set of ground scars, containing pieces of the left wing, began 6,644 feet (2,026 meters) from the threshold, the report said. “Fuel was spilled throughout the area of the initial ground scars, and most of the grass in this area was burned,” the report said. “A large trench began approximately 300 feet [91.5 meters] from the initial ground scar.”

Beyond the trench was a large crater. “Pieces of the cockpit side window, a nose landing-gear door, forward fuselage, a main cargo-door latch assembly and pieces of the No. 2 engine were found in and around the crater,” the report said. “A 10-foot [3-meter]

section of the left wing tip was located near the crater. This piece had been heavily damaged by fire, and the outboard tip structure was mangled and bent.”

During the crash sequence, the airplane fuselage broke into two large sections and the cockpit, the report said. “The cockpit and forward fuselage suffered severe impact damage. The upper cockpit structure remained recognizable, but the lower cockpit structure, radome and fuselage were mostly broken into smaller pieces. The upper, forward section of the cockpit was found upside down, and the front windows were shattered,” the report said.

All three crew members were found in the cockpit, “and rescue personnel reported that seat belts were worn by all three,” the report said. Investigators determined that the “survivable space within the cockpit was compromised to the point that this accident is considered unsurvivable,” the report said.

The forward section of the fuselage had “remained intact and attached to the wing structure,” the report said. “The left and

During the crash sequence, the airplane fuselage broke into two large sections and the cockpit.



Photo: Pat Cariseo, U.S. National Transportation Safety Board

An engine rests near the aft section of the fuselage.

right sides were sooted, more so on the left side and near the wings, but no soot and only minor deformation were observed on the interior of the fuselage. ... The aft fuselage section remained intact, and with the empennage attached. Some postcrash sooting was observed. The cabin structure remained intact, with no fire penetration. The fuselage belly sustained considerable crushing damage," the report said.

During the crash sequence, "all four engines and pylons and the landing gear assemblies separated from the airplane," the report said.

The background and qualifications of the flight crew were reviewed. The captain, 48, held a U.S. airline transport pilot (ATP) certificate, with type ratings for the McDonnell Douglas DC-6, DC-7 and DC-8. He had 9,711 total flying hours, with 3,129 hours as captain in the DC-8, and 1,354 hours as first officer in the DC-8. He had flown 60 hours in the previous 30 days, all in the DC-8, the report said.

The captain held a current FAA first-class medical certificate, with the requirement to wear and possess corrective lenses for distant vision and near vision, respectively.

When reviewing the captain's FAA records, investigators found that he had been cited with a violation in 1994, while employed by another airline as a first officer on a DC-8. "The violation involved a three-engine ferry flight from Belgium to Canada, in which four passengers and 6,250 pounds [2,835 kilograms] of company cargo were carried," the report said. "The operations specification for the airline prohibited carrying any passengers or cargo other than what was essential for the ferry flight."

As a result of this incident, "the FAA proposed to suspend his ATP certificate for 45 days," the report said. "However, after an informal interview with FAA attorneys, the suspension was voided, and action was reduced to a warning letter, which addressed his responsibilities as a first officer to be aware of such limitations and to express these limitations to the pilot-in-command."

Investigators also reviewed records of the captain's training as a first officer for the same airline, and found contradictory comments about his abilities. A check airman entered the following comments after a line check in 1993: "Excellent ride. [This pilot] would make a great captain," the report said.

Fifteen days later, however, another check airman entered the following comments after a simulator proficiency training session: "[This pilot], at this time, does not exhibit the confidence and command authority necessary to function as a pilot-in-command. I do not recommend [that] he be considered for upgrade at this time," the report said.

One day later, the report said, another check airman made the following comments after another simulator proficiency training session: "Good instrument scan and aircraft control. Weak on procedures. All proficiency training maneuvers completed satisfactorily."

In 1994, the captain was hired by ATI as a DC-8 captain, the report said. Approximately three months after he was hired by ATI, the captain flew with a check airman to determine his capability to operate on international flights. "According to a company training supervisor, the check captain did not think

that the captain was ready for the international authority; therefore, he did not conduct a line check," the report said. "It was decided to restrict the captain to domestic routes until he was 'more seasoned.'"

Two days prior to the accident flight, the captain was observed on an annual line check, on a round-trip flight to Germany from DOV, the report said. "This was also termed an international line check," the report said. "All items were rated satisfactory by the check captain. In the comments section, the check captain stated, 'Very nice job.'"

The captain had also received simulator training in three-engine ferry procedures during the 12 months preceding the accident flight, the report said. During one training session, the captain's engine ferry procedures were graded as satisfactory. "In addition, pilot logbook entries indicated that the captain was a first officer on three actual three-engine ferry flights in DC-8 airplanes," the report said. The last two of these were in November 1993. "No record was found that he had performed pilot-in-command duties during a three-engine takeoff," the report said.

Investigators interviewed the captain's family, who reported his health as excellent. "They also said that he did not take prescription medicine, never drank alcohol and would not have taken any drugs that would have affected his performance," the report said.

The first officer, 38, held a U.S. ATP certificate, with a type rating in the Boeing 737. He also held a commercial pilot certificate with multi-engine and instrument ratings, a flight instructor certificate for single- and multi-engine land, and instrument. The first officer had 4,261 total flying hours, with 171 hours as first officer in the DC-8. He had flown 39 hours in the previous 30 days, all in the DC-8, the report said.

The first officer held an FAA first-class medical certificate that had been issued approximately nine months before the accident. There were no limitations on the certificate, the report said.

The first officer was hired by ATI in 1994. At the time of the accident, he was still within his one-year probationary period, the report said. Before being employed by ATI, the first officer flew as a captain in the Beech 99 and the twin-engine Piper PA-31-350 Chieftain for two companies during a three-year period.

In 1992, the first officer had failed his initial flight check for the ATP certificate in a PA-31-350, the report said. He was retested 14 days later and passed. In 1993, the first officer failed his initial simulator rating check for the

B-737. He completed a successful recheck 10 days later, the report said.

The first officer's training records at ATI indicated that he had received three-engine ferry simulator training approximately four months before the accident, the report said. "Interviews with captains who had flown with the first officer described him as eager to learn, but lacking large-airplane experience and lacking confidence in his own ability to fly large airplanes," the report said. "There was no evidence that the first officer had ever been involved in an actual three-engine ferry flight."

The flight engineer, 48, held a U.S. flight engineer certificate (turbojet), and a mechanic certificate with A&P rating. He had 4,460 total flying hours, with 218 hours in the DC-8. He had flown 57 hours in the previous 30 days, all in the DC-8. The flight engineer held a current FAA second-class medical certificate, with the requirement to wear corrective lenses for near vision, the report said.

The flight engineer was hired by ATI in 1994. "At the time of the accident, the flight engineer had been flying the line as a DC-8 flight engineer with ATI for five months," the report said. "This was his first experience as a commercial air carrier crew member, although he had accumulated over 4,000 flight hours as a flight engineer in the [U.S. Air Force], and had acquired additional postmilitary experience as a civilian [Lockheed Martin] C-141 flight engineer instructor. He was still on probation at ATI," the report said.

The report noted: "Although [the flight engineer's] experience was extensive in the ... C-141, interviews revealed that Air Force procedures did not include three-engine takeoffs, except in emergency wartime situations; therefore, it is likely that this was his first three-engine takeoff." The report said that the flight engineer's family declined to be interviewed by the NTSB.

The activities of the flight crew prior to the accident flight were reviewed. On Feb. 13 (three days before the accident flight), the captain and first officer traveled from their respective homes to DOV and checked into the crew hotel at 2330 EST, the report said. The flight engineer checked into the crew hotel at DOV the following morning at 1050.

On Feb. 14, the crew met at 1435 (1935 coordinated universal time [UTC]) with the check pilot who would administer the international operations check ride, and discussed the details of the flight, the report said. At 1730 (2230 UTC), the crew departed DOV for Ramstein, Germany. The flight arrived at Ramstein at 0628 local time (0528 UTC) on Feb. 15, for a total flight time of approximately seven hours. The crew had breakfast together and were in their hotel rooms by 0915. They

"No record was found that [the captain] had performed pilot-in-command duties during a three-engine takeoff."

CVR Transcript of Accident Flight's Final Moments

2026:12 CAPT: Okay, and we're cleared for takeoff, lights are extended and on. Checklist is complete?

2026:24 FE: Checklist is complete.

2026:24 CAPT: Okay.

2026:25 CAM: (Sound of increasing engine noise.)

2026:33 CAPT: Make sure that, ah, two and three is, ah... .

2026:37 FE: At max power?

2026:37 CAPT: Yeah.

2026:39 FE: Okay.

2026:40 FE: I'll set max power.

2026:46 FE: One one.

2026:49 FE: One two.

2026:50 FE: One three.

2026:52 FE: One four.

2026:54 FE: One five.

2026:58 FE: One six.

2026:59 FO: Airspeed's alive.

2026:59 FE: One seven.

2027:01 CAPT: God bless it.

2027:05 CAPT: Keep it goin' .

2027:06 CAM: (Sound of engine noise increasing.)

2027:07 FE: Keep it goin' ?

2027:07 CAPT: Yeah.

2027:07 FO: Eighty knots.

2027:11 FO: Ninety knots.

2027:13 FO: One hundred knots.

2027:17 CAPT: Okay.

2027:17 CAM: (Sound of loud crash.)

2027:20 FO: We're off the runway.

2027:21 CAPT: Go max power.

2027:26 CAPT: Max power.

2027:27 FO: Get the nose down.

2027:28 CAPT: Max power.

2027:29 FO: You got it.

2027:30 CAM?: We're gunnar' go... .

2027:30 CAM: (Sound of loud crash.)

2027:30 CAM: (Sound of screams.)

2027:32 (End of recording.)

CAPT = Captain
FO = First officer
FE = Flight engineer
CAM = Cockpit area microphone
CAM? = Unidentified voice in cockpit
CVR = Cockpit voice recorder

Source: U.S. National Transportation Safety Board

spent about nine hours and 45 minutes in their hotel rooms, according to the report.

At 2128 (2028 UTC), the crew departed Ramstein for DOV via Gander, Newfoundland, Canada. They arrived in Gander at 2237 local time (0237 UTC), 15 hours after their arrival in Ramstein, the report said.

The crew departed Gander at 2328, and arrived at DOV at 0148 EST (0648 UTC) on Feb. 16 (the day of the accident flight), the report said. Their total flight time between Ramstein and Dover was nine hours and 29 minutes. The check pilot said that the captain "did an excellent job, including good landings in difficult wind conditions at Ramstein and Gander," the report said. "He [the check pilot] said that the first officer was new to the airplane, but that he was eager to learn, and that he did well." The check pilot "described the flight engineer as very conscientious," the report said. "The crew members did not seem fatigued, and there was no evidence that any of them had medical difficulties."

At 0240, the three crew members checked into the crew hotel. The captain telephoned ATI operations at 0314. The next telephone call made by the captain was at 0802, when he called home and spoke for 25 minutes. "His wife said he had just awakened and that he sounded relaxed and very happy because of the successful check ride," the report said.

At 1030, "the captain received a call from the ATI manager of crew scheduling to notify the crew that they were to ferry aircraft from Dover to Orlando, Florida [U.S.]," the report said. Fifteen minutes later, "the captain received a call from ATI crew scheduling to notify the crew that the Orlando ferry was canceled, and that he should go back to sleep and be prepared for a [1700] departure for Orlando or Dayton, Ohio [U.S.]," the report said.

At 1400, "two calls were received by the captain from ATI scheduling to notify the crew of a proposed departure from Kansas City of a three-engine ferry flight to [CEF]," the report said. "The chief pilot joined in the second call. The departure time was to be as soon as possible. The captain indicated he would depart within one hour," the report said.

The crew checked out of the hotel at 1500. "The desk clerk said that all three of them appeared rested, and appeared to get along well with each other," the report said. "Their time in the hotel was 12 hours, 20 minutes. The longest period of undisturbed time for the captain was four hours, 47 minutes."

The crew departed DOV for MCI at 1518 (2018 UTC), and arrived at MCI at 1739 CST (2339 UTC). "The captain who had flown the accident airplane into MCI met the three crew members briefly at 1825, and spoke with the captain for about 10 minutes ... ," the report said. "He described the captain's mood as fairly good, and he said that all three crew

members appeared alert and free from evident medical difficulties.”

At 2007, the crew received taxi instructions for their first takeoff attempt. The accident occurred at 2027 (0227 UTC), the report said.

Investigators reviewed the possible effects of fatigue in this accident. The international flights flown by the crew in the days immediately preceding the accident crossed six time zones between Dover and Ramstein. “This, and the fact that the Dover-Ramstein-Gander-Dover legs were flown at night following daytime rest periods, caused the crew to experience circadian rhythm disruption,” the report said. “In addition, the captain’s last rest period prior to the accident was repeatedly interrupted by the company.”

The flights from Dover to Ramstein and return were operated in accordance with FARs Part 121. Upon returning to Dover, “the crew was required to take a rest period of at least 16 hours before they could legally be assigned to any further Part 121 duty,” the report said. “However, only about 12 hours after checking into the hotel, they checked out to assume duty under FARs Part 91 ferry flight rules. There are no flight time limits or rest requirements for Part 91 ferry flights that follow Part 121 revenue flights.”

The captain’s opportunity for sleep was disturbed in the hours before the accident. “His longest uninterrupted rest period was four hours and 47 minutes,” the report said. “Therefore, the [NTSB] believes that he was experiencing fatigue at the time of the accident. ... The captain’s performance in the accident reveals many areas of degradation in which fatigue is probably a factor. Similar considerations apply to the other two crew members, who were also subject to the same schedule and were most likely fatigued at the time of the accident. ... Several areas of performance degradation exhibited by the crew are characteristic of fatigue, such as the crew’s difficulties in setting proper priorities and their continuation of the takeoff attempt despite disagreement and confusion on important issues.”

The report concluded: “The crew could not have legally flown a revenue trip at the time of the accident. The [NTSB] believes, however, that the fact that the flight was legal under the terms of the Part 91 ferry flight provisions does not reduce the amount of rest needed to prevent crew fatigue. The [NTSB] therefore concludes that the crew members were not properly rested.”

The investigation also reviewed the possibility of self-induced pressure on the crew to reach their destination before the curfew. “... [T]he crew members were unaware that the curfew time could be extended through ATI management channels,” the report said. [The NTSB noted that ATI management did

not telephone Westover Airport and ask for a curfew extension because they were unaware that the flight was behind schedule.] “Prior to taxiing, the captain said that they should try to fly direct routes between navigational aids, in order to reduce the en route flight time. After the first takeoff attempt, the flight crew again discussed the subject of trying to reach the destination airport.”

As the crew taxied back to the runway for their second takeoff, their average taxi speed was 26 knots, the report said. The NTSB believed that this speed was too fast, especially at night and while the crew was discussing the previous rejected takeoff.

The NTSB concluded that “the flight crew was convinced that they should arrive at their destination prior to the landing curfew, and that they were preoccupied with this goal. This probably influenced their judgment regarding the three-engine takeoff and added an element of stress to the entire decision-making process.”

Investigators reviewed ATI’s decision to assign the accident flight crew to the three-engine ferry flight. The NTSB noted that this decision “did not take into consideration the experience levels of the available flight crews, although it was within policy established by ATI, and within federal regulations,” the report said. “ATI management’s decision not to assign a more experienced flight crew to the ferry flight was based upon a desire to minimize the delay of [a] scheduled revenue cargo flight The NTSB believes that company scheduling issues took priority, resulting in the less experienced flight crew being assigned to the accident flight.”

As part of the investigation, nine other cargo operators were surveyed about flight crew scheduling for three-engine takeoffs. The NTSB found that only two of the nine operators “used line flight crews for three-engine takeoffs, and that one of these two operators restricted three-engine takeoffs to only ‘the most experienced and selected’ flight crews,” the report said. “Seven of the nine restrict[ed] such takeoffs to only management flight crews, such as check airmen or special maintenance ferry crews. Therefore, the [NTSB] concludes [that] ATI’s policy of routinely assigning line flight crews for such operations, when almost all other operators restrict such flights, must be considered inappropriate,” the report said.

A review of the accident airplane’s maintenance records revealed that it had been inspected and maintained according to currently accepted practices. “The investigation revealed no evidence of pre-existing structural defects in the airframe, and no failure of airplane structure prior to ground impact,” the report said.

The investigation also reviewed the possibility of self-induced pressure on the crew to reach their destination before the curfew.

The report also noted: “There was no evidence of any engine problems or in-flight fire other than reports of flame in or around the No. 2 engine. This flame was the result of an engine compressor surge caused by disrupted airflow into the engine during the high angle-of-attack flight of the airplane immediately after liftoff.”

Investigators analyzed the tire marks made by the accident aircraft on the runway during both takeoffs. The tire marks indicated that “the thrust asymmetry of the three-engine takeoff exceeded the capability of the rudder (and the nose-wheel steering, if used) to maintain directional control,” the report said. “It is not known whether the captain utilized the steering tiller during any portion of the takeoff attempts. In addition, data available from [McDonnell] Douglas show that the engine power of the No. 4 engine, as indicated on the CVR [cockpit voice recorder], would have exceeded the capability of full rudder and nose-wheel steering to maintain directional control,” according to the report.

Data also showed that “the thrust on the No. 4 engine was increased too quickly after brake release, resulting in excessive thrust asymmetry during the accident takeoff,” the report said. “FDR [flight data recorder] heading data and the presence of nose-tire marks almost 10 feet [three meters] to the right of runway centerline on the second takeoff attempt suggest that the captain may have steered the airplane to the right to provide the airplane more room to maneuver as the thrust from the No. 4 engine was increased, anticipating possible problems maintaining directional control.”

When reviewing the performance calculations for the accident takeoff, investigators found that “the takeoff data card found in the wreckage showed a V_{mcg} speed of 107 knots rather than 116 knots,” the report said. “The [NTSB] believes that during preflight planning, the flight engineer entered the three-engine takeoff chart incorrectly during the calculations of the takeoff data. It appears likely that he used the temperature in degrees Fahrenheit, rather than Centigrade.”

(V_{mcg} chart) are entered using the Fahrenheit temperature scale. The fact that the ... chart is entered in Centigrade temperature, and that the chart is used so infrequently at ATI, would make a calculation mistake more likely. ATI procedures stated that the captain or first officer will verify the data prior to the pilots setting their speed bugs. This apparently was not accomplished.”

The miscalculation of V_{mcg} resulted in the crew applying takeoff power on all three operating engines at 107 knots, instead of the correct airspeed of 116 knots. “Directional control of the airplane is difficult if early power is applied

on the asymmetrical engine,” the report said. “The faster the airplane is traveling, the more rudder authority will be available, and directional control becomes easier. In fact, if full power on the asymmetric engine is applied before 116 knots, it is impossible for the pilot to continually maintain runway centerline using the rudder alone,” the report said.

[The report said that ATI had experienced two other DC-8 accidents since 1991, one involving crew miscalculations. In a March 12, 1991, accident at John F. Kennedy International Airport, New York, New York, U.S., the NTSB determined that “the probable causes of this accident were improper preflight planning and preparation, in that the flight engineer miscalculated the aircraft’s gross weight by 100,000 pounds (45,360 kilograms) and provided the captain with improper takeoff speeds; and improper supervision by the captain. Factors relating to the accident were an improper trim setting provided to the captain by the flight engineer, inadequate monitoring of the performance data by the first officer, and the company management’s inadequate surveillance of the operation.” There were no injuries, but the airplane was destroyed.]

During the first attempted takeoff, the power on the asymmetric engine was applied too quickly.

During the first attempted takeoff, the power on the asymmetric engine was applied too quickly. “Discussions with pilots experienced in three-engine takeoffs confirmed that the power on the asymmetrical engine needs to be applied very slowly, and it is not until much closer to V_{mcg} that the power can be increased to approach the takeoff EPR,” the report said.

The NTSB believed that the section of ATI’s operations manual describing three-engine takeoffs could have caused confusion. “One section of the company operations manual stated, ‘As soon as possible, smoothly accelerate the engine opposite the inoperative engine to MAX power during acceleration to V_{mcg} ,’” the report said. “The [NTSB] believes that this particular instruction, taken out of context, implies that early (‘as soon as possible’) acceleration of the asymmetric engine is desirable.”

Following the rejected takeoff, the crew discussed why the EPR on the No. 4 engine increased so quickly. The captain remarked, “It just came up too fast is what it did,” the report said. The NTSB believed that “the reason for the increase in EPR was most likely the result of the captain’s advancing the asymmetric throttle forward at a rate that was too fast,” the report said.

During the discussion, the flight engineer suggested, “If you want to try it again, I can try addin’ the power if you like,” the report said. The captain replied, “Okay, let’s do it that way, yeah ...,” the report said.

The report commented: “This was a procedure that the flight crew created themselves and was patently incorrect. The

operating manual clearly states that the captain should control the throttles. This decision to allow someone else to do so was not challenged or even discussed by the flight crew.”

Investigators experimented with having a flight engineer apply asymmetric power in a DC-8 simulator, and “found it extremely awkward and somewhat disconcerting,” the report said. “The [NTSB] believes that allowing someone not even in nominal control of the airplane to apply the asymmetric power required the captain to constantly react to an unknown quantity of thrust and an unknown rate of thrust application during the accident takeoff roll. This increased his mental workload dramatically and probably contributed directly to the accident,” the report said.

As the accident crew taxied for the second takeoff, they discussed the amount of rudder used during the rejected takeoff. The captain commented that he had used full rudder control. “However, there was never a discussion about why directional control could not be maintained, even though the captain used all the available rudder,” the report said.

The report noted: “The first officer then made a statement which clearly indicated that he did not understand the concept of V_{mcg} . The first officer said, ‘When we ... get near V_{mcg} or get near V_r or V_{mcg} if we’re usin’ all our rudder authority you might wanta consider abort possibly because once we get higher we’re gunnar be ... in even worse trouble correct.’ The captain replied, ‘That’s correct absolutely.’”

The report added: “The flight engineer challenged the statement by saying, ‘No actually above V_{mcg} you[r] rudder has more authority, it’s helping you more.’ The captain did not respond to this statement, which was, in fact, correct. ... The [NTSB] believes that the only person in the cockpit who had an understanding of the basic concept of a three-engine takeoff was the flight engineer. It is not clear, however, if any of the flight crew understood the concept of the V speeds as applied to the three-engine takeoff.”

Figure 1 (page 11) compares the accident takeoff with a McDonnell Douglas demonstration of an ideal three-engine takeoff.

Investigators evaluated the DC-8-60-series simulator used by ATI for training its flight crews for three-engine takeoffs. “The simulator performance was not realistic in that the simulator was very easy to control, no matter how fast the power was applied on the asymmetrical engine during the simulated three-engine takeoffs,” the report said. “Both the company check airman and a [McDonnell Douglas] test pilot assisting in the exercise agreed with this assessment.”

Investigators conducted a second set of three-engine takeoff experiments after the simulator’s performance was adjusted. “Afterward, the three-engine takeoffs were more realistic, but it was still possible to maintain runway centerline with full

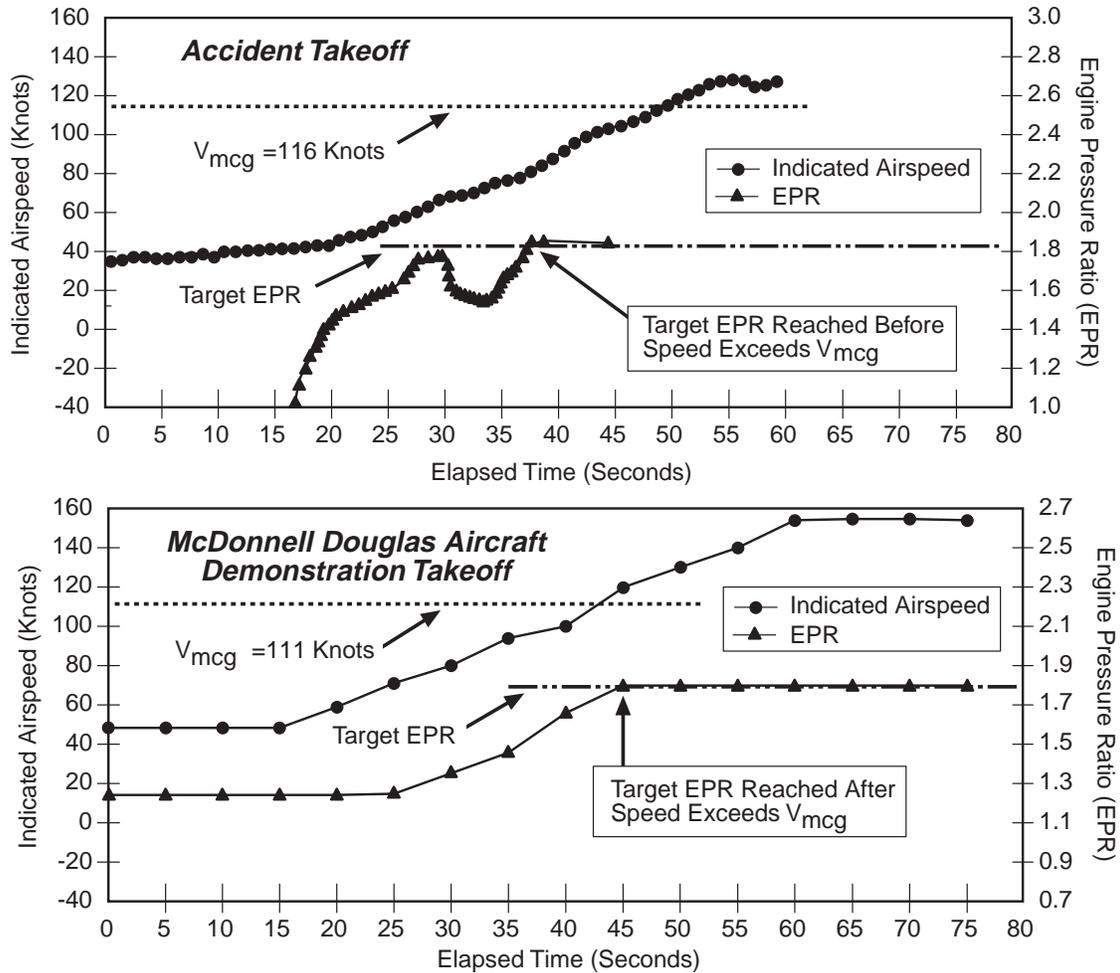
power on the asymmetric engine prior to V_{mcg} ,” the report said. “Although there was no way to positively determine that the simulator was providing inaccurate simulation when the accident flight crew received its three-engine training, the [NTSB] concludes that the training conducted in the simulator probably did not provide the accident flight crew with an accurate, realistic rehearsal for an actual three-engine takeoff,” the report said.

The NTSB reviewed the FAA’s oversight of ATI. Investigators found that the FAA principal operations inspector (POI) overseeing ATI’s operations “did not have sufficient knowledge of the surveillance that was being performed by FAA geographic units, both in the international operations and at the Denver training facility,” the report said.

Based on its investigation, the NTSB developed the following findings:

- “The airplane was properly certified and maintained in accordance with existing regulations. It was also properly prepared for the three-engine departure by maintenance personnel;
- “There was no evidence of any systems malfunction that may have contributed to the accident. Specifically, there was no evidence of malfunction of the flight controls, landing gear, tires, brakes or nose-wheel steering system that would have led to directional control difficulties on the runway;
- “The flight crew assigned to the ferry trip had a shortened rest break after performing an international trip. Federal regulations permit companies to eliminate these rest periods after flying a [FARs] Part 121 operation when the flight will be conducted as a ferry operating under ... Part 91;
- “At the time of the accident, the flight crew was suffering from fatigue as a result of the limited opportunities for rest, disruption to their circadian rhythms and lack of sleep in the days before the accident. However, the [NTSB] was unable to determine the extent, if any, to which their fatigue contributed to the accident;
- “The flight crew did not have adequate, realistic training in three-engine takeoff techniques or procedures because the DC-8 simulator with which they trained was not programmed to replicate actual yaw forces, and the three-engine takeoff procedure description in the airplane operating manual was confusing;
- “There was no record that the captain had previously performed a three-engine takeoff as pilot-in-command, and it is unlikely that the other flight crew members had ever assisted in a three-engine takeoff prior to the accident takeoff;

Asymmetric Engine Power/Airspeed, Accident Takeoff vs. McDonnell Douglas Demonstration Takeoff



$V_{m_{cg}}$ = Minimum control speed on the ground

Source: U.S. National Transportation Safety Board

Figure 1

- “The flight crew did not adequately understand the three-engine takeoff procedures, including the significance of $V_{m_{cg}}$;
- “Another more experienced flight crew was available to conduct the ferry flight;
- “Flight crew comments on the CVR prior to the accident suggested that they were operating under self-induced pressure to arrive before a landing curfew at the destination airport, and that this may have influenced their decision making;
- “The flight engineer improperly determined the $V_{m_{cg}}$ speed, resulting in a value that was nine knots too low. Neither the captain nor the first officer detected the error;
- “During the first attempted takeoff, the captain was not able to maintain directional control because he applied high power to the asymmetrical engine too soon, and he rejected the takeoff. During the taxi back for a second takeoff, he and his crewmates did not properly analyze the reasons for the loss of control;
- “The captain agreed to modify the three-engine takeoff procedure by allowing the flight engineer to advance the throttle on the asymmetrical engine, a deviation [from] the prescribed procedure. The captain was unable to maintain directional control on the second takeoff, decided not to reject the takeoff, and rotated the airplane early in an attempt to take off prior to departing the paved runway surface;
- “FAA oversight of ATI was inadequate because the ATI POI and the geographic inspectors were unable to effectively monitor domestic crew training and international operations, respectively;

- “Existing ... Part 121 flight time limits and rest requirements that pertained to the flights that the flight crew flew prior to the ferry flights did not apply to the ferry flights flown under ... Part 91. This permitted a substantially reduced flight-crew rest period when conducting the nonrevenue ferry flights; [and,]
- “Current one-engine inoperative takeoff procedures do not provide adequate rudder availability for correcting directional deviations during the takeoff roll compatible with the achievement of maximum asymmetric thrust at an appropriate speed greater than ground minimum control speed.”

As a result of its findings, the NTSB made the following recommendations to the FAA:

- “Review the effectiveness of the geographic unit oversight program, with particular emphasis on the oversight of supplemental air carriers and their international operations, and the improvement of overall communications between principal operations inspectors and geographic inspectors;
- “Evaluate surveillance programs to ensure that budget and personnel resources are sufficient and used effectively to maintain adequate oversight of the operation and maintenance of both passenger and cargo air carriers, irrespective of size;
- “Require airplane manufacturers to revise one-engine inoperative takeoff procedures to provide adequate rudder availability for correcting directional deviations during the takeoff roll and provide performance figures and

runway requirements compatible with the achievement of maximum asymmetric thrust at an appropriate speed greater than ground minimum control speed; [and,]

- “Finalize the review of current flight- and duty-time regulations and revise the regulations, as necessary, within one year to ensure that flight- and duty-time limitations take into consideration research findings in fatigue and sleep issues. The new regulations should prohibit air carriers from assigning flight crews to flights conducted under ... Part 91 unless the flight crews meet the flight and duty time limitations of ... Part 121 or other appropriate regulations.”

The NTSB also made the following recommendations to ATI:

- “Review the ATI DC-8 operating manual discussion on three-engine takeoffs to ensure that it is understandable to all pilots who must accomplish such takeoffs. This section of the manual should emphasize the specifics of proper throttle-application technique; [and,]
- “Discontinue the company policy of routinely assigning line flight crews for three-engine ferry operations. Allow only specifically designated, highly experienced crew members to perform such operations.”♦

Editorial note: This article was adapted from *Uncontrolled Collision with Terrain, Air Transport International, Douglas DC-8-63, N782AL, Kansas City International Airport, Kansas City, Missouri, February 16, 1995*. Report No. NTSB/AAR/95/06, prepared by the U.S. National Transportation Safety Board (NTSB). The 145-page report includes diagrams and illustrations.

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