

## ACCIDENT CASE STUDY



## COLGAN AIR FLIGHT 3407

## BACKGROUND INFORMATION

<b>Date</b>	February 12, 2009
<b>Time</b>	10:17 p.m.
<b>Airline</b>	Colgan Air, operating as Continental Connection Flight 3407
<b>Aircraft</b>	Bombardier DHC-8-400
<b>Location</b>	Instrument approach to Buffalo-Niagara International Airport, New York
<b>Severity</b>	Crashed into a residence in Clarence Center, New York, about 5 nautical miles northeast of the airport. The two pilots, two flight attendants and 45 passengers aboard the airplane died; one person on the ground died; and the airplane was destroyed by impact and fire.





## ABBREVIATIONS AND TERMS

### **CAPTAIN**

The person aboard the aircraft who is ultimately responsible for its operation and safety during flight. The captain sits in the left seat of the aircraft.

### **COCKPIT VOICE RECORDER (CVR)**

Used to record the audio environment in the flight deck of an aircraft for the purpose of investigation of accidents and incidents.

### **COMMUTING**

When a pilot travels between his or her home and the base where stationed. In this example, the first officer lived in Seattle, Wash., but worked out of Newark, N.J.

### **CONTROL COLUMN**

The device used to control a fixed-wing aircraft (its steering wheel), also referred to as a yoke.

### **FIRST OFFICER**

The second pilot (also referred to as the co-pilot) and second-in-command of the aircraft to the captain.

### **INSTRUMENT APPROACH**

A series of predetermined maneuvers by reference to flight instruments that guide an aircraft in instrument conditions (in the clouds) to landing or to a point from which a landing may be made visually.

### **INSTRUMENT METEOROLOGICAL CONDITIONS (IMC)**

Weather conditions that require pilots to fly primarily by reference to instruments rather than by outside visual references under visual flight rules. This often means the aircraft is flying in cloudy or bad weather.

### **STALL**

Occurs when the wing's critical angle of attack is exceeded. At this point, the wing is not producing enough lift to keep the aircraft flying. For more on critical angle of attack, refer back to your notes about airfoils from Unit 2 in the first semester.

### **STERILE COCKPIT RULE**

An FAA regulation requiring pilots to refrain from non-essential activities during critical phases of flight, normally below 10,000 feet. In other words, pilots should only be running checklists, talking to air traffic control and making required verbal callouts.

### **STICK PUSHER**

If a pilot fails to respond to a stick shaker, the aircraft will make a final attempt to prevent an aerodynamic stall by pushing the stick forward automatically. This system is referred to as a stick pusher.

### **STICK SHAKER**

Warns a pilot of an impending stall (the airplane is getting too slow to fly) by vibrating the control column.

### **VISUAL METEOROLOGICAL CONDITIONS (VMC)**

Weather conditions in which pilots have sufficient visibility to fly the aircraft maintaining visual separation from terrain and other aircraft. The aircraft is not flying in clouds or fog when in VMC.



## HISTORY OF THE FLIGHT

(Extracted from NTSB's final aircraft accident report)

On Feb. 12, 2009, about 10:17 p.m. Eastern Standard Time, a Colgan Air Bombardier DHC-8-400 operating as Continental Connection Flight 3407 was on an instrument approach to Buffalo-Niagara International Airport (BUF) in New York when it crashed into a residence in Clarence Center, N.Y., about 5 nautical miles (nm) northeast of the airport. The two pilots, two flight attendants and 45 passengers aboard the airplane died; one person on the ground died; and the airplane was destroyed by impact and fire. Night visual meteorological conditions (VMC) prevailed at the time.

The home base of operations for both the captain and the first officer was Liberty International Airport (EWR) in Newark, New Jersey. On Feb. 11, 2009, the captain had completed a two-day trip sequence, with the final flight arriving at EWR at 3:44 p.m. Also that day, the first officer began her commute from her home near Seattle, Washington, to EWR at 5:51 p.m. Pacific Standard Time, arriving at EWR on the day of the accident at 6:23 a.m.

The flight crew's first two scheduled flights of the day, from EWR to Greater Rochester International Airport (ROC) in New York and back, were canceled because of high winds at EWR and the resulting ground delays at the airport.

The company dispatch release for Flight 3407 showed an estimated en route time to Buffalo of 53 minutes.

**8:30 p.m.** According to the cockpit voice recorder (CVR), the EWR ground controller provided taxi instructions for the flight, and the first officer acknowledged.

The first officer stated, "I'm ready to be in the hotel room," to which the captain replied, "I feel bad for you." She continued, "This is one of those times that if I felt like this when I was at home, there's no way I would have come all the way out here."

She then stated, "If I call in sick now, I've got to put myself in a hotel until I feel better...We'll see how... it feels flying. If the pressure's just too much ... I could always call in tomorrow. At least I'm in a hotel on the company's buck, but we'll see. I'm pretty tough." The captain responded by saying the first officer could try an over-the-counter herbal supplement, drink orange juice or take vitamin C.

**9:18 p.m.** The CVR recorded the tower controller clearing the airplane for takeoff.

The flight data recorder (FDR) showed that during the climb to altitude, the propeller deicing and airframe deicing equipment were turned on and the autopilot was engaged.

**9:34 p.m.** The airplane reached its cruising altitude of 16,000 feet. The cruise portion of flight was routine and uneventful. The CVR recorded the captain and the first officer engaged in an almost continuous conversation throughout that portion of the flight, but these conversations did not conflict with the sterile cockpit rule, which prohibits nonessential conversations within the cockpit during critical phases of flight.



- 9:49 p.m.** The CVR recorded the captain making a sound similar to a yawn.
- 9:50 p.m.** The first officer reported the winds in Buffalo to be from 250° at 15 knots, gusting to 23 knots; afterward, the captain stated that Runway 23 would be used for the landing.
- 9:53 p.m.** The first officer briefed the airspeeds for landing with the flaps at 15° as 118 knots, and the captain acknowledged this information.
- 9:56 p.m.** The first officer stated, “Might be easier on my ears if we start going down sooner.” The captain instructed the first officer to ask air traffic control for an altitude assignment of 12,000 feet. Less than one minute later, a controller from Cleveland Center cleared the flight to descend to 11,000 feet, and the first officer acknowledged the clearance.
- 10:03 p.m.** The Cleveland Center controller instructed the flight crew to contact Buffalo’s approach control, and the first officer acknowledged this instruction. The first officer made initial contact with Buffalo approach control and stated that the flight was weather descending from 12,000 to 11,000 feet and that the flight crew had the most recent report for the airport. The approach controller told the crew to plan an instrument approach to Runway 23.
- 10:04 p.m.** The captain began the approach briefing.
- 10:05 p.m.** The approach controller cleared the flight crew to descend and maintain 6,000 feet, and the first officer acknowledged the clearance. About 30 seconds later, the captain continued the approach briefing, during which he repeated the airspeeds for a flaps 15° landing.
- 10:06 p.m.** The airplane descended through 10,000 feet. From that point on, the flight crew was required to observe the sterile cockpit rule.
- 10:07 p.m.** The CVR recorded the first officer making a sound similar to a yawn.
- 10:08 p.m.** The approach controller cleared the flight crew to descend and maintain 5,000 and 4,000 feet, respectively, and the first officer acknowledged the clearances. Afterward, the captain asked the first officer about her ears, and she indicated that they were stuffy and popping.
- 10:10 p.m.** The first officer asked whether ice had been accumulating on the windshield. The captain replied that ice was present on his side of the windshield and asked whether ice was present on her side. The first officer responded, “Lots of ice.” The captain then stated, “That’s the most I’ve seen – most ice I’ve seen on the leading edges in a long time. In a while anyway, I should say.”

About 10 seconds later, the captain and the first officer began a conversation that was unrelated to their flying duties. During that conversation, the first officer indicated that she had accumulated more actual flight time in icing conditions on her first day with the airline than she had before her employment with the company. She also said when other company first officers were “complaining” about not yet having upgraded to captain, she was thinking that she “wouldn’t mind going through a winter in the Northeast before [upgrading] to captain.” The first officer explained that before joining the company, she had “never seen icing conditions ... never deiced ... never experienced any of that.”



- 10:12 p.m.** The approach controller cleared the flight crew to descend and maintain 2,300 feet, and the first officer acknowledged the clearance. Afterward, the captain and the first officer performed flight-related duties but also continued the conversation that was unrelated to their flying duties.
- 10:12 p.m.** The approach controller cleared the flight crew to turn left onto a heading of 330°. The captain called for the descent and approach checklists, respectively, which the first officer performed.
- 10:14 p.m.** The approach controller cleared the flight crew to turn left onto a heading of 310°, and the autopilot started to level the airplane to fly at an altitude of 2,300 feet. When the airplane reached this altitude, the airspeed was about 180 knots.
- 10:15 p.m.** The captain called for the flaps to be moved to the 5° position, and the CVR recorded a sound similar to flap handle movement. Afterward, the approach controller cleared the flight crew to turn left onto a heading of 260° and maintain 2,300 feet until established on the localizer for the ILS approach to Runway 23. The first officer acknowledged the clearance.

The captain began to slow the airplane less than three miles from the outer marker to establish the appropriate airspeed before landing. The engine-power levers were reduced and both engines were at minimum thrust.

The approach controller then instructed the flight crew to contact the Buffalo air traffic control tower. The first officer acknowledged this instruction, which was the last communication between the flight crew and air traffic control (ATC). Afterward, the CVR recorded sounds similar to landing gear handle deployment and landing gear movement, and the FDR showed that the propeller levers were moved forward to their maximum.

- 10:16 p.m.** The first officer told the captain the gear was down; at that time, the airspeed was about 145 knots. Afterward, an “ice detected” message appeared on the engine display in the cockpit. About the same time, the captain called for the flaps to be set to 15° and for the before landing checklist.

The CVR then recorded a sound similar to flap handle movement, and the airspeed at the time was about 135 knots.



**10:16 p.m.** The CVR recorded a sound similar to the stick shaker. The CVR also recorded a sound similar to the autopilot disconnect horn, which repeated until the end of the recording.

FDR data showed that when the autopilot disengaged, the airplane was at an airspeed of 131 knots.

**10:16 p.m.** The control columns moved aft, and the engine power levers were advanced. The CVR then recorded a sound similar to increased engine power, and data showed that engine power increased to about 75 percent maximum power. The airplane pitched up while engine power was increasing.

As the airplane pitched up, it rolled to the left, reaching a roll angle of 45° left wing down and then rolled to the right. As the airplane rolled to the right through wings level, the stick pusher activated, and flaps 0° was selected (flaps retracted).

**10:16 p.m.** The first officer told the captain that she had put the flaps up. At that time, the airplane's airspeed was about 100 knots. The CVR recorded the captain making a grunting sound. Data showed that the roll angle had reached about 35° left wing down before the airplane began to roll again to the right.

Afterward, the first officer asked whether she should put the landing gear up, and the captain stated "gear up" and an expletive. The airplane's pitch and roll angles reached about 25° airplane nose down and 100° right wing down, respectively, when the airplane entered a steep descent.

**10:16 p.m.** The stick pusher activated a third time. About the same time, the CVR recorded the captain stating, "We're down," and the sound of a thump. The airplane impacted a single-family home (where the ground fatality occurred), and a post-crash fire ensued.

**10:16:54 p.m.** The CVR recording ended.

PROPRIETARY



## ADDITIONAL INFORMATION

### Wreckage and Impact Information

The airplane wreckage was mostly contained within the property boundaries at 6038 Long Street, Clarence Center, N.Y. The airplane was severely fragmented, with extensive fire damage. About 60 percent of the main structural components could be conclusively identified, including structure from the radome and both wingtips. The empennage was found intact in the wreckage. Numerous small pieces of airplane structure were recovered but were not conclusively identified.

All of the examined fracture surfaces exhibited signs consistent with overload failure; no evidence indicated any pre-impact failures. Flight control continuity could not be determined because of severe fragmentation and burn damage. The airplane impacted the south side of the house near ground level, and pieces of the airplane traveled through the house, coming to rest beyond the northeast corner of the house's foundation.

The stage 1 low-pressure compressors in both engines were found with blades bent in the direction opposite rotation, fractured blades, damage to the airfoil leading edge impact and ingested dirt. No evidence of a turbine failure or an uncontainment was found in either engine. Both engine-power levers and the No. 1 engine condition lever appeared to be in the full forward position, and the No. 2 engine condition lever appeared to be in its midrange position. The ice-protection panel was recovered in the wreckage and was found to be severely burned. The ice-detector probes were not identified in the wreckage. No segments of the leading-edge deice boots from the left wing were identified. Two leading-edge sections from the right wing were located in the wreckage. The deice boots from these sections appeared to still be bonded to the leading edge, except in some areas that appeared to be associated with impact damage.

The pneumatic lines leading to the connections on the inside of the leading-edge sections were intact. These and other deice system pneumatic lines did not show any evidence of leaks, ruptures, or missing or damaged line couplings. The leading-edge deice boots for the horizontal and vertical stabilizer were found in good condition. Portions of all eight flap actuators (which move the flap surfaces to a selected position and maintain the selected position against the aerodynamic forces acting on the flap surfaces) were recovered.

### Medical and Pathological Information

Toxicology tests were performed by the FAA's Civil Aerospace Medical Institute on tissue specimens from both pilots. Specimens from the captain tested negative for ethanol. Also, with the exception of Diltiazem (to control high blood pressure), his specimens tested negative for a wide range of drugs, including major drugs of abuse (marijuana, cocaine, phencyclidine, amphetamines and opiates).

Specimens from the first officer tested negative for ethanol and a wide range of drugs, including major drugs of abuse.

The Erie County Medical Examiner's Office determined that the cause of death for the airplane occupants and the ground victim was multiple blunt force trauma.

### Pilot Training at the Company

Company training personnel stated that demonstration of the airplane's stick pusher system was not part of simulator training at the time of the accident. Nevertheless, one instructor indicated that he demonstrated the stick pusher during initial simulator training. The instructor stated that most of the pilots who were shown the pusher in the simulator would try to recover by overriding the pusher. Most of the company pilots interviewed after the accident reported that they had not received a demonstration of or instruction on the stick pusher.

### Air Traffic Control

The accident flight was handled by the Buffalo approach controller. The controller stated that after he instructed the flight crew to contact the tower, he continued to monitor the airplane's progress. The controller reported seeing the altitude readout in the radar display data block change to "XXX," which was an indication that the radar system had interpreted the altitude readout to be unreliable. Afterward, the airplane target and the data block disappeared from the radar display.



The approach controller contacted the tower controller to find out if something had happened to the flight and asked the tower controller to attempt to contact the airplane. The air traffic control transcript showed that both controllers attempted to contact the airplane during the next minute. The approach controller also asked the pilot of a Delta Air Lines airplane (which was being vectored for an ILS approach to Runway 23) to see if the Colgan airplane was off to the right.

The pilot of the Delta flight reported that he did not see the airplane and that no target for it appeared on the traffic alert and collision avoidance system. The approach controller reported that this information seemed to be confirmation that the airplane had been involved in an accident. The controller asked the controller-in-charge to call the airport fire department, which coordinated all off-airport events.

The approach controller who handled the accident flight stated that he then began trying to figure out what had happened to the flight. He asked other airplanes operating in the area about icing and learned that some airplanes had encountered icing but that the conditions did not seem to be “especially serious.” The controller also checked the ILS monitor panel to see if a problem had occurred with the instrument landing system equipment but found everything working normally.

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**STUDENT ACTIVITY**

Using the information contained in your accident-case-study packet and a reanimation video, your “Go Team” will evaluate the crash of Colgan Air Flight 3407. Each team will present its “findings” and “recommendations” upon completing the study.

**STEP 1**

Each member of your team will choose one element of the “Go Team.” If you have less than seven members, some students will need to accept more than one “Go Team” responsibility.

“GO TEAM” RESPONSIBILITY	TEAM MEMBER ASSIGNED
<p><b>OPERATIONS</b></p> <p>Collect history of the accident flight and crewmembers’ duties for as many days before the crash as appears relevant.</p>	
<p><b>STRUCTURES</b></p> <p>Document the airframe wreckage and the accident scene.</p>	
<p><b>POWERPLANTS</b></p> <p>Examine engines (and propellers) and engine accessories.</p>	
<p><b>SYSTEMS</b></p> <p>Study components of the plane’s hydraulic, electrical, pneumatic and associated systems, together with instruments and elements of the flight control system.</p>	
<p><b>AIR TRAFFIC CONTROL</b></p> <p>Reconstruct the air traffic services provided to the pilot, including acquisition of ATC radar data and transcripts of controller-pilot radio transmissions.</p>	
<p><b>WEATHER</b></p> <p>Gather all pertinent weather data from the National Weather Service, and sometimes from local TV stations, for a broad area around the accident scene.</p>	
<p><b>HUMAN PERFORMANCE</b></p> <p>Study crew performance and all before-the-accident factors that might be involved in human error, including fatigue, medication, alcohol, drugs, medical histories, training, workload, equipment design and work environment.</p>	



## STEP 2

Using the reanimation video and the information provided in your accident packets, each team member should evaluate their area of responsibility. Provide research in the space below for your area of responsibility.

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**STEP 3**

After your individual research, regroup and compile this information as a team. Review these items with your teacher before moving on to step 4.

1. Identify at least three factors that may have contributed to the accident.

*Factors that may have contributed to the accident:*

- Pilot's failure to monitor flight instruments properly
- Pilot's inappropriate response to the activation of the stick shaker, indicating that the airplane was stalling from too slow of an airspeed
- Lack of training involving the stick shaker and how to respond to low airspeed cues
- Icing conditions that caused the airplane to stall at a higher than normal airspeed
- Pilots being distracted by conversation not pertinent to the flight, lack of pilot professionalism
- Pilot fatigue (due to commuting from Seattle), late-night flying, and possible illness

*The National Transportation Safety Board determined that the probable cause of this accident was the captain's inappropriate response to the activation of the stick shaker, which led to an aerodynamic stall from which the airplane did not recover. Contributing to the accident were: 1) the flight crew's failure to monitor airspeed in relation to the rising position of the low speed cue; 2) the flight crew's failure to adhere to sterile cockpit procedures; 3) the captain's failure to effectively manage the flight; and 4) Colgan Air's inadequate procedures for airspeed selection and management during approaches in icing conditions.*

2. List the limitations or challenges that would have been factors in conducting an effective investigation of this accident.

*Limitations or challenges to conducting an effective investigation of this accident:*

- Location is a rural area of residential home
- Severity of the wreckage and post-crash fire

3. Based on what you learned about the party system in the last lesson, name at least three other parties that might be brought into this investigation.

- Colgan Air
- Bombardier
- Engine, propeller manufacturers
- Air traffic controllers
- Other system and component manufacturers (avionics, deicing systems)
- Airline pilot union

**STEP 4**

Identify several safety recommendations that your “Go Team” creates as a result of your investigation.

*Student answers will vary. Safety recommendations that might result from this investigation include:*

- Improved training on proper aircraft control during low-speed flight and proper monitoring of flight instruments
- Improved training on stick pusher operations and pilot response
- Improved training and adherence to sterile cockpit rules
- Improved leadership training for captains, including professional standards and codes of conduct
- Airline to address fatigue risks brought about by commuting, late flights, and illness

*The safety issues discussed in the final accident report focus on strategies to prevent flight-crew monitoring failures, pilot professionalism, fatigue, remedial training, pilot training records, airspeed selection procedures, stall training, Federal Aviation Administration (FAA) oversight, flight operational quality assurance programs, use of personal portable electronic devices on the flight deck, the FAA's use of safety alerts for operators to transmit safety-critical information, and weather information provided to pilots.*

**STEP 5**

Each “Go Team” will present their accident investigation findings and recommendations to a “review board” (the rest of the class) who will ask probing and clarifying questions.

Each “Go Team” presentation should include conclusions regarding the following:

- An assessment of the factors that contributed to the accident
- Uncertainties or unanswered questions that remain regarding accident
- At least two recommendations for preventing similar accidents

The presentations should be 5 minutes long.