## ICAO ESAF UPRT/OPS WORKHOP: CASE STUDIES

## CASE STUDY 1: Colgan Air Flight 3407

### Narrative:

A Colgan Air DHC-8-400, N200WQ, operating as Continental Connection flight 3407, crashed during an instrument approach to runway 23 at the Buffalo-Niagara International Airport (BUF), Buffalo, New York. The crash site was approximately 5 nautical miles northeast of the airport in Clarence Center, New York, and mostly confined to one residential house (6038 Long St, Clarence). The four-flight crew and 45 passengers were fatally injured and the aircraft was destroyed by impact forces and post-crash fire. There was one ground fatality. Night visual meteorological conditions prevailed at the time of the accident.

Flight CJC3407 departed Newark-Liberty International Airport, NJ (EWR) at 21:20 on a domestic flight to Buffalo Airport, NY (BUF). At 22:15:14 the Buffalo Approach controller cleared the flight for an ILS approach to runway 23: "Colgan thirty-four zero seven three miles from klump turn left heading two six zero maintain two thousand three hundred till established localizer clear i l s approach runway two three." The flight acknowledged that clearance.

At 22:16:02, the engine power levers were reduced to flight idle. At that time Buffalo Approach instructed the crew to contact Buffalo Tower. The crew extended the landing gear and the auto flight system captured the ILS 23 localizer. The captain then moved the engine conditions levers forward to the maximum RPM position as the copilot acknowledged the instructions to Buffalo Tower.

At 22:16:28 the crew moved the flaps to 10°, and two seconds later the stall warning stick shaker activated. The autopilot disconnected at about the same time that the stick shaker activated. The crew added power to approximately 75% torque. The airplane began a sharp pitch up motion, accompanied by a left roll, followed by a right roll, during which the stick pusher activated. During this time, the indicated airspeed continued to decrease to less than 100 kts. Eight seconds after the flaps had been selected to 10°, and at an airspeed of less than 110 kts, the crew retracted the flaps. Sixteen seconds later the flaps were fully retracted.

Following further pitch and roll excursions the airplane pitched down and entered a steep descent from which it did not recover. The airplane impacted a residential house and was destroyed.

## CASE STUDY 2: West Caribbean Airways Flight 708

### Narrative:

West Caribbean Airways flight 708, an MD-82, crashed near Machiques, Venezuela, following a loss of control while enroute from Panama City to Fort de France, killing all 160 on board.

The MD-82 arrived at Panama City-Tocumen after a flight from Medellín-José María Córdova Airport (MDE). The plane was then prepared to carry out a flight to the Caribbean Island of Martinique.
Flight WCW 708 departed Panama City at about 06:00 UTC and climbed to its cruising altitude of FL310.

This altitude was reached at about 06:25 UTC. Sixteen minutes later the airplane began a normal climb to FL330. At 06:49 the speed began to steadily decrease from Mach 0.76. The horizontal stabilizer moved from about 2 units nose up to about 4 units nose up during this deceleration. At 06:51 UTC the crew reported at FL330 over the SIDOS waypoint, over the Colombian/Venezuelan border, and requested a direct course to the ONGAL waypoint. The controller instructed the crew to continue on the present heading and to await further clearance direct to ONGAL. The flight crew meanwhile discussed weather concerns that included possible icing conditions and the possible need to turn on engine and airfoil anti-ice.

At 06:57 UTC the flight crew requested permission to descend to FL310, which was approved. The autopilot was disconnected and the airplane started to descend. As the airplane descended past about FL315, the airspeed continued to decrease and the engine EPR decreased to about flight idle. Two minutes later a further descent to FL290 was requested, but the controller at Maiquetía did not understand that this was a request from flight 708 and asked who was calling. Flight 708 responded and immediately requested descent to FL240. The controller inquired about the state of the aircraft, to which they responded that both engines had flamed out. The controller then cleared the flight to descent at pilot's discretion.

In the meantime, the altitude alert warning had activated, followed by the stick shaker and the aural stall warning alert. The airspeed had reached a minimum of about 150 indicated air speed (IAS) knots at about FL250. The crew reported descending through FL140 and reported that they were not able to control the airplane. The aircraft descended at 7000 ft/min, and finally crashed in a swampy area.
The entire descent from FL330 had taken approx. 3 minutes and 30 seconds.

## CASE STUDY 3: TransAsia Airways Flight 235 (ATR 72-600, 2015)

### Narrative:

TransAsia Airways flight GE235, an ATR 72-600, crashed into the Keelung River shortly after takeoff from Taipei-Songshan Airport, Taiwan, killing 43 occupants; 15 survived the accident.

A TransAsia ATR-72-600 operating as flight GE235 from Taipei to Kinmen Island impacted a highway viaduct and the waters of the Keelung River near New Taipei City shortly after takeoff. Forty-three occupants on board the airplane suffered fatal injuries. Fifteen were injured.

The airplane took off from Taipei-Sung Shan Airport's runway 10 at 10:51 hours local time and turned right, climbing to an altitude of 1350 feet. At 10:52 the master warning sounded in the cockpit associated with the right engine (no. 2) flame out procedure message. Some 26 seconds later the left hand (no. 1) power lever was retarded to flight idle. After twenty seconds the left engine condition lever was set to the fuel shutoff position resulting in left engine shutdown.

Instead of continuing the climbing right hand turn, the airplane had turned left and began losing altitude and speed with several stall warnings sounding in the cockpit. At 10:53, the flight contacted the Sung Shan Tower controller declaring a Mayday and reporting an 'engine flameout'. The airplane then turned to the right while the crew attempted to restart the left hand engine.

This succeeded at 10:54:20 hours. Fourteen seconds later the stall warning sounded in the cockpit. Video footage of the accident show that the airplane banked almost 90 degrees left as it hit a taxi on a viaduct. Parts of the left hand wing broke off upon hitting the barrier of the viaduct. The airplane broke up as it impacted the Keelung River and came to rest inverted.

## CASE STUDY 4: UPS Flight 1354

### Narrative:

UPS Flight 1354, an Airbus A300F4-622R, N155UP, crashed and burst into flames near Birmingham-Shuttlesworth International Airport (BHM). Both pilots were killed.

Flight 1354 departed Louisville International Airport, KY (SDF) about 05:04 hours EDT on a regular cargo service to Birmingham (BHM).

The flight was on approach to runway 18 when it struck trees. The airplane contacted terrain and crashed in a field; 1000 m short of the runway.

### Synopsis of Events

The Airbus had flown approx. 11,000 hours and 6,800 cycles at the time of accident. Departure was from Louisville, bound for Birmingham. The scheduled arrival was around 04:51 CDT.

Weather: Nighttime, dark night visual flight rules at the airport, but variable instrument meteorological conditions (IMC) with a variable ceiling north of the airport on the approach course. A NOTAM was in effect: runway 06/24 (the longest runway with a precision approach at BHM) was closed from 04:00 to 05:00 CDT, meaning only runway 18 — a shorter runway with a non-precision localizer approach — was available for arrival. The crew briefed the localizer runway 18 non-precision "profile" approach. The first officer entered the approach into the Flight Management System (FMS). However, the FMS still contained a "direct-to" leg (the direct to KBHM) from earlier, causing a flight plan discontinuity and the vertical guidance (profile descent) could not properly engage.

As the aircraft neared the Final Approach Fix (FAF) for runway 18, it approached at ~2,500 ft MSL which was higher than the published crossing altitude of 2,300 ft MSL for that approach. Shortly after the before-landing checklist, the captain switched the autopilot to Vertical Speed (VS) mode and initiated a descent rate of about 1,500 fpm. The first officer gave the 1,000-ft above airport elevation call-out, but the captain maintained a high descent rate. The aircraft descended below the decision altitude of 1,200 ft MSL (for this approach) without the runway in sight.

An Enhanced Ground Proximity Warning System (EGPWS) "sink rate" alert triggered at about 1,000 ft MSL (~250 ft AGL) but the descent continued. The captain reported "runway in sight" about 3.5 s after that alert; however, the aircraft was still descending at about 1,000 fpm and was approximately 1 nautical mile short of the runway threshold. The aircraft then struck trees, followed by a "too low terrain" warning, and impacted terrain uphill of the airport.

## **CASE STUDY 5**: **Asiana Airlines Flight 214**

### **Narrative:**

Asiana Airlines flight 214, Boeing 777-200 was destroyed in a landing accident at San Francisco International Airport, California (SFO). There were 291 passengers and 16 crew members on board. Three passengers died and 48 were seriously injured.

Flight OZ214 originated in Seoul-Incheon International Airport (ICN), South Korea where it departed at 16:35 local Korean time. Destination of the flight was San Francisco, CA.

The weather at San Francisco was fine with 6-7 knot winds and a visibility of 10+ miles. The pilot undergoing initial operating experience was in the left hand seat as Pilot Flying. An instructor pilot was sitting in the right hand seat. The relief first officer was in the jump seat at the time of the approach.

The pilot flying had logged about 9700 flying hours. Flight 214 was his tenth flight leg on a Boeing 777 while undergoing initial operating experience.

The flight was cleared for an approach to runway 28L, the ILS glidepath of which had been declared unserviceable in the current Notam.

The airplane was configured for landing with 30 degrees of flaps and gear down. Target threshold speed was 137 knots. According to preliminary information from the cockpit voice recorder, the crew did not state and anomalies or concerns during the approach. The throttles were at idle and autothrottle armed.

At 1600 feet the autopilot was disengaged. The aircraft descended through an altitude of 1400 ft at 170 kts and slowed down to 149 kts at 1000 feet.

At 500 feet altitude, 34 seconds prior to impact, the speed dropped to 134 kts, which was just below the target threshold speed. The airspeed then dropped significantly, reaching 118 knots at 200 feet altitude. The instructor pilot reported that he noticed four red PAPI lights and concluded that the autothrottle had not maintained speed.

Eight seconds prior to impact, the throttles were moved forward. Airspeed according to the FDR, was 112 knots at an altitude of 125 feet. Seven seconds prior to impact, one of the crew members made a call to increase speed.

The stick shaker sounded 4 seconds prior to impact. One second later the speed was 103 knots, the lowest recorded by the FDR. One of the crew members made a call for a go around at 1.5 seconds before impact. The throttles were advanced and the engines appeared to respond normally.

The main landing gear and rear fuselage then struck a sea wall, just short of runway 28L. Airspeed was 106 knots. The empennage separated at the rear bulkhead.

The airplane then ballooned, yawed left and spun 360 degrees before it came to rest to the left of runway 28L, 735 m (2400 ft) from the seawall.

A post impact fire occurred when a fuel tank ruptured inboard of the no. 2 engine, spilling fuel on the hot engine, causing it to ignite.

The ILS glidepath for runway 28L and 28R at SFO had been declared unserviceable from June 1 until August 22.

## CASE STUDY 6: Turkish Airlines Flight 1951

### Narrative:

Turkish Airlines flight 1951, a Boeing 737-800, crashed while on approach to Amsterdam-Schiphol Airport, Netherlands, killing 9 occupants; 126 survived the accident.

Flight TK1951 departed Istanbul-Atatürk International Airport (IST) for a flight to Amsterdam-Schiphol International Airport (AMS), The Netherlands. The flight crew consisted of three pilots: a line training captain who occupied the left seat, a first officer under line training in the right seat and an additional first officer who occupied the flight deck jump seat. The first officer under line training was the pilot flying. The en route part of the flight was uneventful.

The flight was descending for Schiphol and passed overhead Flevoland at about 8500 ft. At that time the aural landing gear warning sounded.

The aircraft continued and was then directed by Air Traffic Control towards runway 18R for an ILS approach and landing. The standard procedure for runway 18R prescribes that the aircraft is lined up at least 8 NM from the runway threshold at an altitude of 2000 feet. The glidepath is then approached and intercepted from below. Lining up at a distance between 5 and 8 NM is allowed when permitted by ATC.

Flight 1951 was vectored for a line up at approximately 6 NM at an altitude of 2000 feet. The glide slope was now approached from above.The crew performed the approach with one of the two autopilot and auto throttle engaged.

The landing gear was selected down and flaps 15 were set. While descending through 1950 feet, the radio altimeter value suddenly changed to -8 feet. And again, the aural landing gear warning sounded.

This could be seen on the captain's (left-hand) primary flight display. The first officer's (right-hand) primary flight display, by contrast, indicated the correct height, as provided by the right-hand system. The left hand radio altimeter system, however, categorized the erroneous altitude reading as a correct one, and did not record any error. In turn, this meant that it was the erroneous altitude reading that was used by various aircraft systems, including the autothrottle. The crew were unaware of this, and could not have known about it. The manuals for use during the flight did not contain any procedures for errors in the radio altimeter system. In addition, the training that the pilots had undergone did not include any detailed system information that would have allowed them to understand the significance of the problem.

When the aircraft started to follow the glidepath because of the incorrect altitude reading, the autothrottle moved into the *□retard flare′ mode.* This mode is normally only activated in the final phase of the landing, below 27 feet. This was possible because the

other preconditions had also been met, including flaps at (minimum) position 15. The thrust from both engines was accordingly reduced to a minimum value (approach idle). This mode was shown on the primary flight displays as "RETARD". However, the right-hand autopilot, which was activated, was receiving the correct altitude from the right-hand radio altimeter system. Thus, the autopilot attempted to keep the aircraft flying on the glide path for as long as possible. This meant that the aircraft's nose continued to rise, creating an increasing angle of attack of the wings. This was necessary in order to maintain the same lift as the airspeed reduced.

In the first instance, the pilots' only indication that the autothrottle would no longer maintain the pre-selected speed of 144 knots was the RETARD display. When the speed fell below this value at a height of 750 feet, they would have been able to see this on the airspeed indicator on the primary flight displays. When subsequently, the airspeed reached 126 knots, the frame of the airspeed indicator also changed colour and started to flash. The artificial horizon also showed that the nose attitude of the aircraft was becoming far too high. The cockpit crew did not respond to these indications and warnings. The reduction in speed and excessively high pitch attitude of the aircraft were not recognised until the approach to stall warning (stick shaker) went off at an altitude of 460 feet.

The first officer responded immediately to the stick shaker by pushing the control column forward and also pushing the throttle levers forward. The captain however, also responded to the stick shaker commencing by taking over control. Assumingly the result of this was that the first officer's selection of thrust was interrupted. The result of this was that the autothrottle, which was not yet switched off, immediately pulled the throttle levers back again to the position where the engines were not providing any significant thrust. Once the captain had taken over control, the autothrottle was disconnected, but no thrust was selected at that point. Nine seconds after the commencement of the first approach to stall warning, the throttle levers were pushed fully forward, but at that point the aircraft had already stalled and the height remaining, of about 350 feet, was insufficient for a recovery.

According to the last recorded data of the digital flight data recorder the aircraft was in a 22° ANU and 10° Left Wing Down (LWD) position at the moment of impact.

The airplane impacted farmland. The horizontal stabilizer and both main landing gear legs were separated from the aircraft and located near the initial impact point. The left and right engines had detached from the aircraft. The aft fuselage, with vertical stabilizer, was broken circumferentially forward of the aft passenger doors and had sustained significant damage. The fuselage had ruptured at the right side forward of the wings. The forward fuselage section, which contained the cockpit and seat rows 1 to 7, had been significantly disrupted. The rear fuselage section was broken circumferentially around row 28.