UAE521 : A Go Around Gone Wrong

On 3 August 2016, at 0837:38 UTC, an Emirates Boeing 777-31H Aircraft, registration A6-EMW, operating a scheduled passenger flight with ICAO flight number UAE521 (IATA flight number EK521), impacted runway 12L at Dubai International Airport (OMDB) during an attempted go-around, and slid on its lower fuselage along the runway surface for approximately 32 seconds before coming to rest.

The Aircraft had departed Trivandrum International Airport (VOTV), India, at 0506 UTC for a 3 hour 30 minute flight to OMDB, the United Arab Emirates, with 282 passengers, 2 flight crew and 16 cabin crewmembers on board.

The flight crew had a rest period of approximately 30-hours, and the cabin crew were off-duty for periods of time varying between 53 hours and 72 hours prior to operating flight UAE521. All of the crewmembers arrived at Trivandrum airport approximately two hours before departure time, where they were briefed for the flight. The operational flight plan briefing package was obtained by the Commander at 0110 UTC and it included the forecast weather for OMDB together with other en-route information and the B777-300 Aircraft variant assigned to the flight.

The variant was a 777-31H equipped with Rolls-Royce Trent 892 engines. The Aircraft takeoff weight was 257,789 kg, and the calculated landing weight was 229,682 kg. The Commander, who was seated in the left pilot seat, was the pilot flying (PF) and the Copilot was the pilot monitoring (PM). Approximately 60 minutes prior to landing, the Commander and the Copilot completed the approach briefings for OMBD runways 12L and 30L. The Commander briefed the Copilot that in case of a go-around, flaps 20 was to be selected and climb to 3,000 ft. This was in accordance with the missed approach LIDO plate 7-50. At 0735, the United Arab Emirates National Center of Meteorology and Seismology (NCMS) issued a moderate windshear warning affecting all OMDB runways, with a validity from 0740 to 0900.

The OMDB Arrival automatic terminal information service (ATIS) commenced broadcasting the windshear warning at 0800 with information ZULU. At 0806, as recorded in the cockpit voice recorder (CVR), the Commander briefed for the possibility of windshear and stated to the Copilot that "in case of a windshear, windshear TOGA, no configuration change". They then discussed their previous go-around experiences. The Copilot stated that he experienced a windshear during descent "like three months ago". The Commander stated that "I had one into Dubai but it was more like wind shift. The speed went ten knots more so we went around". This conversation lasted approximately 60 seconds. At 0817, as the Aircraft descended through 16,000 ft pressure altitude, the crew communicated with OMDB air traffic control (ATC) Approach and confirmed that they had received ATIS

information Zulu. The Commander stated to the Investigation that prior to the UAE521 flight, he had experienced similar windshear warnings on ATIS at OMDB. For UAE521, because there was no additional information from ATC regarding the windshear warning, he did not believe that the landing would be affected. The calculated reference landing speed (VREF30) was 147 kt. An approach speed of 152 kt (VREF30 +5) was selected on the mode control panel (MCP) for a normal landing configuration

ATC vectored the Aircraft for RNAV (GNSS) approach to runway 12L. At 0829, and at 0831, two preceding aircraft performed go-arounds. The go-arounds were followed by two Emirates B777 aircraft that landed on runway 12L at 0833 and 0835. The UAE521 flight crew were not informed by ATC of the two go-arounds. At 0834, the flight crew selected the landing gear to the down position, armed the speedbrake lever, selected flaps 30 and completed the landing checklist. At 0836 the flight crew received and acknowledged the landing clearance for runway 12L from the Tower which gave the wind speed and direction as 11 kt from 340 degrees.

The approach was stabilized before 1,000 ft radio altitude. As the Aircraft descended through 930 ft radio altitude at 0836:10, the Commander disengaged the autopilot and continued the approach, with the autothrottle (A/T) engaged, in accordance with the Operator's policy. The A/T was in 'SPEED' mode. The flight directors remained in the 'on' position. At 0836:22, as the Aircraft passed 750 ft radio altitude, at 153 kt indicated airspeed (IAS) the flight data recorder (FDR) recorded that the wind direction changed from a headwind to a tailwind component.

At 0836:40, at 450 ft radio altitude, and 156 kt IAS, an automated 'minimums' callout was annunciated, and the Commander announced "Landing". The Copilot provided feedback indicating that he had heard and understood the Commander's decision. The wind speed component was now 10 kt from 317 degrees. At 0836:56, passing 190 ft radio altitude at 152 kt IAS, the Copilot announced "Sixteen knots tailwind", which was acknowledged by the Commander. During this time, the Commander was maintaining the Aircraft on the nominal glidepath, at an average pitch of 0.7 degrees. At 115 ft radio altitude and 157kt IAS, the Copilot announced "Reducing to thirteen knots", with reference to the tailwind. This was acknowledged by the Commander who replied "Checked".

The rate of descent was decreasing from 800 to 700 ft per minute, with an average pitch angle of 0.5 degrees. This was followed by a cockpit automated callout of "One hundred". The wind speed was now 13.5 kt from 308 degrees. Because of the reduction in the tailwind component, the airspeed started to increase which resulted in the A/T retarding both thrust levers. At 0837:05, the Aircraft passed over the threshold of runway 12L at about 54 ft radio altitude and 159 kt IAS. Over the next four seconds automated callouts of 'fifty', 'forty', 'thirty', 'twenty' and 'ten' were annunciated. At 0837:06, after the Aircraft had flown approximately 100 m beyond the threshold, as recorded by the FDR, the Commander initiated the flare at approximately 40 ft radio altitude with a pull on the control column. At the start of the flare, the pitch angle changed from 0.0 to 0.4 degrees. Over the next 5 seconds, until the Aircraft reached 7 ft radio altitude, there was a steady increase in the Aircraft pitch angle from 0.4 to 2.6 degrees, with a corresponding decrease in the sink rate from 692 towards 350 ft per minute At 0837:08.

As the Aircraft passed 25 ft radio altitude, 158 kt IAS, approximately

300 m beyond the threshold, the A/T mode changed on the cockpit primary flight display (PFD) flight mode annunciations (FMA) from 'SPEED' to 'IDLE'. As designed, from 25 ft radio altitude, the A/T transitioned both thrust levers towards the idle position, and the engine pressure ratio (EPR) steadily decreased from 1.074 to 0.98. Approximately two seconds later, the airspeed decreased to 153 kt as the Aircraft descended below 13 ft radio altitude.

From 0837:12 at 5 ft radio altitude several pulls and pushes on the control column along with control wheel roll and rudder inputs were recorded by the Aircraft FDR. The Commander made a left roll input to the control wheel, and at about this time, the Commander said "Oops". The IAS had increased to 160 kt, and the ground speed was 176 kt and decreasing. Two seconds later, with the Aircraft at 2 ft radio altitude, the IAS had increased to 165 kt, the ground speed had reduced to 172 kt, and the sink rate had reduced to 80 ft per minute. The Commander uttered an exclamation and stated "Thermals", and the Copilot replied with "Check".

Neither flight crewmember was aware of the increase in airspeed because their focus was on external scanning of the runway. The Commander stated that in an attempt to have the Aircraft touch down, he had momentarily pushed the control column three times to lower the nose. This action was confirmed by the data recorded on the FDR. At 0837:16, the Aircraft rolled 3 degrees to the left due to the wind effect and the Commander corrected with right control wheel input of 30 degrees. In response to this input, the resulting right bank of 7.4 degrees caused the right main landing gear to contact the runway approximately 1,090 m beyond the threshold.

The right main gear contact with the runway caused it to 'untilt' as indicated by the main landing gear 'tilt' and 'untilt' switch position recorded by the Aircraft FDR. Runway contact was made at an airspeed of 161 kt IAS, 14 kt above the landing reference speed of 147 kt. From 0837:16 to 0837:22, as recorded by the Aircraft FDR, both main landing gear experienced a series of 'tilt/untilt' cycles. During this six-second period, there were two automatic partial movements of the speedbrake lever recorded by the FDR.

The Commander stated during his interview "Below 2,000 ft started having tailwind and getting close to the runway, like 50 feet flare height, we had thermals updraft coming from the ground because of the heat so it was pushing the aircraft up so it caused a long flare. It [the Aircraft] was going towards the end of the touchdown zone, so after that we decided to go around."

The Copilot stated during his interview "The flare felt like it just wouldn't land it was bumpy." The Copilot also stated, "I would say we were definitely less than 50 feet at the initiation of the go around." The Commander stated that he pushed the left takeoff/go-around (TO/GA) switch and then called "Go-around". The push on the TO/GA switch did not have any effect on the A/T and the thrust levers remained at the idle position. The Commanders' declaration of a go-around was immediately followed by a 'long landing' automated cockpit annunciation.

The Commander pulled the control column back and the Aircraft pitch-up angle started to increase. One second after the Commander's 'go-around' declaration the Copilot responded by saying "Okay". This was followed by a second 'long landing' cockpit annunciation. During his interview, the Commander stated he had his right hand on the thrust levers when he pushed the TO/GA switch. He stated that the initiation of the go-around was before touchdown. He could not remember any changes in the flight director and the FMA after pushing the TO/GA switch. He also stated that during the go around, he pitched the Aircraft to an approximate pitch attitude of 7.5 degrees and had positive climb. The

FDR indicated that the Aircraft had touched down for a duration of six seconds. During this time, both main landing gear were simultaneously in 'ground' mode for a period of less than two seconds. The nose landing gear remained in the air throughout this time.

At 0837:22 the Commander called "flaps 20". Just before 0837:23, the main landing gear transitioned back to 'air' mode, and the Aircraft became airborne at 153 kt IAS (VREF + 6.5 kt), with the flaps in the 30 position (landing configuration). As the Aircraft climbed, the wind direction was from 102 degrees at 8 kt. The Copilot moved the flap lever to the flaps 20 position and verbally confirmed this action. The Aircraft continued gaining height and when it reached approximately 47 ft radio altitude, the Copilot announced "Positive climb." In his interview, the Copilot stated that he could not recall information in changes in the FMA and had referred to the PFD vertical speed indicator to confirm that the Aircraft was in a positive climb. The Commander called "Gear-up" as the Aircraft was passing 58 ft radio altitude, at a rate of climb of 608 ft per minute, and 145 kt IAS. Thereafter, the rate of climb started to decrease. Shortly after the "Gear-up" call by the Commander, the Tower transmitted a modified missed approach instruction to UAE521 to continue straight ahead and climb to 4,000 ft.

At 0837:29, the Copilot stated "Gear-up" while the Aircraft was climbing pass 77 ft radio altitude and 135 kt IAS. The Copilot then read back the Tower instructions and changed the preselected missed approach altitude from 3,000 ft to 4,000 ft in the MCP. Two seconds later, at 0837:31, the Aircraft started to lose height after reaching a maximum of 85 ft radio altitude at 131 kt IAS. Three seconds after the Aircraft started to lose height, the Commander called "Windshear TOGA" as the Aircraft was sinking below 67 ft radio altitude. The A/T mode on the FMA changed from 'IDLE' to 'THR' ('thrust' mode). One second later (0837:35), the Commander advanced both thrust levers manually to maximum at the same time as an automated 'don't sink' cockpit aural warning was annunciated. The Copilot called out "Check speed" followed by a cockpit AIRSPEED LOW caution at 128 kt IAS, and a 'don't sink' cockpit aural warning annunciation for the second time. Following these warnings, the Aircraft was losing height at a rate of 800 ft per minute. The Commander increased the Aircraft pitch to 9.2 degrees in an unsuccessful attempt to regain height.

At 0837:38, the Aircraft aft fuselage impacted the runway, at a speed of 124 kt IAS, which was above the Aircraft stall speed. The impact with the runway occurred 18 seconds after the initiation of the go-around, and 7 seconds after the Aircraft started to sink from 85 ft radio altitude. The FDR data indicated that the EPR for both engines had started to respond to the manual thrust lever movement, but the height remaining did not provide enough time for the engine thrust to increase sufficiently to prevent the Aircraft from sinking onto the runway.

The Commander stated during his interview "we noticed the aircraft speed dropping so I applied maximum power because TO/GA power sometimes limits the thrust so I pushed the thrust lever forward. However, the aircraft continued to lose airspeed because of the shifting wind and windshear. At that time, I called windshear TOGA". The Commander stated that after gear up "the speed started reducing until the aircraft lost speed and then it started going down". He further clarified that "It didn't climb much just a few feet once we started positive climb and then I felt the aircraft just sinking".

The initial impact point of the Aircraft on runway 12L was abeam the intersection with taxiway November 7, with the landing gear in transition to the 'up' position. The right (No.2) engine contacted the runway and the engine/pylon assembly separated from

the wing as the Aircraft slid along the runway. Fire was observed on the right engine and pylon and another fire started to emanate from the bottom of the left (No.1) engine.

After the Aircraft came to rest adjacent to taxiway Mike 13, on a magnetic heading of approximately 250 degrees, and 70 m to the right of the runway centerline, dense grey smoke was observed coming from the right side of the fuselage in the vicinity of the right main landing gear bay. At 0839:04, the Commander transmitted a 'mayday' call and informed ATC that the Aircraft was being evacuated. The flight crew completed the evacuation checklist in about one minute from the time that the distress call was transmitted and instructed the cabin crew to commence the evacuation.

The fire commander and the first two Airport rescue and firefighting service (ARFFS) vehicles arrived at the Accident site within 90 seconds of the Aircraft coming to rest and immediately started to apply fire extinguishing agent. Additional firefighting vehicles arrived shortly after. Apart from the Commander and the senior cabin crewmember, who both jumped from the L1 door onto the detached escape slide, crewmembers and passengers evacuated the Aircraft using the available passenger door escape slides.

Twenty-one passengers, one flight crewmember, and six cabin crewmembers sustained minor injuries. Four cabin crewmembers sustained serious injuries. Approximately 9 minutes and 40 seconds after the Aircraft came to rest, the center wing tank exploded which caused a large section of the right wing upper skin to be liberated. As the panel fell to the ground, it struck and fatally injured a firefighter. The Aircraft sustained substantial structural damage as a result of the impact and its movement along the runway and it was eventually destroyed by fire.

Causes

The Air Accident Investigation Sector determined that the causes of the Accident are:

(a) During the attempted go-around, except for the last three seconds prior to impact, both engine thrust levers, and therefore engine thrust, remained at idle. Consequently, the Aircraft's energy state was insufficient to sustain flight.

(b) The flight crew did not effectively scan and monitor the primary flight instrumentation parameters during the landing and the attempted go-around.

(c) The flight crew were unaware that the autothrottle (A/T) had not responded to move the engine thrust levers to the TO/GA position after the Commander pushed the TO/GA switch at the initiation of the FCOM -Go-around and Missed Approach Procedure.

(d) The flight crew did not take corrective action to increase engine thrust because they omitted the engine thrust verification steps of the FCOM-Go-around and Missed Approach Procedure.

Contributing Factors

The Investigation determined that the following were contributory factors to the Accident:

(a) The flight crew were unable to land the Aircraft within the touchdown zone during the attempted tailwind landing because of an early flare initiation, and increased airspeed due to a shift in wind direction, which took place approximately 650 m beyond the runway threshold.

(b) When the Commander decided to fly a go-around, his perception was that the Aircraft was still airborne. In pushing the TO/GA switch, he expected that the autothrottle (A/T) would respond and automatically manage the engine thrust during the go-around.

(c) Based on the flight crew's

inaccurate situation awareness of the Aircraft state, and situational stress related to the increased workload involved in flying the go-around maneuver, they were unaware that the Aircraft's main gear had touched down which caused the TO/GA switches to become inhibited. Additionally, the flight crew were unaware that the A/T mode had remained at 'IDLE' after the TO/GA switch was pushed.

(d) The flight crew reliance on automation and lack of training in flying go-arounds from close to the runway surface and with the TO/GA switches inhibited, significantly affected the flight crew performance in a critical flight situation which was different to that experienced by them during their simulated training flights.

(e) The flight crew did not monitor the flight mode annunciations (FMA) changes after the TO/GA switch was pushed because:

1 According to the Operator's procedure, as per FCOM -Flight Mode Annunciations (FMA), FMA changes are not required to be announced for landing when the aircraft is below 200 ft;

2. Callouts of FMA changes were not included in the Operator's FCOM - Go-Around and Missed Approach Procedures.

3. Callouts of FMA changes were not included in the Operator's FCTM Go-Around and Missed Approach training.

(f) The Operator's OM-A policy required the use of the A/T for engine thrust management for all phases of flight. This policy did not consider pilot actions that would be necessary during a go-around initiated while the A/T was armed and active and the TO/GA switches were inhibited.

(g) The FCOM - Go-Around and Missed Approach Procedure did not contain steps for verbal verification callouts of engine thrust state.

(h) The Aircraft systems, as designed, did not alert the flight crew that the TO/GA switches were inhibited at the time when the Commander pushed the TO/GA switch with the A/T armed and active.

(i) The Aircraft systems, as designed, did not alert the flight crew to the inconsistency between the Aircraft configuration and the thrust setting necessary to perform a successful go-around.

(j) Air traffic control did not pass essential information about windshear reported by a preceding landing flight crew and that two flights performed go-arounds after passing over the runway threshold. The flight crew decision-making process, during the approach and landing, was deprived of this critical information.

(k) The modification of the go-around procedure by air traffic control four seconds after the Aircraft became airborne coincided with the landing gear selection to the 'up' position. This added to the flight crew workload as they attentively listened and the Copilot responded to the air traffic control instruction which required a change of missed approach altitude from 3,000 ft to 4,000 ft to be set. The flight crews' concentration on their primary task of flying the Aircraft and monitoring was momentarily affected as both the FMA verification and the flight director status were missed. FTP