SERIOUS INCIDENT

Aircraft Type and Registration:	Airbus A319-111, G-EZEW
No & Type of Engines:	2 CFM CFM56-5B5/P turbofan engines
Year of Manufacture:	2004 (Serial no: 2300)
Date & Time (UTC):	30 June 2016 at 1008 hrs
Location:	On departure from Bristol Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 6 Passengers - 144
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	38 years
Commander's Flying Experience:	8,500 hours (of which 6,500 were on type) Last 90 days - 164 hours Last 28 days - 43 hours
Information Source:	AAIB Field Investigation

Synopsis

When the co-pilot, who was the Pilot Flying (PF), asked for the landing gear to be retracted, the Pilot Monitoring (PM) retracted the landing gear and flaps. Realising his error, the PM told the PF to select TOGA[1] thrust. The PM moved the flap lever back to position 1, when instructed by the PF to reselect the flaps, and the slats began to extend. The flight continued without further incident.

History of the flight

G-EZEW was operating a flight from Bristol Airport to Lisbon Airport, Portugal, with six crew and 144 passengers on board. The co-pilot was the PF and the commander was the PM. The reported weather conditions included surface wind from 230° at 8 kt, more than 10 km visibility, broken cloud at 1,600 ft agl, a temperature of 15°C and a QNH of 1009 hPa.

The aircraft began its takeoff from Runway 27 at 1007 hrs with the flap lever in position 1, giving a slat and flap configuration known as CONFIG 1+F (leading edge slats extended to 18° and trailing edge flaps extended to 10°). The PF began to rotate the aircraft at 140 kt CAS[2]

Footnote

[1] TOGA: Takeoff/Go Around. Aircraft often take off with a thrust setting below the maximum available (TOGA thrust). If necessary, TOGA thrust can be selected at any time

[2] CAS:Copmted Airspeed

and it lifted off at 147 kt CAS. The PM called 'POSITIVE CLIMB' to which the PF responded 'GEAR UP'. The landing gear was selected UP four seconds after lift-off and, three seconds later at approximately 190 ft radio altitude (RA) and 157 kt CAS, the PM moved the flap lever to position 0, causing the slats and flaps to begin to retract.

The aircraft pitch attitude began to increase, airspeed began to decrease and, at a height of 370 ft RA, the PF applied a nose-down corrective pitch input which prevented the CAS from decreasing below 153 kt. As the aircraft climbed through 550 ft RA the flaps were fully retracted, the slats were retracting through 7.5° and the CAS was increasing through 160 kt. The PM told the PF what he had done and announced "SET TOGA"[3], to which the PF responded by moving the thrust levers to the TOGA detent.

After the flaps were selected up, the PF saw the V_{LS}[4] indication on the PFD[5] "shoot up" to 180 kt, 30 kt above the current speed (Figure 1). He asked the PM to extend the flaps again and the PM moved the flap lever back to position 1, which caused the slats to begin to extend. The aircraft was at 710 ft RA and 183 kt. The V_{LS} indication reduced below the instantaneous airspeed and, when the aircraft accelerated to S speed[6], the PF moved the thrust levers to the CLB detent to reduce thrust to the climb setting. The PF asked for the slats to be retracted, which the PM did at approximately 850 ft RA and, passing 870 ft RA, the autopilot was engaged and the climb continued.

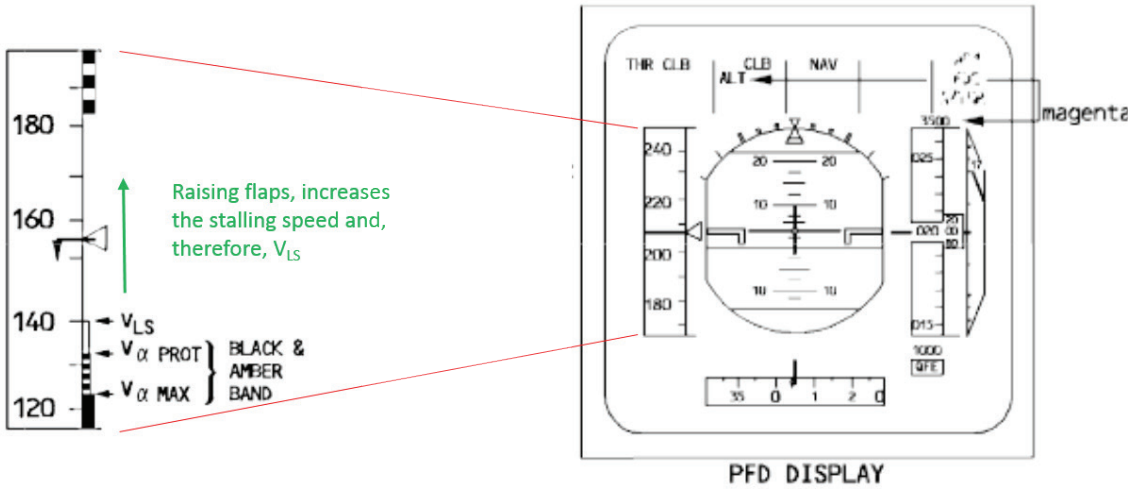

Figure 1

The V_{LS} indication moves up the airspeed scale on the PFD when the flaps are raised

[3] TOGA: Takeoff/Go-around (thrust)
[4] VLS: the lowest selectable speed
[5] Primary flight display
[6] S Speed: see Aircraft characteristic speeds below

Recorded data

The following relevant parameters were recorded:

- When the flap lever was set to position 0, at 190 ft RA and 157 kt CAS, the pitch attitude was 15.1° nose-up and the angle of attack (AOA) was 7.3°.
- During slats and flap retraction, the CAS reached a minimum of 153 kt, at which the pitch attitude reached a maximum value of 17.2° nose-up and AOA reached 9.1° (reaching its maximum recorded value of 9.3° shortly afterwards). When the aircraft reached the clean configuration (slats and flaps fully retracted), the CAS was recorded as 171 kt.
- As the aircraft passed 550 ft RA the AOA was 7.5°, decreasing to a stabilised value of 7.2° to 7.3°.

Aircraft technical information

Aircraft characteristic speeds

V_{LS} is calculated by the Flight Augmentation Computer (FAC) and displayed on the PFD as the top of a vertical amber strip along the airspeed scale. V_{LS} corresponds to:

a. 1.13 times the stalling speed during takeoff
b. 1.28 times the stalling speed in the clean configuration

The manufacturer calculated that the stalling speed of the aircraft in the clean configuration was 156 kt at a gross weight of approximately 63,000 kg.

'S speed' is the lowest speed at which flaps should be selected to position 0 and is displayed as a green letter 'S' on the airspeed scale of the PFD.

Flap system logic

When the flap lever is moved to position 0 from CONFIG 1+F after takeoff, the flaps and slats begin retracting at the same time if the CAS is above 154 kt. In flight, when the CAS is above 100 kt, moving the flap lever from position 0 to 1 commands CONFIG 1 rather than CONFIG 1+F, extending the slats but not the flaps. If, after takeoff (and above 100 kt), the flap lever is moved from position 1 to 0 and then back to 1, the slats and flaps begin to retract but, although the slats will extend again, the flaps will continue to retract.

Alpha/Speed lock function (slats)

The Alpha/Speed lock function inhibits the retraction of slats at high AOA (alpha) or low speeds. If AOA exceeds 8.5° or the airspeed reduces below 148 kt, retraction of slats from position 1 to position 0 is inhibited. It is no longer inhibited when AOA reduces below 7.6° and speed exceeds 154 kt.

After the flap lever has been moved to position 0, this protection is not active even if the AOA exceeds 8.5° or the airspeed decreases below 148 kt.

Operator's report on the incident

Information from the pilots

During their pre-flight briefing, and subsequently during the morning, the pilots had discussed a previous flap mis-selection event that occurred during takeoff from the same airport. The commander stated that he had been thinking about that event while waiting for the instruction to raise the flaps, and wondered later whether these thoughts and the earlier discussions had been a trigger for him selecting the flaps to position 0 before being asked to do so.

Operator's Analysis

The operator's report noted that, when the flap lever reached position 0, the AOA was 7.3° and the CAS was 157 kt. Consequently, the Alpha/Speed lock protection did not activate, and the flaps and slats moved as selected. When the flap lever was selected back to position 1, the slats began to extend again but the flaps did not, in accordance with normal flap system logic. There was no specified procedure for crews to follow in these circumstances but, in this case, the recovery action was effective: reducing the AOA, increasing thrust and extending the slats.

The operator's report stated:

> 'The combination of the fact that [the PM] had been thinking about the previous event, perhaps rehearsing how it could have happened, and that he was anticipating the flap 0 call from [the PF], became a trigger and led [the PM] to actually action that sequence in reality by selecting the flap lever to zero.'

Previous event

In its report into a similar incident in 2016[7], the operator referred to the routine procedure of retracting flaps after takeoff, commenting:

> *'Tasks which are highly practised, routine and largely physical actions are more vulnerable to action slips than more cognitively demanding tasks. These well-practised tasks are linked with automatic processing where [we can do the task] 'without thinking'. Our ability … to automate our processing [allows] us to develop expertise and create the cognitive capacity to process more complex tasks. However, it can also leave us vulnerable to making errors in relatively simple tasks.'*

The operator noted that the flap mis-selection was not an isolated event, indicating that flight crew are vulnerable to this type of slip, and consequently undertook a study into other events involving inadvertent flap retraction after takeoff.

Footnote

[7] See AAIB Bulletin 8/2016; G-EZTZ

Study into flap mis-selection after takeoff

The Airbus A319 has a further protection known as Alpha Floor[8], which applies maximum thrust regardless of pilot input if the AOA is too great. The operator determined that neither Alpha/Speed Lock nor Alpha Floor protection had been triggered in any of the events reviewed, noting that this was reassuring. However, it commented that there were other risks associated with the aircraft being in a low energy state near to the ground, including the possibility that crew members would become confused leading to a loss of situational awareness. In addition, the operator was not clear how much performance margin would remain in the event of a loss of thrust in one engine or a requirement to increase the climb angle to avoid an obstacle.

The manufacturer studied the events and concluded that, in the circumstances examined where the Alpha Lock function had not been triggered, the aircraft had sufficient performance to maintain a climb and accelerate. None of the operator's events, or other similar events of which the manufacturer was aware, had triggered the Alpha Floor protection. The manufacturer stated that:

a. Had the flap lever been moved to position 0 with the aircraft at higher climb angles or lower speeds, the Alpha/Speed Lock function would have inhibited slat retraction.
b. Aircraft climb performance following early flap retraction would exceed that demonstrated in the case of an engine failure after takeoff.
c. Should an increased climb rate be required with the aircraft at a very high angle of attack, the Alpha Floor protection would activate to provide TOGA thrust.

The manufacturer stated that the takeoff performance calculations used by the operator, when properly computed and applied, combined with the protections above, would allow the aircraft to climb safely should there be a repeat of this type of event even when combined with other adverse factors, such as obstacle or terrain avoidance.

Operator safety action

Following its review into flap mis-selection after takeoff, the operator took or proposed the following safety action:

a. It reviewed its current training and guidance to support crews in handling the aircraft in a low energy state at low altitude.
b. Crews would be trained in 'active monitoring', focussing on switch selections and lever movements.
c. It amended its SOPs for flap and landing gear selection to ensure the correct lever is identified before being moved.
d. It would develop training to help crews manage distractions (which had played a role in some events).
e. It would raise awareness amongst pilots of the events reviewed through a dedicated flight safety communication.

Footnote

[8] Alpha-floor protection automatically selects TOGA thrust when the aircraft reaches a very high AOA.

Subsequent event

On 19 March 2017 one of the operator's A320 aircraft, G-EZWM, was taking off from Nice Airport when the PM, when asked by the PF to retract the landing gear, responded "gear up" but moved the flap lever to position 0 with the aircraft 105 ft above the runway. The PF noticed a large increase in $V_{LS,}$ which alerted him that the flaps were retracting, and exclaimed "Flaps!" He selected TOGA, and the PM raised the gear, but the flap lever remained at position 0. The flaps and slats retracted fully but, after TOGA was selected, the aircraft accelerated "rapidly" and climbed.

In discussion after the event, the crew could not explain definitively why the mis-selection might have happened but noted that the PM had just finished the training introduced by the operator to combat this sort of action slip. They wondered whether the PM, by actively trying not to make a mis-selection, brought about that very outcome.

Conclusion

The operator realised that the flap mis-selection event to G-EZEW was not an isolated event and carried out a study into similar incidents with assistance from the manufacturer. The operator was concerned about the risk associated with aircraft being in a low energy state near to the ground, including performance risks and the possibility that crew members would become confused leading to a loss of situational awareness.

Information from the manufacturer indicated that properly-computed takeoff performance calculations, combined with the aircraft's Alpha/Speed Lock and Alpha Floor protection functions, would allow the aircraft to climb safely following a flap mis-selection event, even when combined with other, adverse, factors. Aircraft climb performance following early flap retraction would exceed one engine inoperative climb performance.

The operator began to focus training effort on avoiding the mis-selection of switches and levers, and amended its SOPs with the same intention. However, a similar event occurred to a pilot shortly after he underwent that training and he wondered subsequently whether, by focussing on not making the action slip, he had brought it about. This hypothesis would be supported by the comment of the pilot of G-EZEW in this report who stated that, while waiting for the instruction to raise the landing gear, he had been thinking about an earlier mis-selection event by another crew at his home base.