

## Indonesia AirAsia Flight Accident.

On 28 December 2014, ATC lost contact with an Airbus A320 (PK-AXC) being operated by Indonesia AirAsia on a scheduled passenger flight from [Surabaya](#) to [Singapore](#) which had just reached its cruise level of FL320 (Flight Level 320 = 32,000ft). in day IMC (Instrument meteorological conditions). It was subsequently found to have crashed after a loss of control with the sea impact resulting in the destruction of the aircraft and the deaths of all 162 occupants.



## Investigation

An Investigation was carried out by the Indonesian National Transportation Safety Committee (NTSC) - the Komite Nasional Keselamatan Transportasi (KNKT). After an intensive sea search, the FDR (flight deck recorder) and 2-hour CVR (cockpit voice recorder) were both recovered, respectively on 12 and 13 January 2015 and their data were subsequently successfully downloaded. Recorded ATC data were also available. Some of the wreckage was eventually recovered.

It was established that the aircraft had reached FL320 uneventfully fourteen minutes after take-off with the First Officer as [PF](#). Twelve minutes later, the first of four identical Cautions concerning the status of both rudder limiters had occurred. The first three were found to have been actioned by the Captain in accordance with the corresponding ECAM (Electronic centralised aircraft monitor) drill and each time, normal system status was restored. Fourteen minutes after the first Caution, the fourth one occurred. This time, the pilot response was not in accordance with the ECAM drill, which required the sequential resetting of the two Flight Augmentation Computers (FAC) using their overhead panel switches, but instead involved the tripping and resetting of the 26V AC CB for each FAC in turn.

The effect of this unapproved in-flight action, which it was found that the Captain had seen being carried out on the ground by an engineer responding to a report of the same fault three days earlier, was that neither FAC returned to normal functionality and successive Cautions for first a single FAC Fault and then a dual one were annunciated. This resulted in a reversion of the Flight Control System from Normal Law to [Alternate Law](#), the most immediately obvious effect of which was that the AP

and A/T were automatically disconnected, which it was considered would have been unexpected by both pilots.

One of the other effects of Alternate Law was a rudder deflection to the left of  $2^\circ$ , which led to an uncommanded roll to the left at a rate of  $6^\circ/\text{second}$ , about twice as fast as the normal rate of roll. There was no pilot response to this developing wing drop for 9 seconds, by which time the bank angle had reached  $54^\circ$ . It was considered that the attention of the PF may have temporarily been diverted from the PFD although noted that the rate of roll had been well above the generally accepted threshold for vestibular sensitivity. When PF side stick movement did begin, it was very abrupt and consisted of a substantial rearward movement followed by a maximum deflection to the right. The effects of this were a reduction in the left bank from  $54^\circ$  to  $9^\circ$  in 2 seconds and an increase in the pitch attitude to  $9^\circ$  up in 3 seconds. The latter was noted to have been far in excess of the less-than- $2^\circ$  pitch attitude which had been required to maintain level flight with the AP engaged. The Captain was recorded as exclaiming "Oh my God" as this abrupt response was occurring.

Immediately the wings had almost returned to level, maximum deflection left was input to the right side-stick and the left bank increased rapidly to  $53^\circ$ , almost where it had just been. One second after this, with right side stick rearward pressure still being applied and the aircraft climbing through FL329 just 9 seconds after the AP had disconnected as a result of the Captain's FAC reset action, the Angle of Attack (AoA) - which was not displayed to the pilots - reached  $8^\circ$ , the threshold for a Stall Warning and the sound of this was momentarily recorded. The Captain then repeated the word "level" four times but this was only followed by a slight movement of the right side-stick towards neutral and the rearward movement was resumed almost immediately. Twice during the next ten seconds, he made a 2 second input on his side stick without any call that he wished to take control. He then called "pull down" - repeated several times - just before the Stall Warning was reactivated and again just after it started. Apart from a single second shortly after the reactivation, the Warning was then continuous - as was buffet - until the final recorded data shortly before impact as the right side-stick pitch up command remained substantial and continuous until impact just over three minutes later.

Six seconds after the Stall Warning had become continuous, the First Officer is heard exclaiming in French "what is happening" as the Captain begins a continuous input to his side-stick, still without announcing that he wished to take control or pressing and holding his side-stick take over button (for the required 40 seconds) which would have been necessary to gain this if the other pilot did not cease their inputs. On two subsequent occasions, the Captain's take over button was pressed for 2 and then 5 seconds, but because this had no effect, the side-stick inputs of both pilots were, in accordance with system design, summed for the remainder of the flight.

Cruise Power remained set as the aircraft pitch attitude reached  $45^\circ$  nose up, speed reduced to as low as 55 knots and AoA increased to  $48^\circ$ . At a climb rate of up to 11,000 fpm, a maximum of FL385 was reached just under a minute from the AP (auto-pilot) disconnect. At the top of this climb, with left bank reaching a maximum of  $104^\circ$ , the Captain exclaimed "My God" and the aircraft began to descend, stalled, at



It was found that the 53 year-old Captain, an Indonesian national, had 20,537 hours flying experience including 4,687 hours on the accident aircraft type and had been an Air Force pilot for 10 years until 1993. He had joined the Operator on the Boeing 737 fleet and later trained and qualified on the A320 through a conversion which had included simulator details covering stall recovery in Alternate Law and high altitude handling/stall recovery. The 46 year-old First Officer, a French national, had 2247 hours flying experience including 1367 hours on type having joined Indonesia Air Asia two years previously immediately after completing his professional licence training at flying school following a lengthy business management career outside the aviation sector.

It was found that neither pilot had received, nor been required to receive by the Indonesian DGCA, upset recovery training on the A320, although the Captain had received such training on the Boeing 737 when he had joined Indonesia Air Asia. The Investigation noted that "the (A320) FCTM stated that the effectiveness of fly-by-wire architecture and the existence of control laws eliminate the need for upset recovery manoeuvres to be trained on protected Airbus".

The convincing evidence from the CVR that CRM (Crew Resource Management) on the flight deck had been ineffective was noted, as was the potential effect of both 'startle reflex' and 'spatial disorientation' on the pilots' performance following the sudden and unexpected requirement to fly the aircraft manually.

On the question of the repetitive Rudder Limiter Cautions which had begun the sequence of events which led to the accident, it was noted that "there was no approved means for flight crews to handle multiple or repeated Master Caution alarms in order to reduce distraction". The failure of the continuing airworthiness process to address what was found to have been a significant history of such Cautions occurring in flight was also noted, as was inability of regulatory oversight procedures to detect this. The line maintenance response to each after-flight report of the occurrence was found to have been mainly confined to resetting the component involved - the Rudder Travel Limiter Unit (RTLU) - by either cycling the FAC push button(s) or tripping and re-setting the associated CBs with no concurrent development of organisational awareness of the ongoing nature of the problem.

When the RTLU recovered from the accident aircraft was examined, it was found that the cause of the repeated failures and consequent system Caution annunciations had been cracking solder in both channels which would have led to loss of electrical continuity and thus RTLU failure.

The Investigation formally identified five **Contributory Factors** in respect of the accident as follows:

- The cracking of a solder joint of both channel A and B resulted in loss of electrical continuity and led to RTLU failure.
- The existing maintenance data analysis led to unresolved repetitive faults occurring with shorter intervals. The same fault occurred 4 times during the flight.

- The flight crew action to the first 3 faults was in accordance with the ECAM messages. Following the fourth fault, the FDR recorded different signatures that were similar to the FAC CBs being reset resulting in electrical interruption to the FACs.
- The electrical interruption to the FAC caused the autopilot to disengage and the flight control logic to change from Normal Law to Alternate Law (with) the rudder deflecting 2° to the left resulting (in) the aircraft rolling to 54° angle of bank.
- Subsequent flight crew action leading to inability to control the aircraft (manually) in Alternate Law resulted in the aircraft departing from the normal flight envelope and entering a prolonged stall condition that was beyond the capability of the flight crew to recover.

A total of 10 **Safety Recommendations** were made as a result of the Investigation as follows:

- that **Indonesia Air Asia** should re-emphasise the importance of Standard Call-Outs in all phases of flight.
- that **Indonesia Air Asia** should re-emphasise the procedure for taking over control in various critical in-flight situations.
- that the **Directorate General Civil Aviation** should ensure that the implementation of air operators' flight crew training is in accordance with the approved operations manual.
- that the **Directorate General Civil Aviation** should ensure that air operators (regulated) under Indonesian Civil Aviation Safety Regulations (CASR) 121 conduct simulator upset recovery training in a timely manner.
- that the **Directorate General Civil Aviation** should ensure that air operator maintenance systems have the ability to detect and address all repetitive faults appropriately.
- that the **Directorate General Civil Aviation** should ensure that the Indonesian Civil Aviation Safety Regulations regulate the duties of the pilot in command as specified by ICAO Annex 6.
- that **Airbus** should consider developing a means for flight crews to effectively manage multiple and repetitive Master Caution alarms to reduce distraction.
- that **Airbus** should consider and review the FCTM concerning the Standard Call-Outs in all phases of flight.
- that the **FAA** and the **EASA** should note that the KNKT supports Safety Recommendation (FRAN-2015-024) made by the French BEA as the result of a different investigation which says that that "in coordination with manufacturers EASA should ensure that future programmes defined in the context of Operational Suitability Data include initial and recurrent training relating to taking over control of aeroplanes equipped with non-coupled control sticks".
- that the **FAA** and the **EASA** should expedite the implementation of mandatory upset recovery training to (achieve it) earlier than 2019.

### ALTERNATE LAW

**If Multiple Failures of Redundant Systems occur, the flight controls revert to Alternate Law.  
The ECAM displays the message: ALTN LAW: PROT LOST**

Ground Mode	The ground mode is identical to Normal Law.
Flight Mode	<ul style="list-style-type: none"> <li>• In pitch alternate law the flight mode is a load factor demand law similar to the Normal Law flight mode, with reduced protections.</li> <li>• Pitch alternate law degrades to pitch direct law when the landing gear is extended to provide feel for flare and landing, since there is no flare mode when pitch normal law is lost.</li> <li>• Automatic pitch trim and yaw damping (with limited authority) is available.</li> <li>• Turn coordination is lost.</li> <li>• When pitch law degrades from normal law, roll degrades to Direct Law - roll rate depends on airspeed.</li> </ul>
Protections	<ul style="list-style-type: none"> <li>• All protections except for load factor maneuvering protection are lost.</li> <li>• The load factor limitation is similar to that under Normal Law.</li> <li>• Amber <span style="color: #FFA500;">XX</span>'s replace the green = attitude limits on the PFD.</li> <li>• A low speed stability function replaces the normal angle-of-attack protection             <ul style="list-style-type: none"> <li>○ System introduces a progressive nose down command which attempts to prevent the speed from decaying further.</li> <li>○ This command CAN be overridden by sidestick input.</li> <li>○ <b>The airplane CAN be stalled in Alternate Law.</b></li> <li>○ An audio stall warning consisting of "crickets" and a "STALL" aural message is activated.</li> <li>○ The Alpha Floor function is inoperative.</li> </ul> </li> <li>• The PFD airspeed scale is modified:             <ul style="list-style-type: none"> <li>○ <math>V_{LS}</math> remains displayed</li> <li>○ <math>V_{ALPHA\ PROT}</math> and <math>V_{ALPHA\ MAX}</math> are removed</li> <li>○ They are replaced by a red and black barber pole, the top indicating the stall warning speed <math>V_{SW}</math></li> </ul> </li> <li>• A nose up command is introduced any time the airplane exceeds <math>V_{MO}/M_{MO}</math> to keep the speed from increasing further, which CAN be overridden by the sidestick.</li> <li>• Bank angle protection is lost.</li> <li>• Certain failures cause the system to revert to Alternate Law without speed stability.</li> <li>• Yaw damping is lost if the fault is a triple ADR failure.</li> </ul>