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REPORT
INCIDENT

Take-off with inconsistent information on the FMA and then on the FD, automatic flight system anomaly

Aircraft	Airbus A300-600ST aeroplane registered F-GSTA
Date and time	13 September 2011 at 7 h 05 UTC(1)
Operator	Airbus Transport International
Place	Toulouse-Blagnac (31) airport
Type of flight	Chartered cargo transport
Persons on board	Captain (PNF), copilot (PM), flight engineer
Consequences and damage	None

(1)Unless otherwise mentioned, the times given in this report are expressed in universal coordinated time (UTC).

This is a courtesy translation by the BEA of the Final Report on the Safety Investigation. As accurate as the translation may be, the original text in French is the work of reference.

1 - HISTORY OF FLIGHT

The history of flight was based on analysis of the Quick Access Recorder (QAR) and crew interviews.

The crew performed a flight from Toulouse-Blagnac to Chester (Great Britain). This leg was the first of three. The meteorological conditions on departure were VMC. The configuration selected for take-off was: slats 15° flaps 20° for a weight of 114.4 tonnes. The V2 speed displayed on the flight control unit (FCU) was 141 kt. The copilot stated that, lined up on runway 14R, he gradually increased power and triggered the Go levers. He read the mode displayed on the FMA(2) display while the captain called out "FMA indications checked". The flight engineer followed the thrust levers to the TOGA position, specifying that he never overrode them.

(2)The copilot did not remember with certainty the modes called out. The captain stated that it was THR-SRS-RWY.

After the rotation, during retraction of the landing gear, the captain stated that the THR L indication in continuous green was displayed on both FMA and that he no longer saw the SRS mode. He noted a pitch-down order on the FD1 crossbar. The copilot stated that, on his screen, the FD indications were consistent with the take-off flight path followed (pitch attitude +10° and runway centreline). Given the divergence between captain / copilot information, he then decided to disengage the THR L mode and saw MAN THR on the FMA. He asked the captain to engage the auto-thrust (A/THR) on the FCU: it engaged in SPD mode. The copilot and flight engineer then noted a decrease in thrust. The copilot countered it immediately by preventing the movement of the thrust levers backwards and then by disengaging the A/THR. He continued the take-off manually. Climbing through 3,500 ft, he engaged the A/THR and the autopilot (AP1). The flight continued without further anomalies.

Study of the QAR data showed that THR L mode was active as soon as the Go levers were triggered.

2 - ADDITIONAL INFORMATION

2.1 AP/FD modes used on take-off

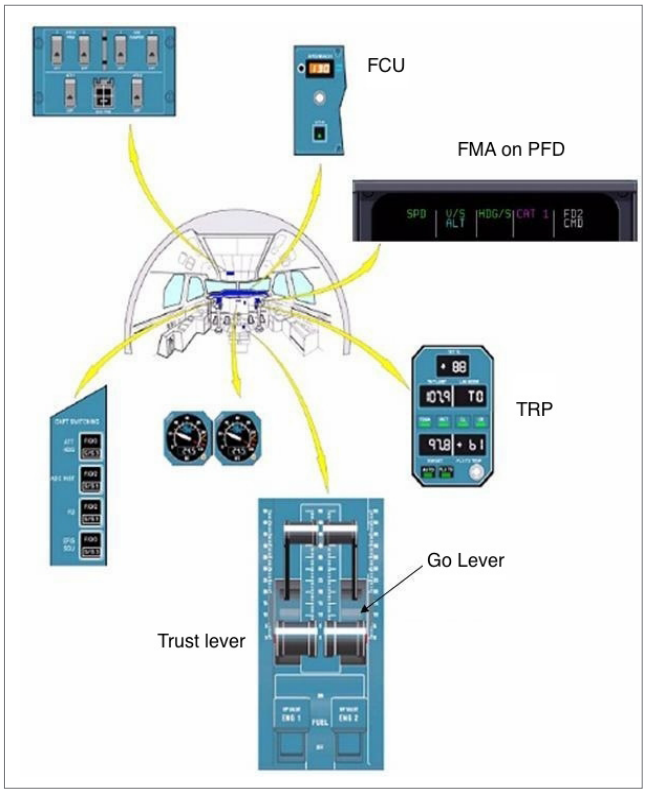
- On take-off, the input on the Go levers engages the TAKE OFF mode if the slats are extended by at least 15° and if the main landing gear is compressed. This mode corresponds to the longitudinal **SRS** (Speed Reference System) mode and to the lateral **HDG SEL** , **HDG** or **RWY** mode.

  This input also engages the A/THR in **THR** mode and captures the thrust limit corresponding to the mode selected on the TRP[3] (TO or FLEX TO mode on take-off).

  The **SRS** mode enables acquisition of and maintaining the V2 speed selected on the FCU, plus 10kt[4], or maintaining pitch attitude of 18° or maintaining a minimum slope depending on aeroplane energy. The corrections to be carried out are indicated by the longitudinal crossbar on the FD.

- The **THR L** (Thrust Latch) mode on the ATS also orders the capture of and maintaining thrust limit corresponding to the mode selected on the TRP (TO or FLEX TO mode on take-off). The difference is that the A/THR is not engaged (the light is off on the FCU) and **THR** is not displayed on the FMA.

- If the TAKE OFF mode does not engage, then the AP/FD (**V/S-HDG**) basic modes are active. In flight, if the A/THR is engaged via the FCU, then it is in **SPD** mode. During take-off, the vertical speed displayed on the FCU is 0 ft/min (V/S at the time the AFS is engaged, on the ground) and the speed selected on the FCU is the V2 entered on the FMS.



[3]Thrust Rating Panel: control panel used to select the thrust limit that the ATS will maintain in THR or THR L mode.

[4]This increase is applied when both engines are running. It is equal to the highest of the following values in the event of engine failure: V2 or the current speed of the aeroplane.

2.2 Thrust levers

The speed of movement of A/THR depends on the flight phase and the AP/FD mode engaged. In **GO AROUND** ou **THR L** mode, this speed is 8 °/s. It is 3 °/s in all other modes. During the event, the angle increased by 18° in approximately 3 s; the QAR data confirmed that **THR L** was active.

2.3 Recording of the flight parameters

Only the parameters relating to the AP/FD from side 1 (captain) were recorded. It was not possible to show any divergence between the information displayed on displays 1 and 2. The FCC1 (Flight Control Computer 1) controls the FD1 and the modes display on the FMA1. The FCC2 controls the FD2 and provides the indications required for mode display on the FMA2. It is possible that the FMA1 and 2 displayed different information.

Input on the Go levers was not recorded. However, it was confirmed by the change of status of identified parameters.

2.4 Analysis of the take-off sequence

The recorded flight parameters and the sequence of flight described by the crew show divergences. Furthermore, according to the crew, the indications provided by the FD 1 and 2 were not the same.

Analysis of the recordings of the incident flight and of the two following flights, during which no anomaly in the automatic flight system operation was noted, enabled us to deduce that:

- During the incident flight, **THR L V/S HDG** was displayed on the FMA;
- During the following flight, **THR SRS HDG SEL** was displayed on the FMA;
- During the flight after that, **THR SRS RWY** was displayed on the FMA.

In addition the speed of power lever movement during the incident flight was about 8°/s, and 3°/s for the two flights that followed.

The case of the incident flight corresponded to an inactive TAKE OFF mode. The ATS mode was **THR L** (instead of **THR**) and the longitudinal mode was **V/S** (instead of **SRS**).

The copilot stated having triggered the Go levers, and called out the modes from the FMA. The captain confirmed them without noticing any anomaly. The flight engineer accompanied the automatic movement of the thrust levers by monitoring the N1 target. The difference in speed of the automatic movement of the levers was not detected by the crew (8°/s vs 3°/s). During retraction of the landing gear the captain noticed **THR L** on the FMA and called it out. The copilot disconnected the THR L mode and then asked the captain to engage the A/THR which had engaged, by design, in **SPD** mode. The A/THR decreased the thrust to reduce and stabilise the speed at the target value of 141 kt. The FD1 displayed a pitch-down order consistent with the target V/S of 0 ft/min. The copilot disengaged the A/THR and accelerated the aeroplane on the climb.

2.5 Troubleshooting

The TCC1 (Thrust Control Computer 1) received the signal from the Go Levers since it engaged the **THR L** mode on the ATS. However, this signal was not received by the FCC1 since the TAKE OFF mode was not engaged. This anomaly probably came from an erratic failure of the wiring between the Go levers and the FCC1.

The Go levers were inspected and no defects were noted. An inspection of the wires and connectors between the Go levers and the FCC1 was conducted and revealed no defects. It was not possible to reproduce the malfunction that occurred during the flight.

Several tests were conducted by the operator in the flight conditions of the event and none of them made it possible to reproduce the malfunction observed.

2.6 Previous event

On 11 May 2011, another crew had reported a similar anomaly on the same aeroplane during a take-off from Toulouse-Blagnac: *"On take-off, after the landing gear was retracted, on both FMA, we read THR L and no more SRS displayed. We noted, without any action by us, a clear decrease in the thrust and a pitch-down order from the FD1"*.

Analysis of the technical causes did not make it possible to highlight a failure consecutive to this event.

2.7 Procedures in the event of unengaged TAKE OFF mode

The operations manual (part B2) indicates that the decision to abort take-off before 100 kt may be left to the captain's discretion according to the circumstances. This manual does not therefore indicate explicitly the procedure to follow in the event of a disengaged TAKE OFF mode.

However, there is a procedure in the event of reversion during take-off of the TAKE OFF mode (THR-SRS-RWY) in basic mode (SPD-V/S-HDG)[5]:

"In the event of mode reversion on take-off, crews are requested to trigger the Go levers:

- *If the aeroplane is still on the ground, the THR-SRS-RWY modes are engaged again;*
- *If the aeroplane is in flight, the THR – GO AROUND modes are engaged. The crew must therefore select a lateral mode to exit the Go Around mode"*.

The case of reversion of the TAKE OFF mode in basic mode is a different event to the one that occurred during the incident, although the consequences at the level of the AP/FD engaged modes are identical (V/S – HDG instead of SRS – RWY). However, it is more easily detectable by crews as it impacts both FD and both FMA.

[5] One case was observed by the operator when the LOC signal (used for the RWY centreline monitoring function) was disrupted during the take-off run.

3 - LESSONS LEARNED AND CONCLUSION

3.1 Monitoring and call-outs

The investigation showed that the FMA did not show the expected display after triggering of the Go levers on take-off. It also made it possible to determine that a display of different modes on the FMA, as reported by the crew, could have occurred.

The detection of the TAKE OFF mode not being engaged was even more difficult given that from triggering of the Go levers, the thrust levers moved automatically and the first line of the FMA indicated the active modes in green. The indication on the copilot's FMA may have been the following: **THR L SRS RWY** instead of the one expected in normal operation: **THR SRS RWY**. The difference between the expected visual and the one probably displayed was not obvious. The indication available for the Captain was: **THR L V/S HDG**. The Captain's verbal check call out did not include calling out the displayed modes but consisted of calling out "CHECKED". This check may have been carried out in a routine manner. It proved to be ineffective. The speed of movement of the levers, twice as high as that encountered during a normal take-off, may have drawn the crew's attention to the ATHR not being engaged in THR mode.

There is no specific procedure associated with the detection of the TAKE OFF mode not being engaged or with the divergence of indications during the PF call-out and the PM check. The manufacturer has agreed to modify the FCOM of the A300-600ST in order to introduce an operational instruction that will deal with the TAKE OFF mode not being engaged.

Engaging A/THR in **SPD** mode led to a decrease in thrust to find a target speed (V2) lower than the current speed. This decrease was immediately detected and countered by the crew. However this was not anticipated. This lack of anticipation may lead to flying very low with reduced thrust and incorrect flight attitude displayed, if it follows the FD indications (objective of nil vertical speed, valid on the ground as soon as the Go levers are triggered).

The QAR data made it possible to reconstruct the modes that were displayed on the left FMA. Their development showed a divergence between the situation described by the crew and that recorded by the QAR. This divergence has not been explained.

3.2 Causes

The incident was due to the crew's failure to detect the non-engagement of the TAKE OFF mode during the FMA check during the take-off run phase. This malfunction probably originated in an erratic failure of the wiring between the Go levers and the FCC1.