

# **Executive Summary**

## **CI202 Occurrence Investigation**

On June 14, 2020, China Airlines scheduled passenger flight CI202, an Airbus A330-302 aircraft, registration B-18302, took off from Shanghai Pudong International Airport for Taipei Songshan Airport with 2 flight crew members, 9 cabin crew members, and 87 passengers, for a total 98 persons onboard. The aircraft landed on runway 10 of Songshan Airport at 1746 Taipei local time. At touchdown, the aircraft experienced the quasi-simultaneous failure of the 3 flight control primary computers (FCPC or PRIM), thus ground spoilers, thrust reversers, and autobrake were lost. The flight crew was aware of the autobrake and reversers failure to activate, and applied full manual brake rapidly to safely stop the aircraft about 30 feet before the end of runway 10 without any damage to the aircraft nor injuries to the passengers onboard.

The relevant document including dispatch sheet, weather information, technical logbook, and deferred defects logbook were checked by the flight crew before their departure from Pudong Airport. There was no anomaly.

The aircraft took off at 1625 with the captain as the pilot flying (PF) and the co-pilot as the pilot monitoring (PM). During descent, the flight crew received the information L from automatic terminal information system (ATIS), and was instructed to use the instrument landing system (ILS) of runway 10. After calculating the landing performance, the Electronic Flight Bag (EFB) showed that there would be 362 feet runway distance remaining if autobrake was set at low.

During the descent and approach phases, no abnormalities were found. About six minutes before landing, the PF was alerted about the rain near Songshan Airport, he asked the PM to review the latest weather information, and learned that the tail wind blew from 280 degrees at 6 knots with a light thunder shower rain. Runway 10 was in use.

At 1743:21, during the final approach, the airplane was at the barometric altitude of about 3,008 feet, the flight crew was informed by the tower that the visibility at the airport had dropped to 2,500 meters.

At 1743:51, the airplane was at the barometric altitude of about 2,480 feet, the tower issued a landing permission: "dynasty 202 runway 10 wind 250 degrees 9 knots caution tail winds clear to land." About fifteen seconds later, the PF reminded the PM, "call out when spoilers deploy so I can tell if the main gear has touched down."

At 1744:37, the airplane was at the barometric altitude of about 1,832 feet, the flight crew conducted landing checklist and the PF asked the PM to set the autobrake from low to medium due to the weather change at Songshan Airport.

At 1745:41, the airplane was at the radio altitude of about 996 feet, the tower reminded that wind speed was 10 knots. Six seconds later, the radio altitude was 919 feet, and the PF said "the wipers can be faster, it's okay", the PM answered "it's at the fastest speed already".

At 1745:58, the airplane was at the radio altitude of about 773 feet, the PM reported "approach lights ahead" and the PF then disengaged the autopilot to continue the approach.

At 1746:41, the airplane was at the radio altitude of about 136 feet, the PM reminded the PF “center line” to maintain on track.

Seven seconds after the aircraft passed the radio altitude of 60 feet, at 1746:54, the aircraft touched down at between 1,500 and 2,000 feet from runway 10 threshold with pitch up about 4.2 degrees, roll to the right at about 1.1 degrees, and its magnetic heading at about 94 degrees. The ground speed was 147 knots (indicated airspeed was 135.5 knots) and the maximum vertical acceleration was 1.28g's. The slats/flaps configuration was FULL. Ground spoilers (i.e. spoilers 2 to 6) started to deploy.

One second after the touchdown, the PM immediately called out “spoilers”, while the left and right main gear shifted between air mode and ground mode for about 0.75 seconds and 0.5 seconds respectively. Three seconds after the main gear touched down, autobrake system fault was recorded on FDR. One second later, PRIM1/PRIM2/PRIM3 faults were recorded at the same time and the spoilers retracted, as the ground spoiler function was lost. The PM called out “reverse” and the nose gear touched ground at the same time. After that, the nose gear flipped between air mode and ground mode for nearly 7 seconds.

At 1746:59, the PF asked twice if “autobrake is on” (the ground speed was 141 knots). The PM answered, “autobrake is not on”. About five seconds later (1747:04), the PF called out “manual brake”, and applied full brake pedal. The normal brake hydraulic pressure value was 448 psi and longitudinal acceleration rate value was about -0.1g, indicating a deceleration.

At 1747:07, the PM called out "reverse no green", about one second later, the PF requested to his first officer "quickly help me brake help me brake" (the ground speed was 127 knots at this time), from then on, both pilots applied full pedals on the brakes manually, the normal brake pressure was up to 576 psi and the longitudinal acceleration rate was -0.14 g 's.

Until 1747:36 when the aircraft came to a full stop at 30 ft before the end of the runway, the aircraft brake pressure and longitudinal acceleration rate fluctuated from 128 psi to 2,560 psi and from -0.05g's to -0.47g's respectively during this period.

According to the Transportation Occurrence Investigation Act of the Republic of China (ROC), and the content of Annex 13 to the Convention on International Civil Aviation, the Taiwan Transportation Safety Board (TTSB), an independent transportation occurrence investigation agency, was responsible for conducting the investigation. The investigation team also included members from France Bureau d'Enquêtes et d'Analyses (BEA), Airbus, EASA, China Airlines and Civil Aeronautics Administration (CAA), Taiwan.

The 'Draft Final Report' of the occurrence investigation was, by the procedures, reviewed at TTSB's 25th Board Meeting on May 07, 2021 and then sent to relevant organizations and authorities for comments. After comments were collected and integrated, the Final Report was reviewed and approved by TTSB's 29th Board Meeting on August 13, 2021.

There are 15 findings from the Final Report as follows.

## **I. Findings as the result of this investigation**

### **Findings related to probable causes**

1. The three flight control primary computers (FCPCs) of the occurrence aircraft became inoperative almost at the same time during touchdown. The root cause was determined to be an undue triggering of the rudder order COM/MON monitoring concomitantly in the 3 FCPC. At the time of the aircraft lateral control flight law switching to lateral ground law at touch down, the combination of a high COM/MON channels asynchronism and the pilot pedal inputs resulted in the rudder order difference between the two channels to exceed the monitoring threshold. The FCPC1 failed first.
2. After the FCPC1 failure, the master control of flight control system was handed over to FCPC2 and FCPC3 in sequence whose asynchronism were also high at that moment; thus eventually all three FCPCs became inoperative. As a consequence of the three FCPCs loss, the thrust reversers, the ground spoilers, and the autobrake system were lost, resulting in an increased landing distance for the aircraft.

### **Findings related to risk**

1. During landing, flight controls reconfigured from normal law to direct law after all three flight control primary computers (FCPCs) became inoperative. While all aircraft primary control surfaces were still controllable, the deceleration devices including ground spoilers, thrust reversers, and autobrake were lost, the deceleration of aircraft was relied on manual brake by the pilots.

2. Given all three flight control primary computers (FCPCs) failed seconds after touchdown, should other factors (long flare, runway state, ...) have affected the landing distance, the aircraft could have overrun the runway even if the pilots had immediately applied maximum manual brake after realizing the autobrake had failed.

### **Other findings**

1. The occurrence flight crew were properly certificated and qualified in accordance with the requirements of the Civil Aviation Authority of Taiwan. Records of training and checks have no anomaly related to this occurrence operation. The rest and activities of flight crew 72 hours before the occurrence were normal. No evidence indicated any pre-existing medical conditions or alcohol that might have adversely affected the flight crew's performance during the occurrence flight.
2. During the approach, flare, landing, and roll out until aircraft came to a full stop, the actions performed by the flight crew complied with stable approach and manual landing Standard Operation Procedures (SOP) prescribed in Flight Crew Operating Manual (FCOM).
3. During the landing roll, the crew kept good interaction and high situation awareness based on pilot-flying's response to decelerating the aircraft and pilot-monitoring's call out of relevant abnormal system status.
4. With three FCPCs inoperative, actual remaining runway distance (30 feet margin) of the occurrence flight was shorter than the calculated value (172 feet margin), possibly due to tailwinds, runway conditions, and manual braking as these factors might increase the braking

distance.

5. Ground spoilers function requires at least one functional FCPC, arming autobrake requires at least two functional FCPCs, deployment of thrust reversers require unlock signal from either FCPC1 or FCPC3. As a consequence of the three FCPCs loss, the non-release of the independent locking system prevented the reversers' deployment, the ground spoilers were cancelled and autobrake system was lost.
6. Shop finding of FCPC1 indicated that the unit is no fault found (NFF). The built-in test (BITE) shows SAO ( Spécification Assistée par Ordinateur ) fault at the time of the triple FCPC fault. The SAO fault corresponds to the fault was triggered during COM/MON monitoring rather than the fault of computer hardware.
7. Following the occurrence, Airbus reviewed its in-service experience, and confirmed that no other triple PRIM fault at touchdown event had been reported on A330/A340 aircraft family since entry into service. The A330/A340 fleet fitted with electrical rudder has accumulated 8.7 millions of Flight Cycles and 44.3 millions of Flight Hours (in-service data from April 2020).
8. The runway surface friction, longitudinal slope, transverse slope, and longitudinal slope changes of the Songshan Airport runway 10 complied with relevant standards.
9. The deceleration performance of the occurrence flight between 6,600 feet and 7,300 feet from the threshold of runway 10 deteriorated. It may be due to paint marking and rubber deposit on the touchdown zone of runway 28.
10. The occurrence flight first touchdown and second touchdown were

about 1,500 feet and 1,800 feet respectively with respect to the runway threshold. The touchdown points were both located at runway touchdown zone.

11. After the flight crew applied manual braking, the overall deceleration performance was between “medium” and “good” level consistent with the reported wet condition of the runway, which should be able to rule out the effect of hydroplaning.

## **II. Safety Actions**

During the investigation, TTSB maintained close communication with all relevant organizations. The aircraft manufacturer, Airbus, provided its proactive safety actions to address the lack of robustness discovered during this investigation with regards to the FCPC COM/MON rudder order monitoring. The Taiwan CAA also released an Aviation Safety Bulletin related to this occurrence on July 13, 2020. The China Airlines released a Flight Operation Information, FOI 2020-034, to his flight crew on July 3, 2020 and updated version (FOI 2021-007) on February 22, 2021. Following are summary of these proactive safety actions.

### **Safety Actions taken by Airbus**

#### ***1. Short term actions – Communications to Operators***

*The objective of these short-term actions was to remind all affected Operators of the importance of the Landing SOP, in particular during the rollout phase, to minimize the consequences of the triple PRIM failure on the aircraft landing distance.*

#### **Operators Information Transmission (OIT)**



*The 28th of July 2020, Airbus issued an Operators Information Transmission (OIT) ATA 27 – A330 Primary Flight Control failures at touchdown (reference 999.0054/20 Rev 00) towards all A330/A340 Operators to inform them of the incident.*

*The OIT is provided in the Annex 4.*

#### *AirbusWIN video*

*The 28th of December 2020, Airbus published a video on its Worldwide Instructor News website*

*(AirbusWIN, <https://www.airbus-win.com>), which detailed:*

- The deceleration means at landing and the logic behind them*
- The standard callouts during landing in normal operations*
- The callouts during landing in the event of abnormal operations*

The video can be downloaded under the following link: <https://www.airbus-win.com/wp-content/uploads/2020/12/what-about-deceleration-means-at-landing-en.mp4>

## **2. FCPC software enhancement addressing the root cause**

*A software enhancement will be implemented in the next FCPC standards on the A330 family, to address the root cause of the B-18302 event:*

- P19 for the A330-200 (Ceo) and A330-800 (Neo), targeted for Q3-2022*
- M28ceo for the A330-300 (Ceo), targeted for Q3-2023*
- M3x for the A330-900 (Neo), targeted for mid 2024*

*The modification will consist of several system improvements:*

- Decrease of the COM/MON asynchronism level for the flight/ground information treatment*
- Improvement of the COM/MON rudder order monitoring robustness in case of ground to flight and flight to ground transitions*

- *Higher unitary monitoring robustness during such transitions*
- *Avoid cascading/“domino’s” effect that leads to several PRIM fault*

### **3. FCPC specification robustness review**

*Following the event, Airbus has launched a detailed review of the FCPC software specification, focusing on the COM/MON monitorings during the flight/ground transition. The objective was to detect potential robustness issues, going beyond the scenario of the B-18302 event. At the time of writing of this report, this review is still on-going.*

*At this stage, Airbus has not identified another type of COM/MON monitoring robustness issue that could result in an undue monitoring triggering with subsequent repercussions having similar level of severity than the B-18302 event.*

### **Safety Actions taken by CAA, Taiwan**

Civil Aeronautics Administration released ASB No : 109-060/O R1 on July 13, 2020.

#### ***Subject:***

*An ROC-registered A330 encountered a loss of all three primary flight computers (P1/P2/P3), the thrust reverser system and its automatic braking system upon landing on a wet runway. The root cause is still under investigation. All A330 operators shall set countermeasures for the abovementioned condition to ensure flight safety.*

#### ***Description:***

*Upon landing on a wet runway with the thrust reverser system activated, the flight crew on an A330 aircraft noticed the loss of all three primary flight computers (P1/P2/P3), the thrust reverser,*

*spoilers and automatic braking systems, thus affecting aircraft deceleration. Maximum manual braking was applied, and the aircraft was stopped right before the end of the runway safely. For safety concerns, the flight crew requested aircraft-towing.*

***Recommendations:***

- 1. Before any A330 flight dispatch, consider possible deceleration deficiency with the conditions mentioned above if the runway condition is reported “wet” at the destination airport.*
- 2. Corresponding landing distance required on a wet runway shall be predetermined. If the landing distance available is a concern, consider diverting to an alternate airport.*
- 3. Operators shall enhance crew’s awareness of wet runway operations for proper aircraft deceleration. If automatic braking is out of function, promptly apply manual braking.*
- 4. ROC-registered Airbus aircraft operators with similar flight control computers and braking systems should refer to this bulletin to ensure flight safety.*

**Safety Actions taken by China Airlines**

1. China Airlines released a Flight Operation Information, FOI 2020-034, to her flight crew on July 3, 2020 and updated version (FOI 2021-007) on February 22, 2021.

***SUBJECT: CONSIDERATION FOR LANDING ON SHORT RUNWAY UNDER WET OR SLIPPERY CONDITION***

***MESSAGE:***

*Recently there was a case regarding A330 landed on TSA airport under heavy rain with deceleration devices malfunction.*

*Before landing on wet or slippery runways, crew should apply FlySmart to calculate 2 landing distances during approach preparation:*

- 1. Normal landing distance,*
- 2. Given condition;*
  - a. RW condition: Good or reported RWY condition / braking action, whichever is worse*
  - b. BRK mode: Manual*
  - c. REV: NO*
  - d. ECAM: F/CTL SPLRS FAULT (ALL SPLRS)*

*If the calculated factored landing distance (F-L/D DIST) from condition 2 is marginal, PIC should carefully consider select longer runways, using maximum manual brake, reducing weight or diversion.*

*Pay extra attention on short runways (such as TSA, KHH, NRT 16L/34R, HND 22, SYD 07/25...etc.). For flare and landing operation, flight crewmember shall be vigilant and close monitor the aircraft system operation such as autobrake and reversers, and take proper actions immediately when necessary such as application of manual brake.*

- 2. For disseminating potential hazards of the long landing if encountering situation similar to this incident with the condition of short runway, tail wind, and wet runway surface, China Airlines has made the flight safety poster about this case in Q2 2021 and has made it as a lesson learnt in the 1st half EBT briefing to the flight crew to be aware of the long landing risk.*
- 3. Regarding conservative dispatch, CAL has examined every authorized*

*airports. Risk-controlled measure of this event is as follows:*

*For A330 flights using runway length shorter than 9,000 feet, in addition to ensure aircraft relative deceleration systems are normal for dispatch, when calculating landing performance, the dispatchers will not use ground spoilers nor reversers as benefit for conservative dispatch principles.*

**Note: The language used in occurrence investigation Final Report is in Chinese. To provide general understanding of this investigation for non-Chinese reader, the Executive Summary of the Final Report was translated into English. Although efforts are made to translate it as accurate as possible, discrepancies may occur. In this case the Chinese version will be the official version.**