

Executive Summary

TR-996 Occurrence Investigation

On March 24th, 2019, Scoot Tigerair scheduled passenger flight TR-996, an Airbus A320-232 aircraft, registration 9V-TAU, at 0848 Taipei time took off from Singapore Changi International Airport (WSSS) for Taiwan Taoyuan International Airport (RCTP) with 2 flight crew members, 4 cabin crew members, and 178 passengers, a total of 184 persons on board. During the approach to RCTP, at 1254, about altitude 14,000 ft, 28.8 nautical miles southwest from RCTP, an excessive cabin altitude warning was shown in the cockpit. Pilots donned their oxygen masks immediately and manually deployed the cabin oxygen masks. Aircraft continued the descent and safely landed at RCTP at 1311 without any further event.

For the occurrence flight, the captain who occupied the left seat was the pilot flying (PF) and the first officer who occupied the right seat was the pilot monitoring (PM). The flight crew stated that there was no anomaly during the takeoff and climb phase of the occurrence flight. When the aircraft was in the vicinity of Tainan, the flight management system indicated the estimated fuel quantity at landing was about 5.9 to 6.0 tonnes. The flight crew was concerned with the risk of an overweight landing, they then decided to increase the fuel consumption by operating the auxiliary power unit (APU) in the air.

According to the flight data recorder (FDR), cockpit voice recorder (CVR), cabin pressure controller (CPC) download data and interview records, at 1234:15, when the aircraft was at approximately 27,000 ft, the

first officer started the APU. The first officer pressed APU Bleed push-button with the intention for the APU bleed air to supply the air conditioning pack. After 12 seconds, the APU Bleed caution message was shown on Electronic Centralized Aircraft Monitor (ECAM) Engine Display (ED). When the flight crew realized that the maximum altitude for APU bleed air to supply air conditioning is 20,000 ft, the first officer pressed the APU Bleed push-button again to deselect the supply of APU bleed air. When the aircraft altitude was below 20,000 ft, the first officer pressed the APU Bleed push-button again and there was no caution message.

At 1242:06, as the aircraft descended past 19,732 ft, the CAB PR SYS 1 FAULT message appeared on the ECAM ED. The flight crew cleared the ECAM message, in accordance with the ECAM checklist, and continued the flight. As the aircraft passed through a cloud layer, the flight crew switched on the engine anti-ice system.

At 1251:20, the captain instructed the first officer to keep the engine anti-ice system on and turn off the APU bleed air. At 1252:32, the first officer pressed the APU Bleed push-button to remove the supply of APU bleed air to the air conditioning packs. The air conditioning packs were then supplied by bleed air from the two engines. At 1252:42, when the aircraft was in a holding pattern at 14,748ft in the vicinity of waypoint Jammy, the CAB PR SYS 1+2 FAULT message was shown on the ECAM ED. This indicated the failure of both cabin pressurization system 1 and 2 to provide automatic control of the cabin pressure. At that time, the cabin altitude was about -192 ft. As required by the ECAM checklist, the flight

crew selected the cabin pressure mode selector to manual (MAN) mode to manually control the cabin pressure by operating the manual vertical rate toggle switch (MAN V/S CTL).

At about 1253:39, when the aircraft was at 14,296 ft, the cabin altitude rose to 4,224 ft. The first officer pointed out that the cabin altitude was increasing. The captain said “increasing we ok so we need open it up”, and instructed the first officer to open the outflow valve (OFV) just a little bit. Following that instruction, the first officer recalled that he toggled the MAN V/S CTL switch to the down (DN) position. After about 4 seconds, the captain said “up”. At 1253:59, the cabin altitude rose to about 6,000 ft and the captain verbalized "increasing very quickly why ". After 11 seconds, the captain then instructed the first officer to continue to open the outflow valve, to which the first officer answered "ok, open it faster".

At 1254:20, when the aircraft was at 13,956 ft, the cabin altitude rose to 9,680 ft. One second later, the “EXCESS CAB ALT” warning message was shown on the ECAM ED. The flight crew donned their oxygen masks and saw that the cabin altitude indication on the ECAM System Display turned to red color. The first officer pressed the passenger oxygen mask button on the overhead panel to deploy the passenger oxygen masks. According to the flight crew, they took into consideration that the aircraft was at 13,000 ft and descending at a rate of 1,600 fpm, so they decided that an emergency descent procedure was not necessary and requested to the air traffic control for a direct descent to 10,000 ft.

At about 1301:49, when aircraft reached 6,680 ft, the captain updated the cabin crew and passengers of the situation through the passenger address system. The air traffic control then vectored the aircraft to intercept the runway 05L ILS at RCTP. At 1311, the aircraft landed safely.

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 Singapore Transport Safety Investigation Bureau (TSIB), France Bureau d'Enquêtes et d'Analyses (BEA), Airbus Company, Germany Bundesstelle für Flugunfalluntersuchung (BFU), Nord-Micro GmbH & Co., and Scoot Tigerair Pte Ltd.

The 'Draft Final Report' of the occurrence investigation was, by the procedures, reviewed at TTSB's 9th Board Meeting on March 06, 2020 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 12th Board Meeting on June 5, 2020.

There are six findings from the Final Report, two safety recommendations issued to the related organizations and three safety actions taken by the operator.

I. Findings as the result of this investigation

Findings related to probable causes

1. The two automatic cabin pressurization systems had failed one after another during descent. This resulted in the aircraft losing the automatic cabin pressurization function.
2. After the failure of both automatic cabin pressurization systems, the flight crew controlled the cabin pressure manually, as required by the ECAM checklist. The captain misunderstood the direction of operation for the MAN V/S CTL toggle switch and the corresponding effect on the position of outflow valve, and provided the wrong instruction to the first officer. The first officer did not recognize the incorrect instruction to operate the outflow valve in the direction of opening, causing the cabin altitude to rise rapidly and eventually exceeding the cabin altitude limitation.

Other findings

1. The occurrence flight crew were properly certificated and qualified in accordance with the requirements of the Civil Aviation Authority of Singapore. Records of training and checks have no anomaly related to this occurrence operation. The rest and activities of flight crew 72 hours before 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. The occurrence flight crew were not familiar with the altitude limitations of using APU bleed air.
3. When the excessive cabin altitude warning occurred, the cabin pressurization was selected in manual mode. Tests performed by the component manufacturer on the cabin pressurization controller and

outflow valve did not reveal any anomaly that could have affected the manual operation of the cabin pressurization system.

4. One of the probable causes of fault associated with both automatic cabin pressurization systems is the intermittent contact within the potentiometer of outflow valve which caused the sensing voltage for the position of the outflow valve being out of range. The other probable cause is the contamination on outflow valve which had an adhesive effect on the panels of the valve leading to an overcurrent during the opening of the outflow valve from the fully closed position. Both probable causes had no relation and no bearing on the manual operation to control the cabin pressurization.

II. Safety Actions

During the investigation, TTSB proposed a preliminary draft safety recommendation related to enhancing flight crew's training of cabin pressurization system to Scoot Tigerair. The TTSB noted that the Scoot Tigerair had worked with the CAAS on the following safety actions:

1. The flight crew recurrent training was revised and implemented in July 2019 to incorporate demonstration sessions to refresh the crew on the procedures required to operate the manual pressurization control system correctly and safely.
2. The two flight crew members involved with the occurrence completed a series of retraining that included crew resource management, simulator and line training. They also completed simulator and line checks satisfactorily before they returned to operational duties.

3. Scoot Tigerair also took the opportunity to reinforce aircraft system knowledge (beyond cabin pressurization) for all its pilots. ‘Aircraft System Refresher Modules’ were implemented in July 2019 covering all aircraft systems over a period of 12 months.

In view of the safety actions taken by the operator, the TTSB did not issue the previously drafted safety recommendations.

III. Transportation Safety recommendation

Arising from the conclusions of the investigation, the following safety recommendations are issued to relevant organizations.

To Singapore Scoot Tigerair Pte Ltd

1. Enhance Crew Resource Management training especially on the situations when mismatched mental models are formed and/or incorrect instruction are given between pilots, and an open discussion should be employed to clarify the situations. (TTSB-ASR-20-06-001)

To Civil Aviation Authority of Singapore

1. Supervise and ensure that Scoot Tigerair enhance Crew Resource Management training especially on the situations when mismatched mental models are formed and/or incorrect instruction are given between pilots, and an open discussion should be employed to clarify the situations. (TTSB-ASR-20-06-002)