

**FINAL REPORT ON TAIL STRIKE INVOLVING AN
AIRBUS A330-343 AIRCRAFT (REG: 9V-SSI) AT
YANGON INTERNATIONAL AIRPORT,
ON 25 NOVEMBER 2019**

**Aircraft Accident Investigation Bureau
Ministry of Transport and Communications
Myanmar**

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Aircraft Accident Investigation Bureau of Myanmar

The Aircraft Accident Investigation Bureau (AAIB) is the aircraft investigation authority in Myanmar responsible to the Ministry of Transport and Communications. Its mission is to promote aviation safety through the conduct of independent and objective investigations into air accidents and incidents.

The AAIB conducts the investigations in accordance with the Myanmar Aircraft Act and Myanmar Aircraft Accident and Incident Investigation Rules and Annex-13 to the Convention on International Civil Aviation.

In carrying out the investigations, the AAIB adheres to ICAO's stated objective, which is as follows:

"The sole objective of the investigation of an accident or incident shall be the prevention of accidents and incidents. It is not the purpose of this activity to apportion blame or liability."

Accordingly, it is inappropriate that AAIB reports be used to assign fault or blame or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose.

GLOSSARY OF ABBREVIATIONS

AAIB	Air Accident Investigation Bureau of Myanmar
AGL	Above ground level
CVR	Cockpit voice recorder
FCOM	Flight crew operating manual
FDR	Flight data recorder
IAS	Indicated air speed
IFR	Instrument flight rule
LT	Local time
PF	Pilot flying
PFD	Primary flight display
PIC	Pilot-in-command
PM	Pilot monitoring
SP	Safety pilot
TSIB	Transport Safety Investigation Bureau of Singapore
VFR	Visual flight rule
WOW	Weight-on-wheels

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SYNOPSIS

At 09:08 local time (LT) on 25 November 2019, a Singapore Airlines AIRBUS A330-343 aircraft (registration number: 9V-SSI) performed flight SQ998 from Singapore to Yangon, Myanmar. The aircraft encountered a tail strike during landing into Yangon International Airport Runway 21. While there was no injury in this occurrence, the aircraft sustained substantial damages to the airframe. The Aircraft Accident Investigation Bureau of Myanmar classified the occurrence as a serious incident.

Aircraft Details

Registered operator	: Singapore Airlines
Registered owner	: AP Leasing 1666 Limited
Aircraft type	: AIRBUS A330-343
Nationality	: Singapore
Registration	: 9V-SSI
Place of Occurrence	: Yangon International Airport (VYYY), N 16° 54' 42", E 96° 07' 57"
Date & Time	: 25 November 2019 at 09:08 Local time
Type of operation	: Scheduled Passenger Flight
Phase of operation	: Landing on Runway 21
Persons on Board	: 13 crewmembers and 282 passengers

1. FACTUAL INFORMATION

All times used in this report are Myanmar times. Myanmar time is six hours and thirty minutes ahead of Coordinated Universal Time (UTC).

1.1 History of the flight

At 07:55 local time (LT) on 25 November 2019, an Airbus A330-343 aircraft, registration 9V-SSI, operated a scheduled passenger flight from Changi International Airport to Yangon International Airport. The flight crew comprised the following members:

- a. Pilot-in-command (PIC): An instructor pilot, seated in the right seat performing pilot monitoring (PM) duties
- b. Pilot flying (PF): A Captain undergoing aircraft type training, seated in the left seat
- c. Safety Pilot (SP): A senior first officer, seated in the first observer seat

At the top of descent, the PF informed the PIC that he would initiate flare earlier at 50ft above ground level (AGL) to compensate for the upslope of the runway and the expected tailwind.

At 09:06:15, when the aircraft was at 2150ft AGL, the autopilot was disengaged and the PF performed the manual approach to land the aircraft on Runway 21. At 09:08:30, the PF initiated flare when the aircraft was passing 100ft AGL. One second later, the PIC said “flare” twice to which the PF responded by providing more pitch up input.

The exchange between the PIC, PF and SP over the next twelve seconds was as follows:

09:08:34	PIC: <i>Alright and good</i>
09:08:36	PIC: <i>Okay never mind and just hold the attitude</i>
09:08:39	PIC: <i>Spoilers</i>
09:08:40	PIC: <i>Oh hold the attitude</i>

09:38:41 SP: *Nose attitude*
 PIC: *Hold*
 SP: *Nose attitude too high*
 PIC: *Hold the attitude*
09:38:43 PIC: *Hold the attitude*
09:38:44 PF: *Okay*

At 09:08:34, during the above exchange, the first Weight-on-Wheels (WOW) Ground signal was recorded for both the left and right main gears, indicating the first instance where landing gear made contact with the surface of the runway. At this first instance of touchdown, the aircraft heading was 212.9 degrees, the indicated air speed (IAS) was 136 knots and the pitch angle was 7.21 degrees (nose up).

The recorded WOW signal for both the left and right main gear indicated a bounced landing as the following was observed over the next three seconds:

09:08:35 – left and right main gear WOW signal changed from Ground to Air

09:08:37 – left and right main gear WOW signal changed from Air to Ground

Throughout this period – nose gear WOW signal remained as Air

Two seconds after the main gears touched down for the second time, both thrust reversers were deployed and a further second later, the ground spoilers were extended. During this period, the pitch command from left side stick changed from -6.58 to -16.44 degrees, indicating that the PF intended for the aircraft to pitch up further. The pitch angle of the aircraft was at 8.61 degrees (nose up) just as the thrust reversers were being deployed, decreasing to a minimum of 5.10 degrees two seconds later before increasing to a maximum of 10.72 degrees a further two seconds later, when both the thrust reversers and ground spoilers were fully deployed.

The thrust reversers for both engines were stowed at 09:08:52 and the nose gear made contact with the runway at 09:08:54. The aircraft turned off the runway at 09:09:33 and taxied to its parking bay. According to the flight crew, they were unaware that a tail strike had occurred and were only made aware when a ground maintenance personnel informed them that damage to the tail section was observed during the post flight check.



Figure (1) Layout of the Site

1.2 Injuries to Persons

Injuries	Crew	Passengers	Other	Total
Fatal	0	0	0	0
Serious	0	0	0	0
None	13	282	0	295
Total	13	282	0	295

1.3 Damage to Aircraft

- (a) Fuselage Lower Skin between frames 68 and 73 in the tail section were dented, scratched and torn
- (b) Fuselage frames between frames 60 and 73 in the tail section were bent and scratched

A surveillance camera located at a lookout hut in the vicinity of the runway recorded the event landing. Figures (2) and (3) shows the sequence of the tail strike.



Figure (2) Main landing gears touched down on the runway



Figure (3) Photos showing the tail strike on the runway



Figure (4) Scrape marks on aircraft tail section

1.4 Other Damage

Scrape marks were found on the surface of the runway.



Figure (5) Scrape marks on the runway



Figure (6) Tail strike marks on the runway

1.5 Personnel Information

Pilot-in-Command

Age	: 52 years
Licence	: Airline Transport Pilot Licence
Licence issued date	: 13 August 1993
Total flying hours	: 19,080 hrs
On type	: 688 hrs
Medical expiry	: 31 January 2020
Line check date	: 29 June 2019
Type rating check date	: 11 November 2019
Last 90 days	: 103 hrs 08 mins
Last 30 days	: 27 hrs 46 mins
Last 24 hours	: Nil
Rest before duty	: 25 hrs 10 mins

The PIC has been an instructor pilot since 2007. He was appointed as an A330 instructor pilot since 2018 and was previously an instructor pilot for the Boeing B777 and Airbus A380 aircraft types.

Pilot Flying

Age	: 44 years
Licence	: Airline Transport Pilot Licence
Licence issued date	: 06 December 2004
Total flying hours	: 13,926 hrs
On type	: 2 hrs 29 mins
Medical expiry	: 30 June 2020
Line Check date	: 3 July 2019
Type rating check date	: 30 November 2019
Last 90 days	: 48 hrs 18 mins
Last 30 days	: Nil
Last 24 hours	: Nil
Rest before duty	: 68 hrs 55 mins

The occurrence flight was the PF's first line flight as part of his conversion training to operate the A330. The PF started his conversion training on 16 September 2019. Training records indicated that the PF had completed 20 hours of simulator training satisfactorily and did not have any areas of weakness that required re-training. The event flight was the first time for the PF to operate into Yangon Airport. Prior to the conversion training, the PF operated on the B777 aircraft type. He had also flown the Airbus A340-300/500 previously.

Safety Pilot

Age	: 50 years
Licence	: Airline Transport Pilot Licence
Licence issued date	: 12 May 2008
Total flying hours	: 9,522 hrs
On type	: 1,213 hrs
Medical expire	: 31 May 2020
Line Check date	: 18 April 2019

Type rating check date : 5 September 2019
 Last 90 days : 207 hrs
 Last 30 days : 65 hrs 28 mins
 Last 24 hours : Nil
 Rest before duty : 36 hrs 25 mins

1.6 Aircraft information

Manufacturer : Airbus
 Type : A330-343
 Serial number : 1,666
 Date of Manufacture : 29 -9 -2015
 Total Airframe hours : 18,443 hrs
 Certificate of Registration : 9V-SSI
 C of A issue date : 19 September 2015
 Last Time Check : 9 September 2019
 Total flying hours : 18,443 hrs

1.7 Meteorological Information

The METAR weather reported at Yangon International Airport on 25 November 2019 at 09:00 LT was wind direction 20° at five knots, visibility 6000 meters, temperature 26°C, dew point 25°C and regional atmospheric pressure 1015hpa.

1.8 Aid to Navigation

During the time of the incident the availability and use of navigation aids at Yangon airport were normal and no fault was reported.

1.9 Communications

Radio communications between the aircraft and Mingaladon Tower were normal and were not a factor in this incident.

1.10 Aerodrome Information

Yangon International Airport has one main runway 03/21 with a length of 11,200ft at an elevation of 110ft above mean sea level and is certified for both VFR and IFR flight. Runway strength is 230,000kg and the airport has an ATC control tower, controlling Class B airspace with radar surveillance facilities.

It is a certificated aerodrome and the associated aerodrome manual has been developed and implemented since 2010. The aerodrome operates 24 hours. The aerodrome category for the firefighting is CAT-9.

1.11 Recorders

The aircraft's cockpit voice recorder and flight data recorder were removed and read out in the facility of the Transport Safety Investigation Bureau of Singapore (TSIB).

1.11.1 Flight Data Recorder

The Flight Data Recorder (FDR) was of Part Number 2100-4245-00 and Serial Number 000925594.

The recording of the FDR data was of good quality. The FDR contained 109 hours and 55 minutes and 58 seconds of flight data that included recorded data of the incident flight. The FDR had 1131 parameters in the data frame file.

The recorded data contained information pertaining to the event flight. The information was useful for the investigation team to analyse the sequence of events related to the occurrence.



Figure (7) Flight Data Recorder

1.11.2 Cockpit Voice Recorder (CVR)

The Cockpit Voice Recorder (CVR) was of Part Number 2100-1026-02 and Serial Number 010651420. The recorded data contained information pertaining to the event flight which was useful for the investigation team to understand the communication among the flight crew members during the occurrence.



Figure (8) Cockpit Voice Recorder

1.12 Wreckage, Site and Impact Information

The coordinates of serious incident site were Latitude N 16°54' 42", Longitude E 96°08' 26". The tail strike marking on the runway was 56.1m long and 0.7m wide. The tail strike could be seen clearly at the 1.5m of runway centerline and about 3,000ft from the Runway 21 threshold near the Distance Marker Board 8/3.

1.13 Medical and Pathological Information

The pilots underwent medical and toxicological tests after the occurrence. The tests revealed no abnormality.

1.14 Fire

There was no fire before and after the incident.

1.15 Survival Aspects

This was a survivable occurrence. Emergency evacuation from the aircraft was not required and all persons on board disembarked normally. Nobody was injured in this occurrence.

1.16 Organizational and Management Information

Singapore Airlines is the flag carrier of Singapore with its hub at Changi Airport. It was established in 1972 and based in Singapore. Singapore Airlines' fleet include the A330-300, A350-900, A380, B777(200, 200 ER, 300, 300 ER), B787-10 and B747-400. Singapore Airline's fleet of A330-300 is currently non-operational and is in the process of being decommissioned.

1.17 Additional Information

1.17.1 Operator's Aircraft Type Conversion Training Programme

The operator engages the aircraft manufacturer to deliver the A330 aircraft type conversion for its pilots. The programme includes:

- a. 32 hours of fixed simulator training for pilots to be familiar with the cockpit layout and procedures;
- b. At least 20 sessions of full motion simulator training to learn and be assessed on their flight operation competency; and
- c. Line training that involves actual aircraft operations.

While the instructor pilots are employees of the operator, they have to meet the requirements and certified by the aircraft manufacturer before they could assume instructor roles, such as simulator or line flight instructors, in the programme delivered by the aircraft manufacturer. The training was conducted in accordance with the Flight Instructor Manual provided by the aircraft manufacturer. To ensure that each pilot undergoing training can be objectively assessed, there is not fixed instructor assigned to any of the pilots.

1.17.2 Tail strike Prevention System

The aircraft manufacturer provides an optional tail strike prevention system for the A330 aircraft type. The system introduces a tail strike pitch limit indicator on the primary flight display (PFD) that will be displayed below 400ft AGL to indicate the maximum pitch attitude to avoid a tail strike. In addition, a "PITCH PITCH" automatic callout is activated when the predictive pitch one second ahead is greater than +9 degrees.

The event aircraft was not installed with this optional system. According to the manufacturer, if the aircraft had been equipped with this system, the automatic callout would have been triggered as the predictive pitch during the event reached +9.3 degrees.

1.17.3 Standard Operating Procedures

According to the operator's Flight Crew Operating Manual (FCOM), the PM should announce "PITCH PITCH" as the pitch angle reaches +7.5 degrees. The PM can monitor the pitch angle of the aircraft which is shown on the PFD.

In this occurrence, the phrase "PITCH PITCH" was not recorded in any of the CVR audio tracks.

1.17.4 Intervention by Instructor Pilot

During flight training, the instructor pilot should always guard the controls and be prepared to take control of the aircraft. The instructor pilot should take over controls when he assesses that the pilot undergoing training can no longer ensure the safe operation of the aircraft.

According to the PIC (as the instructor pilot), there were previous occasions where he would take over controls during training flights. Those situations usually involved second officer trainee pilots.

2. ANALYSIS

2.1 Introduction

The analysis by the investigation team focused on the following areas:

- a) Communications among the flight crew
- b) The duty of the pilot monitoring
- c) Taking over of controls

2.2 Communications among the flight crew

During the sequence shortly after the aircraft landing gear contacted the runway, the PIC said, “Hold the attitude”. At one point, the SP mentioned “nose attitude too high” to which the PIC replied “hold the attitude” twice.

In the post incident interviews, the PIC indicated in those instances that he mentioned “hold the attitude”, he intended for the PF to maintain the aircraft’s pitch attitude at its current position. On the other hand, the PF indicated that when he heard the PIC saying, “hold the attitude”, his understanding was that the aircraft was losing its pitch attitude. This was consistent with his reaction where he pulled back on the sidestick to provide pitch up inputs shortly after each instance of the PIC saying, “hold the attitude”.

The difference in understanding of the phrase “hold the attitude” appears to have contributed to the PF providing additional pitch up inputs. The net effect of the PF’s cumulative pitch up inputs led to the aircraft’s pitch attitude reaching a maximum value of 10.7 degrees which was the likely instance where the tail strike occurred.

2.3 The duty of the pilot monitoring (PM)

According to the operator’s procedures, the PM should monitor the pitch angle and announce “PITCH PITCH” when it exceeds 7.5 degrees nose up attitude. The aircraft was porpoising during the initial touchdown and the pitch angle of the aircraft exceeded 7.5 degrees three times during the 12 seconds period prior to the tail strike.

The PM recalled that during that period, he was paying attention to the external environment to ensure that the PF controlled the aircraft to maintain it along the runway centerline. The absence of “PITCH PITCH” in the CVR audio track suggests that the PM did not notice the PFD showing that the aircraft pitch angle had exceeded 7.5 degrees.

Pilots should be mindful that when an aircraft is not installed with the predictive tail strike prevention system, the PM’s role in monitoring the aircraft’s pitch angle is even more critical in detecting an impending tail strike and alerting the PF to react to the situation.

2.4 Taking over of controls

The PIC, acting as the role of the PM, did not consider taking over the controls during the event. According to the PIC’s assessment at that point, the PF was able to respond to his instructions and reacted appropriately, and the safety of the aircraft was not gravely compromised. Therefore, the PIC did not take over the control of the aircraft.

It is challenging for instructor pilots to determine the appropriate time to take over control of the aircraft. Intervening too early will deprive the trainee of his learning opportunity while too late, the safety of the flight might be jeopardized.

To the extent that the PIC repeated the “hold the attitude” instruction four times within 12 seconds, it indicates that the PIC was concerned with the attitude of the aircraft during the landing. The landing and take-off, phases are statistically the more dangerous phases of flight. As such, instead of providing repeated instructions to the PF, it might have been more prudent for the PIC to be more decisive in taking over the control of the aircraft.

3. CONCLUSIONS

3.1 Findings

From the evidence available, the following findings are made. These findings should not be read as apportioning blame or liability to any particular organization or individual:

- (a) During the event landing, the PIC repeatedly gave instructions to the PF to “hold the attitude” with the intention for the pitch attitude to be maintained.
- (b) The PF’s understanding of the phrase “hold the attitude” was that the aircraft was losing its pitch attitude, hence he provided pitch up input to his sidestick.
- (c) The PIC, who was the PM, did not announce “PITCH PITCH” in the three instances when the pitch angle of the aircraft exceeded 7.5 degrees, as required by the operator’s procedures.
- (d) The PIC, who was acting in the capacity of an instructor pilot, did not take over the control of the aircraft. Instead he repeated his instructions “hold the attitude” four times over 12 seconds.

3.2 Primary Cause

During the landing, the pitch up inputs by the PF caused the aircraft to reach a maximum pitch angle of 10.7 degrees, resulting in the tail strike.

4. SAFETY RECOMMENDATIONS

To reduce and eliminate of accidents and serious incidents, the AAIB recommended the followings:

- (1) The operator to ensure that its instructor pilots have greater urgency to take over control of the aircraft, especially during landing.
- (2) The operator to ensure that pilots performing pilot monitoring duties to use standard phraseology such as “PITCH PITCH” when the pitch angle of the aircraft exceeds 7.5 degrees during landing, as required by its procedures.

Investigator- in- charge