FINAL REPORT

PIPER PA34-220T SENECA III, REGISTRATION 9M-RBI
LANDING ACCIDENT IN SELETAR AIRPORT
1 JANUARY 2016

AIB/AAI/CAS.120

Transport Safety Investigation Bureau
Ministry of Transport
Singapore

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The Transport Safety Investigation Bureau

The Transport Safety Investigation Bureau (TSIB) is the air and marine accidents and incidents investigation authority in Singapore responsible to the Ministry of Transport. Its mission is to promote aviation and marine safety through the conduct of independent and objective investigations into air and marine accidents and incidents.

For aviation related investigations, the TSIB conducts the investigations in accordance with the Singapore Air Navigation (Investigation of Accidents and Incidents) Order 2003 and Annex 13 to the Convention on International Civil Aviation, which governs how member States of the International Civil Aviation Organization (ICAO) conduct aircraft accident investigations internationally.

In carrying out the investigations, the TSIB will adhere 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 TSIB reports should be used to assign fault or blame or determine liability, since neither the safety investigation nor the reporting process has been undertaken for that purpose.

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GLOSSARY OF ABBREVIATIONS

AES : Airport Emergency Service

ATC : Air Traffic Control

CAG : Changi Airport Group

Kts : Knots (Nautical miles per hour)

LT : Local Time

PIC : Pilot-in-Command

RPM : Revolutions per minute

SYNOPSIS

On 1 January 2016, at about 1624LT, a twin-engined general aviation aircraft (a Piper PA34-220T) landed on Runway 03 at Seletar Airport, Singapore with the landing gears retracted. The aircraft had only one pilot (PIC) on board and he was not injured.

On the final approach to Seletar Airport, the PIC engaged full flaps and first contacted the runway at about 150m from the threshold of Runway 03. During the flare phase, the PIC felt a bounce on the left wheel and decided to reject the landing and carried out a go-around procedure. The PIC retracted the landing gears but could not retract the flaps. The aircraft sank, contacted Runway 03 and came to rest at about 600m from the threshold of Runway 03.

The propellers of both engines had curled and the belly area of the aircraft was damaged.

The Transport Safety Investigation Bureau classified the occurrence as an accident.

AIRCRAFT DETAILS

Aircraft type:	PA34-220T (Piper Seneca III)
Manufacturer:	Piper Aircraft Corporation
Operator:	Private owner
Registration:	9M-RBI
Engine details:	2 X Teledyne Continental
Date and time of accident:	1 January 2016, 1624LT
Location of occurrence:	Seletar Airport, Singapore
Type of flight:	General aviation flight
Person on board:	1

1 FACTUAL INFORMATION

All times used in this report are Singapore Time. Singapore time (LT) is eight hours ahead of Coordinated Universal Time (UTC).

1.1 History of the flight

1.1.1 The Piper PA34-220T aircraft departed Senai Airport in Malaysia at 1613LT for Seletar Airport in Singapore. The runway length available for take-off at Senai Airport was 3,800m. This was long enough for the aircraft to take off with flaps retracted and therefore the PIC did not engage flaps for departure.

1.1.2 Before the departure, the PIC carried out a visual inspection of the aircraft and performed a pre-flight check (more on this in paragraph 1.2).

1.1.3 En-route to Seletar Airport, the PIC reported having Seletar in sight and was subsequently cleared by Air Traffic Control (ATC) to join the left downwind leg for Runway 03 at Seletar Airport. There was no other traffic in the circuit.

1.1.4 The Seletar Tower controller issued the landing clearance when the aircraft was observed to have lined up on final approach. The PIC told the investigation team he had enough time to carry out his checks. He said he carried out the approach and landing checks at the downwind leg, but he did not carry out the landing gear warning horn checks.

1.1.5 According to the PIC, the landing gears were lowered at the downwind leg and he did not notice any anomalies about the landing gear system. He also did not notice any landing gear warning horn annunciation[1]. The PIC selected full flaps (40°) as the aircraft turned for base leg. The flap selection was made by depressing a button (plunger plug) on the end of the flap control lever[2] (**Figure 1**) and shifting the lever to the desired flaps indicator. The PIC said he had felt a sticky resistance when he tried to depress the button, but he managed to depress the button and engage the flaps.

[1] The landing gear warning horn is a safeguard to alert the pilot during an approach for landing when the landing gear is in an unsafe position. The warning annunciation comes through a speaker situated behind the instrument panel and not through the intercom system. The PIC said that he was using a noise cancelling headset at the time of the incident and he did not hear any warning annunciations.

[2] The flap control lever is situated between the two front seats of the aircraft.

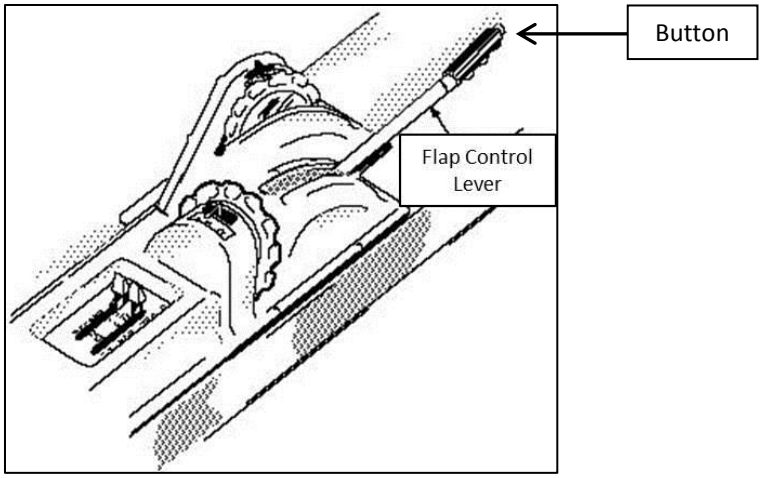

Figure 1. Flap control lever

1.1.6 The approach speed was 95kts reducing to 85kts. The PIC aimed to flare the aircraft at the first marker after the threshold of Runway 03, which was about 150m from the start of the runway. The PIC said that during the flare, he felt a bounce on the left wheel and decided to abort the landing and go around.

1.1.7 For the go-around, the PIC applied full power and increased the aircraft pitch. He tried to retract the flaps but he could not depress the button (plunger plug). The flaps were stuck at 40°. This caused drag on the aircraft and the PIC decided to raise the landing gears to reduce drag. He raised the landing gears without first verifying that the aircraft was having a positive climb[3]. Despite all this, the aircraft sank. The PIC attempted to lower the gears again. The aircraft contacted the runway before the landing gears could be extended again and the aircraft came to a halt eventually.

1.1.8 The PIC said that the aircraft engines were operating normally throughout the flight. He did not look at the RPM indicator on the instrument panel after he had applied full power during the go-around, but he felt that the engine was responding to the full power application.

1.1.9 The time interval between the aircraft's bouncing and re-contact with the runway was estimated to be of the order of five seconds and the maximum height attained by the aircraft during the go-around was estimated to be of the order of 3-5m.

1.1.10 There was no fire. No one was injured in the occurrence. The PIC carried out the emergency shutdown procedure to secure the aircraft.

[3] The go-around procedure prescribed in the aircraft's Flight Manual calls for application of full power, raising of the landing gears when the aircraft has achieved a positive climb, and then retraction of the flaps.

1.1.11 The disabled aircraft was subsequently recovered and moved to a hangar facility on a dolly (**Figure 2**).

Figure 2. Recovery of disabled aircraft

1.2 Pre-flight check

1.2.1 Before the departure at Senai Airport, the PIC carried out a visual inspection of the aircraft and performed a pre-flight check. According to the PIC, he did not carry out a full pre-flight check. The items that he omitted checking included the flap system. While the PIC said he had checked the landing gear lights, he could not recall if he had checked the landing gears down-and-locked indication lights.

1.2.2 It had rained the night before and the PIC noticed that the carpet of the cockpit floor was wet. He checked and was satisfied that the condition of the battery and the radios was normal.

1.2.3 The PIC checked and was satisfied that there was nothing around the aircraft that would obstruct his departure manoeuvre.

1.3 Damage to aircraft

1.3.1 The propellers on both engines were curled and the belly area of the aircraft was damaged.

1.3.2 The tips of all three propeller blades on each engine were bent forward (**Figure 3**). This suggests that the propeller was being driven under positive power from the engine and that the propeller revolutions per minute (RPM) is relatively high[4].

[4] Reference: ICAO *Manual of Aircraft Accident and Incident Investigation Part III Investigation* (Doc. 9756)

Figure 3. Propeller tip bent forward

1.3.3 The material loss at the aircraft's belly area due to the aircraft's contacting the runway was more pronounced at the front of the aircraft than at the back (**Figure 4**).

Figure 4. Damage at the belly of the aircraft

1.4 Personnel information

1.4.1 The PIC held a Commercial Pilot Licence with Instrument Rating (CPL/IR) issued by the Department of Civil Aviation of Malaysia. The Licence was valid at the time of the accident.

1.4.2 The PIC had a total flying experience of about 4,221 hours.

1.5 Aircraft information

1.5.1 The aircraft held a valid Certificate of Airworthiness issued by the Department of Civil Aviation, Malaysia.

1.5.2 The aircraft had a tricycle landing gear. The landing gear was fully retractable and gear extension/retraction was hydraulically operated.

1.5.3 Flaps were manually operated and spring-loaded to return to the retracted position.

1.6 Wreckage and impact information

1.6.1 The aircraft came to a rest about 600m from the start of Runway 03, with a heading of about 030° (i.e. in the direction of Runway 03). There were ground marks on the runway of the right and left propellers. **Figure 5** shows the positions of aircraft and the ground marks.

Figure 5. Showing the positions of aircraft final stop; first strike marks of right propeller and the left propeller.

1.6.2 The propeller ground marks suggested that right propeller had struck the runway tarmac before the left propeller (**Figure 6**).

Figure 6. Position of the aircraft and impact marks

1.6.3 The distance between the right engine propeller first strike mark and left engine propeller first strike mark was 30m (**Figure 7**).

Figure 7. Distance between right and left engines propeller first strike marks (30m)

1.6.4 The distances between the propeller strike marks for the left and right engines were as follows (**Figure 8**):

For the left engine:
(a) Distance between the first and second strike marks – 47cm
(b) Distance between the second and third strike marks – 48cm

For the right engine
(c) Distance between the first and second strike marks – 52cm
(d) Distance between the second and third strike marks – 55cm

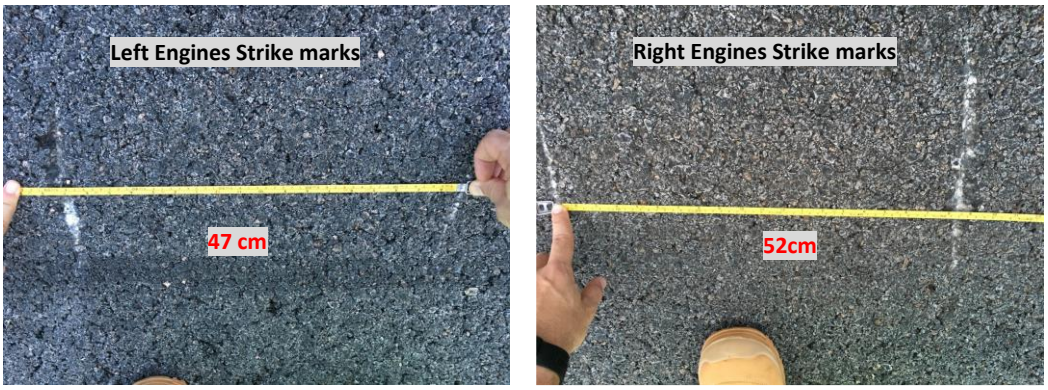

Figure 8. Measurements taken between the propellers for the left and right engines

1.6.5 The following positions of instruments and controls were noted:

Flap lever	40°
Flaps	fully extended
Rudder pedals	neutral
Rudder trim	slight right of neutral
Throttle lever	fully aft
Mixture lever	idle cut-off
Fuel Selector	both on
Airspeed indicator	0
Altimeter	0, subscale 1011mb
Direction indicator	033°
RPM gauge	0
Gear indicator	down

1.6.6 The positions of the elevators and the ailerons at the time of the accident could not be determined as they could have been altered when the PIC executed the emergency shutdown procedure to secure the aircraft.

1.7 Meteorological information

1.7.1 The meteorological station reported the wind at 1600LT as 030/14kts. The visibility was 10km.

1.7.2 At the time of the occurrence, the Tower controller reported the runway surface wind as 020/11kts.

1.8 Medical and pathological information

1.8.1 The PIC underwent a medical check following the occurrence. There was no evidence of any relevant medical/toxicological factors that could affect the performance of the PIC.

1.9 Tests and research

1.9.1 The investigation team observed a series of tests performed in accordance to the Piper Seneca III maintenance Manual to ascertain the proper functioning of landing gears, flaps and engines. The aircraft was put on jacks when the following tests were carried out:

i) Landing gear functional and warning system test
ii) Flap system test
iii) Cold cylinder compression tests

Landing gear system functional and warning system test

1.9.2 According to the PIC, he did not notice any anomalies about the landing gear system. Post-accident tests also show that the landing gear system functioned as expected and there is no evidence of any malfunction of the system during the flight.

1.9.3 Post-accident tests also showed that the landing gear warning horn functioned as expected.

Flap system test

1.9.4 Post-accident tests showed that there was no problem with depressing the button on the end of the flap control level nor with shifting the flap control lever. There was also no problem with the flaps moving as commanded by the flap control lever.

Cold cylinder compression tests

1.9.5 The aircraft's piston engine comprised six cylinders. Post-accidents tests show that two cylinders in the right engine and one cylinder in the left engine did not meet compression limit specification, a sign that there was internal leakage in these cylinders.

1.9.6 It is estimated that the internal leakage of the two cylinders in the right engine would correspond to a power loss of about 20% and the internal leakage of the one cylinder in the left engine would correspond to a power loss of 5%.

1.9.7 Cold cylinder compression tests were last performed on the engines on 15 July 2015. Test results were satisfactory.

2 DISCUSSION

The analysis will discuss the following:

(a) Go-around procedure
(b) Pre-flight check
(c) Landing gear system
(d) Position of the landing gears during landing
(e) Attitude of the aircraft at the time of contact with the runway
(f) Engine power
(g) Aircraft's performance after full power was applied for the go-around
(h) Flaps
(i) Airport runway surveillance camera

2.1 Go-around procedure

2.1.1 The go-around procedure prescribed in the aircraft's Flight Manual calls for application of full power, then raising of the landing gears when the aircraft has achieved a positive climb, and then retraction of the flaps.

2.1.2 In this accident, the PIC did not execute the go-around in accordance with the procedure prescribed in the Flight Manual. He applied full power, then tried raising the flaps, and then raised the landing gears without first checking that the aircraft had achieved a positive climb.

2.2 Pre-flight check

2.2.1 During the pre-flight check in Senai Airport, the PIC did not check the flap system.

2.2.2 Post-accident tests show that the flap system, including the operation of the button on the end of the flap control lever, was normal. Nevertheless, if, as the PIC said, the button had some stickiness problem, then this would likely have been discovered before taking the aircraft to the air had he carried out the pre-flight check thoroughly.

2.2.3 This occurrence shows that the need to adhere fully to a pre-flight check cannot be overemphasised.

2.3 Landing gear system

2.3.1 During the interview, the PIC said that pre-landing checks were carried out at the downwind leg for Seletar Airport runway 03. He used the BUMPH[5] mnemonic for the checks. The Approach and Landing checklist for Piper PA34-220T Seneca III was available in the approved Flight Manual. The Flight Manual had included a gear warning horn check sometime during the approach for a landing. The PIC said that he was certain that the landing gear was extended and the three green indicator lights on the instrument panel were displayed, but he did not retard the throttle control to check the gear warning horn, as required by the Flight Manual, although he had the checklist by his side. The gear warning horn would sound at low throttle settings if the gear is not down and locked.

2.3.2 The investigation noted that the PIC was using a noise cancelling headset at the time of the incident and he did not hear any audible warning annunciations in the cockpit. The use of noise cancelling headsets may have the potential for misdetection of audible alarms and other environmental sounds. However, it is difficult to assess any effects the headsets may have on discerning these sounds.

2.4 Position of the landing gears during landing

2.4.1 According to the PIC, he attempted to lower the landing gear again to cushion the landing when the aircraft did not respond to his go-around manoeuvre and was sinking. However, the aircraft was at such a height that there was not enough time for the landing gear to extend fully in time for the ground contact.

2.4.2 The rear of the aircraft was not damage and the abrasions in the belly area was limited which suggested that the impact energy was low. In addition, the abrasions in the belly area were more pronounced in the front than the rear area. This indicates that it is very likely that the front part of the aircraft had contacted the runway before the rear. This is consistent with a flat aircraft pitch attitude, which is not a normal aircraft configuration during landing. In a normal landing configuration, the aircraft is pitched at a nose up attitude to flare for landing. The nose up pitching would normally result in the main landing gears contacting the runway before the nose landing gear. A belly landing situation would have caused more damages at the rear due to the higher energy impact and more abrasion at the rear of the belly. Should the aircraft come in with landing gears retracted during the first approach; the

[5] BUMPH is an acronym for **B**rakes – unlocked; **U**ndercarriage – down and locked; **M**ixture – set full rich; **P**ropeller – set full fine pitch; **H**atches (and harness) – secured. The BUMPH check is commonly used by pilots of light aircraft when approaching an airport to land. The BUMPH serves only as a reminder and does not obviate the need of a proper pre-landing check.

damage on the aircraft should be more pronounced in the rear part of the aircraft.

2.5 Attitude of the aircraft at the time of contact with the runway

2.5.1 As regards the attitude of the aircraft at the moment of the belly contact with the runway, the damage at the belly area suggests that the aircraft did not have much of a positive attitude, if it had a positive attitude at all.

2.6 Engine power

2.6.1 The results of the post-accident cold cylinder compression tests suggested internal leakage in the engines. Such engine problem would reveal itself, when an engine is running, as vibrations during flight and low climb rate. However, the PIC indicated the engines were operating normally throughout the flight. The investigation team could not determine the cause of the engines' leakage problem but noted that this could be a result of the aircraft's impact with the runway following the unsuccessful go-around.

2.7 Aircraft performance after full power was applied for the go-around

2.7.1 The spacing between consecutive propeller strike marks may be used to estimate the propeller RPM if the aircraft's ground speed at impact is known and *vice versa*. The following formula shows the relationship between RPM and ground speed[6]: was used to determine approximately the propeller speed in rpm at the time of impact with the ground:

$$V = \frac{RPM \times D \times N}{3088}$$

Where:
D = Distance in cm between strike marks
V = Ground speed in kts
N = Number of blades (3 in this case)

2.7.2 The aircraft approached Seletar Airport at a speed of about 85kts. The speed would be reduced after the aircraft's bounce on the runway. The application of the full power during the go-around might increase the speed somewhat but the increase is likely to be marginal. If we assume that the speed after the bouncing to be of the order of 80-90kts, then the RPM would be of the order of 1,550-1750 for the right engine and 1750-1950 for the left engine. These RPM values are consistent with the pilot's power application for the go-around.

[6] Reference: ICAO *Manual of Aircraft Accident and Incident Investigation Part III Investigation* (Doc. 9756)

2.8 Flaps

2.8.1 The PIC indicated that he could not depress the button (plunger plug) to change the flaps setting when he carried out the go-around. However, the operation of the button appeared normal during post-accident tests of the flap. The investigation team is unable to determine the reason for the difficulty experienced by the PIC.

2.9 Airport runway surveillance camera

2.9.1 During the go-around, the PIC tried to retract the flaps without success. He then raised the landing gears. Later, when he found that the aircraft was sinking, he attempted to lower the landing gears again.

2.9.2 The investigation team could not determine whether, at the time of the aircraft's impact with the runway, the landing gears were still in the aircraft's landing gear holds or whether they were midway in their extension. If there were runway surveillance cameras at the landing areas, this uncertainty might be able to be resolved.

2.9.3 Not knowing the exact position of the landing gears at the time of the aircraft's impact with the runway would not leave altered the general course of the investigation in this case. However, in other circumstances, such runway surveillance cameras could be invaluable sources of evidence for investigation authorities.

3 SAFETY RECOMMENDATION

A safety recommendation is for the purpose of preventive action and shall in no case create a presumption of blame or liability.

3.1 It is recommended that the civil aviation authorities consider issuing a safety information to remind general aviation pilots of the need to comply with the set of checks found in the approved flight manual.
[TSIB Recommendation RA-2016-002]

3.2 It is recommended that the aerodrome operator consider installing runway surveillance cameras at the landing areas which would assist in post incident investigation and analysis for the enhancement of aviation safety.
[TSIB Recommendation RA-2016-003]