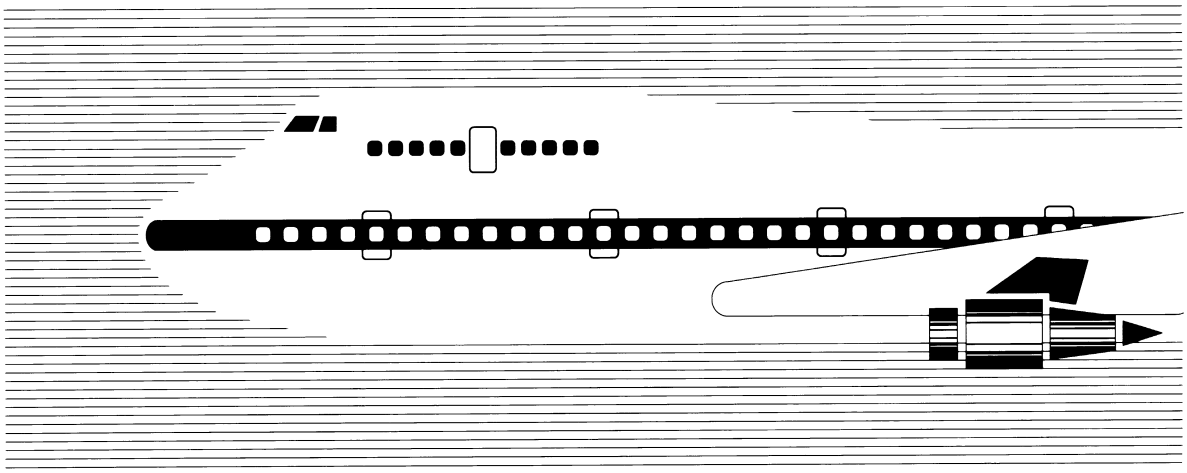
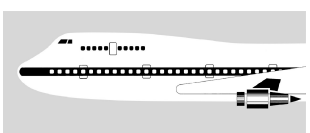
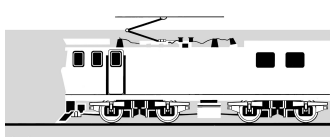


AVIATION OCCURRENCE REPORT

02-002 Piper PA34-200T Seneca ZK-SFC, undercarriage failure and subsequent wheels-up landing, Gisborne and Hastings Aerodromes 25 January 2002


TRANSPORT ACCIDENT INVESTIGATION COMMISSION
NEW ZEALAND

The Transport Accident Investigation Commission is an independent Crown entity established to determine the circumstances and causes of accidents and incidents with a view to avoiding similar occurrences in the future. Accordingly it is inappropriate that reports should be used to assign fault or blame or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose.

The Commission may make recommendations to improve transport safety. The cost of implementing any recommendation must always be balanced against its benefits. Such analysis is a matter for the regulator and the industry.

Report 02-002

Piper PA34-200T Seneca

ZK-SFC

undercarriage failure and subsequent wheels-up landing

Gisborne and Hastings Aerodromes

25 January 2002

Abstract

On Friday, 25 January 2002, at about 1430, Piper PA34-200T Seneca ZK-SFC was on approach to land at Gisborne Aerodrome when the nose undercarriage failed to extend. After several unsuccessful attempts to extend the nose undercarriage, the pilot diverted to Hastings Aerodrome where a full wheels-up landing was completed. The 2 crew members and one passenger on board were uninjured and the aircraft sustained minor damage.

The reason for the undercarriage malfunction was not fully determined. However, the nose undercarriage retraction system had become misaligned over time, possibly because of a combination of the nose leg exceeding its limitations during aircraft towing and the aircraft being turned too tightly while manoeuvring over rough ground. The misalignment of the nose undercarriage probably contributed to it jamming after retraction.

The safety issues identified were the need for operators and maintainers to be aware of aircraft taxiing and towing limitations, and the requirement for regular, thorough inspections of the nose undercarriage assembly.

Piper PA34-200T Seneca ZK-SFC
after landing at Hastings

Contents

Figures

Abbreviations

CAA	Civil Aviation Authority
km	kilometre(s)
mm	millimetre(s)
UTC	Coordinated Universal Time

Data Summary

Aircraft registration:	ZK-SFC
Type and serial number:	Piper PA34-200T Seneca, 34-7770054
Number, type and serial number of engines:	two Teledyne Continental TSIO-360, 320119 and 319072
Year of manufacture:	1976
Operator:	Air Gisborne Limited
Date and time:	25 January 2002, 1554[1]
Location:	Hastings Aerodrome latitude: 39° 38.8′ south longitude: 176° 46.02′ east
Type of flight:	air transport, ambulance
Persons on board:	crew: 2 patient: 1
Injuries:	crew: Nil patient: Nil
Nature of damage:	minor, restricted to lower skin, aerials and propellers
Pilot's licence:	Commercial Pilot Licence (Aeroplane)
Pilot's age:	21
Pilot's total flying experience:	1147 hours (521 on type)
Investigator-in-charge:	I R M^{c}Clelland

[1] Times in this report are New Zealand Daylight Time (UTC + 13 hours) and are expressed in the 24-hour mode.

1. Factual Information

1.1 History of the flight

1.1.1 On Friday, 25 January 2002, at about 1330, Piper PA34-200T Seneca ZK-SFC was taxiing for take-off from Hamilton Aerodrome, for an ambulance flight to Gisborne Aerodrome. On board were the pilot, a stretcher patient and a non-flying pilot assisting in the hospital transfer. The weather at Hamilton was reported as a light and variable wind of less than 3 knots, good visibility with scattered cloud at 4000 feet. The take-off and 40-minute flight to Gisborne proceeded normally.

1.1.2 During preparation for landing at Gisborne the pilot moved the undercarriage selector lever down to extend the undercarriage. When he did so, he noticed the "undercarriage unsafe" light remained illuminated and the nose wheel was indicated as not being locked down. The pilot recycled the undercarriage selection and the nose wheel again failed to extend. The pilot vacated the circuit area and entered a holding pattern at Wainui, 5 km east of the aerodrome.

1.1.3 The pilot and non-flying pilot reviewed the manuals for the aircraft, obtaining operational and technical advice, before again attempting to extend the undercarriage. They used both the normal and emergency extension procedures, but the nose undercarriage still failed to extend.

1.1.4 The pilot elected to divert to Hastings Aerodrome where technical support for the aircraft was based. The emergency services were advised accordingly. After further discussion with the operator and the non-flying pilot, the pilot elected to land with the undercarriage retracted to minimise the risk of the aircraft tipping over during the landing. The pilot discussed the co-ordination of duties with the non-flying pilot and completed several practice approaches to the runway.

1.1.5 The pilot landed on about the fourth approach. The engines were shutdown in the landing flare, and the aircraft slid a short distance before coming to rest upright on the runway. The occupants vacated the aircraft as emergency services arrived. There were no injuries. No fire occurred.

1.2 Damage to aircraft

1.2.1 The aircraft slid along the runway on its belly, causing lower panel and antenna damage. The propellers on both engines struck the runway and were damaged beyond repair. Inspections on both engines were required before they could be returned to service.

1.3 Pilot information

1.3.1 The pilot was aged 21. He held a Commercial Pilot Licence (Aeroplane), C category flying instructor rating, instrument rating, and a Class 1 Medical Certificate valid until 15 December 2002.

1.3.2 At the time of the accident the pilot had amassed 1147 flying hours, including 521 hours on the Seneca, of which 365 hours were as the pilot-in-command. He had worked for the operator as a charter and air ambulance pilot, and flying instructor since about April 1999. He had obtained his Seneca-type rating on 25 May 2000.

1.4 Aircraft information

1.4.1 ZK-SFC was a Piper PA34-200T Seneca, manufactured in 1976. The Seneca was a low wing, twin-engine aircraft, fitted with 2 Teledyne Continental TSIO-360 engines and retractable undercarriage. The aircraft was capable of carrying 6 people or, with some seating removed, a stretcher patient and crew. The Seneca was approved for single pilot operation, but duplicate flight controls were fitted for instruction or multi-crew operations if desired.

1.4.2 The operator purchased ZK-SFC in about October 2000. The aircraft was primarily used for charter flights, including hospital patient transfers. Some multi-engine instruction was also given, but this was normally limited to company pilots who were converting onto the aircraft.

1.4.3 Aircraft records indicated ZK-SFC was maintained in accordance with the prescribed maintenance schedule. The last inspection was a 100-hour inspection, completed on 7 January 2002, at 3659.8 aircraft hours. ZK-SFC had flown 3703.1 hours at the time of landing at Hastings.

Undercarriage system

1.4.4 The undercarriage was a standard tricycle, air-oil, strut-type undercarriage, hydraulically retracted or extended by an electrically-powered, reversible, hydraulic pump. When the undercarriage was fully extended, 3 downlocks, one for each undercarriage leg, would normally lock the undercarriage down, shut off the pump, and illuminate 3 green lights on the instrument panel. A separate red light would indicate if the undercarriage was in an unsafe position. Emergency extension of the undercarriage was achieved by releasing hydraulic pressure and allowing the undercarriage to "free fall" to the locked position.

1.4.5 The nose undercarriage was steerable and hinged to retract forward into the nose well. Moving the rudder pedals not only moved the rudder at the tail, but also moved a "steering channel", which was connected to the nose wheel via a tiller and steering ball arrangement as shown in Figure 1. The steering tiller was rigidly connected to the nose oleo strut. When the nose wheel was retracted the steering ball slid out of the steering channel and down a track assembly channel, leaving the rudder pedals free to move independently of the retracted nose undercarriage.

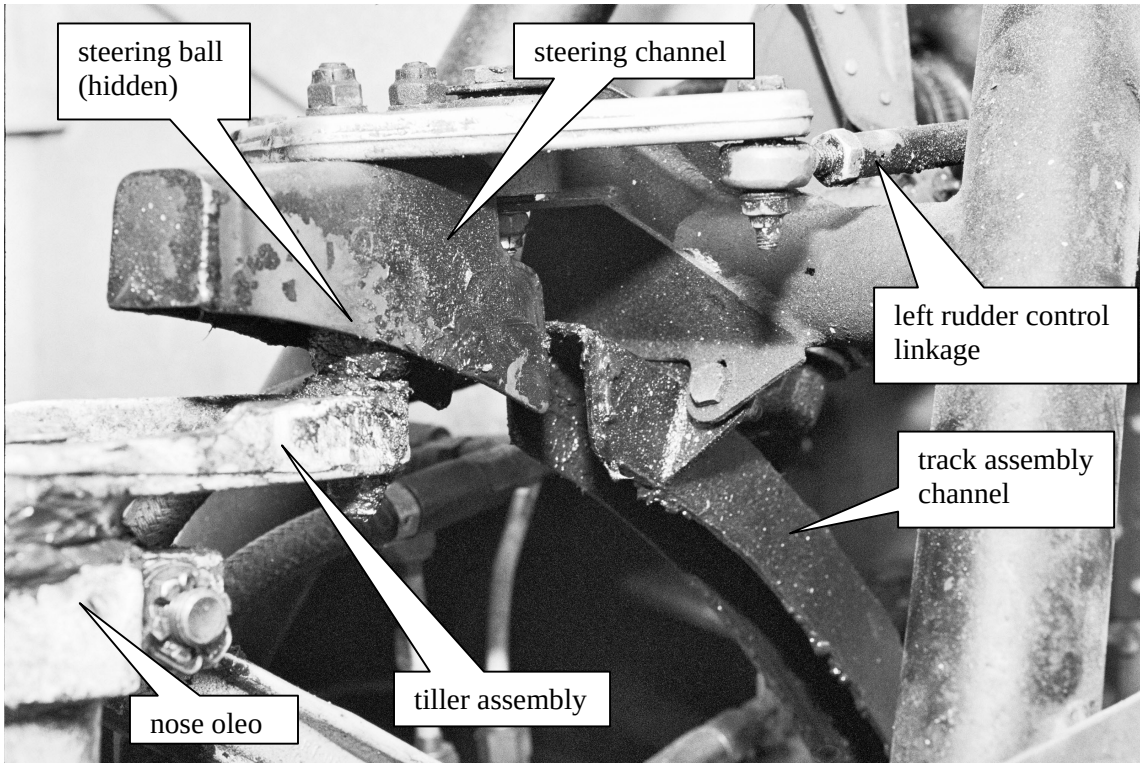


Figure 1
Nose undercarriage on ZK-SFC
(looking rearwards with the undercarriage down)

1.4.6 In the absence of any rudder pedal input, a gear-centring spring helped align the nose wheel fore and aft, to ensure the steering ball fed cleanly into the track assembly channel when the undercarriage was retracting. The track assembly channel guided the steering ball and the nose oleo strut into the nose undercarriage well.

1.4.7 If the pilot was applying rudder inputs at the time the undercarriage was retracting, the steering channel would not be aligned fore and aft with the track assembly channel, but there was enough tolerance built into the arrangement to allow for such occasions.

1.5 Wreckage and impact information

1.5.1 ZK-SFC was removed from the runway under police supervision and quarantined in the maintainer's hangar for the Commission. A hoist had been used to initially lift ZK-SFC so jacks could be positioned under the aircraft. The undercarriage up-locks had been released by activating the emergency system, enabling the main undercarriage to extend. The nose wheel had remained jammed, with the ball of the nose gear tiller outside and to the right of the track assembly channel. The ball was freed and forced back inside the channel through a gap in the bottom of the track, which had been ground off during the landing. The nose wheel was then locked down and the aircraft towed to the hangar.

1.5.2 Inspection of ZK-SFC confirmed that the ball on the nose undercarriage oleo tiller had travelled down the right-hand outside of the channel track for most of its length before jamming. Other than the damage caused by the aircraft sliding along the runway, the nose undercarriage and retraction system appeared normal. There was no other observable damage or disturbance to the nose undercarriage assembly.

1.6 Tests and research

1.6.1 The aircraft was suspended on jacks and the nose leg rotated left and right by use of rudder application. The nose leg was able to rotate freely throughout its designed range of travel. With the rudder pedals central and the nose wheel facing directly fore and aft, the steering channel was noted to be misaligned from the track assembly channel, with some flaring out of the steering channel on the right side (see Figure 2). In addition to some general deterioration, the steering ball was damaged during the landing and, therefore, an accurate assessment of ball diameter was not possible. However, the ball was estimated to be between 20 and 21.4 mm in diameter. The replacement steering ball was measured to be 22.1 mm in diameter.

1.6.2 With the nose wheel straight, the gap between the 2 channels was 11.5 mm on both sides. With the nose wheel deflected fully to the left, the gap on the left side increased to 16 mm. Full right deflection opened the gap on that side to 15.7 mm. The manufacturer advised that there was no information concerning the limits for the gap between the fixed and upper steering channels and the ball.

1.6.3 The undercarriage was retracted and extended several times without problem – the steering ball remaining inside the channel track. The exercise was repeated with varying amounts of rudder and nose wheel steering application. Again, the steering ball remained inside the channel track.

1.6.4 The only way to get the ball on the tiller to run down the right-hand outside of the channel was to apply full right rudder, and force the ball through the gap by applying additional sideways force to the nose wheel, countering the pressure of the centring spring. The centring spring was removed, inspected, and found to be functioning correctly.

1.6.5 Several other Senecas were inspected, and the gaps between the 2 sections of channel measured at different amounts of nose wheel steering. The measurements were found to be within 2 mm of those on ZK-SFC.

1.6.6 A search of the incident and accident databases of several overseas countries revealed no similar occurrences. The manufacturer, however, reported similar incidents, 'where the tiller has jumped the channel, especially when there has been a previous over-steering incident damaging the channel'.

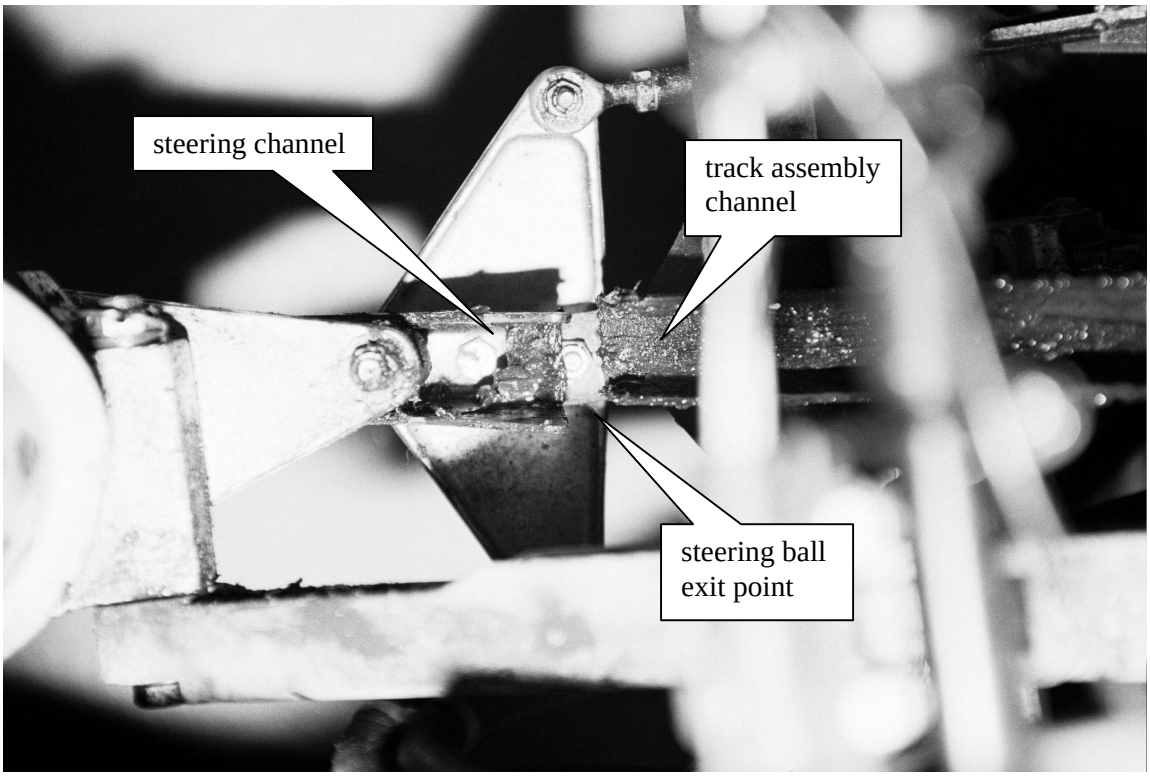


Figure 2
Alignment of nose undercarriage channels on ZK-SFC (looking upwards)

2. Analysis

2.1 The flight was to be a routine patient transfer. The crew were qualified and experienced for the operation, and the weather was suitable for the flight. The taxi and departure from Hamilton was routine, the crew noting nothing out of the ordinary until approaching Gisborne and selecting the undercarriage down.

2.2 After getting airborne from Hamilton and reaching a safe height, the pilot selected the undercarriage up. For some reason, as the undercarriage began to retract, the steering ball on the nose oleo exited through the gap between the steering and track assembly channels. The ball then travelled down the right-hand outside of the channel and became lodged at the bottom of its travel. When the undercarriage was selected down, the available hydraulic pressure was then insufficient to free the ball and extend the nose undercarriage. Had the ball come free and the nose undercarriage extended, the aircraft would have had offset, and possibly uncontrollable, nose wheel steering after landing.

2.3 How the ball was able to exit through the gap on the right side of the channel was unclear. The gap on the right side was at its maximum with full right rudder deflection. However, the weather conditions, with little or no wind, meant that there should have been no requirement for the pilot to apply any significant amount of rudder during the take-off sequence. Further, neither pilot recalled anything other than small applications of rudder to hold the aircraft on its take-off heading.

2.4 Should a large application of rudder be required, for example when countering a large crosswind or the effects of an engine failure, the undercarriage centring spring is designed to ensure the steering ball returns to the centre as it exits the steering channel and enters the track assembly channel. Although the centring spring was removed and determined to be serviceable, it is possible that the spring stuck momentarily causing the ball to be forced along the right side of the channel. The nose undercarriage should, however, have still moved towards centre as the ball followed the steering channel during retraction.

2.5 The misalignment of the 2 channels meant that, as the nose wheel retracted, the steering ball would have been displaced to the right side, which was the side the ball exited the steering channel. The ball may then have jammed against the gap and been eventually forced through by hydraulic pressure. Subsequent tests were unable to repeat the failure, however, they were carried out manually without hydraulic assistance.

2.6 The reason why the channels were misaligned was not determined. The misalignment may have been progressive, or the result of a single incident. Performing tight turns while taxiing, especially over rough ground, would place additional sideways pressure on the steering channel. Likewise, exceeding the turning limits while towing the aircraft could damage the nose undercarriage assembly. The Commission was not made aware of any past incident that could have caused such a misalignment.

2.7 The nose undercarriage assembly was required to be inspected every 100 flying hours. The inspection would normally have been performed by first removing the cover inside the nose locker to gain access. This would have provided a side profile view of the upper assembly similar to the view in Figure 1. Alignment of the 2 channels would, therefore, have been difficult to identify. A vertical view of the channels, as in Figure 2, would have required the removal of the aircraft's lower panel, which only occurred when specifically required. The misalignment could, therefore, have been present for some considerable time.

2.8 The actions of the pilot, assisted by the non-flying pilot, were appropriate for the emergency. The decision to divert to Hastings was logical and the relevant emergency services responded correctly.

2.9 The operating handbook for the PA34-200T Seneca gave no recommendation for landing with the main undercarriage retracted or extended should the nose undercarriage fail to lower – the final decision resting with the pilot. For ZK-SFC, landing with the undercarriage retracted was probably the safest option available to the pilot. While landing with the main wheels extended may have minimised damage to the aircraft, the potential for serious damage and injury would have been greater, had the aircraft caught and tipped over during the landing roll.

3. Findings

3.1 The pilot was appropriately qualified and fit to conduct the flight.

3.2 The aircraft was suitable for the operation being flown.

3.3 The aircraft had a valid Certificate of Airworthiness, and its records indicated that it had been maintained in accordance with the prescribed maintenance schedule.

3.4 There was no evidence that pilot mishandling contributed to the failure of the nose undercarriage.

3.5 The misalignment of the steering and track assembly channels probably contributed to the nose steering ball exiting through the gap between the 2 channels, causing the nose wheel to jam in the up position.

3.6 The misalignment of the 2 channels had possibly occurred over an extended period of time, and was possibly due to exceeding towing limitations or large rudder input when manoeuvring over rough ground.

3.7 The pilot's actions were appropriate, preventing any injury and limiting damage to the aircraft.

4. Safety Recommendation

4.1 On 27 August 2002 the Commission recommended to the Director of Civil Aviation that he:

4.1.1 Remind operators and maintainers of Piper PA34-200T Seneca aircraft of the requirement to adhere to aircraft towing limitations, and to regularly and thoroughly inspect the nose undercarriage assembly for correct alignment. (029/02)

4.2 On 12 September 2002 the Director of Civil Aviation replied, in part:

4.2.1 029/02 : I accept this recommendation and have sent a letter to all operators of PA 34-200T Seneca aircraft. This was commenced in August and is now complete.

Approved for publication 07 August 2002

Hon. W P Jeffries
Chief Commissioner

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