Report 00-004

Piper PA31T3-T1040

ZK-FPL

wheels-up landing

Taupo Aerodrome

24 March 2000

Abstract

On Friday 24 March 2000 at 1019 hours, ZK-FPL, a Piper PA31T3-T1040, landed on runway 18 at Taupo Aerodrome with its undercarriage retracted. The 10 passengers and the pilot on board the aircraft were not injured.

The pilot had elected to delay lowering the undercarriage because of parachutists landing at the aerodrome, so he passed over that checklist item during his before-landing checks. He subsequently became preoccupied with the parachutists and did not remember to return to the outstanding checklist action of lowering the undercarriage. The aircraft undercarriage unsafe warning system did not give sufficient warning to alert the pilot in time for him to recover the situation.

The pilot's omission is an example of an unintended act that can occur when conscious attention is diverted elsewhere. Defences should be in place to prevent such omissions resulting in accidents.

Safety recommendations were made to the operator to reduce the potential for this type of accident to recur.

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.

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Contents

List of Abbreviations

DME	distance measuring equipment
kg	kilogram
NDB	non-directional radio beacon
nm	nautical mile
UTC	Coordinated Universal Time

Data Summary

Aircraft type, serial number and registration:	Piper PA31T3-T1040, 31T-8475001, ZK-FPL
Number and type of engines:	2 Pratt and Whitney PT6A-11
Year of manufacture:	1984
Date and time of occurrence:	24 March 2000, 1019 hours[1]
Location:	Taupo Aerodrome latitude: 38º 44.5´ south longitude: 176º 05´ east
Type of flight:	air transport, charter
Persons on board:	crew: 1 passengers: 10
Injuries:	crew: nil passengers: nil
Nature of damage:	substantial to the aircraft
Pilot's licence:	Airline Transport Pilot Licence (Aeroplane)
Pilot's age:	40
Pilot's total flying experience:	8296 hours (425 hours on type)
Investigator-in-charge:	K A Mathews

[1] Times in this report are New Zealand standard time (UTC + 12 hours)

1. Factual Information

1.1 History of the flight

1.1.1 On Friday 24 March 2000 at 0848 hours, ZK-FPL, a Piper PA31T3-T1040 operated by Airwork (NZ) Limited (the operator), took off from Wellington International Aerodrome on a charter flight to Taupo via Palmerston North. One pilot and 4 passengers were on board the aircraft.

1.1.2 The flight to Palmerston North Aerodrome was uneventful and the aircraft landed at 0914 hours. Six additional passengers boarded the aircraft and it took off for Taupo at 0942 hours.

1.1.3 The aircraft climbed to cruise at 9000 feet on top of cloud. Around 30 nautical miles (nm) south of Taupo the pilot of ZK-FPL (the pilot) contacted Auckland Control, who advised him that parachuting operations were in progress at Taupo Aerodrome and that an aircraft was climbing to 13 000 feet over the aerodrome to drop parachutists. In this instance they were tandem parachutists. Auckland Control advised the pilot of the parachutists' aircraft that ZK-FPL was on descent and inbound to Taupo. At about 20 nm south of Taupo the pilot changed to the Taupo Aerodrome radio frequency and spoke directly to the pilot of the parachutists' aircraft.

1.1.4 The pilot planned to carry out an NDB/DME (non-directional radio beacon, distance measuring equipment) Bravo approach at Taupo, which would take ZK-FPL to around 9 nm north of the aerodrome before turning the aircraft south and inbound to the aerodrome. The pilot of the parachutists' aircraft advised the pilot that he would delay dropping the parachutists until ZK-FPL had crossed the NDB, which was positioned on the aerodrome, and was heading north away from the aerodrome.

1.1.5 ZK-FPL descended and entered cloud about 8000 feet above mean sea level. The aircraft broke out of the cloud into visual meteorological conditions with good visibility when it crossed the NDB at around 5000 feet. The pilot made a radio transmission on the Taupo Aerodrome radio frequency, advising that he had crossed the NDB, that he was in visual conditions and that he would carry out the instrument approach. The pilot could have carried out a visual approach, but he planned to follow the instrument approach procedure so that the parachutists could complete their drop before he landed.

1.1.6 Shortly after ZK-FPL had crossed the NDB the pilot of the parachutists' aircraft advised the pilot that ZK-FPL should be well clear of the parachutists and that he was dropping the parachutists from 13 000 feet. The tandem masters[2] advised that, although there was some cloud above and to the south of the aerodrome, they did not descend through cloud. They were aware of the Civil Aviation Rules requiring parachutists to remain clear of cloud in non-controlled airspace and the proximate danger of descent through cloud above Taupo Aerodrome, with a lake immediately to the west and extensive forest and hilly terrain immediately to the east. The tandem masters said that they must be able to see the ground before they will jump and that sometimes they will descend through breaks in the cloud. The pilot said that ZK-FPL was some 2 nm north of the aerodrome when the parachute drop commenced.

1.1.7 When he was 7 nm north of the aerodrome, having turned inbound, the pilot advised that he was at Wairakei at 3000 feet and joining straight in for runway 18. The pilot first saw the parachutists, below the main cloud base, when he was about 5.5 nm from the aerodrome on final approach. He saw 4 or 5 parachutes, but did not know how many to expect because he could not recall hearing the parachutists' pilot advise how many parachutists he had dropped.

[2] The people responsible for the direct control of a tandem parachute descent.

1.1.8 The pilot continued his approach, observing the parachutists' progress and looking for any that he might not have seen. The pilot normally lowered the undercarriage for landing by 3 nm from the aerodrome, but on this approach he decided to delay lowering the undercarriage until he was sure that the parachutists were clear of the runway. He said that he wanted to avoid having the drag of the undercarriage in the event that he had to manoeuvre the aircraft to give the parachutists time to clear the end of the runway. The pilot made a radio transmission advising that he was on a 3 nm final for runway 18.

1.1.9 The pilot continued with the approach using normal approach power of around 300 foot pounds of engine torque, at a normal descent rate and speed, while continuing to observe the parachutists, which were staggered vertically and horizontally and crossed the southern end of the runway from east to west. He said the first parachutists crossed the end of the runway when ZK-FPL was on about a 3 nm final approach and the last parachutist crossed just prior to the aircraft reaching the runway threshold.

1.1.10 The pilot said that on short final approach he was still monitoring the progress of ZK-FPL relative to the parachutists. As ZK-FPL crossed the threshold, a warning horn sounded when the pilot retarded the power levers and commenced his landing flare. He momentarily thought it was the stall warning horn, but then quickly realised that it was the undercarriage warning horn. As he initiated a go-around the aircraft propellers struck the runway, and the cargo pod under the aircraft settled onto the runway.

1.1.11 The aircraft slid along the runway on its cargo pod some distance, before slewing about 15 metres onto the grass on the western side of the runway and coming to rest just past the taxiway. No fire occurred.

1.1.12 Aerodrome personnel attended the aircraft and assisted the passengers to the terminal building. Police and emergency services personnel arrived some 7 minutes after the accident. The accident occurred at 1019 hours.

1.2 Injuries to persons

1.2.1 No one was injured during the landing.

1.3 Damage to aircraft

1.3.1 The empty cargo pod fitted under the belly of the aircraft absorbed the majority of the landing force and was destroyed. Both propellers sustained severe rotational impact damage and were destroyed. The lower engine cowlings on each engine were damaged. Some skin damage occurred to the trailing edge of both flaps. There was some fuselage skin deformation just forward of the left main wing. The right engine nacelle showed evidence of some skin deformation just aft of its firewall.

1.4 Pilot information

1.4.1 The pilot was a male aged 40 years. He held an Airline Transport Pilot Licence (Aeroplane) and a Class 1 medical certificate, with a restriction to wear distance vision spectacles, valid until 15 September 2000. He held various aircraft type ratings, including ratings for the Piper PA31T3, Fokker F27, Piper Cheyenne and Metroliner. He held a category C flight instructor rating.

1.4.2 The pilot's total flying experience amounted to 8296 hours at the time of the accident, including 425 hours in the accident aircraft type.

1.4.3 During the 90 days before the accident the pilot had flown 21 hours in the Piper PA31T3-T1040, plus 49 hours in a Piper Cheyenne and 25 hours in Metroliner aircraft, for a total of 95 hours. The Piper PA31T3-T1040 and Piper Cheyenne are similar aircraft.

1.4.4 During the 30 days before the accident the pilot had flown 40.9 hours and recorded 111 hours duty time. He was permitted to be on duty up to a maximum of 200 hours during a 30-day period and fly up to a maximum of 100 hours. He had flown 11.8 hours in the 7-day period before the accident and recorded 29 hours duty time. In any 7-day period he was permitted to fly up to a normal maximum of 30 hours. The normal maximum permitted daily flight time was 6 hours.

1.4.5 On the day of the accident the pilot started duty at 0715 hours. His recorded duty and flying times for the 7-day period before the accident were:

- Thursday 23 March – on standby at home; no flying
- Wednesday 22 March – on duty 1230 to 2115 hours; 3.6 hours flying
- Tuesday 21 March – off duty
- Monday 20 March – off duty
- Sunday 19 March – on duty 0745 to 1630 hours; 4.1 hours flying
- Saturday 18 March – on standby at home; no flying
- Friday 17 March – on duty 0830 to 1945 hours; 4.1 hours flying.

1.4.6 The pilot's most recent competency check was an instrument flight rules annual check on 19 January 2000 in the PA31T3-T1040. His single-pilot flight crew competency check, valid for 6 months, was due on 17 July 2000. His last biennial flight review was carried out on 19 May 1999.

1.4.7 The pilot worked full-time for the operator as a pilot and had worked for the operator during the previous 10 years. During the 3 months before the accident he had been employed predominantly for on-call air ambulance flights, mainly using the Piper Cheyenne as a single-pilot operation. He was also a company line-training captain. He had previously been the operator's Wellington base captain.

1.4.8 The pilot said that it was the operator's standard practice for pilots in single-pilot operations to memorise the aircraft checklists and to confirm the action taken using the aircraft checklists. He said that it was also standard practice to complete a memory check on short final approach to double check the flap setting, the power setting and the undercarriage position, although this was not documented on the aircraft checklists.

1.4.9 The pilot said that he had gone to bed quite early the night before the accident and had a good sleep. He said that he did not feel fatigued and felt fit to carry out the flight. He said that he did not particularly enjoy flying to Taupo Aerodrome, ever since the aerodrome flight information service facility had been discontinued.

1.5 Aircraft information

1.5.1 ZK-FPL was a Piper PA31T3-T1040, serial number 31T-8475001, twin-engine all-metal aircraft, constructed in the United States in 1984. The aircraft was fitted with Pratt and Whitney gas turbine PT6A-11 engines.

1.5.2 The aircraft had been issued with a non-terminating Certificate of Airworthiness in the standard category. The aircraft had seating normally for up to 10 passengers, was approved for single pilot operation and had an approved maximum take-off and landing weight of 9000 pounds (4083 kg).

1.5.3 The load sheet prepared by the pilot prior to the flight recorded that the aircraft weight and balance were within limits, with a landing weight at Taupo of around 8432 pounds (3826 kg). No cargo or baggage was on board the aircraft, except for the normal aircraft equipment and some small personal items belonging to the occupants.

1.5.4 The aircraft records indicated that the aircraft had been maintained in accordance with its approved schedule and that it had accumulated 13 347.82 hours total time-in-service. The last inspection, an Event 1, was completed on 24 February 2000 at 13 296.54 hours. The next check, an Event 2, was due after a further 47.9 hours.

1.5.5 The aircraft was equipped with a hydraulically actuated, fully retractable, tricycle undercarriage with an emergency extension system. Positioning the undercarriage selector control knob, shaped like a wheel, in the down position would lower the undercarriage. The selector control knob was on the instrument panel to the right of, and adjacent to, the pilot's control wheel. One red and 3 green undercarriage indicator lights were positioned to the right of the selector control knob. Each green light, one for each undercarriage leg, would glow when its respective undercarriage leg was down and locked. The red light would glow when the undercarriage was in transit between its "up locked" and "down locked" positions. No indication lights glowed when the undercarriage was up and locked. The indication lights could be dimmed for night operation. A mirror on the left engine cowling enabled the pilot to visually check the nose undercarriage position.

1.5.6 The aircraft was fitted with an undercarriage unsafe audio warning system, which the aircraft maintenance manual stipulated should be set to actuate a warning horn if power were reduced on either engine to below "150 foot pounds of engine torque", when the undercarriage was not in the down and locked position. The flap position did not actuate or influence the undercarriage warning horn.

1.5.7 On 24 February 2000, during the Event 1 inspection, the undercarriage warning horn and indicator light system were checked for normal operation. They were found to operate satisfactorily.

1.5.8 The aircraft had a pilot checklist, which listed certain actions pilots were to take during various checks. The before-landing checks called for the undercarriage to be selected down below 156 knots, to check that the 3 undercarriage indicator lights were green (confirming that the undercarriage was down and locked), and to check the nose undercarriage position in the mirror on the left engine cowling. The checklist did not list any short final approach checks.

1.6 Meteorological information

1.6.1 The weather conditions reported at Taupo by the automatic weather information broadcast were: wind 130 degrees magnetic at 13 knots, 40 kilometres visibility, broken cloud at 3500 feet above ground level and a temperature of 17 degrees Celsius.

1.6.2 The pilot said the cloud was more extensive than indicated by the automatic weather broadcast and the aircraft altimeter read around 5000 feet (about 3600 feet above the ground) when he broke out of some cloud on descent and crossed the NDB. He said there was complete cover over the aerodrome and the cloud extended from the lakeshore to over the aerodrome and some distance to the south and east. Some cloud was over Taupo township to the northwest. The cloud broke up progressively to the west over the lake.

1.7 Navigation aids

1.7.1 Taupo Aerodrome was equipped with an NDB and DME for navigation, approach and letdown procedures. The avionics suite fitted to the aircraft enabled the pilot to utilise those navigation aids.

1.8 Communications

1.8.1 The aircraft was equipped with very high frequency transceiver equipment for normal air to air and air to ground communications.

1.9 Aerodrome information

1.9.1 Taupo Aerodrome was a non-controlled aerodrome. A two-way radio communications facility (UNICOM) providing useful aerodrome information for pilots was in operation at the time of the accident. This replaced a flight information service, which had been withdrawn several years earlier. A mandatory broadcast zone extended out to 12 nm to the south, west and north of the aerodrome and 2 nm to the west. The aerodrome had an elevation of 1335 feet above mean sea level.

1.9.2 A parachute drop zone existed at Taupo Aerodrome where extensive parachuting operations occurred frequently, particularly tandem parachuting. A parachute drop (alighting) area extended some 700 metres to the west of runway 18, from about the mid-point of the runway perimeter to opposite the threshold of runway 36. The aerodrome information charts in the aeronautical information publications were annotated that Taupo Aerodrome was New Zealand's busiest parachute drop zone and that pilots should be alert for any parachuting. The chart annotation also said that aircraft were to remain clear of the parachute drop area when parachute operations were in progress, when joining overhead the aerodrome.

1.9.3 Regular air transport operators to Taupo Aerodrome had established procedures with the parachuting operators to minimise conflicts or disruptions to their operations. The regular air transport operators did not have any undue concerns about the parachuting operations and believed the procedures worked well.

1.10 Tests and research

1.10.1 Following the accident the commission tested the normal functioning of the aircraft undercarriage retraction and lowering system, including the indicator lights and warning horn. The system functioned normally. The indicator lights were found in the daylight (full bright) position.

1.11 Additional information

1.11.1 The aircraft manufacturer advised that systems which utilise a radar altimeter or logic airdata system using power versus airspeed output can be installed in the aircraft to give additional advanced warning of an undercarriage unsafe condition. Ground proximity warning systems were also available for fitment in the aircraft, which would normally have given the pilot a ground proximity alert on a landing approach with the undercarriage retracted.

1.11.2 The National Transportation Safety Board advised that in the United States there were only 4 wheels-up landing accidents in the 14-year period from 1985 to 1998, involving the Piper PA31 series aircraft. None of these was in the PA31T3 type. Since the commission was formed in 1990 it has investigated only one wheels-up landing accident involving the Piper PA31 series aircraft, which resulted from the undercarriage being unable to be lowered due to a selector cable failure.

2. Analysis

2.1 The flight was conducted by a qualified and experienced senior pilot as a single-pilot operation, in a serviceable and properly maintained aircraft. The pilot was accustomed to operating in a single-pilot environment.

2.2 Although the pilot did not fly to Taupo regularly he was familiar enough with the aerodrome and sufficiently experienced that the aerodrome environment should not have posed any significant concerns to him. However, he expressed some apprehension about operating into Taupo because of the withdrawal of the flight information service and the establishment of the mandatory broadcast zone, several years earlier. The pilot was aware of the parachuting operations and spoke to the pilot of the parachutists' aircraft to coordinate his arrival, so that the parachuting could go ahead once ZK-FPL had crossed the NDB positioned at the aerodrome.

2.3 After ZK-FPL was established inbound to the aerodrome for runway 18 on the NDB approach the pilot attempted to locate the parachutists to ensure they would not conflict with his landing. He first saw the parachutists when he was about 5 nm from the runway but he was unsure how many there were. He continued to look for any that he may have missed and to monitor the progress of the ones that he had located.

2.4 Operating as a single-pilot into an aerodrome environment with which he was not entirely comfortable, where parachuting operations were in progress, the pilot had a relatively high workload. When he carried out his before-landing checks he made a conscious decision to pass over the checklist item that called for the undercarriage to be lowered, with the intention of returning to that action and completing it after he was certain the parachutists would not conflict with his landing. With that action omitted the pilot had only his memory to prompt him to return to it.

2.5 The pilot was accustomed to completing a short final check from memory to confirm the undercarriage position just before landing, but on this occasion he either did not complete the check or did not recognise that the 3 undercarriage indicator lights were unlit. The undercarriage position indicator lights were not readily visible because of their low position on the instrument panel and could have been obscured by the pilot's control wheel. During his landing approach the pilot became preoccupied with the parachutists, and his attention was diverted from the need to complete the outstanding checklist action and to positively confirm that the undercarriage was down before landing.

2.6 Human factors literature describes an error (an unintended act) such as forgetting to lower the undercarriage when conscious attention is diverted elsewhere as a lapse, during an automatic mode of behaviour. Undercarriage lowering is a skill-based behaviour that is automatic, but one which requires a conscious check to ensure that the action has been completed. During skill-based automatic behaviour the conscious check is often not done when other demands are high, which can be a common source of erroneous aircraft control operation. Skill-based behaviour is most prone to error when the user is preoccupied with other tasks.

2.7 Another common human error in conjunction with skill-based behaviour can occur when a particular operation is associated with a given environmental situation. This is known as environmental capture. An example is a pilot believing the undercarriage is down, and that he has observed 3 green undercarriage indicator lights, because that is what he expected with the aircraft established on short final approach and about to land.

2.8 The aircraft undercarriage unsafe warning system was set in accordance with the manufacturer's requirements, but it did not give the pilot enough advance warning to alert him with sufficient time to lower the undercarriage, or execute a timely go-around. During a normal approach in the aircraft, engine power is usually only reduced to the level necessary to actuate the undercarriage warning horn when the aircraft approaches or crosses the threshold prior to touch down. Nuisance warnings, especially during descent, can result if aircraft undercarriage unsafe warning systems are set to actuate the warning horn at too high power thresholds. The aircraft manufacturer advised that it was not considering any modification to raise the threshold at which the undercarriage unsafe audio warning system will actuate the undercarriage unsafe warning horn, and that no undercarriage unsafe audio modification linking the flap position to that of the undercarriage was available. Research has also shown that unintentional wheels-up landing accidents are uncommon with Piper PA31 series aircraft.

2.9 Additional systems were available for fitment to the aircraft series, which could have given the pilot an earlier warning that the undercarriage was retracted. One example is ground proximity warning systems. A feature of these systems is that they will give ground proximity alerts when aircraft are on approach to land with their undercarriage retracted. Had such a system been fitted in the aircraft, the pilot should have received an alert and been prompted to check the undercarriage position in time for him to lower the undercarriage or execute a timely go-around. These systems can be invaluable safety devices, particularly for single-pilot operations.

2.10 The potential for human errors such as slips[3] and lapses to occur can be reduced by standardisation, such as strictly following checklists. Even though the standard operating procedure was to complete a memory checklist on short final approach, which included a check of the undercarriage position, the aircraft checklist did not document that procedure. If it had, the check would have been formalised and could have helped reinforce to pilots that it was mandatory.

[3] Attentional failure.

3. Findings

Findings and safety recommendations are listed in order of development and not in order of priority.

3.1 The aircraft had a valid Certificate of Airworthiness and its records indicated that it had been maintained appropriately and was airworthy and operating within the required maintenance period.

3.2 The aircraft was serviceable.

3.3 The pilot was appropriately licensed, authorised and fit to conduct the flight.

3.4 The pilot was experienced, accustomed to single-pilot operations and practised on the aircraft type.

3.5 The pilot's conscious decision to pass over the checklist action of lowering the undercarriage, with the intention of returning to it, created the environment for human error to occur by depriving the pilot of the benefit of following a standardised procedure.

3.6 The pilot forgot to lower the undercarriage before landing, through either becoming preoccupied with the parachuting operations, or environmental capture where he may have believed the undercarriage was extended because that was his expectation for landing.

3.7 Although the operator's standard operating procedure was for pilots to complete a short final check of the undercarriage position, the aircraft checklist did not specify that procedure.

3.8 The undercarriage unsafe audio warning system did not give the pilot sufficient warning to prevent the accident.

3.9 Additional aircraft systems were available, which could have given an earlier warning of an undercarriage unsafe condition.

4. Safety Action

4.1 Following the accident the operator put the pilot through recurrency training before reinstating him to full flying duties. The training included the use of checklists and recognition of the stall warning and undercarriage unsafe warning horns.

5. Safety Recommendations

5.1 On 7 July 2000 the Commission recommended to the Managing Director of Airwork (NZ) Limited that he:

5.1.1 Document the short final check on all the aircraft checklists (043/00).

5.1.2 Emphasise to all his pilots the need to follow the standardised checklist procedures and that they should not continue past a checklist item until it has been completed (044/00).

5.1.3 Explore the option of installing some system that will give an advanced warning if the undercarriage has not been lowered for landing, with a view to installing such a system in his single-pilot operated aircraft (045/00).

5.2 On 17 July 2000 the Managing Director of Airwork (NZ) Limited responded as follows, in part:

5.2.1 We do not accept all the safety recommendations for the following reasons:

043/00 A further checklist will be an additional diversion and more likely to create problems than avoid them. If the pilot in command of an aircraft fitted with retractable undercarriage, does not out of his/her own volition check that the undercarriage is down, then that pilot should not be flying.

044/00 We have already carried this out and will do so again, as I agree it is vital.

045/00 There is already a warning system and if the pilot chooses to ignore that, then that is purely human error.

What we need [to] understand is that all the safety systems possible are not going to overcome the human error factor. For example, there are three undercarriage warning systems already on the aircraft ZK-FPL.
Will another actually achieve anything more?

Finally, to answer your specific requests:

we intend to adopt recommendation 044/00 immediately
we do not intend to adopt 043/00 nor 045/00 for reasons given above
we do not intend to carry out further analysis.

Approved for publication 2 August 2000

Hon. W P Jeffries
Chief Commissioner