NO. 94-007

PIPER PA31-350

ZK-PKC

CHRISTCHURCH INTERNATIONAL AIRPORT

8 MARCH 1994

ABSTRACT

On 8 March 1994, ZK-PKC, a Piper Navajo Chieftain was landed wheels-up at Christchurch after a cable failure rendered the undercarriage lowering system inoperative.

TRANSPORT ACCIDENT INVESTIGATION COMMISSION

AIRCRAFT ACCIDENT REPORT NO 94-007

Aircraft Type, Serial Number and Registration:	Piper PA31-350, 31-7405207 ZK-PKC
Number and Type of Engines:	Two Lycoming TIO-540-J2BD
Year of Manufacture:	1974
Date and Time:	8 March 1994, 0219 hours*
Location:	Christchurch International Airport Latitude 43°29'S Longitude 172°31'E
Type of Flight:	Air Transport, Night Charter
Persons on Board:	Crew: 2
Injuries:	Crew: 2 Nil
Nature of Damage:	Substantial
Pilot in Command's Licence:	Commercial Pilot Licence (Aeroplane)
Pilot in Command's Age:	25
Pilot in Command's Total Flying Experience:	3443 hours 260 hours on type
Information Sources:	Transport Accident Investigation Commission field investigation
Investigator in Charge:	Mr K A Mathews

* All times in this report are NZDT (UTC + 13 hours)

1. NARRATIVE

1.1 On the night of 7/8 March 1994 ZK-PKC, a Piper Navajo Chieftain, operated by United Aviation, was chartered for a night freight run from Palmerston North to Christchurch and return to Palmerston North.

1.2 All the passenger seats were removed from ZK-PKC for the loading of freight and a full load placed on board.

1.3 The flight departed Palmerston North, proceeded normally, and landed at Christchurch International Airport.

1.4 At Christchurch the freight was offloaded, and the aircraft was serviced and prepared for the return flight.

1.5 235 litres of fuel was uplifted, which brought the total fuel on board the aircraft to 500 litres for the return flight. This gave an endurance of approximately three hours.

1.6 A freight barrow containing a bulk load of 798 kg of freight, as weighed by bridge scales, was positioned by the aircraft and the aircraft loaded. The aircraft was loaded by two experienced freight loaders under the supervision and with the assistance of the pilot in command. A quantity of freight described by the loaders as "a couple of pieces" and by the pilots as "a considerable amount" could not be loaded because there was insufficient space remaining in the aircraft. These pieces were estimated by the loaders to have weighed about 20 to 30 kg in total. The pilot in command stated that he had advised the loaders that he was able to accept only 640 kg of freight and, as a result, 25% of the load remained on the barrow. Neither of the two freight loaders nor the supervisor recalled receiving or acknowledging any such instructions to limit the load.

1.7 The heavier items of cargo were loaded in the nose locker and other suitable packages in the wing lockers. A bed end was loaded in the centre of the cabin and cargo stacked on either side of and around this item.

1.8 The freight loaders stated that two copies of a bulk "loadweight" statement recording 800 kg of freight were handed to the pilot at the completion of the loading. This statement did not record any dangerous goods. It indicated the total weight of freight loaded on board the aircraft, but did not reflect that an estimated 20 to 30 kg of freight had been removed from this total. The freight weight on board the aircraft was therefore around 773 kg (1700 pounds) bringing the aircraft's all up weight to around 3300 kg (7260 pounds). The maximum permissible take-off weight for the aircraft was 3182 kg (7000 pounds). The pilots subsequently denied that they had been handed a bulk "loadweight" statement.

1.9 At 2315 hours the aircraft departed Christchurch International Airport for Palmerston North. After take-off the undercarriage was selected up, but the undercarriage lever failed to return to its neutral position. Suspecting that the undercarriage had not fully retracted the pilot elected to recycle it. On moving the undercarriage lever to the down position the undercarriage failed to extend and the pilot noticed that the lever was loose and free.

1.10 Christchurch Tower was advised of the situation by the pilot and permission was given to hold at 2000 feet to the west of the airport. Several attempts were then made to lower the undercarriage using the emergency extension system, but to no avail. A cellular telephone carried on board the aircraft was used to make contact with the engineering manager of the firm responsible for the aircraft's maintenance, to discuss the problem.

1.11 After some discussion, and several further unsuccessful attempts to lower the undercarriage using the emergency system, it was decided that the flexible cable connecting the undercarriage lever to the hydraulic power pack had broken or become disconnected. Unless the undercarriage could be selected down on the power pack, the emergency system was not able to lower it.

1.12 The hydraulic power pack was situated in a compartment forward of the cockpit front bulkhead. It was therefore impossible for the crew to reach the power pack from the cockpit and select the undercarriage down manually, although a number of attempts were made to do so.

1.13 The pilot in command decided not to proceed to Palmerston North, but carry out a wheels-up emergency landing on runway 20 at Christchurch International Airport. Air Traffic Control were kept advised of the situation and permission was given to hold at 2000 feet above the airport for better visual reference than that afforded to the west. Emergency services were put on full alert to attend the planned emergency landing.

1.14 The aircraft held for a further two hours in this new position to burn off excess fuel. This was done to lighten the aircraft for the emergency landing and to reduce the likelihood of a fire. The fuel in the main tanks was consumed, and the tip tanks taken to one quarter capacity for the emergency landing.

1.15 During this time the pilots discussed what actions they would take, and communicated, via radio, with the Senior Fire Officer on duty. The Senior Fire Officer was briefed about the contents of the freight and its positioning in the aircraft, and was informed that there were no nets between the pilots and the freight in the cabin. The pilot in command advised that there were "some dangerous goods ...., mainly in the nose locker, and a couple down the back of the main fuselage" on board. These were identified as non-flammable aerosols and medicines. The pilot also stated that there was "a portable oxygen cylinder behind one of our seats, that we were going to use on the flight."

1.16 In his initial communication with the Senior Fire Officer, the pilot in command stated that they (the pilots) would be breaking through one of the cockpit side perspex windows with an axe in order for them to vacate the aircraft quickly, after the emergency landing. The Senior Fire Officer asked whether access to the exits was "impeded by the cargo", to which the pilot in command responded; "Yeah, pretty much, not too bad, but we'll be choosing to vacate the quickest route which will be out the front window." Approximately thirty minutes later the pilot contacted the Senior Fire Officer again and stated, "it was decided now that there is an emergency exit three windows down on the starboard side. We'll be trying to pop that initially, and if there's any sign of fire will be coming out the front side windows."

1.17 At the appropriate time to commence the landing the Control Tower was advised and the aerodrome was closed to other traffic. A "crash emergency" was declared by Air Traffic Control, and the emergency services assembled in position on runway 29, clear of the active runway.

1.18 The aircraft was cleared to land on runway 20 and the VASIS lights were intercepted at 9 miles. The threshold was crossed at 115 KIAS, a higher speed than normal. This was to allow extra time in the round out for the co-pilot to pull the mixture levers to idle cut off, close the firewall fuel shut-off valves and select the fuel tanks to "OFF".

1.19 The throttles were closed and the aircraft touched down. The pilots estimated that the aircraft slid about 150 m before coming to rest. During the slide the pilots saw what they believed to be smoke issuing from the console area, so before the aircraft came to rest the co-pilot broke away the right cockpit perspex window with the "crash" axe. The master switch was selected to "OFF" and both pilots abandoned the aircraft through the broken window.

1.20 No fire occurred, but the fire service vehicles moved into position and sprayed foam under the aircraft as a precautionary measure. The fire crew gained access to the cockpit area, confirmed that the crew had escaped and that the electrical system master switch and fuel tank selectors were "OFF". The crew were located at a safe distance uninjured, off to one side of the runway. The battery was located and isolated, and after further checking the area was declared to be safe.

1.21 In order to lighten the aircraft to lift it with air bags the aircraft recovery personnel decided to offload the freight. The freight, which was found not to be restrained, was placed on the back of a utility vehicle and the aircraft raised. Jacks were then used to support the weight and the undercarriage was lowered manually. The aircraft was towed clear of the runway and runway 20 was reopened at 0345 hours.

1.22 The aircraft sustained extensive damage to its belly, flaps and propellers.

1.23 The weather at the time was generally fine and the 0200 hours Christchurch Metar included:

Wind:	250°/10 knots
Visibility:	30 km
Cloud:	1 octa stratus at 400 feet
Temperature: +8°C QNH:	1012 hPa

A passing rain shower had been observed in the hour prior to the accident, and the reported weather conditions for the landing included:

Wind:	210°/10 knots Visibility: 20 km
Cloud:	1 octa at 2500 feet, 3 octas at 3500 feet

1.24 Subsequent investigation revealed that the undercarriage selector push-pull cable, part number 44289-00, had failed at the undercarriage lever end close to a flexible swaged end fitting.

1.25 The cable was a Bowden type consisting of an outer sheath of plated steel, a black plastic liner and a

flexible inner movable cable made up of 7 strands of stainless steel wire. The outer sheath was crimped, at each end, into a sleeve which contained a ball and socket type swivel joint. The inner cable was fastened into a threaded pull rod at each end. One rod was attached to the undercarriage selector lever and the other to a control arm on the hydraulic power pack.

1.26 This control arm moved a shuttle valve which ported hydraulic fluid to either raise or lower the undercarriage. When moved to either the UP or DOWN position it was locked in place by action of a handle release valve acting against a release mechanism detent. The handle remained in this position until fluid pressure within the hydraulic system reached 750 psi to 1250 psi. At this point the lever returned to the UP or DOWN NEUTRAL position, relieving all pressure in the system by allowing the fluid to circulate freely between the pump and control unit. To lower the undercarriage using the emergency system the control arm on the hydraulic power pack, via the undercarriage lever, needed to be selected to the DOWN position. This was necessary to allow fluid from the hand pump to be ported to lower the undercarriage.

1.27 To lower the undercarriage using the emergency extension procedure, the aircraft's flight manual detailed the following steps which needed to be carried out in sequence.

"1. Slow the aircraft to below 130 KIAS

2. Place the gear selector handle in the down position.

3. Pull the emergency pump handle out as far as possible.

4. Pump the handle up and down until all three green lights come on. Continue pumping until pressure builds up and the selector handle returns to neutral."

1.28 The airframe at the time of the failure had around 13,400 hours time in service, and the undercarriage selector push-pull cable was the original cable. There had been no requirement to replace this cable as it was an "on condition" item. Periodic inspections, as per the Piper Service Manual and Programmed Inspection Schedule, called only for a visual inspection of the cable assembly. The cable however operated inside a conduit which prevented a detailed inspection of the cable being carried out effectively.

1.29 On the 18 February 1994 Piper Aircraft Corporation had issued an amendment to the PA31 Navajo service manuals and programmed inspection schedules. This amendment called for the replacement of the "landing gear selector cable" at 4,000 hours time-in-service or 10 years, whichever came first. Prior to the accident, no service information relating to the cable had been received from Piper for the PA31-350 Navajo Chieftain, nor had the maintenance organisation received any amendments to their inspection schedules alerting them of any need to replace the cable.

1.30 A detailed examination of the cable assembly by Industrial Research Ltd revealed that the inner cable had failed about 10 mm from the push-pull rod on the selector lever end of the cable, adjacent to a swivel joint. The swivel joint had been extensively deformed, probably during initial installation in the aircraft, which allowed the cable to travel through a greater angle than normal. At least one of the stainless steel wires in the inner cable failed as a result of stress corrosion cracking, which may have been enhanced by hydrogen embrittlement and a cyclic load being applied to the cable. When one or more of the wires failed, the cable probably jammed when the wires stuck at the end of the outer sheath. At this point the other wires would have failed as a result of overload or very low cycle fatigue.

1.31 The pilot in command was a "B" category flying instructor and the operator's Chief Pilot. He was flying Air Transport operations for his company up to the time of the accident.

1.32 On 14 February 1994 the pilot in command's class 1 medical certificate had expired. On 1 March 1994 he presented himself to a Designated Medical Examiner for the purpose of undergoing a medical examination for the issue a new class 1 medical certificate. He did not sign the "request for medical assessment at the CAA medical unit" form which resulted in a delay of the completed medical documents being sent to the Civil Aviation Medical Assessment Unit. These documents were received on 8 March 1994, and the pilot was assessed as being medically fit and issued a new class 1 medical certificate on 10 March 1994.

1.33 The co-pilot held a valid Commercial Pilot Licence (Aeroplane) and PA31 Type Rating. He was a "C" category flying instructor with some 1500 hours total flying experience. He worked part-time for the company,

and on the flight to Christchurch and return he was to gain route experience under the supervision of the pilot in command.

1.34 The return flight was originally planned for 9,000 feet, in accordance with the Operator's standard flight plan, but prior to departure it was amended to 13,000 feet. The pilots stated that this was in order to avoid thunderstorm activity to the north of Christchurch and that they planned to return to 9,000 feet.

1.35 The portable oxygen cylinder behind the pilot's seat was charged to 1500 psi. It was not an approved installation and its testing did not comply with Labour Department Regulations. The oxygen masks did not have individual regulators but were supplied with oxygen via a common "T" junction from one regulator connected to the supply terminal. As there was no flow gauge, the crew had no means of determining whether or not oxygen was being delivered to the masks. The masks were not equipped to allow the pilots to communicate using the aircraft radio equipment and to communicate with each other by interphone. The pilots subsequently advised that the oxygen cylinder had never been intended for use as an oxygen source, and that it was carried for "simulated use" only. As the Operator was planning to install oxygen equipment in the aircraft the pilots said they thought they would benefit from being able to simulate an emergency requiring the donning of oxygen masks during flight.

1.36 The volume of freight loaded in the cabin was such that ready access to the cabin door in the rear of the aircraft was not available to the crew. It would have been necessary for them to crawl across the top of the freight to reach the door. An emergency exit on the forward right side of the cabin was obstructed by cargo and would not have been available to the crew readily in the event of an emergency. Photographs and statements from emergency services and aircraft recovery personnel who attended the accident and offloaded the freight supported this. However the crew stated that ready access to the main cabin door and emergency exit was available to them.

1.37 The aircraft did not have any structure or netting separating the freight from the cockpit area, and the freight was not restrained. During the TAIC inspection of the aircraft on the day of the accident no evidence of any restraining devices or tie down points was found. The pilot in command stated that he had restrained the cargo with two straps secured to tie down points in the back of the aircraft, and that he had released the straps after the landing. The co-pilot stated that he could not remember if the cargo had been restrained or not.

1.38 A completed copy of the aircraft's load sheet was not left at the departure airport. Although there was no record of a weight and balance computation, the pilot in command stated that a weight and balance computation for the aircraft had been carried out, as prescribed in the Operator's Operations Manual, and in accordance with Standard Operating Procedures.

2. FINDINGS

2.1 The Pilot in Command's Class 1 Medical Certificate had expired, therefore he was not entitled to exercise the privileges of his Commercial Pilot Licence.

2.2 The Pilot in Command was fit for the flight.

2.3 The aircraft had a valid Certificate of Airworthiness and Maintenance Release.

2.4 The aircraft's centre of gravity could not be determined subsequently, as the freight had been unloaded.

2.5 The all up weight of the aircraft, on departure from Christchurch International Airport, probably exceeded its maximum allowable all up weight.

2.6 The aircraft was maintained correctly.

2.7 The failure of the undercarriage selector push-pull cable prevented the lowering of the undercarriage with the normal or emergency systems.

2.8 The normal and emergency exits were obstructed by freight and not readily accessible to the crew.

2.9 Emergency services responded to the accident appropriately.

2.10 Runway 20 was reopened to operations 1 hour and 26 minutes after the accident.

2.11 The aircraft was not suitably equipped for freight operations.

2.12 The freight on board was not secured as required by Civil Aviation Regulations.

2.13 The portable oxygen equipment carried on board the aircraft was not of an approved type as required by Civil Aviation Safety Orders.

2.14 The failure of the undercarriage selector push/pull cable was due to stress corrosion cracking, possibly enhanced by hydrogen embrittlement and a cyclic load being applied to the cable.

3. OBSERVATIONS

3.1 On 29 March 1994 the Civil Aviation Authority issued a Defect Alert Notice to all New Zealand operators of the PA31 series aircraft, as follows:

> "PIPER PA-31 SERIES LANDING GEAR SELECTOR CABLE
>
> Investigation of an accident involving a Piper PA-31-350 revealed the landing gear selector cable failed and prevented the crew lowering the gear via normal or emergency means. Metallurgical examination revealed the cable failure was a result of stress corrosion cracking. The cable is fully encased within a conduit and cannot be easily inspected.
>
> Piper have recently amended service instructions for the PA-31 Navajo aircraft to require the cable to be renewed at 4000 hours time in service or 10 years whichever occurs first (refer service manual extracts attached). They advise that they are presently revising the PA-31-350 Chieftain Manuals to include the same replacement requirement.
>
> The CAA strongly recommend that all owners of Piper PA-31 series aircraft comply with this service requirement."

29 June 1994

M F Dunphy
Chief Commissioner

ABBREVIATIONS COMMONLY USED IN TAIC REPORTS

AD	Airworthiness Directive
ADF	Automatic direction-finding equipment
agl	Above ground level
AI	Attitude indicator
AIC	Aeronautical Information Circular
AIP	Aeronatical Information Publication
amsl	Above mean sea level
ASI	Airspeed indicator
ATA	Actual time of arrival
ATC	Air Traffic Control
ATD	Actual time of departure
ATPL (A or H)	Airline Transport Pilot Licence (Aeroplane or Helicopter)
AUW	All-up weight
C	Celsius
CAA	Civil Aviation Authority
CASO	Civil Aviation Safety Order
CFI	Chief Flying Instructor
CPL (A or H)	Commercial Pilot Licence (Aeroplane or Helicopter)
DME	Distance measuring equipment
E	East
ELT	Emergency location transmitter
ERC	En route chart
ETA	Estimated time of arrival
ETD	Estimated time of departure
F	Fahrenheit
FAA	Federal Aviation Administration (United States)
FL	Flight level
g	Acceleration due to gravity
GPS	Global Positioning System
HF	High frequency
hPa	Hectopascals
IAS	Indicated airspeed
IGE	In ground effect
IFR	Instrument Flight Rules
ILS	Instrument landing system
IMC	Instrument meteorological conditions
ins Hg	Inches of mercury
kHz	Kilohertz
KIAS	Knots indicated airspeed
kt	Knot(s)
LF	Low frequency
LLZ	Localiser
M	Mach number (e.g. M1.2)
M	Magnetic

MAANZ	Microlight Aircraft Association of New Zealand
MAP	Manifold absolute pressure (measured in inches of mercury)
MAUW	Maximum all-up weight
METAR	Aviation routine weather report (in aeronautical meteorological code)
MF	Medium frequency
MHz	Megahertz
mph	Miles per hour
N	North
NDB	Non-directional radio beacon
NOTAM	Notice to Airmen
nm	Nautical mile
NZAACA	New Zealand Amateur Aircraft Constructors Association
NZGA	New Zealand Gliding Association
NZHGPA	New Zealand Hang Gliding and Paragliding Association
NZMS	New Zealand Mapping Service map series number
NZDT	New Zealand daylight time (UTC + 13 hours)
NZST	New Zealand standard time (UTC + 12 hours)
NTSB	National Transportation Safety Board (United States)
OGE	Out of ground effect
PAR	Precision approach radar
PIC	Pilot in command
PPL (A or H)	Private Pilot Licence (Aeroplane or Helicopter)
psi	Pounds per square inch
QFE	An altimeter subscale setting to obtain height above aerodrome
QNH	An altimeter subscale setting to obtain elevation above mean sea level
RNZAC	Royal New Zealand Aero Club
RNZAF	Royal New Zealand Air Force
rpm	Revolutions per minute
RTF	Radio telephone or radio telephony
S	South
SAR	Search and Rescue
SSR	Secondary surveillance radar
T	True
TACAN	Tactical Air Navigation aid
TAF	Terminal aerodrome forecast
TAS	True airspeed
UHF	Ultra high frequency
UTC	Coordinated Universal Time
VASIS	Visual approach slope indicator system
VFG	Visual Flight Guide
VFR	Visual flight rules
VHF	Very high frequency
VMC	Visual meteorological conditions
VOR	VHF omnidirectional radio range
VORTAC	VOR and TACAN combined
VTC	Visual terminal chart
W	West