Papua New Guinea

FINAL REPORT

AIC 10-1005

PAPUA NEW GUINEA

ACCIDENT INVESTIGATION COMMISSION

FINAL REPORT

MAF-PNG

P2-MFK

Gippsland Aeronautics GA8−TC 320

Hard landing – Downdraft undershoot

Sindeni, Eastern Highlands Province

PAPUA NEW GUINEA

30 September 2010

About the AIC

The Accident Investigation Commission (AIC) is an independent statutory agency within Papua New Guinea (PNG). The AIC is governed by a Commission and is entirely separate from the judiciary, transport regulators, policy makers and service providers. The AIC's function is to improve safety and public confidence in the aviation mode of transport through excellence in: independent investigation of aviation accidents and other safety occurrences within the aviation system; safety data recording and analysis; and fostering safety awareness, knowledge and action.

The AIC is responsible for investigating accidents and other transport safety matters involving civil aviation, in PNG, as well as participating in overseas investigations involving PNG registered aircraft. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

The AIC performs its functions in accordance with the provisions of the PNG Civil Aviation Act 2000 (As Amended), Civil Aviation Rules 2004 (as amended), and the Commissions of Inquiry Act 1951 (as amended), and in accordance with Annex 13 to the Convention on International Civil Aviation.

The object of a safety investigation is to identify and reduce safety-related risk. AIC investigations determine and communicate the safety factors related to the transport safety matter being investigated.

Readers are advised that in accordance with Annex 13 to the Convention on International Civil Aviation, it is not the purpose of an AIC aircraft accident investigation to apportion blame or liability. The sole objective of the investigation and the Final Report is the prevention of accidents and incidents. (Reference: ICAO Annex 13, Chapter 3, paragraph 3.1.)

However, it is recognised that an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the AIC endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why it happened, in a fair and unbiased manner.

About this report

The AIC did not conduct an investigation into this occurrence.

The investigation was conducted by the operator’s International organisation, MAF International (MAFI) The aircraft manufacturer and engine manufacturer were consulted about technical issues raised during the investigation.

AIC comment

The AIC acknowledges the detailed investigation conducted by MAF International and has accepted the report as written. Pages 27 to 30 have been left out of the MAFI report as they covered internal MAFI information.

Mission Aviation Fellowship

FINAL

ACCIDENT REPORT

P2-MFK

GA8-TC 320 S/N 130

Sindeni Airstrip
Eastern Highlands Province, PNG
30th September 2010

Introduction

The MAFI ARD determined that this accident was to be internally investigated by a team with members from AP region and at least one other MAFI region. The final investigation team was composed of two AP ARD members, one US ARD member, and the MAF PNG Quality Manager. The PNG Accident Investigation Commission (AIC) and the aircraft manufacturer declined to conduct an on-site investigation. The aircraft manufacturer and engine manufacturer have been available to consult about technical issues raised during the investigation.

Due to the ongoing investigation of a number of technical issues, a preliminary report was issued to report on contributing factors and recommendations to date. These investigations have now been completed, and changes have been made to sections 1-3. This document is the final report. It has been made available to MAF PNG management, ARD members, the PNG AIC, and those others whom the CEO of MAFI deems to be parties with an interest in this event. This Company report remains the property of MAFI and must not be copied or forwarded without permission.

Synopsis

On September 30, 2010 a turbocharged GA8-TC 320 Airvan, registered P2-MFK departed from Andakombe airstrip in the Eastern Highlands province for a short flight to Sindeni airstrip, located only 9 nautical miles NNE. Two pilots were onboard the aircraft. The pilot under instruction in the left seat was pilot flying, and was undergoing area familiarisation. He was under the supervision of a Check Captain, who was seated in the right seat and was the pilot-in-command.

Three passengers and their baggage were aboard the aircraft. One was to be disembarked at Sindeni, and the other two intended to travel onward to Goroka, where the aircraft was based. After a short climbing flight, the aircraft arrived overhead Sindeni airstrip and joined the circuit for landing. On final, just after the pilot under instruction called committed, a large updraft was encountered, followed by a strong downdraft. The pilot under supervision advanced the throttle to full power, but the aircraft struck the airstrip prepared surface about 10 m short of the threshold with a high rate of descent.

The aircraft was significantly damaged by the vertical landing forces and subsequent slide to a stop. One passenger received a cut on his left eyebrow as a result of the occurrence. Some passenger baggage items (mainly foodstuffs) in the pod were damaged or destroyed.

1 Factual Information

1.1 History of the flight

On September 30, 2010, the occurrence aircraft was carrying out PNG CAR 135 passenger operations in the Eastern Highlands province of PNG. Two pilots were aboard the aircraft as operating crew. The pilot in the left-hand seat (PUI) was operating under instruction from the pilot in the right-hand seat, who was pilot-in-command (PIC). The PUI was pilot flying for all flight sectors.

On the morning of the occurrence flight, the aircraft had carried out a four sector flight from Goroka, where the aircraft was based, to Aiyura, Obura, Owena, and then back to Goroka.

The second flight for the day was planned to be a three sector flight from Goroka to Andakombe, Sindeni, and back to Goroka. The PUI was tasked to supervise the loading of the aircraft. The aircraft was refuelled with an additional 110 L of avgas which increased the usable fuel on board to 210 L. Ground staff had been asked to prepare a load of 330 kg maximum for this flight, but they had manifested a total of 368 kg. The PUI asked ground staff members to reduce the load, and elected to remove another of the aircraft seats (one had already been removed from the aircraft at the beginning of the day) to gain a few kilograms of available weight.

This process didn't go as quickly as he wanted it to. In consultation with the PIC, the PUI determined that offloading 10 L of fuel would alleviate the situation. Both pilots understood that this would not leave the aircraft with sufficient fuel for holding requirements that would be needed after 2 PM local time, but they felt that with carefully managed turnaround times that the aircraft could be back to Goroka before this time. After the offloading of one aircraft seat, and 10 L of fuel, the aircraft was loaded with four passengers, their baggage, and some consigned cargo to bring the aircraft weight up to 1814 kg, which was the maximum certificated takeoff weight (MCTOW) for the aircraft type. The aircraft departed Goroka at 10:21 local time for the flight to Andakombe.

During the descent into Andakombe, the crew noticed some turbulence but didn't feel it was unusually severe, or would warrant any adjustments to aircraft speed. The height of cloud on the ridges to the north of Andakombe meant that the descent into the circuit was steeper than normal. Because of this, the aircraft ended up being a little high on final approach. This, combined with 10 kt of tailwind, resulted in the landing occurring beyond the pilots' selected aiming point. The aircraft was still able to be stopped comfortably abeam the parking bay, which is about halfway up the airstrip.

At Andakombe, the aircraft was unloaded, and three other passengers and their baggage were loaded for the sectors to Sindeni and Goroka. A fourth passenger was not able to be carried because the passengers had too much baggage. The time required to sort out the aircraft load was more than the pilots intended, but the pilots were able to come to an agreement with the passengers about what should be carried first. The aircraft was loaded with three passengers and their baggage which resulted in an aircraft weight of 1756 kg. The PUI carried out a passenger safety briefing and ensured that seatbelts were fastened before closing the door. The aircraft departed Andakombe at 11:32 AM local time.

Sindeni and Andakombe airstrips are located in the same River Valley, but Andakombe, which is downriver, is at a considerably lower altitude than Sindeni, though they are only nine nautical miles apart. This required that the aircraft climb at normal climb power for most of the short flight. The PUI noticed that turbulence induced movement of the aircraft was greater on departure from Andakombe than it had been on his arrival. He leveled off at approximately 6100 feet about 1 min. before reaching the circuit area at Sindeni.

The pilots discussed the variable nature of the winds being indicated on the two wind socks at Sindeni and determined to shift the aircraft aiming point 30 m farther from the runway threshold. While carrying out the aircraft descent checklist, the PUI noticed that the passenger in the right-hand seat of row two had his shoulder harness improperly positioned, and ensured that this was fixed. The aircraft crossed the airstrip centerline to the east of the runway threshold and proceeded to join right-hand downwind for landing on runway 28. The PUI noticed that positive aircraft control was required in the circuit because of the turbulence.

On final approach, turbulent conditions required the PUI to work hard to maintain the nominated aircraft speed of 70 kt and remain on glide slope, although there didn't appear to be any excessive updrafts or downdrafts. On short final approach, just past the point where the PUI called "committed", a large updraft was experienced, and the aircraft ascended above the glide slope. Engine power was reduced to idle by the PUI to control the aircraft speed and glide slope. Shortly thereafter, the aircraft entered a large downdraft, and a high rate of vertical descent developed. The PUI added engine power, and at the urging of the PIC advanced the throttle full power, but at 11:40 local time the aircraft struck the extended runway centreline approximately 10 m short of the threshold with a high rate of descent.

After contacting the ground, the aircraft travelled up the airstrip about 74 m past the threshold, where it rotated 90° to the right, and came to rest near the left edge of the airstrip surface.

After securing the aircraft, the two pilots exited, and assisted the three passengers to exit from the left-hand rear door. The PUI provided first aid to a passenger that had received a cut above his left eye while the PIC used the aircraft HF radio to contact the Chief Pilot in Goroka. At 11:45 AM local time, contact with the Chief Pilot was established, and he was informed of the occurrence.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Others
Fatal	0	0	0
Serious	0	0	0
Minor/None	2	3	0

1.3 Damage to Aircraft

The aircraft was damaged substantially in the occurrence.

All 3 propeller blades were bent back about 60 degrees. The engine crankshaft was subsequently found to be cracked as a result of the propeller striking the ground. The cowl flap torque tube was bent.

The nose gear attachment area and firewall were damaged and displaced aft, buckling the lower firewall skin just aft of the firewall for about 20 -25 cm, and bending the centre fuselage "keel" members.

The lower fuselage skin sustained dents, wrinkling, and some punctures aft of the firewall, and near the left main gear area. The internal fuselage ribs near the left main gear sustained some damage as well.

The vertical stabilizer was creased and dented with the top of the stabiliser bent towards the left.

The right hand rudder pedal torque tube arm was bent.

There was some scuffing on the L/H wing tip and a couple of dents in the top surface. A former in the wing tip was bent, the pitot tube and supporting structure were damaged.

The nose wheel fork and wheel assembly was broken and the left main gear was broken off.

The cargo pod was destroyed and the left hand pilot step was broken off.

1.4 Other Damage

Much of the airstrip initial landing area is of hard coronus material and was not significantly damaged in the occurrence. Several softer areas of the airstrip further up from the threshold suffered light scoring damage as a result of the aircraft sliding on it.

Some passenger baggage items (mostly bananas and other foodstuffs) located in the cargo pod were damaged or destroyed.

1.5 Personnel Information

Operating Crew

	Pilot in Command	Pilot Under Instruction
Name	Richard Ebel	Richie Axon
Age	38	31
Weight	72 kg	72 kg
Injuries	None	None
Seat occupied	Row 1 Right	Row 1 Left
Flight duties	Initial area, airstrip checking	Operation under supervision
Restraint system used	4 point lap and shoulder	4 point lap and shoulder
Licence type/number	ATPL P20414	Commercial P21000
Medical validity date	Until 09/01/2011	Until 01/07/2011
Ratings	SE, ME	S/E
Endorsements	S/E <5700, CSU, Retract DHC6, Instrument SP, MP Flight Instructor, Supervisor	S/E <5700, CSU, Retract
Company authorisations	Senior Pilot GA8, PIC 3 C206 PIC3, DHC6 FO2	None
Total flying experience	4868.9	774.4
Total hours in command	3782.4	553.4
Total program hours	2566.7	67.2
Total type hours	turbo 176.1 / total 610.6	Turbo 89.2
Area hours	> 1000	67.2
Total take-offs this location	10-15 / 2 on type	1
Total landings this location	10-15 / 2 on type	1
Days since last day off	4	3
Flight hours this day	1.95 / 5 landings	1.95 / 5 landings
Duty hours this day	5.4	5.4
Flight hours last 7 days	13.65	10.75
Duty hours last 14 days	83.3	71.6
Flight hours last 30 days	71.9 / 65.9 on type	58.7 / 58.7 on type
Flight hours last 365 days	592.0	76.4

Both pilot crewmembers were adequately rested on the evening before the flight. The PUI had awoken once during the night to attend to a child, but had slept again afterwards. Both pilots had the previous Saturday and Sunday free of duty, and the PUI also had Monday free of duty as well. The PIC is taking some medication for a long term condition which is known by his aviation medical examiner. Neither pilot appeared to be suffering from fatigue or any other pre-condition that would have significantly affected their performance.

1.6 Aircraft Information

a) Airworthiness and Maintenance

Manufacturer	Gippsland Aeronautics
Type and model	GA8-TC 320
Year of manufacture	2008
Serial number	GA8 TC 320-08-130
Total airframe time	912.4 hours
Engine type	Avco Lycoming TIO 540 AH1A
Serial number	L-13538-61A
Engine time (TSN)	8.8 hours
Propeller	Hartzell HC-C3YR-1RF/F8068
Serial number	DY7558B
Propeller time (TSN)	912.4 hours

The aircraft documentation indicated that for the occurrence flight the aircraft was certified, equipped and maintained in accordance with existing regulations and approved procedures. There were no aircraft deficiencies known to the pilots, and there were no outstanding maintenance log items recorded.

A replacement engine had been installed in the aircraft a week before the occurrence. This was the result of a discovery that the engine had been equipped with inappropriate pistons by the engine manufacturer at the time of manufacture. When the replacement engine was run by engineering staff on post maintenance testing it was noted that the EDM 800 engine RPM indication was not available and this had been noted in the observation section of the engine run sheet.

The day previous to the occurrence, the engine manifold pressure slope controller had been adjusted to increase the maximum engine manifold pressure. This was a follow-up of pilot feedback garnered from the first five hours of aircraft operation after the engine change.

b) Performance

Maximum certificated take-off weight	1814 kg
Maximum landing weight	1814 kg
Actual landing weight	1749 kg
Centre of gravity limits (occurrence flight)	Forward: 1404 mm aft of datum Aft: 1626 mm aft of datum
Actual centre of gravity location	1509 mm aft of datum

Company performance charts allowed for a take-off from Andakombe airstrip at the maximum certificated take-off weight, and a landing at Sindeni airstrip at the maximum landing weight, with wind limitations.

Neither pilot reported performance issues relating to the airframe or engine before the occurrence. Both pilots reported a slow engine response to throttle opening just prior to the aircraft landing hard at Sindeni airstrip. The pilots reported that, although the PUI selected full throttle, they felt that the engine power had not increased to full power before the aircraft struck the ground.

c) Fuel Types

Approved Fuel Types	100/130, 100LL
Fuel Type Used	100LL

1.7 Meteorological Information

Temperature	Approx 23°C
Surface winds	Reported SSE, 5-10 kt gusting
Visibility	Greater than 5 km, reduced by smoke some areas outside of circuit
Altimeter	1009 hPa area QNH
General conditions	Daylight, bright sunny conditions, no rain

There was no significant cloud reported in the circuit area, but building cumulus clouds were present along the ridges to the north and west of Sindeni airstrip. Local villagers reported that there had been no rainfall for more than a month previous to the occurrence, and the local community was experiencing the effects of drought. They indicated that the weather had been very hot and dry, and that it was normal for strong gusting winds to develop in the afternoons.

Pilots reported that there was light turbulence departing Andakombe which increased to moderate turbulence at their arrival overhead Sindeni.

The Chief Pilot, and other pilots flying in the area, had indicated that the dry gusty weather pattern had been established in that area for a number of weeks, and some operations had been rescheduled as a result of the turbulent weather conditions.

1.8 Aids to Navigation

There are no ground-based navigation aids at the departure point or the arrival point. The aircraft is equipped with dual Garmin GNC420W GPS units, but the flight was being operated as a VFR flight, with reference to local geographical features only.

1.9 Communications

Both Andakombe and Sindeni airstrips are in uncontrolled airspace. The PUI was maintaining contact with the Lae flight service unit, which was providing a SARWATCH service on High Frequency (HF) radio. The PUI also made broadcasts of his position and intentions on the VHF area frequency, 120.7 MHz. After the aircraft came to rest, the PUI was able to contact the Lae flight service unit and inform them of the landing occurrence.

A community HF radio permits the communication of weather data and booking requests to the Company base in Goroka, on several mission frequencies, but these frequencies are not available for aircraft use.

1.10 Aerodrome Information

a) Sindeni Airstrip Information

Elevation	5350' AMSL
Runways	10/28
Published length	600m
Width	30m
Slope	9.8% longitudinal, 3% transverse
Surface	coronus, gravel, grass

Sindeni is alternately spelled as Sendeni in some publications. The airstrip is located in the Eastern Highlands Province of PNG at position S 07°00.43', E 145°48.00' It is located in a narrow river valley and is surrounded by high terrain. It has been constructed relatively recently, and was licensed by the PNG CAA in 1999.

The runway strip is orientated 280°/100°. It is located on the sloping side of a steep river valley and is oriented almost perpendicular to the river direction. The airstrip permits one-way operations only due to rapidly up sloping terrain to the west and southwest. Landings are conducted on runway 28, and take-offs on runway 10.

Although the published length of the airstrip is 600 m, a survey during the occurrence investigation revealed that the runway length available was only 557 m. It appears that the runway threshold markers may have been displaced further from the cliff face than when the airstrip was first built.

The average runway longitudinal slope is 9.8% down towards the east, with some portions sloped as greatly as 13.7%. The slope in the touchdown zone is less than 5%. A transverse slope of 3% down towards the north exists at the threshold of runway 10.

Runway markings are provided by white fibreglass cones that are situated along the sides of the runway at intervals of about 60 m. Three white fibreglass cones in the shape of an L are used to mark the corners of both runway ends. These cones are not fixed to the runway surface, and there was evidence that some of them had been moved at the time of the on-site inspection.

Two windsocks are installed along the south side of the airstrip. One is near the runway threshold, and the other is located approximately 160m further toward the west. The threshold windsock is intended to indicate touch down area winds, and tends to more accurately indicate river valley winds. The more westerly sock is intended to indicate winds in the sheltered area of the airstrip. When the two windsocks indicate different wind directions and velocities, pilots understand this to mean that turbulence on approach is likely.

The surface of the runway is coronus, gravel and grass. Grass on the runway surface was less than 5 cm tall, and mostly brown due to lack of moisture.

In general the runway surface was very hard due to the lack of rain in the previous month. There are areas of coronus bedrock very close to the runway surface in the touchdown area which would remain hard despite heavy rain.

Water drainage is designed to take place off each side of the runway. There are ditches dug along the south perimeter and the western end of the runway to facilitate this

Maintenance of the airstrip is undertaken by the community at Sindeni.

b) Aerodrome Categorisation and Documentation

The Company uses an airstrip classification system that places airstrip in one of three categories, A, B, or C. This is based on length, slope and surface condition. The most restrictive airstrip category is category C. Airstrips that are less than 600 meters long, and have a slope of less than 5% or airstrips that are less than 500 m long and have a slope of greater than 5% are classified as category C airstrips. Other airstrips that don't meet these requirements, but require a high level of flight crew member skill for operations, may also be accorded a category C rating.

Sindeni, documented as 600 meters long, with a 10% slope, was classed as a C category airstrip.

The Chief Pilot's office, in conjunction with the regional Aviation Resources Division, produces aerodrome charts which outline the general details of the airstrip and the surrounding terrain, provide general circuit instructions, specific aircraft type performance limits, as well as cautions and other operational information.

These charts are considered to be a part of the Route and Aerodrome Guide, a copy of which can be carried by each company pilot and is available to him or her in flight. At the time of the occurrence, the RAG had only been issued to operating bases, and was available at the Goroka base for pilot reference.

On the aerodrome chart, a committal point, i.e. the last point at which a go-around can be safely conducted, is identified. For Sindeni airstrip, this committal point is positioned at a location about three quarters of the way down the final approach path and before reaching the cliff just before the runway threshold.

The occurrence pilots were carrying an airstrip "Mini Manual". This manual contains the basic information on each airstrip but does not include GA8 performance information, an airstrip diagram or details of the committal point. The pilots were carrying GA8 performance information as a separate document.

1.11 Flight Recorders

The occurrence aircraft was not fitted with a flight data recorder. Engine parameter data was recorded in the JPI instruments EDM 800 engine data monitoring instrument which was located in the left-hand instrument panel. At the recording interval set by the equipment, parameters for 20 hours of engine operation were recorded, and this was successfully downloaded. This included data for the entire history of the replacement engine as well as some data from the previously installed engine.

This unit captures individual cylinder head temperatures, individual cylinder exhaust gas temperatures, turbocharger inlet temperature, oil temperature, engine RPM, manifold pressure, fuel flow, and electrical bus voltage.

The engine RPM sensor for the EDM 800 unit was apparently unserviceable, and no engine RPM information was available for download.

This aircraft was not fitted with an automatic flight following device, as are some other company GA8 aircraft, so there was no storage of flight related data that could have assisted in the investigation of this occurrence.

1.12 Wreckage and Impact Information

Refer to appendix A for diagram of marks and wreckage.

From marks observed at Sindeni airstrip, the aircraft initial touchdown point was 9.6 meters before the threshold and slightly right of the extended runway centreline. The left-hand main wheel struck the ground first, followed by the left rear corner of the cargo pod, the right main gear, and the nose wheel shortly thereafter. Shortly after the left main wheel struck the ground, the wheel and stub axle assembly were separated from the main gear leg. This assembly bounced up and struck the left side of the aircraft vertical stabilizer with great force, severely damaging it.

The main gear leg tube then dug into the runway surface, and was broken off near the fuselage attach point. The aircraft then settled onto the cargo pod, which began to collapse as the aircraft continued to move forward. After the nose wheel struck the runway, the nose wheel axle bolt pulled through the retaining caps, and the fork broke into three pieces, liberating the wheel and axle assembly. This allowed the aircraft nose to descend to the point where the aircraft propeller struck the ground and engine stoppage resulted.

After the engine stopped, the aircraft continued to slide up the runway, sliding on the aircraft pod, the right main wheel, and the nose oleo.

At a point approximately 55 meters from the threshold, the nose oleo encountered softer ground and began to dig more deeply into the surface. The aircraft tail began to swing to the left, the left wing dipped and touched the runway surface, and the aircraft came to a halt at 81.8 meters from the threshold. The aircraft nose came to rest at 90° from the runway direction.

1.13 Medical and Pathological Information

One passenger received a laceration on his left eyebrow and received first aid at Sindeni airstrip.

The pilot crewmembers and the passengers were all transported to medical facilities in Goroka several hours after the occurrence for examination (including x-rays) by medical doctors. Apart from some bruising and soreness, pilots were not found to be suffering from any injury. The passenger with a laceration was subsequently treated by a medical facility in Goroka. Medical doctors reported no other injuries to passengers, apart from some bruising. Passengers were given a course of antibiotics as a precaution and released.

1.14 Fire

There was no fire.

1.15 Survival Aspects

The airframe showed indications consistent with the absorption of vertical impact energy. The deformation of the left main landing gear leg assembly, the crushing of the cargo pod, the failure of the nose gear fork, and the movement of fuselage skin in the landing gear areas all testified to large vertical loads.

The pilots were wearing a four point lap belt and over the shoulder inertia reel harness, and were seated on crew seats that are certificated under the most recent requirements of US CFR part 23. Both seats showed evidence of deformation and crushing in the structure surrounding the seat rail attachments. The greatest deformation on both seats occurred near the aft left-hand seat attachment.

Crewmembers were uninjured in the occurrence, although one pilot later reported a sore back.

The passengers were seated in row 2 right, and row 3 left and right. The passengers' seat restraints consisted of a lap belt and a single point inertia reel shoulder harness anchored to the cabin wall aft of each seat. Evidence gathered at passenger interviews after the occurrence indicated that at least two of the passengers were not properly wearing the shoulder harness at the time aircraft struck the ground. It is likely that they had swung an arm up so as to tuck the shoulder harness underneath it. This reduced the effectiveness of their upper body restraint, and resulted in one passenger striking the shoulder harness guide on the seat back in front of his seat position which resulted in a laceration to his eyebrow. A second passenger reported sore ribs under his arm from where he also had tucked the shoulder harness.

Passenger seating also showed evidence of crushing and deformation in the area surrounding the seat attachments. The greatest deformation of seat structure was found on the seat in the row 3 left position. All seats where passengers were seated showed more deformation near the aft left hand seat attachment.

The cabin area was intact and undamaged. Cargo located behind the aft barrier net remained restrained in the occurrence. The two pilots were both able to exit the aircraft normally through the crew doors, and the rear passenger door was able to be opened from the outside in the normal fashion to allow the passengers to exit.

The aircraft was equipped with an Artex 406 MHz emergency locator transmitter (ELT). There was no automatic activation of this device. It appears that horizontal impact forces were insufficient to activate the ELT. The ELT unit was subsequently tested and found to be serviceable.

This aircraft was not fitted with an automatic flight following device, as are some other company GA8 aircraft, so there was no opportunity to test emergency functioning of this device.

1.16 Tests and Research

a) ELT

The aircraft ELT was inspected and functionally tested, and determined to be operating within the manufacturer's specification, which requires that a minimum deceleration force of 2g in the velocity axis parallel with the aircraft longitudinal axis is required to activate the "g" switch. Assuming 70 kt approach speed and a uniform deceleration over distance of approximately 90m, horizontal deceleration force would have been less than 1g.

b) Engine response to power lever application

Testing was carried out concerning the engine acceleration time from idle. The turbocharged engine in the GA8 TC accelerates more slowly from idle then the normally aspirated engine in the GA8 does.

At equivalent density altitudes, another Company aircraft of the same type demonstrated a consistent 7 second response time from idle to full power. Discussion with the engine manufacturer's representative determined that engine manifold pressure indication lagged actual engine manifold pressure due to an orifice in the line to the indicator.

Subsequent testing of the occurrence engine was carried out at an independent facility test stand, which included accelerating it at different rates from idle RPM of 700 to 2000 RPM. It achieved normal and expected performance on every test. The engine test facility is located near sea level, so no there was no ability to test the engine performance at a higher density altitude. The facility concluded testing by stating that the engine could not be faulted, and performed normally in all aspects of its operation.

A recent brief investigation with a factory new GA8-TC 320 aircraft indicated that the engine installed in this aircraft would accelerate from idle to full power in 4 seconds. This test was performed at a lower density altitude than the occurrence altitude. It appears that an engine at a higher altitude takes longer to accelerate to full power than one at sea level does.

Investigation into the turbocharged Lycoming engine variant found in the Cessna Turbo 206 H carried out in another region indicates that there were concerns that it accelerated more slowly than the Teledyne Continental engine powered Turbo 206G did. The physical size and operating limits of the turbocharger unit on the 206H are different than those of the Lycoming engine variant installed in the GA8-TC 320.

c) **Landing gear component failure**

There have been two concerns expressed about landing gear component failures. The first was that main landing gear leg deformation and failure seemed to occur at lower vertical loads than has been the case with the Cessna 206 (leg deformation has also been seen in other incidents).

The second was the failure in this occurrence of the nose landing gear fork in two places, which liberated the nose wheel. This too was a failure type that hasn't been seen in other Company landing occurrences with the Cessna 206. Laboratory testing of these components determined that they met the required material specifications and had all failed in ductile overload, with no pre-existing fatigue indications. A laboratory report is attached in appendix B.

1.17 Organizational and Management Information

The company operations training structure in PNG has four levels of authorization for Instructor Pilots (IP) and Examiner Pilots (EP), which is managed by the Chief Pilot, who is the senior person for flight operations in PNG. There are two levels of IP authorization. The first of these is for route and aerodrome familiarization only. The second level is for aircraft type endorsement training. The EP authorization requires that pilots have held both IP authorizations and have gained the necessary training experience.

A senior level EP on each aircraft type is granted a Senior Pilot authorization. This position requires the holder to be the responsible person for arranging pilot airstrip checking, and to be a resource for other pilots operating the aircraft type. The PIC of the occurrence flight was the holder of the Senior Pilot authorization for the GA8 aircraft type.

In 2008, the Company reinstituted a regional standards organization whose function was to develop organizational standards and take responsibility for the production of operational documentation implementing those standards. At present, the responsibilities and function of this group have not been documented in PNG program operating procedures manuals.

1.18 Additional Information

a) Approach speed calculation

The Company GA8 procedure outlines the requirement to calculate and then fly a specific approach reference airspeed to achieve optimal short field landing performance. The procedure specifies a speed of 66 knots for the aircraft at maximum landing weight to a level airstrip in still air. This speed is then adjusted for aircraft weight, airstrip touchdown area slope, and for wind.

For the approach into Sindeni, because the touchdown area is almost level, and the aircraft was almost at maximum landing weight, no adjustments needed to be made to approach speed.

The company operations procedure also specifies that for operations in gusty conditions, the approach speed may be increased by adding 50% of the gust speed. If wind shear is also expected, an additional increase in approach speed should be considered. Based on this requirement, a 5 kt gusting wind would require a pilot to consider an additional speed increment of 2 to 3 kt or more, if it was thought that wind shear would be a factor and runway length would permit the higher-approach speed.

The PUI indicated that the crew had briefed for a target speed of 70 kt for the approach.

b) Circuit and landing procedures

The Company GA8 procedure calls for a circuit to be flown at a height of 800 feet above the airstrip elevation for airstrips located in the highlands areas of PNG. Based on this, the circuit at Sindeni would be flown at a height of 6150 feet on the area altimeter setting (area QNH).

Terrain and weather conditions can affect achieving an ideal circuit at Sindeni, but in order to arrive on final approach at the correct height, speed and aircraft configuration, there is a requirement that the height, speed and aircraft configuration conditions are met by the end of the downwind leg of the circuit.

Company operations procedures also require that the aircraft must be stable, i.e. at the correct speed, configuration, rate of descent and power settings and with all checklists completed by 300 feet above the airstrip or a go around must be conducted. Where there is a committal point identified, the stabilised condition must be met by the committal point if this occurs prior to the 300 foot point.

The Company General Operating Procedures Manual states that "On shorter runways pilots should aim to touchdown as soon as possible after the beginning of the runway. On longer runways, landings further in may be made, provided braking requirements and runway condition are taken into account."

1.19 Useful or Effective Investigation Techniques

None specified in this report.

2 Analysis

2.1 Weather conditions

Local weather conditions at the time of the occurrence were not unusual for the river valley in which Sindeni is located. During the course of the day, as the sun warms the surrounding mountains, anabatic winds are generated, and an up-valley wind commences. This wind can generate substantial mechanical turbulence as it flows across the various ridges that project into the river valley. It is common at this time of the year for there to be hotter days with less cloud and therefore a greater incidence of anabatic and up valley winds.

Because Sindeni is situated almost perpendicular to the up valley wind direction, and the threshold of the runway is situated on a ridge that projects into the valley, it is common for aircraft to encounter up- and down-drafts on the final approach to landing there. The Company route and aerodrome guide contains the following caution: POSSIBLE DOWNDRAFT ON SHORT FINAL.

It appears that the hot dry weather had lasted for longer than is usually the case in this season. Other pilots had reported that the winds had been very strong on some days, and that they were unwilling to attempt a landing.

On the morning of the occurrence, the winds and turbulence at Andakombe airstrip were noticed to be increasing by the pilots. They then noticed stronger turbulence at Sindeni, but reported a quartering tailwind of only 5 kt on the windsock. This turbulence caused the pilots to change their aiming point to a point further down the runway, which would allow them to be at a higher altitude over the runway threshold.

The PIC considered that the level of wind showing on the windsock was insufficient to indicate the possibility of a "strong" downdraft on final, although he had briefed with the PUI about the possibility of a go-around. This may have been based on his knowledge of the performance of other aircraft types that he had operated to Sindeni in turbulent conditions, but his experience to other similar airstrips in the GA8 should have given him a broad knowledge of GA8 landing performance.

On the morning of the airstrip site investigation, one of the investigation team was delivered to the airstrip in a Cessna 206 operated by another organization. The pilot of that aircraft had not previously operated to Sindeni. Faced with the same inconsistent winds indicating on the windsock, the pilot commenced the approach only to encounter the same updraft/downdraft pattern that occurred to the occurrence pilots. The pilot carried out a go- around procedure, and a second approach was completed to a landing.

2.2 Airstrip

Sindeni airstrip, although located in a narrow highlands river valley, and noted for its downdrafts, has no special training precautions attached to it. At a licensed length of 600 m and 9.8% slope, Sindeni was a category C airstrip, but many PNG Highlands airstrips are category C. Sindeni is wider, longer, and firmer than many others.
Some airstrips in PNG have a "curfew" placed on them. This is an operational limitation on an airstrip based on the time of day. This curfew may limit or prohibit operations by all

aircraft or certain aircraft types after a certain time of day. This is commonly used when a regular, known hazard is likely to occur i.e. excessive tailwinds or turbulence.

Generally, however, the Company weight penalty system for landings is considered appropriate for mitigating tailwind risk. Company management staff may have considered a curfew unnecessary, based on the random or more seasonal nature of the tailwinds and downdrafts. It is possible that they felt a curfew unnecessary based on the performance of the DHC6 and Cessna 206 types that have been operating there before the advent of the GA8.

In PNG, the Company further categorizes airstrips based on their technical difficulty. This could be because of their shorter length, more difficult circuit, or other unusual features. These airstrips are generally not available for solo operations by new pilots until they have a certain minimum experience in country. These category C airstrips may be categorized as a "150 hour" or "250 hour" airstrips.

A new pilot will not be allowed to operate solo into a 150 hour airstrip until he has a minimum of 150 hours experience on the senior pilot is satisfied with the pilots ability. A pilot will not be approved to operate into any 250 hour airstrip until he has passed a flight check with a checking pilot and demonstrated competence in operations to some representative 250 hour airstrips.

As of the date of the occurrence, the Company had not chosen to categorize Sindeni as a 150 hour or 250 hour airstrip, so there has been no other recognition of turbulence related issues, or limitations placed on operations there. This may be more necessary with the introduction of GA8 operations there.

Neither pilot was aware that the airstrip was only 557 m long, and not 600 m as indicated in the Company route and aerodrome guide. There is no indication that anyone in the Company was aware that the airstrip was actually shorter than its published length. This would not have made a difference to GA8 aircraft performance requirements, given the large upslope of the landing runway.

The Company GA8 operations procedures require that pilots calculate their reference approach airspeed based on the slope of the touchdown area of the runway, but the Company route and aerodrome guide has no facility to report this information. Pilots are setting this speed based on their local airstrip knowledge.

These airstrip survey concerns were already known to the Company, but implementation of new airstrip survey standards had not been completed countrywide by the date of the occurrence, and regional management had not produced a route and aerodrome guide template with a touchdown area slope field.

Although the PIC had operated to this airstrip numerous times before, he had operated to Sindeni only twice in the GA8-TC 320, and only once in the right-hand seat of that aircraft type. He had over 600 hours of experience operating the GA8 aircraft, but the GA8 aircraft type had not been used extensively in this region of the country, and so there was no pilot who had a great deal of GA8 experience to Sindeni. The PUI had landed at Sindeni once on a previous occasion, which was in the GA8-TC 320 aircraft.

2.3 Circuit operations

Although the Company route and aerodrome guide specified a left-hand circuit for approach to Sindeni in the aerodrome diagram, the pilots elected to fly a right-hand circuit. This did not appear to be due to weather pressure, but provided the PUI the opportunity to observe both windsocks while allowing for a simpler approach. This may not have permitted PUI to easily monitor the wind on the downwind and base legs to allow him to observe trends. The approach speed chosen by the pilots was sufficient for the conditions the initially observed, but did not allow any reserve for a stronger wind gust.

The PIC felt that the location of the committal point was perhaps a little early, and considered they go around when the aircraft initially encountered on updraft just after the PUI called committed, but he felt it was more important that the PUI follow-through with the committal decision that he had made. At that initial stage, he felt that the PUI was acting appropriately under the circumstances and was satisfied to let him continue. The PIC did not consider it necessary to take control of the aircraft at that time either, although he felt the PUI may have responded a little slower than he would have in the same situation, because he felt there was nothing additional that could be done. The updraft moved the airplane slightly above glide slope and right of centre line, although the PUI had selected the throttle to idle to try to prevent this.

The PIC felt that the strength of the downdraft on short final was greater than anything he had encountered before at that airstrip. It is possible that this may have been due to their relative unfamiliarity with the response of the GA8 TC 320 in this type of situation. The PIC called to the PUI to add power as he appreciated the magnitude of the downdraft and its affect on the aircraft. The PUI felt sure that the throttle had been moved to the full throttle position before the aircraft struck the ground, but there is no way to ascertain this.

Neither pilot recalls having heard the stall horn. It appears unlikely that the aircraft slowed to stalling speed in the downdraft. It is more likely that the pilots were unable to sufficiently arrest the rate of sink with the speed and power available to them, before the aircraft struck the ground. Wheel marks at impact indicated that the aircraft was in an attitude that allowed the left main wheel to strike the ground first, at a position that was slightly right of the runway centreline, and about 10 m before the threshold.

2.4 Engine Performance

Both pilots reported after the occurrence that they felt the engine was not developing full power, on short final at Sindeni, although they said full power had been selected with the throttle. Data from the EDM 800 is inconclusive. The maximum manifold pressure reading was only 27"which is well below the maximum of 38" at that altitude. RPM indications were not available due to failure of the RPM sensor at an earlier date. A high fuel flow indication recorded would signify a large and rapid throttle opening.

The engine manufacturer indicated that manifold pressure indication would lag the actual manifold pressure being produced on a rapid acceleration due to a restrictor orifice in the pressure line to the cockpit indicator. The EDM 800 manifold pressure sensor uses the same pressure line for its reference source.

Engine testing carried out on the engine after the occurrence indicated that it was operating normally.

Thrust bending of propeller blades was not as great as would normally be expected for a propeller striking the ground at full power.

Testing engine acceleration response in another GA8-TC 320 aircraft at an identical density altitude delivered an average response time of 7 seconds from idle to full power. This was reported on the aircraft EDM 800 equipment which was later downloaded.

A new GA8-TC 320 aircraft recently delivered to the Company was tested for throttle response, although not in identical density altitude conditions, and delivered a response time of 4 seconds from idle to full power.

It appears that engine throttle response time is directly related to the adjustment of the turbocharger wastegate. The wastegate is adjusted by engineering based on the need to achieve a specified “critical altitude” (a density altitude where maximum manifold pressure is still available), which is determined by the manufacturer based on maximum turbocharger RPM limits plus a safety factor. As a result, faster throttle response is limited at higher density altitudes by the maximum RPM of the turbocharger impeller.

MAF experience to date has been that the “critical altitude” of the engine often needs adjusting, after the engine has had a short period of operation. It is important that this be checked on a regular basis, so that throttle response times are not affected as well.

It is possible that completely full power was not selected by the pilots, or that the engine could not adequately accelerate in the number of seconds before impact with the given density altitude.

Neither pilot was aware that the turbocharged Lycoming engine would require as long to accelerate as has been demonstrated in testing, nor were any senior pilots in the Company aware of this. Pilots are made aware of the generally slower acceleration time of turbocharged engines, and are cautioned about operating them at idle power settings on final approach.

Recent testing indicates that a longer acceleration time is required for a turbocharged Lycoming engine as found in the GA8 than is required for a turbocharged Continental engine as found in the Cessna 206. Had the pilots been aware of this, they may have been less likely to move the throttle to idle so close to the runway threshold on final approach.

2.5 Introduction of the GA8-TC 320

The first turbocharged GA8 Airvan arrived in PNG in May, 2009. This was the final outcome of a long process that had begun in April of 2005. The Company was seeking a replacement for the Cessna 206, and reducing the age of its fleet.

Initially, several normally aspirated GA8 Airvans were operated in PNG, but the type was not considered suitable for highlands use without a turbocharged engine. Limited highlands operations were carried out, but the aircraft was not extensively introduced into the highlands because of the significant take-off performance penalties that were due to the lack of engine power.

Other performance differences that were noticed, in relation to the Cessna 206, were the requirement for a higher approach speed, the need for a lower power setting on final approach due to the "cleaner" airframe, and greater residual lift on landing rollout, which affected braking.

It was apparent that the GA8 was not going to be an exact replacement of the Cessna 206. A significant amount of operational experience has been gained by the Company while operating the GA8 in the lowlands of PNG, and the aircraft has been made to "fit in" to the program in many areas.

New performance criteria were specified to allow for the higher approach speeds, and procedures were put into place to mitigate against residual lift concerns. The manufacturer has also been receptive to suggestions for modification and improvement although sometimes slow in implementing them.

When the turbocharged GA8 aircraft was first made available to the Company, it was considered to be simply a more powerful variant of an aircraft that was already known. It was now an aircraft that could be used more effectively by the Company for highlands work. As a result, there was very little formal evaluation of the GA8-TC 320 in the PNG highlands by regional management. There was no process for a phased introduction of the type, requiring benchmarking or an evaluation process for changes to procedures.

The process was made more complex by some early maintenance issues. An initial engine mixture setting/fueling issue caused the engine of one GA8-TC 320 aircraft to run overly rich at idle, and a turbocharger critical altitude issue affected the operation of another aircraft. After a great deal of maintenance troubleshooting, this first issue was traced to a faulty engine driven fuel pump, and the second to a turbocharger waste gate problem.

Because the GA8 aircraft has less drag with full flaps than a C206, less power is required on final to maintain a given approach gradient. This means that the Lycoming engine in the GA8-TC 320 is operating more closely to idle and requires a greater advance to full power than the Continental engine in the C206 does. The further acceleration required, and the observed lower acceleration rate, mean that more time is required to accelerate the engine to a higher power setting when this is urgently needed.

In the introductory period, some consideration was given towards using a slightly flatter approach gradient that would allow more power to be carried on final approach, but this technique was not implemented for general operations of the type.

Total implementation of the turbocharged variant required that it operate into some of the more challenging airstrips in the Eastern Highlands and Morobe provinces, where there was almost no GA8 experience to date, although approximately 900 operations had occurred in similar airstrips in the Western Highlands and Sandaun Provinces before the occurrence.

Operating conditions such as a higher likelihood of strong wind related mechanical turbulence, higher density altitudes, and rougher airstrip surfaces are much more likely to be associated with highlands airstrips, especially in rugged areas like Morobe Province or the Eastern Highlands Province.

The combination of these additional "highlands" factors against the engine acceleration rate, the lower required power setting, the higher approach speed and residual lift issues were not effectively measured or fully known.

The regional management did not seek any external advice about the operation of turbocharged Lycoming engines in highlands areas, although other regions have operated the TU206H with a similarly configured Lycoming turbocharged engine. This aircraft was extensively tested in the head office location of another region before it was operated in an overseas program.

2.6 Pilot Orientation and Training

The occurrence flight was an operational training flight with the PUI operating as a supervised PIC. The PUI was new to the Company and to operations in PNG and was undergoing an orientation into the country, and a familiarisation to airstrips and routes in the local area.

The process for pilot induction and orientation of new pilots presently includes a "technical standardisation" element that introduces new pilots to Company policy and procedures, and operations into unimproved airstrips. This is not conducted in PNG.

After successful completion of this, pilots commence a program of orientation training in PNG. This consists of an initial period of dedicated aircraft training over representative routes and into a number of representative airstrips that is conducted without passengers and with no operational program. Multiple circuits, landings, and go-arounds can be practiced at various airstrips, and familiarisation with terrain elements, weather, and radio communications etc. are carried out.

After this period, a phased introduction to limited operational flying is commenced, with the carriage of passengers, and the introduction of operational schedule elements. The first phase of training is normally carried out with a senior IP. All pre-solo operations are carried out with an IP who holds an authorisation as a training pilot, rather than just a supervisory pilot qualification.

At the conclusion of the orientation training and supervised flying period, the new pilot must demonstrate competence to the type Senior Pilot before receiving an authorisation to operate as PIC on Company operations. After solo authorisation, further check in may be carried out by an IP authorised for route and airstrip familiarisation only.

Because dedicated training is carried out only to representative airstrips, a new pilot may not have received his initial check-in to a particular airstrip in an operation without passengers. Instructor pilots exercise their discretion about which airstrips require a check-in with a demonstrated go-around, or which will be done without passengers.

Because standardisation and training elements have been extensively changed in the last two years, there has been a concern raised that there may be gaps in understanding which elements have been carried out by which parts of the organisation. The program local area orientation elements have also undergone significant change in the last two years. Coordination of training requirements may have been affected as a result of this.

A requirement for an external standard or review to be applied to these changes in the training program, and especially the pilot induction training program in PNG, would have helped with coordination of training elements across the organisation.

The PUI had less total flying experience than had traditionally been required for entry to this program. Previously a 1000 hour experience requirement was in place. After a review of required competencies, pilot experience requirements were reduced, and an increased standardisation element, with required experiences and competencies, was developed. A process for requiring increased supervision of the pilot in PNG, if required, was not undertaken. The pilot had completed the first phase of in-country orientation, and had commenced supervised line operations at the time of the occurrence. He had 67 hours experience in dual and supervised PIC operations in country at the time of the occurrence.

There is relatively little instructor experience on the GA8-TC-320 (in relation to other types operated), due to the fact that instruction on this type has been spread between several instructors, and there is relatively little overall experience operating the type generally. This may have bearing on the decision to be operating it into "newer" and more challenging (to the aircraft type) highlands airstrips with an inexperienced PUI.

Because operational program requirements for operations in the EHP area result in operations being needed into more challenging airstrips in combination with easier ones (to position the aircraft in the area) this results in the PUI being exposed to challenging airstrips before he may be required to operate solo, and at an experience level well before he would be expected to operate solo into these airstrips. It may have been appropriate to categorise airstrips like Kora or Sindeni as "150 hour" or "250 hour" airstrips, with resultant training considerations.

Pilot inexperience on the aircraft type, in the country, and at that location may have resulted in him responding to the downdraft more slowly than an experienced pilot may have. While it may not have been appropriate for the PIC to take over as pilot flying at that late stage, the increased possibility of a difficult situation at Sindeni should have been more fully considered by the IP. There must be an allowance for inexperience and reaction time that the PIC is able to accept.

Although there was a decision by the PIC to consider an adjusted aiming point for the landing, this did not fully mitigate against the risks of an inappropriate response by the PUI to operating conditions, which had been shown to be an intermittent factor in operations over the one week period previous to the occurrence, and on the day of the occurrence, when landing at Andakombe.

These decisions are very hard to make by an IP flying a program and dealing with other operational concerns and pressures. It would have been more appropriate for a more structured framework for orientation and area check-in to be in place. This is especially true in the light of the limited experience of the crew with the turbocharged GA8 aircraft to this airstrip.

The above factors, weighed together, and considered in conjunction with the known wind issues, and actual weather there, should have raised questions about the suitability of operations by the PUI as pilot flying there, at his stage of experience.

2.7 GA8 Damage Issues

Seat damage and deformation as a result of hard landings is an expected consequence of a seat structure designed to collapse while absorbing impact loads. This feature has likely been key in reducing the effect of the vertical impact forces on crew and passengers in the aircraft. All occupied seats showed evidence of deformation.

GA8 seat bases are very intolerant of handling abuse, and require frequent replacement from "normal" wear and tear. It is important that they are in an appropriate condition to function as designed.

The failure mechanism of some key landing gear components in the initial accident sequence has considerably increased the consequential damage to the aircraft.

The initial liberation of the left main gear axle stub from the main gear leg resulted in the torsional failure of the main gear leg and the vertical stabilizer being in significantly damaged by the wheel assembly striking it. The axle stub is secured to the main gear leg using a socket with an interference fit and 2 AN bolts to locate it on the leg.

The failure of the nose landing gear fork resulted in propeller damage and subsequent engine stoppage. While some level of collapse or damage is common in occurrences that involve a high vertical velocity, a failure of the landing gear fork component has not been common, in Company experience.

More significantly, the failure of the fork allowed the oleo assembly, which is attached to the firewall with a great deal of structure, to dig into the ground. The subsequent deceleration forces from the oleo plowing through the runway surface would have almost certainly resulted in the aircraft overturning if the surface had not been in an abnormally hard, dry, condition.

As the oleo stub dug in more deeply, approximately 65 m after touchdown, runway marks indicate that the aircraft decelerated strongly enough that the right main wheel lifted off the ground and the aircraft pivoted almost 90° in a clockwise direction. Both pilots indicated that they felt the aircraft was "going to go over". An aircraft overturn would have considerably increased the risk of passenger injury and the likelihood of more serious aircraft damage.

The rigidly mounted nose gear oleo leg did not appear to have shifted significantly, or deformed at all in the occurrence. Investigation of the nose fork and axle attaching bolt components indicate that material specification was correct, and the parts have failed as a result of a severe overload. There should be thought given to having a more robust nose wheel fork to reduce the likelihood of an aircraft overturn in a future landing occurrence.

Further monitoring and tracking of GA8 main landing gear leg damage is required, in the light of this and three other Company incidences of bent main gear legs. Laboratory tests conducted on the occurrence aircraft left main gear leg indicated that material specification was correct, and that failure was the result of overload, with no other failure mechanism present. Two of the three previous damage events have been the subsequent result of reported hard landings, but one was not. This has not been so much of a problem in other programs where the aircraft is operated.

Other landing gear damage events should be documented, so that landing gear robustness is factored when considering aircraft suitability for operations to rougher PNG highlands airstrips, in 2.5 above.

2.8 ELT

The ELT in the occurrence aircraft, although fully functional, and installed in accordance with the requirements of TSO C126, did not automatically activate. The specification for the unit calls for a "G" switch threshold activation limit of 2g in the velocity axis parallel with the aircraft longitudinal axis. The unit is designed not to be triggered by vertical forces. Assuming a 70 kt approach speed and a uniform deceleration over a distance of approximately 90m, horizontal deceleration force would have been less than 1g. An analysis of the impact forces indicates that most of them were in a vertical direction rather than horizontal.

Considering the type of aircraft the company operates, and the low speeds traditionally used during takeoff and landing, it may be more appropriate to consider an alternate positioning of the ELT, or installing other more suitable equipment which would operate after detecting significant vertical forces. An impact with the forces seen in this occurrence could have potentially been disabling to the pilots, and an automatic activation of the ELT should occur in such situations.

Helicopter installations of a similar ELT require that it be mounted in a different position to more readily activate after slower (forward) speed impacts, or have a different "G" switch design.

The Indigo1 satellite flight following unit installed on some other Company aircraft has a provision to sense, record, and transmit an alert message to a monitoring station when the aircraft undergoes a "hard landing" (high vertical G force) event.

Moving the ELT to an alternate position would presently affect compliance with TSO C126 for the aircraft unit.

3 Conclusions

3.1 Cause Related Findings

a) Landing approach
The winds, updrafts and downdrafts, at a period of time only 4-5 s before touchdown contributed to destabilizing the approach and resulted in the aircraft landing short of the desired touchdown point with a high vertical velocity.

b) Engine acceleration time
The engine had insufficient time to accelerate to full power in the time between the commencement of the downdraft and the aircraft impact with the runway surface. This likely reduced the ability of the aircraft to out-climb the downdraft, or to sufficiently reduce the rate of vertical descent.

c) Left main landing gear failure mode
The liberation of the left main gear axle stub from the landing gear leg very shortly after impact resulted in the torsional failure of the gear leg. This in turn significantly contributed to the amount of damage that the aircraft sustained to the pod and vertical stabilizer.

d) Nose landing gear fork failure
The failure of the (optional 8.00x6) nose landing gear fork shortly after the wheel contacted the airstrip surface resulted in considerably more damage to the aircraft engine, propeller, and front fuselage than may have otherwise resulted and significantly increased the risk of the aircraft overturning.

e) Airstrip surface
The hard, abnormally dry ground in the runway touchdown zone did not absorb as much impact load as might normally have been the case for a grassed soil airstrip. This likely increased the impact load that was transmitted to the airframe. The hard dry ground and coronus in the first 70 m of the airstrip prevented the nose oleo from digging into the runway surface and causing the aircraft to overturn, which would have most likely been the case if the surface had been soft.

f) Runway aiming point
The decision of the pilots to nominate an aiming point farther down the runway due to indications of some turbulence may have resulted in the aircraft landing on the prepared surface of the runway (although short of the indicated start of the runway threshold area) rather than it impacting the lip of the cliff face if the normal aiming point had been selected.

g) Incorrect shoulder harness positioning
At least two of the three passengers were wearing the shoulder harness incorrectly at the time of the occurrence, in spite of indications from the pilots that all aircraft were wearing it correctly at the time of departure from Andakombe.

This contributed to the row 3 left passenger receiving a cut to his eyebrow from the shoulder harness guide on the row 2 left seat.

h) Pilot actions
The PIC did not provide enough allowance for the PUI's level of experience and ability when permitting him to operate as the pilot flying for the landing at Sindeni airstrip, given the airstrip operational history, recent weather conditions, and the PUI's level of competency for landings at difficult airstrips.

3.2 Non-Cause Related Findings

a) EDM 800 RPM sensor
The non-functioning engine RPM sensor prevented the investigation from getting an accurate snapshot of engine RPM at the time of the occurrence.

b) ELT
The ELT, while armed, and fully functional, did not receive enough of a horizontal impact to activate, despite the level of aircraft damage.

c) Shoulder harness guide
The rear side of the shoulder harness guide has a sharp edge that increases the risk of passenger head injury in an aircraft impact

d) Landing configuration of the GA8
Because the GA8 aircraft has less drag with full flaps than a C206, less power is required on final approach to maintain a given approach gradient. This means that the Lycoming engine in the GA8-TC 320 is operating more closely to idle and requires a greater power advance to full power than the Continental engine in the TU206 does. This is significant at higher density altitudes when more time is required for engine acceleration.

e) Aircraft performance
Performance differences between the TU206, GA8-TC 320, and the GA8 were not fully understood or considered in the introduction of the GA8-TC 320 aircraft to PNG. Subsequent fleet complexity issues influenced the placement of the GA8-TC 320 before this knowledge was fully acquired.

f) GA8-TC 320 Evaluation process
There was very little formal evaluation for the GA8-TC 320 in the PNG highlands. There was no clearly defined process for benchmarking and readjustment to the introduction process. Differences in operating conditions such as a higher likelihood of strong wind related mechanical turbulence, density altitude effects, rougher surfaced airstrips are more likely to be associated with highlands airstrips in PNG.
The regional management did not seek any external advice about the operation of turbocharged Lycoming engines in highlands areas, when considering the GA8

TC for PNG highlands use, although other regions have operated the TU206H with a similarly configured Lycoming turbocharged engine.

g) Instructor experience on type
There is relatively little Instructor Pilot experience on the aircraft type, due to the fact that instruction on this type has been spread between several IPs, and there is relatively little overall experience operating the type generally. This has bearing on the decision to be operating it into "newer" and more challenging (to the aircraft type) highlands airstrips with an inexperienced PUI.

h) Airstrip survey
There is presently no published procedure in regional or PNG operational documentation for ensuring that operational airstrips are regularly surveyed for conformance to Company published airstrip data, although an airstrip survey process is presently underway.

i) Airstrip classification and rating
While there have been attempts to classify airstrips at a basic level, many newer airstrips have not been classified according to difficulty, i.e. as "150 hour" or "250 hour" airstrips, with resultant considerations.

j) Training organization
The PIC was working with an insufficient framework for the initial orientation and checkout of the PUI. There was a lack of suitable guidelines and standards in place to prevent the PIC from exposing the PUI to conditions that may have been beyond his level of experience. This must be considered in relation with the regional introduction of a new aircraft type.

k) Documentation
The responsibilities and function of the regional standards and training organization have not been adequately defined and documented in PNG program operating procedures manuals or training manuals. A regional document has been produced, but this has not yet been fully implemented.

This report is the final report submitted by the investigation team, and will not be further amended unless significant new evidence comes to light. The members of the investigation team should be contacted if there are any further questions.

Lowell Deering
AP Flight Standards Manager
On behalf of the investigation team: Dave Rask
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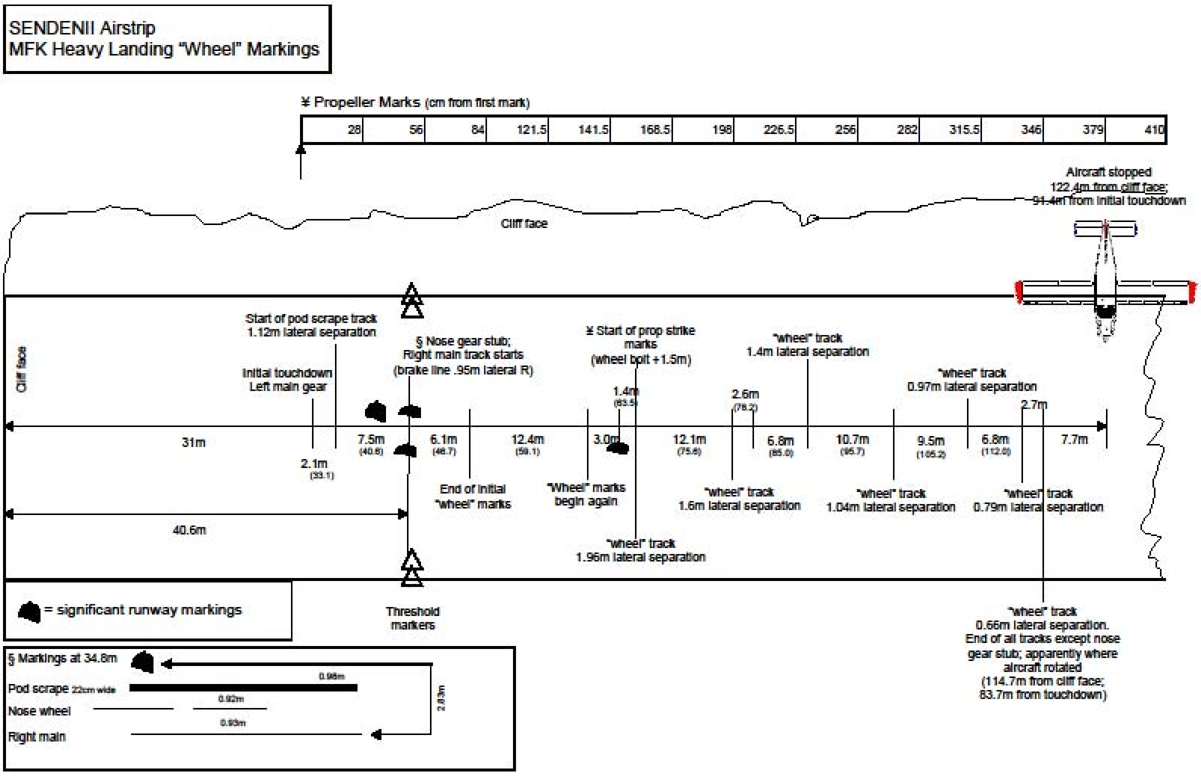
Lowell Deering

Attached:	Appendix A –	Sendeni Airstrip MFK Heavy Landing Wheel Markings Diagram
	Appendix B –	Report 4211-1071, Investigation of GA8 Landing Gear


SENDENII Airstrip
MFK Heavy Landing "Wheel" Markings
¥ Propeller Marks (cm from first mark)
28
56
84
121.5
141.5
168.5
198
226.5
256
282
315.5
346
379
410
Aircraft stopped
122.4m from cliff face;
91.4m from initial touchdown
Cliff face
Cliff face
Start of pod scrape track
1.12m lateral separation
Initial touchdown
Left main gear
§ Nose gear stub;
Right main track starts
(brake line .95m lateral R)
¥ Start of prop strike
marks
(wheel bolt +1.5m)
1.4m
(83.5)
"wheel" track
1.4m lateral separation
2.6m
(78.2)
"wheel" track
0.97m lateral separation
2.7m
31m
7.5m
(40.6)
6.1m
(46.7)
12.4m
(59.1)
3.0m
12.1m
(75.6)
6.8m
(85.0)
10.7m
(95.7)
9.5m
(105.2)
6.8m
(112.0)
7.7m
2.1m
(33.1)
End of initial
"wheel" marks
"Wheel" marks
begin again
"wheel" track
1.6m lateral separation
"wheel" track
1.04m lateral separation
"wheel" track
0.79m lateral separation
40.6m
"wheel" track
1.96m lateral separation
= significant runway markings
Threshold
markers
"wheel" track
0.66m lateral separation.
End of all tracks except nose
gear stub; apparently where
aircraft rotated
(114.7m from cliff face;
83.7m from touchdown)
§ Markings at 34.8m
Pod scrape 22cm wide
Nose wheel
Right main