

**Report 09-003, Fairchild SA227-AC Metroliner III ZK-NSS, runway excursion, New Plymouth  
Aerodrome, 31 March 2009**

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**Report 09-003**

**Fairchild SA227-AC Metroliner III  
ZK-NSS**

**runway excursion**

**New Plymouth Aerodrome**

**31 March 2009**



**Metroliner ZK-NSS**

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Unless otherwise specified, photographs and diagrams in this report are provided by the Commission.

## Executive Summary

On 30 March 2009 at 2340, a Fairchild SA227-AC Metroliner III air ambulance aeroplane, registered ZK-NSS, took off from Auckland International Airport on a night flight to New Plymouth Aerodrome to uplift a patient. On board were 2 pilots and a medical team of 3. The flight was without incident until the approach at New Plymouth.

The pilots carried out a visual approach, although that was generally not permitted by the aeroplane operator at an uncontrolled aerodrome, and without the help of approach slope indicator lights. During the landing checks the right engine did not go to high speed as selected, and the pilots were distracted in trying to find the reason. The base turn was carried out close to the aerodrome and involved a high rate of descent that generated ground proximity warnings. The pilot flying reduced the rate of descent and continued with the approach, rather than carrying out an immediate go-around.

Late on final approach the pilots realised that the aeroplane's current glide path would result in a landing very close to the runway end. The pilot flying said that he had difficulty controlling the aeroplane when power was increased, which he assumed was caused by the engine speed anomaly. He judged that it was preferable to continue and land rather than to attempt a go-around with an apparent control problem, so he left the power unchanged. The aeroplane landed heavily at the runway end and immediately ran off the side of it. No-one was injured and apart from minor damage to the tyres the aeroplane was undamaged.

The approach was rushed because of the pilots' decision to commence a visual approach from a point close to the aerodrome. The resultant high rate of descent, together with the distracting engine speed anomaly, led to the ground proximity warnings. The lack of approach slope indicator lights denied the pilots a useful aid for establishing a stable approach. The runway excursion occurred because the pilot flying had a control difficulty and was not in full control of the aeroplane during the landing.

If the pilots had conducted an instrument approach as the operator had required, the approach would likely have been stable and given them more time to deal with the engine speed issue, the cause of which was not determined. Had they applied typical cockpit resource management techniques and the operator's approach monitoring requirements had been better defined, the unstable approach should have been detected and discontinued. The lack of intervention by the pilot not flying might have been caused by a less-than-optimum trans-cockpit authority gradient.

A few days later, before the aeroplane had been released back to service, a fuel bypass event caused the right engine to run down. Trouble-shooting suggested the Single Red Line interface unit was defective. Although some defects were found in the unit, they would not have led to a fuel bypass, the cause of which remained undetermined. A fuel bypass was not considered to have occurred at New Plymouth, and the 2 events were likely to have been unrelated.

The Transport Accident Investigation Commission (the Commission) made a safety recommendation to the Director of Civil Aviation regarding delays in the notification of serious incidents to the Civil Aviation Authority and to the Commission.

## Abbreviations

AIP	Aeronautical Information Publication New Zealand
Airwork	Airwork Flight Operations Limited
ATC	air traffic control
ATSB	Australian Transport Safety Bureau
CAA	Civil Aviation Authority of New Zealand
CAR	Civil Aviation Rule
CFIT	controlled flight into terrain
CRM	crew resource management
FCU	fuel control unit
FDR	flight data recorder
FSF	Flight Safety Foundation
ft	feet
GPWS	ground proximity warning system
kts	knots
°M	(degrees) magnetic
PAPI	precision approach path indicator
PF	pilot flying
PNF	pilot not flying
RPM	revolutions per minute
SRL	Single Red Line (system)
TAIC	the Transport Accident Investigation Commission
VHF	very high frequency

## Glossary

cycle	one take-off and landing
negative torque system	a propeller feature that automatically increased the propeller pitch to reduce drag
power-plant	the combined engine-propeller installation
runway strip	a defined area, centered on a runway, that is intended to reduce the risk of damage to an aircraft that runs off the runway, and to provide obstacle protection during take-off or landing
trans-cockpit authority gradient	the effective relative status of flight deck crew members

## Acknowledgement

The Commission acknowledges the assistance of the Australian Transport Safety Bureau (ATSB) with the review of the flight data recorder (FDR) data.

## Data Summary

<b>Aircraft registration:</b>	ZK-NSS
<b>Type and serial number:</b>	Fairchild SA227-AC Metroliner III, AC692B
<b>Number and type of engines:</b>	2 Honeywell (Garrett) TPE331-11U-611 turboprop
<b>Year of manufacture:</b>	1987
<b>Operator:</b>	Airwork Flight Operations Limited
<b>Date and time:</b>	31 March 2009 at 0016 <sup>1</sup>
<b>Location:</b>	New Plymouth Aerodrome latitude: 39° 00.3' south longitude: 174° 11.1' east
<b>Type of flight:</b>	air ambulance
<b>Persons on board:</b>	flight crew: 2 passengers: 3
<b>Injuries:</b>	crew: nil passengers: nil
<b>Nature of damage:</b>	minor
<b>Pilot-in-command's licence:</b>	airline transport pilot licence (aeroplane)
<b>Pilot-in-command's age:</b>	36 years
<b>Pilot-in-command's flying experience:</b>	4100 hours, (2450 hours on type)
<b>Investigator-in-charge:</b>	P R Williams

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<sup>1</sup> Times in this report are New Zealand Daylight Time (UTC + 13 hours) and are expressed in the 24-hour format.



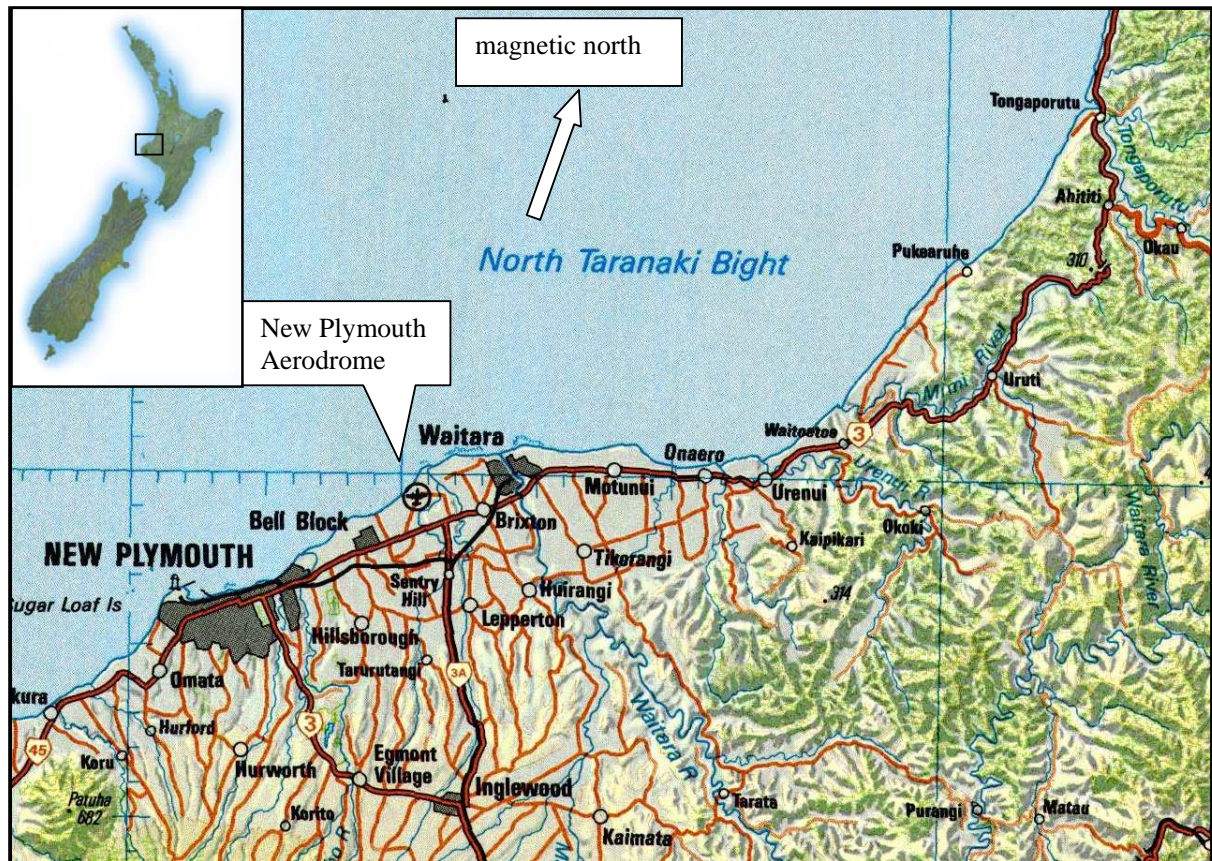


Figure 1  
Location of New Plymouth Aerodrome  
(Map Toaster, n.d.)



# 1 Factual Information

## 1.1 History of the flight

- 1.1.1 At about 2200 on 30 March 2009, the 2 rostered pilots for an Auckland-based air ambulance service operated by Airwork Flight Operations Limited (Airwork) were advised of a task to fly from Auckland International Airport to New Plymouth Aerodrome. They would take a medical team to retrieve a patient who would then be flown back to Auckland. The flight was to be carried out in a Fairchild SA227-AC Metroliner III (Metroliner) aircraft registered ZK-NSS.
- 1.1.2 Because the flight would operate after the normal hours of air traffic control (ATC) at New Plymouth, the air ambulance service coordinator arranged for an agent to turn on the aerodrome lighting prior to the flight's arrival, as provided for in the Aeronautical Information Publication New Zealand (AIP, 2007, p.NZNP AD 2-52.1). The coordinator told the pilots what he had done, but there was no mention of the runway to be used. The coordinator had never asked for a specific runway and he had no knowledge of the precision approach path indicator (PAPI) system that was provided at New Plymouth and elsewhere for visual guidance to the runways.
- 1.1.3 The pilots carried out the required pre-flight planning and loaded sufficient fuel for the return flight. The rostered pilot-in-command sat in the left pilot's seat and was the pilot flying (PF) for the first leg. Another Metroliner captain sat in the right seat as the pilot not flying (PNF) for this leg.<sup>2</sup> A doctor, flight nurse and crewman from the air ambulance service sat in the cabin.
- 1.1.4 At 2340, the aeroplane departed from Auckland. The take-off and cruise at 12 000 feet (ft) were uneventful. Descent was commenced at about 36 nautical miles from the navigation aid located at New Plymouth Aerodrome.
- 1.1.5 The ATC radar controller advised the pilots that there was no reported traffic, provided them with the area altimeter setting and cleared the flight to descend out of controlled airspace. As the New Plymouth aerodrome control tower was not manned, the control zone had reverted to uncontrolled airspace. The last recorded ATC radar data showed ZK-NSS at 4000 ft, about 10 nautical miles from the aerodrome.
- 1.1.6 The pilots had anticipated that conditions and wind from the south-east would allow them to make a visual approach to runway 23, but the PF also briefed and set-up his flight instruments for an instrument approach to that runway. The minimum commencement altitude for the instrument approach was 3000 ft, but the PF elected to descend to 2000 ft in accordance with the minimum sector altitudes published in the AIP (2008, p.NZNP AD 2-43.3).
- 1.1.7 The flight encountered visual conditions below about 4000 ft when 10 nautical miles from the aerodrome, but because there appeared to be a few patches of cloud seaward of the aerodrome, the pilot continued towards the navigation aid. An option available to the PF was to join the 10 mile arc at 2000 ft and intercept the final approach. If conditions had remained unsuitable for a visual approach, the PF had intended to climb to 3000 ft before reaching the aid and to continue with the full instrument approach.
- 1.1.8 The pilots said that about 5 or 6 nautical miles from the navigation aid, while at 2000 ft and with the airspeed about 190 knots (kts), the aeroplane became clear of all cloud and the PF identified the runway lights. The PF said the aeroplane was 'high and a little quick and reasonably close' as he positioned for a right base leg for runway 23.<sup>3</sup> He corrected the flight path by reducing power and asked the PNF to configure the aeroplane for landing. These actions included selecting the engine speed levers to HIGH and extending the wing flaps and landing gear as the speed allowed (Airwork, 2008c, p.9-7).

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<sup>2</sup> The PF and PNF duties were given in the aeroplane flight manual and supplemented by the operator's procedures.

<sup>3</sup> The visual approach flown was a series of turns rather than a strict circuit pattern with square legs.

- 1.1.9 While on the base leg, the pilots heard an audible propeller beat, but it did not cause them concern at that stage. As the aeroplane was turned toward the final approach, the ground proximity warning system (GPWS)<sup>4</sup> aural warning 'Sink rate' sounded, followed immediately by 'Terrain, terrain'. The PNF initially stated that he heard 'Pull-up', but later said he was unsure of that. Both pilots said they had heard the GPWS warning as the aeroplane rolled out of the turn onto final approach and before the normal 500 ft aural alert. The PF said he was sure of the timing of the 500 ft aural call, because he then decided that he would have time to correct the flight path and to try and determine what the RPM problem was. The PF raised the aeroplane nose and increased the power slightly to reduce the descent rate and silence the warning.
- 1.1.10 The on-board FDR was not required to record GPWS warnings, and no cockpit voice recorder data was available to confirm whether and when the 500 ft aural alert was heard. The FDR data showed that the rate of descent peaked at 2600 ft per minute as the aeroplane descended through 500 ft altitude and was still turning right. The rate of descent for a normal approach with a groundspeed of about 130 kts was about 650 ft per minute. The recorded data showed that the aeroplane was below 330 ft altitude, or less than 250 ft above the runway, before runway alignment was achieved.<sup>5</sup>
- 1.1.11 Both pilots acknowledged later that the approach had been rushed. The PF said that he was confident that he was going to land safely, but he would not normally have accepted another pilot flying such an approach. The PNF said he felt the approach profile was at the limit of what he would accept, but as he believed there could have been an asymmetric power situation and was also sure that they would reach the runway, he made no comment.
- 1.1.12 The PF said he had considered that he had achieved a normal glide slope by about 800 ft and 3 nautical miles from the runway and definitely before the standard aural alert of 500 ft height above ground had sounded. Both pilots said the PAPI were not illuminated. The PNF said he thought the landing checklist had been completed, apart from selecting full flap, by about 700 ft. The PF said full landing flap was selected some time after the 500 ft aural alert when he saw that the airspeed was about 130-135 kts. He was confident that the speed was going to reduce to the target threshold speed of 110 kts by the threshold.
- 1.1.13 When the power was increased slightly, the propeller beat was more noticeable and the pilots saw that the right engine RPM was 97%, rather than the 100% expected with the speed lever in the HIGH position. Each pilot confirmed that the speed levers were fully forward. Neither noticed any other abnormal indication or warning light.
- 1.1.14 The flight nurse said that he was familiar with the approach into New Plymouth, in both day and night conditions. He said that the final turn towards the runway was conducted at a noticeably lower height and more steeply than he had experienced previously.
- 1.1.15 The aeroplane had by then drifted right of the runway centreline. The PF attempted to correct this with aileron, but he felt that the aeroplane resisted being rolled to the left, as if there was an asymmetric thrust condition, with the left engine producing more thrust. He then attempted to align the aeroplane using rudder. The PF said there was no intermittent yaw that he would have expected had the propeller negative torque system<sup>6</sup> been active. The PF said that he verbalised the control difficulty he was having. Neither pilot recalled any engine instrument readings.

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<sup>4</sup> There is more information on the GPWS in section 1.2.

<sup>5</sup> Data was extracted 6 April 2009, from FDR Fairchild F1000 (serial number 00483).

<sup>6</sup> The negative torque system operated automatically to increase the propeller pitch and thereby reduce drag.

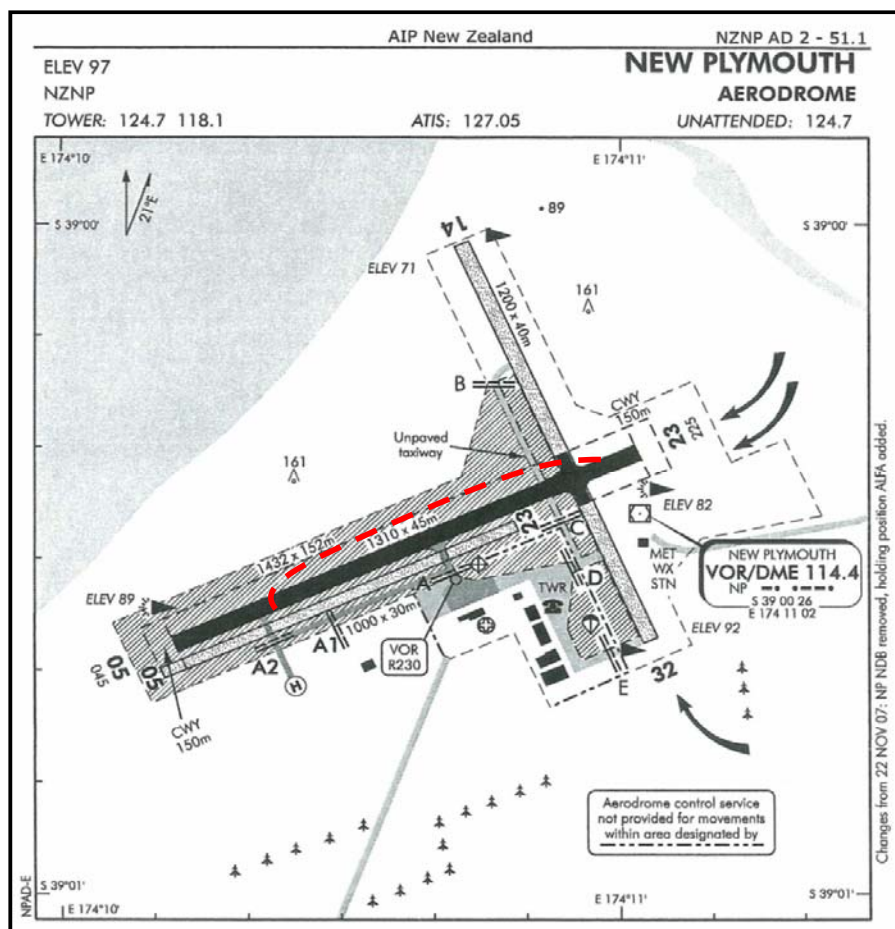
- 1.1.16 The PNF did not advise the PF that any approach parameter was outside the operator's limits, but both pilots recognised that there was a high rate of descent very late on approach after full flap was selected. The PF applied more power, but he said the aeroplane rolled right. Concerned that the aeroplane would roll further right if he attempted to apply more power or go-around, but convinced that the flight path would result in a landing on the runway, the PF concentrated on getting the wings level before landing. Between 150 ft above the runway and landing, the aeroplane heading turned gradually right through 10°.
- 1.1.17 The PNF later said that there had not been an obvious engine problem, and he did not understand why the PF was reluctant to apply more power or go-around. The PF was sure that the power levers were above flight idle because he had corrected the earlier high sink rate when turning onto final approach, and he had closed the power levers fully after landing. Neither pilot noticed whether the right engine achieved high RPM.
- 1.1.18 The doctor, sitting at the rear of the cabin, said that shortly before landing the engines or propellers were making an unusual humming sound, and the aeroplane swerved just before making a very hard landing.
- 1.1.19 At 0016, the aeroplane landed hard on the right wheels, on the right side of the runway just past the threshold markings. The FDR data showed that the airspeed reduced from 108 kts 10 seconds before touchdown to 87 kts at landing. In the same interval, the aeroplane heading altered 8° to be 223° magnetic (°M) on landing, and 228°M 3 seconds later.
- 1.1.20 The PF said that he was holding full left rudder and nearly full left aileron in an attempt to keep the aeroplane straight, but a main wheel tyre crushed a runway edge light 60 metres from the threshold and the aeroplane then veered off the right side of the runway. After crossing the sealed part of the intersecting grass runway, the aeroplane entered longer grass at the edge of the runway strip.<sup>7</sup> Figure 2 is a plan of the aerodrome with the approximate aeroplane track in red (AIP, 2009, p.NZNP AD 2-51.1).
- 1.1.21 The PF regained directional control of the aeroplane after it had crossed the intersecting runway, and after he had moved the power levers into the ground range. The aeroplane then crossed a raised aerodrome service road before the speed had reduced to taxi speed. Figure 3 is a view of the aeroplane's wheel tracks, looking back towards the touch-down point.
- 1.1.22 At the terminal apron, the PF confirmed that the engines operated normally at high speed before he shut them down. No-one was injured in the incident and, although no damage was apparent, the return flight was cancelled.
- 1.1.23 Engineers examined the aeroplane at New Plymouth the next day. No fault was found with the condition, rigging or operation of the right engine and propeller, but the combined fuel pump-fuel control unit (FCU) and the propeller governor on the right engine were replaced as a precaution. The hard landing caused no aircraft damage, but all of the tyres were replaced because of slight or suspected damage caused by running over the runway light and raised service road. The aeroplane was ferried with the landing gear extended to Auckland for further investigation.

### **Subsequent events**

- 1.1.24 On 3 April 2009, a test flight was scheduled prior to ZK-NSS being released back to service, but the take-off was rejected when the right engine did not achieve the expected torque. The right fuel bypass light was on and bypass was confirmed by the reduced indicated fuel flow. Subsequently, the right engine ran down when ground idle power was selected.

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<sup>7</sup> The runway strip was an area 150 m wide overall, centered on the runway, and intended to reduce the risk of damage to an aircraft that runs off the runway and to provide obstacle protection during take-off or landing (Civil Aviation Authority [CAA], 2009).



**Figure 2**  
**New Plymouth Aerodrome**  
showing approximate track of ZK-NSS in red

- 1.1.25 The operator determined that the Single Red Line (SRL) interface unit<sup>8</sup>, the only engine control component common to both engines, was faulty. The interface unit was replaced, and the aeroplane returned to service after extensive engine ground runs and a satisfactory test flight. On 25 August 2009, the operator advised the Commission:

We are confident that this un-commanded shutdown defect during the ground run was caused by the confirmed voltage signal at the Fuel Bypass Solenoid. This assessment is based on the fact that engineering positively identified a hard fault with a voltage signal from the SRL Interface unit. Removal of the Interface unit removed this unexplained voltage. Replacement with a known serviceable Interface unit confirmed no un-commanded voltage with continued on-going operations normal.

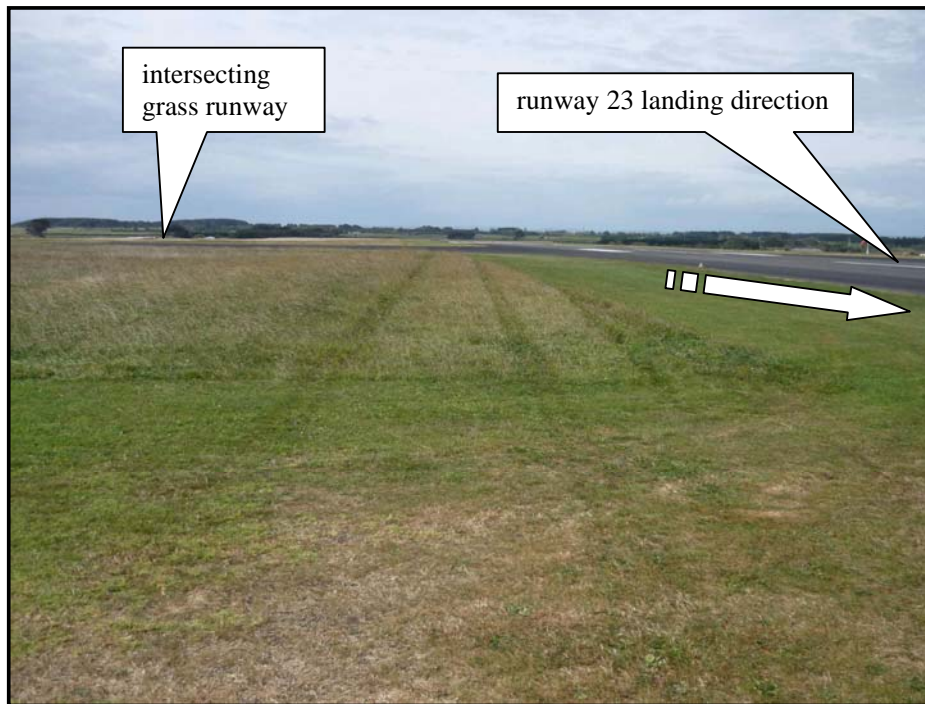
- 1.1.26 On 9 April 2009, the following discrepancy with ZK-NSS was recorded:

Right power lever goes into reverse before left. In-flight, the right power lever is forward of the left yet the left has approximately 20% torque and the right has 0% torque.

Visual inspection of the engine controls and a full engine ground run did not find any fault. A check flight noted 'some improvement' over the previously reported discrepancy. Subsequently, the flight idle blade angle of the right propeller was adjusted, and the aeroplane had operated satisfactorily since.

<sup>8</sup> There is more information on the SRL system in section 1.2.





**Figure 3**  
**ZK-NSS wheel tracks**  
 (New Plymouth District Council, 2009)

## 1.2 Aeroplane information

- 1.2.1 The Metroliner was a pressurised twin turboprop aeroplane manufactured and first certified in the United States in 1980 by the Fairchild Aircraft Corporation. The type certificate was later acquired by M7 Aerospace of Texas (the manufacturer).<sup>9</sup> The aeroplane was designed for passenger, cargo or mixed loads with a maximum certificated take-off weight of 16 000 pounds (7257 kg).
- 1.2.2 ZK-NSS was manufactured in 1987 and imported into New Zealand in 1988. Since 1991, although legal ownership had changed a number of times, the aeroplane had been operated and maintained by the same interests. In 2005, the aeroplane was leased by The Life Flight Trust as a dedicated air ambulance with the pilots and maintenance provided by the operator.
- 1.2.3 On 16 March 2009, all of the flight control cables in ZK-NSS were replaced, as required by an airworthiness directive that was subsequently cancelled. The rudder and elevator hinges were also inspected, and both wing flaps were removed, inspected and reinstalled. On 18 March 2009, a flight test confirmed the aeroplane's flight characteristics were normal. The aeroplane had then flown 17 hours and 17 cycles prior to the flight on 30 March 2009 with no reported flight control discrepancy. After the incident at New Plymouth, all of the flight control cables were re-inspected and no fault was found.
- 1.2.4 The maintenance review was valid until 15 September 2009. As of 31 March 2009, the aeroplane had accrued 19 993.2 flying hours and 23 428 cycles.<sup>10</sup>
- 1.2.5 The target threshold airspeed, excluding any allowance for wind gusts, was typically 1.3 times the stall speed in the landing configuration. For the incident flight the target threshold speed was 110 kts, which suggested a stall speed of about 85 kts.

<sup>9</sup> M7 Aerospace was not strictly the manufacturer, as production of the Metroliner by Fairchild ceased in 1998.

<sup>10</sup> A cycle is one take-off and landing.

- 1.2.6 ZK-NSS was fitted with a stall warning system that sensed the aeroplane's angle of attack and which should sound an alarm at a speed of 1.1 times the stall speed in the landing configuration – this would be about 93 kts for the landing at New Plymouth. The pilots did not recall hearing the stall warning during the landing. The system was previously calibrated in December 2008 and its continued serviceability was tested during the pilots' normal pre-flight checks.

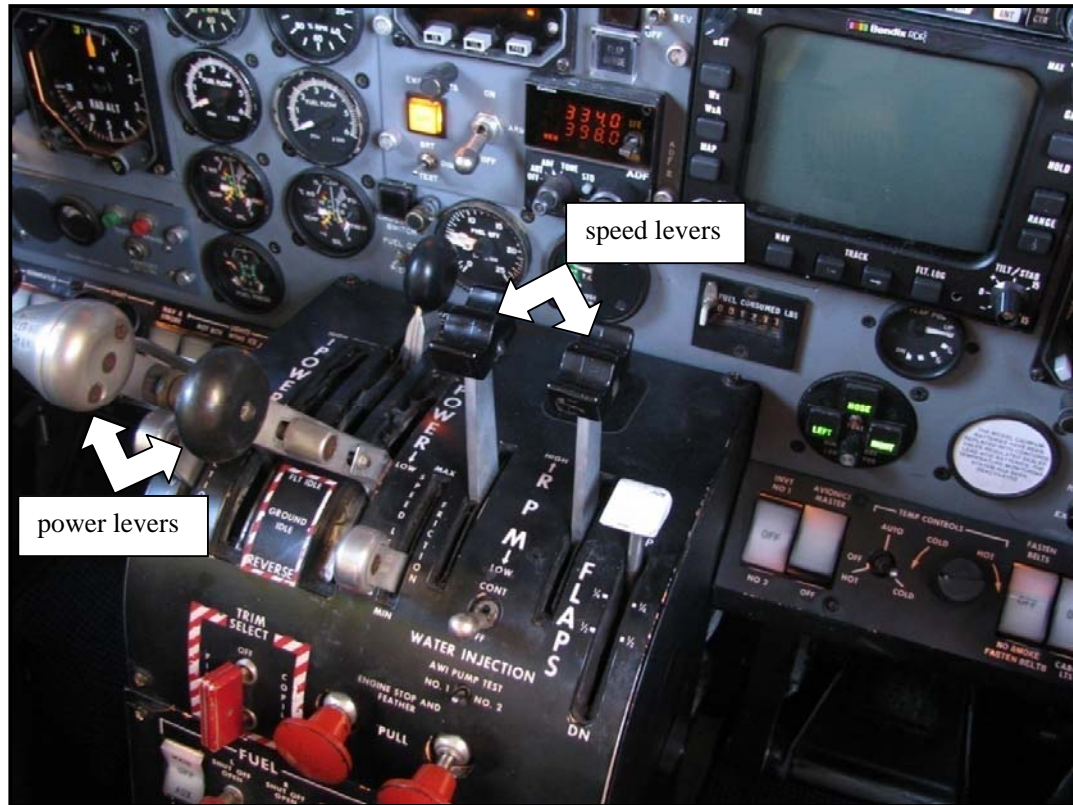
### **Power-plant**

- 1.2.7 Two Honeywell (formerly Garrett) TPE331-11U-611 turboshaft engines each drove a Dowty Rotol R321/4-82-F/8 constant speed, full-feathering, reversible propeller. As at 31 March 2009, the right engine (serial number P44027C) had operated for a total of 22 811.23 hours and 23 138 cycles; and the left engine (serial number P44746C) for 12 161.4 hours and 16 217 cycles.
- 1.2.8 The engines had 2 operating modes: propeller governor mode and *beta* (ground) mode, according to the position of the controls. Figure 4 below shows the control levers in one of the operator's other Metroliners. For each engine, the power lever was connected to both the propeller pitch control and the manual fuel valve on the FCU, and the speed (or RPM) lever was connected to the propeller governor and the under-speed governor in the FCU.
- 1.2.9 In propeller governor mode, i.e. with the power lever forward of the flight idle position, the propeller governor controlled the propeller pitch in order to maintain a constant engine RPM as selected with the speed lever. Movement of the power lever manually metered fuel to the engine and the propeller pitch then automatically changed to match the demanded change. The propeller governor range was 100% to 101% with the speed levers at HIGH, and 93.5% to 94.5% with them at LOW. The operator's normal cruise setting for the speed levers was 97%.
- 1.2.10 In beta mode, when the power lever was between the flight idle and maximum reverse positions, the lever position directly controlled the propeller pitch and the fuel governor maintained the engine RPM. A physical *gate* at the flight idle position separated the 2 modes.
- 1.2.11 If any power lever was retarded to the flight idle position with any landing gear not locked down, a warning horn would sound.
- 1.2.12 The FCU was the principal component that metered the fuel sent to an engine. The fuel flow varied between about 215 pounds per hour at flight idle and 530 pounds per hour at maximum take-off power. Pilot input to an FCU was via the respective power and speed levers. The FCU contained an under-speed governor and an over-speed governor.
- 1.2.13 The under-speed governor operated during beta mode and increased the fuel flow to prevent the engine RPM from going below the value set by the speed lever. The under-speed governor maximum value was 97% RPM.
- 1.2.14 The *Metroliner Quick Reference Handbook* included the following recommendation (Airwork, 2008b, p.1.10):
- In the event that there is an indication of improper operation of a fuel control or propeller control, it is recommended that the affected engine be shut down and a single engine landing be accomplished.

### **Temperature limiting system**

- 1.2.15 Independent SRL computers automatically controlled each engine's start sequence, computed the exhaust gas temperature when the engine speed was above 80% RPM, and enabled exhaust gas temperature limiting above 90% RPM. If the exhaust gas temperature approached the limit, the SRL controller allowed power to a temperature limiter controller for that engine, which signalled the fuel bypass valve on that engine to open and modulate the amount of fuel going to the engine. At maximum bypass, the fuel flow decrease was about 100 pounds per hour. Some degree of fuel bypass was a normal condition at higher power settings.





**Figure 4**  
**Metroliner power-plant controls**

- 1.2.16 The signal from the temperature limiter to the fuel bypass valve was routed through a single SRL interface unit, which provided the signal to illuminate the respective blue BYPASS OPEN light on the centre instrument panel. The brightness of the light was proportional to the amount that the valve was commanded to open, but the intensity could also be dimmed. The operator's normal procedure for night flights was to have all selectable light intensities set to dim.
- 1.2.17 The SRL interface (part number 27-82185-063 and serial number 502012) which was removed in Auckland was examined by the manufacturer who found that variable resistors R1 and R11 were operating intermittently. The manufacturer advised that these resistors were adjustable and were used to establish a reference voltage for the components that monitor and power the BYPASS OPEN lights. However, the interface did not provide operating power to the bypass valves, and the defective resistors could not affect any other controlling unit. The manufacturer advised the Commission that the only possible discrepancy caused by the faulty resistors would be an erroneous BYPASS OPEN light illumination.
- 1.2.18 The flight manual had a procedure for dealing with SRL system failure, but none of the listed symptoms was noted during either of the New Plymouth or Auckland power irregularities (Airwork, 2008b, p.1.11a). Continued operation with a faulty SRL system was permitted, as long as electrical power was removed from the Temperature Limiter to prevent any signal going to the fuel bypass valve.
- 1.2.19 The flight manual also had guidance for operation with the fuel bypass valve failed in either the closed or open position (Airwork, 2008b, p.1.12a). If the valve failed in the open, or near open, position the power levers would have to be *staggered* in order to achieve the same power on each engine. The flight manual had the following comment:

Failure in the open position ... might cause so much reduced fuel flow ... that at power settings near flight idle, the [negative torque] system would activate. This ... could be confirmed by retarding the power lever for the suspect engine to flight idle while flying at speeds near the final approach speed. If negative torquing occurs, the pilot has the options of landing with asymmetric power levers in order to maintain even power, or of shutting down the engine with the failed fuel bypass valve and making a single engine landing.

## Testing

- 1.2.20 The removed FCU and fuel pump were sent to the engine manufacturer for inspection and test. The FCU was found to have a broken spring in the bellows that provided altitude compensation for the demanded fuel flow. The fuel flow was below the required rate at most test points, with a maximum shortfall of 19 pounds per hour at the equivalent of 15 000 ft altitude. The other reported discrepancies were said by the operator to have been normal field adjustments that were unlikely to have had any noticeable effect on engine performance.
- 1.2.21 The inspection report for the fuel pump cited a pitted bearing, collapsed thermostat, scored seal assembly and excessive torque on the input shaft. The pump's condition was relatively poor for its half-life and its performance was not tested. The operator considered that the reported pump condition might have been observable as a slight reduction in maximum power only.
- 1.2.22 The propeller governor was inspected by a specialist contractor. Although they reported the maximum and minimum governed RPM were slightly out of specification, the manufacturer advised that the variances would not have been noticeable in-flight.
- 1.2.23 The manufacturer's advice to the Commission on the events at New Plymouth and Auckland was as follows:

With bypass valve open the engine will not make target torque and at ground idle could flame out [that is, run down] from fuel starvation. As you can see from attached explanation and simple wiring diagram the SRL Interface simply receives signal to illuminate [the] bypass light on the instrument panel. It appears the right engine may have had an intermittent bypass problem causing it to open without proper signal from the Temperature Limiter.

With one engine bypass valve open it will definitely cause asymmetrical thrust as experienced in this flight. I do not believe there would be NTS [negative torque system] action because there still is enough fuel flow to provide positive torque. If the power lever is inadvertently selected less than flight idle this will definitely be a problem as the flat blade angle [pitch] will create excessive drag, this is why we have the "lift latches" on the power levers to go into ground idle. Anytime the crew does not have control of the engine it should be stopped and feathered and proceed single engine.

## GPWS

- 1.2.24 The aeroplane was fitted with a Honeywell Mk-VI GPWS that provided visual and/or aural warnings and advisories for six different conditions, or modes, including the following:
- Mode 1 – excessive descent rate
  - Mode 2 – excessive closure rate to terrain
  - Mode 6 – aural altitude call-outs.
- 1.2.25 Mode 1 compared the barometric descent rate against radio altitude.<sup>11</sup> The rate of descent that would generate an aural warning of 'Sink rate' was proportional to the radio altitude. In addition to the aural warning, a red GPWS lamp on the instrument panel illuminated. If an excessive descent rate continued down to, or occurred at, a low radio altitude, the 'Sink rate' warning was replaced by a repeated 'Pull-up' warning.

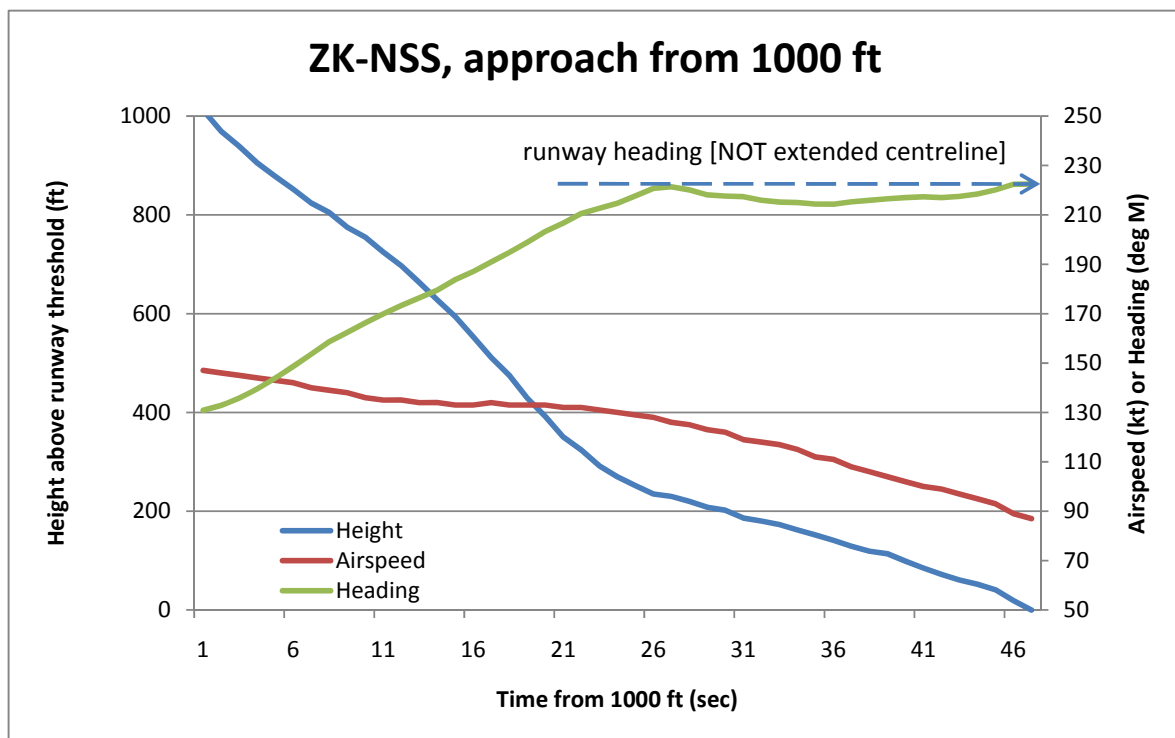
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<sup>11</sup> Although called radio *altitude*, this parameter gave the *height* above the terrain immediately under the aeroplane.

- 1.2.26 Mode 2 compared the rate of change of radio altitude (or terrain closure rate) with radio altitude. The mode was de-sensitised when the aeroplane was configured for landing with flaps extended. The warning was an aural ‘Terrain, terrain’ followed immediately by ‘Pull-up’ and illumination of the GPWS lamp.
- 1.2.27 Mode 6 was an operator-selectable mode that provided automatic height call-outs referenced to the radio altitude. An example was the standard call of ‘500 [ft]’ made during an approach.

### Flight recorders

- 1.2.28 The aeroplane was fitted with a Fairchild F1000 digital FDR (serial number 00483) and a Fairchild A100 cockpit voice recorder. The voice recorder data was not preserved, although the operator had a procedure that required the recorder to be deactivated ‘after any incident or accident which has occurred within thirty minutes of landing’ (Airwork, 2008a, p.1-42).
- 1.2.29 The FDR data was extracted at Auckland while the FDR remained installed. Apart from its internal clock, the FDR recorded uncorrected values of barometric altitude, indicated airspeed, magnetic heading and vertical acceleration, and when a very high frequency (VHF) radio transmission was made. Figure 5 shows flight data for the last 1000 ft of the incident flight. The altitude data has been adjusted to show height above the landing runway threshold.



**Figure 5**  
**Flight data for last 1000 ft**

- 1.2.30 The FDR clock was correlated with recorded ATC radar data and voice communications. The altitude data was corrected by comparison with the radar data and the runway elevations at Auckland and New Plymouth aerodromes. Heading data was compared with the known runway directions at those aerodromes. The validity of the airspeed data was not established.
- 1.2.31 The FDR service contractor advised that, according to the FDR maintenance manual, the recorded parameters on approach should be accurate to within 50 ft, 5 kts and 0.3° as applicable. Data for the incident flight was compared with that for a flight to New Plymouth 2 sectors previously and the magnitude and direction of minor errors were consistent. The ATSB reviewed the data and commented that ‘the recorded parameters appear to be reasonable and within typical tolerances.’

- 1.2.32 The radio keying data suggested the radio connections to the FDR were reversed, compared to the maintenance manual wiring diagram. The operator confirmed there was a wiring error and inspected, and rectified where necessary, the FDR installations on its other Metroliners.
- 1.2.33 The FDR was last functionally tested on 11 December 2003 and was installed into ZK-NSS in May 2004. The FDR had not been serviced or checked since, as there was no maintenance programme requirement to do so.
- 1.2.34 There was no regulated maintenance for flight recorders in this class of aeroplane. The CAA advised that in May 2009 it had initiated a project to determine current practices in flight recorder maintenance. The CAA aimed to publish an *Advisory Circular* on the subject, but had no target date for that. In the interim, the CAA was asking operators to include flight recorders in any maintenance programmes submitted for approval.

### **1.3 Flight crew information**

- 1.3.1 The PF was aged 36 and had obtained his Metroliner type rating with the operator in May 2002, although he was not employed by the operator at the time. He was promoted to captain by his prior employer in November 2004. He had been employed as a captain by the operator since November 2006, and had been a training captain since July 2007. He held an airline transport pilot licence that was issued in November 2004, and 4100 total flying hours, of which 2450 hours were on the Metroliner. His previous line check was in October 2008, and a combined flight crew competency and instrument check was conducted in November 2008. The PF held a current class 1 medical certificate with a restriction that he was to wear correcting lenses, which he had done on the incident flight.
- 1.3.2 The PF had 24 hours free of duty before the incident flight. He had flown 2.5 hours during 3 duty periods in the preceding 7 days, and 18 hours in the previous 30 days. Although he had taken 3 days' sick leave at the beginning of the week preceding the incident flight, he said that he considered himself fit to fly and rested for the flight on 30 March.
- 1.3.3 The PNF was aged 51. He obtained his Metroliner type rating in May 2004 and had been employed by the operator since October 2005. In October 2007, he was promoted to line captain. He also held an airline transport pilot licence, issued in February 2004, and had 7250 total flying hours, including 1300 hours on the Metroliner. His previous flight crew competency check was conducted on 23 February 2009, and on 23 October 2008 he completed a combined instrument and line check. The PNF held a current class 1 medical certificate, with a restriction that he was to wear correcting lenses, which he had done on the incident flight.
- 1.3.4 The PNF had 22 hours free of duty before the incident flight. He had flown 8 hours during 3 duty periods in the preceding 7 days, and 27 hours in the previous 30 days. He said that he considered himself fit to fly and rested before the incident flight.

### **1.4 Meteorological information**

- 1.4.1 The terminal aerodrome forecast obtained by the pilots for New Plymouth Aerodrome was for the period that ended at midnight on 30 March 2009. However, the current meteorological reports met the requirement of Civil Aviation Rule (CAR) 125.157 for planning the flight (CAA, 2008b).
- 1.4.2 The forecast surface wind was a south-easterly at 8 kts, which would have been nearly all cross-wind from the left when landing on runway 23, and 30 kilometres' visibility with the cloud base at 3000 ft. The automated meteorological report at midnight, which was not available to the pilots, showed a 5 kt wind from the southeast, visibility of 10 kilometres, the cloud base at 3000 ft and an altimeter setting of 1024 hectopascal. At 2300, there were cloud patches at 1700 ft.
- 1.4.3 Outside the operating hours of New Plymouth ATC, no weather information was broadcast.

## 1.5 Communication

- 1.5.1 The aeroplane was equipped with 2 VHF radios, designated VHF1 and VHF2. VHF1 was the primary radio used for communications with ATC. VHF2 was used for communications with the company and for advisory calls on the destination aerodrome frequency when necessary before ATC had approved a change of frequency.
- 1.5.2 A copy of the voice recording of voice communications between the pilots and the ATC area controller was obtained. The VHF keying data on the FDR was correlated with the ATC recording. The last transmission keyed from ZK-NSS before landing was on VHF2, just after the aeroplane had descended through 6000 ft.
- 1.5.3 The AIP recommendations regarding position reporting when joining to land at an unattended aerodrome included the following, in part (AIP, 2003, p. ENR 1.1-11):

### 6.2 Position Reporting at Unattended Aerodromes

6.2.1 Unattended aerodromes include controlled ... aerodromes outside the hours of attendance.

6.2.2 Pilots of all aircraft operating outside controlled airspace below 3000 ft [above ground level] within a radius of 10 [nautical miles] of an unattended aerodrome should maintain a continuous listening watch on the frequency listed on the aerodrome chart ...

6.2.3 For the benefit of other traffic, pilots should broadcast their position, altitude and intentions as listed below:

(a) Inbound:

- (i) overhead the radio aid serving the aerodrome, or commencing instrument approach, or when established on [a fixed distance] arc; and

- (ii) when established on final approach; and

- (iii) at the termination of the instrument procedure, i.e. when breaking off from the procedure to proceed in VMC to the aerodrome; and

- (iv) immediately before joining the aerodrome traffic circuit.

## 1.6 Aerodrome information

- 1.6.1 New Plymouth Aerodrome (see Figure 2) was owned and operated by the district council, and located close to the coast in undulating farmland at an elevation of 97 ft. The main runway, 05/23, had a bitumen surface 1310 metres long and 45 metres wide.<sup>12</sup> The runway sloped up from each threshold towards the centre, with the runway 23 threshold elevation at 82 ft. The operator's *Route Guide Manual* (Airwork, 2008a, p.6-31) noted that the runway 'is convex in shape which gives an unusual perspective', but neither pilot believed he had ever had a problem with that.
- 1.6.2 A secondary grass runway crossed the main runway about 180 m from the threshold of runway 23. The grass runway was sealed with bitumen for about 50 m in each direction from its intersection with the main runway. About 600 m from the threshold of runway 23, a sealed service road ran from the main runway to the northern boundary of the aerodrome. There were no obstacles, such as open drains or above-ground obstructions, within the runway strip.
- 1.6.3 The main runway was equipped with low intensity runway edge lights at 60 m spacing, runway end identifier lights, lighted wind direction indicators and PAPI for both runway directions, set at a 3° slope. Airways New Zealand (Airways), the ATC provider, was responsible for the provision and maintenance of aerodrome lighting and navigation aids at New Plymouth.

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<sup>12</sup> The runway designations are the magnetic headings to the nearest 10°. The actual directions of these runways were 045°M and 225°M.

- 1.6.4 Before closing watch each day, the ATC officer on duty would pre-select aerodrome lighting, including the PAPI, to allow its use outside the ATC hours of duty. The lighting selections were not recorded or verifiable. The pre-selected lighting was activated if switched on at the remote control panel located outside near the control tower (see Figure 6).



**Figure 6**  
**Aerodrome lighting remote control panel**  
(New Plymouth District Council, 2009)

- 1.6.5 Aircraft operators wanting to use the aerodrome at night could make a prior request to a security company, acting as an agent of Airways, and a security guard would be instructed to turn the lighting on at the remote control panel. The security company's standard operating procedure was for the guard to select the "airfield lighting" switch to ON and the 'vector' switch to 'either [runway] 05 or 23'. Neither the agent's supervisor nor the guard who attended on the night of 30 March 2009 knew what was activated by the vector switch.
- 1.6.6 Airways had a current programme to shift the remote control of lighting at selected secondary aerodromes to the Christchurch Airways Centre, which provided most of the enroute and approach ATC services in New Zealand. By May 2009, the remote control of lighting for 8 aerodromes had been shifted, but no date had been set to shift New Plymouth Aerodrome's lighting.
- 1.6.7 The 'Ambulance Aircraft' section of the operator's *Route Guide Manual*, at the time of the incident, stated that for night operations 'pilots are to ensure lighting will be available.' The manual did not specify that 'lighting' included the PAPI, if installed, or require pilots to advise the agents of the intended runway for landing (Airwork, 2008a, p.8-41, effective 26 March 2008).
- 1.6.8 There was no CAA or operator requirement that medium size aeroplanes, such as the Metroliner, had to use only aerodromes that had a visual approach slope indicator system like the PAPI. However, the CAA noted that the responsibility for ensuring that an aerodrome met the required lighting standard fell upon both an operator and the pilot.

## 1.7 Organisational and management information

### Air ambulance services

- 1.7.1 The operator performed contract and charter air operations under CAR Parts 121 (large aeroplanes) and 125 (medium aeroplanes) using a mixed fleet of aircraft, including 3 Metroliners. Two additional Metroliners, one each based at Auckland and Wellington, were leased by The Life Flight Trust and configured solely for air ambulance work under Part 125. All of the operator's 24 Metroliner pilots were periodically rostered for air ambulance duties.
- 1.7.2 The Life Flight Trust provided the cabin crew and medical staff needed for ambulance flights. The operator trained those staff annually in the relevant Metroliner emergency procedures.
- 1.7.3 The operator's pilots said that although the duty Life Flight Trust coordinator told them of the urgency of a task, their operational decisions were not challenged. The pilots said that ambulance flights were conducted like any other air transport flight, although pilots were more involved in the flight planning.

### Crew resource management

- 1.7.4 Crew resource management (CRM) was defined by the International Civil Aviation Organisation (1989) as 'the effective use of all available resources ... to achieve safe and efficient flight operations.' When first introduced, CRM training had involved pilots only, and this was still the case for some smaller operators. However, the scope and content of CRM had evolved in stages and the training now included many other participants in the aviation system.
- 1.7.5 There was, at the time, no CAR requirement for CRM training for Part 125 operations. However, the CAA advised that a Part 125 operator would not be certificated unless it had a CRM training programme. The operator of ZK-NSS had a CRM training course which was knowledge-based only, because there was no Metroliner flight simulator in New Zealand and no CAR requirement for Part 125 flight crew simulator training. The operator's syllabus covered a range of topics, including command authority, crew communication, decision making, standard operating procedures, clues to loss of situational awareness, and common cause factors of controlled flight into terrain (CFIT) accidents.<sup>13</sup> The syllabus did not include the more proactive techniques of Threat and Error Management, developed since 1990 and taught at many major airlines since 2001.
- 1.7.6 Edwards (1975) described one aspect of the working relationship between pilots on the flight deck as the *trans-cockpit authority gradient* (cited in Hawkins, 1993, p.35). He suggested there was an optimum trans-cockpit authority gradient: not too flat, as might occur when 2 similarly experienced captains flew together; nor too steep, as might occur when an over-bearing senior captain was paired with a meek junior pilot. The optimum gradient reflected a captain's legal and organisational authority to command, regardless of which pilot was actually PF and in control of the aeroplane, and would be specific to the crew under consideration. If the gradient was far from optimum, pilots could be inhibited from performing the appropriate monitoring and challenging that is necessary for safe operations. Effective CRM training should help pilots to find the optimum gradient for each flight situation.
- 1.7.7 The PF of the incident flight was younger and had less total flight time, but more Metro time, than the PNF who, although also a captain, was not operating in his usual crew seat.

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<sup>13</sup> CFIT occurs when an airworthy aircraft under the control of the flight crew is flown unintentionally into terrain, obstacles or water, usually with no prior awareness by the crew. This type of accident can occur during most phases of flight, but is more common during the approach-and-landing phase.



## Visual approaches

- 1.7.8 The operator permitted its pilots to carry out a visual approach only where the flight remained in controlled airspace and, except at Palmerston North aerodrome, under the control of ATC (Airwork, 2008a, p.1-49, effective 15 December 2008). The incident flight approach and landing at New Plymouth was conducted outside controlled airspace.
- 1.7.9 The following additional information was provided in the *Route Guide Manual*, in the section entitled 'Instrument Approaches' (Airwork, 2008a, p.2-18, effective 26 March 2008):
- Night visual approaches may be carried out at aerodromes, where permitted, provided the following procedure is complied with:
1. The visual approach must be backed up with available approach aids selected and identified.
  2. The approach shall be made with a "stable" 3 in 1 slope.<sup>14</sup>
- 1.7.10 The incident pilots said that on 30 March 2009 they had thought that the operator permitted night visual approaches, and there was some evidence that other company pilots had the same view. However, the operator said the ban on visual approaches outside of controlled airspace had been in place for some years and the sole purpose of the most recent amendment to the standard operating procedure had been to exclude Palmerston North Aerodrome from the ban. On 2 April 2009, the operator reiterated the night visual approach policy to its pilots.

## 1.8 Additional information

### Approach stability

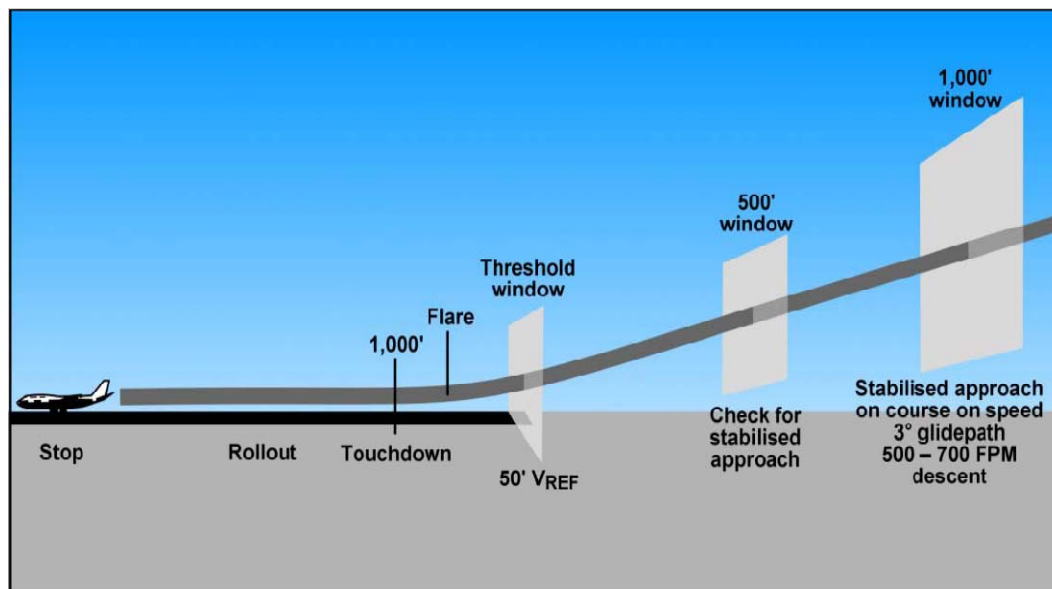
- 1.8.1 The Flight Safety Foundation (FSF)<sup>15</sup> and other authorities have emphasised the importance of an aircraft being established on a stable final approach in order to minimise the risk of an approach or landing accident, including a CFIT accident (FSF, 2000). Figure 7 illustrates the Federal Aviation Administration (FAA) description of a stable approach, which is likely to have the following characteristics (FAA, 2007):
- the aeroplane is on the correct approach path (usually a straight 3° glide path)
  - the glide path is a constant angle towards a predetermined point on the runway
  - only small corrections to heading or pitch are needed to maintain the correct path
  - the aeroplane is in the correct landing configuration, with all checklists completed
  - the power setting is appropriate and not below the minimum approach power as per the flight manual
  - the airspeed is steady and not more than 20 kts above the landing reference speed (target threshold speed) and not less than the landing reference speed
  - a steady descent rate (not more than 1000 ft/min unless specially briefed).

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<sup>14</sup> By '3 in 1' the operator meant the standard approach slope of about 300 ft altitude loss for each nautical mile travelled.

<sup>15</sup> The FSF is a highly regarded independent, international, non-profit organisation engaged in research, auditing, education, advocacy and publishing to improve flight safety.





**Figure 7**  
**Example of a stable approach**

- 1.8.2 If any of these parameters were not achieved, the approach was considered unstable. The FSF emphasised that unstabilised approaches could be prevented through a continuous process of monitoring the approach parameters and correcting any deviations. The FSF suggested (2000, p.3) a strategy of *anticipate, detect, correct* and *decide* that read in part:

**Anticipate** – some factors that are likely to result in an unstabilised approach can be anticipated and avoided. For example, pilots and air traffic controllers should avoid situations where the flight crew are required to rush the approach ...

**Detect** – minimum stabilisation heights and defined maximum deviation limits for the stabilised approach parameters ensure that the flight crew have a common reference for how the approach should be monitored to ensure it remains stabilised ...

**Correct** – it is important that positive corrective actions are taken before deviations from stabilised approach parameters become excessive, and place the aircraft into a challenging or hazardous situation ...

**Decide** – if the approach is not stabilised when the aircraft reaches the minimum stabilisation height, or if deviations from the stabilised approach parameters are beyond limits, a go-around must be conducted immediately.

- 1.8.3 Although the FSF guidance was based on accident data that related to turbojet and turbofan-powered aeroplanes equipped with modern flight deck technology, the FSF recognised that it could be adapted for other aeroplane types. Most major airlines, including the principal airlines in New Zealand, had formulated the FSF guidance into their standard operating procedures.
- 1.8.4 The operator had adopted the general guidance on stable approaches. Its procedures referred to the goal of a 3° approach slope and it recommended that pilots calculate the required rate of descent to achieve that (Airwork, 2008c, p.9-1). The procedures also required the PNF to continuously monitor the height, speed and descent rate when the PF continued an instrument approach by visual reference, and to advise the PF of significant variations. However, the only parameters specified in the procedures at the time of the incident were that a visual approach had to be stabilised by 500 ft above the aerodrome and that the airspeed crossing the runway threshold was not to exceed the target speed by more than 15 kts (Airwork, 2008c, p.9-7).
- 1.8.5 The day before the incident flight, the PF had flown ZK-NSS on another ambulance task to New Plymouth and had been the PF for the day-time visual approach to runway 23. The FDR data showed that that final approach had probably met the usual criteria for a stable approach.

## Runway excursions

- 1.8.6 A runway excursion was considered to be a serious incident by the International Civil Aviation Organisation (2001, p.ATT C-1). An excursion occurred when an aeroplane over-ran the end of the runway (called an over-run) or went off the side of the runway (veer-off). In New Zealand, there had been 5 runway excursions since 1990 involving commercial jet or turboprop aeroplanes. Three of the incidents involved Metroliners that had nose wheel steering problems after landing. The other 2 incidents, which occurred at Queenstown Aerodrome, were a veer-off by an ATR72-500 aeroplane after landing in gusty conditions and a landing over-run by a British Aerospace BAe 146 (TAIC, 2006; TAIC, 1991, respectively).
- 1.8.7 The ATSB conducted a review of worldwide commercial jet aeroplane runway excursions that had occurred in the period 1998 and 2007 (ATSB, 2009). Runway excursions accounted for about 25% of all air transport incidents and accidents, and 96% of all runway accidents in that period. Although the ATSB review excluded accidents involving reciprocating and turboprop-powered aeroplanes, an earlier review by van Es had found no statistically significant difference in the estimated landing over-run accident rate between commercial jet and turboprop aeroplanes (van Es, 2005, cited in ATSB, 2009, p.4.).
- 1.8.8 The ATSB review found that 85% of runway excursions occurred during the landing phase, and identified flight crew technique or decision-related factors, and weather-related factors, as the most common contributory factors. The implicated flight crew factors included flying an unstabilised approach and not conducting a missed approach or go-around when landing conditions were unsafe. Another contributory factor was flight crew performance being affected by spatial awareness, visual illusions or task saturation.
- 1.8.9 The review noted that in most runway excursions, any one or a combination of the identified contributory factors could lead to an unsafe outcome when combined with non-adherence to standard operating procedures or inadequate procedures.
- 1.8.10 In June 2009, the FSF reported the results of its Runway Safety Initiative, a study of global data on runway excursions that had occurred over the previous 14 years. The report had similar conclusions to the ATSB review and repeated the FSF's earlier recommendations (FSF, 2009).

## Prevention of controlled flight into terrain accidents

- 1.8.11 The operator's standard operating procedures included guidance to its pilots for preventing a CFIT accident. Pilots received instruction during their initial training and reviewed the information annually. The operator's records showed that the PF and PNF had last reviewed the subject in November 2008.
- 1.8.12 At the time of the incident, the operator's CFIT Prevention notes included the following (Airwork, 2008c, p.1-13):
- For every approach (including visual approaches) fly a stable "3 in 1" slope.
  - When on a visual approach, never accept "4 reds" [on PAPI]. There is no indication how far below the slope you have gone.
  - On becoming visual, ensure the stable approach is maintained. Maintain the slope by reference to the visual approach aids (PAPI).
  - "If in doubt – Get Out". If at any stage of an approach you are not happy with clearances, aircraft performance/serviceability, instrument indications or your own situational awareness – execute an immediate missed approach.
  - Should the aircraft be equipped with GPWS and you get a GPWS warning – if you are not visual and clearly "not in danger" – execute an immediate "escape" manoeuvre to regain terrain clearance.

- 1.8.13 The last dot point above was less restrictive than, and conflicted to some extent with, the operator's additional notes, attributed to the FSF, that recommended the following:
- When a GPWS warning occurs in instrument meteorological conditions or at night, pilots must conduct immediately the pull-up manoeuvre published in the aircraft operations manual or the quick reference handbook.
  - A pull-up manoeuvre must be conducted immediately, except when the aircraft is in clear daylight visual meteorological conditions and the flight crew knows that a pull-up manoeuvre is not required.
- 1.8.14 The operator's procedures required pilots to conduct immediately a published escape manoeuvre in the event of a 'Pull-up', 'Terrain, terrain' or 'Too low, terrain' GPWS warning at night (Airwork, 2008c, p.1-15).
- 1.8.15 The Commission has previously investigated a fatal CFIT accident that occurred while both pilots were involved in trying to correct a landing gear extension abnormality that arose during an instrument approach (TAIC, 1997). While neither pilot was specifically monitoring the vertical flight path, the aeroplane collided with the terrain about 16 kilometres (9 nautical miles) from Palmerston North Aerodrome. The Commission's report commented that to continue an approach while attempting to rectify a minor abnormal situation 'was an acceptable course of action ... [only] if the approach had been stabilised ...' (TAIC, 1997, para.2.127).
- 1.8.16 The operator had no procedure regarding the commencement or continuation of an approach when there was an unresolved aeroplane abnormality.

### **Incident reporting**

- 1.8.17 CAR 12.3 defined a *serious incident* as an incident involving circumstances indicating that an accident nearly occurred (CAA, 2008a). The related *Advisory Circular 12-1* included in its examples of serious incidents 'take-off or landing incidents such as undershooting, over-running or running off the edges of runways' (CAA, 2007, p.9).
- 1.8.18 CAR 12.51 and 12.55, respectively, required the operator to notify the CAA 'as soon as practicable' of an aircraft accident or serious incident, and listed the details that were to be included with the notification (CAA, 2008a). The acceptable means for notifying the CAA of an accident or serious incident were by freephone or the aeronautical fixed telecommunications network (CAA, 2007, p.5). The freephone was answered by staff of the Rescue Coordination Centre New Zealand, a full-time facility. Whereas *Advisory Circular 12-1* expanded on the requirement to notify accidents as soon as practicable and referred to the acceptable means for doing so, it did not distinguish serious incidents or repeat the similar urgency to notify them.
- 1.8.19 The Civil Aviation Act required the CAA to notify the Commission as soon as practicable of any serious incident that had been notified to the CAA (Civil Aviation Act, 1990). The CAA and the Commission had agreed to use email and/or telephone for that notification (TAIC, 2007).
- 1.8.20 CAR 12.53 and 12.57 separately required that the details of an accident or incident (which included a serious incident) were to be provided to the CAA within 10 days of the accident or 14 days of the incident (CAA, 2008a).
- 1.8.21 Anecdotal evidence obtained by the Commission suggested that some operators and document holders confused the requirement to notify as soon as practicable with the separate requirement to provide fuller, written details later.
- 1.8.22 The incident occurred at 0016 on 31 March 2009 and the PF promptly advised the operator's operations centre by telephone. At 1718 the same day, the operator faxed the details of the incident to the CAA, which informed the Commission on 1 April 2009.

- 1.8.23 The Commission recognised there were a number of reasons for delays in its being notified of serious incidents, including the following:
- an operator or pilot might not consider an incident to be serious
  - an operator or pilot might recognise an incident as serious, but not notify the CAA as soon as practicable
  - a serious incident notified to the Rescue Coordination Centre might not be recognised as such and advised promptly to the CAA or the Commission
  - the CAA might not recognise that a notified incident was serious and not inform the Commission as soon as practicable.

## **2 Analysis**

### **Overview of incidents**

- 2.1 The runway excursion at New Plymouth occurred because the PF was not in full control of the aeroplane during the final approach and landing. The approach had been rushed and was interrupted first by an engine RPM anomaly and secondly by a GPWS warning caused by the rushed approach. Although the airspeed was decreasing quickly on the final approach, the PF decided not to increase power, because he had difficulty controlling the aeroplane, which he attributed to the RPM anomaly. He judged it preferable to continue with the landing rather than to go-around with a possible controllability problem.
- 2.2 The pilots intended to make a visual approach, as shown by the PF descending below the instrument approach procedure minimum commencement altitude, while remaining above the minimum safe altitude. The rushed approach followed because they did not have the necessary visual contact with the runway lights until the aeroplane was, as the PF said, ‘high and a little quick and reasonably close’ to the aerodrome. There was then insufficient time and distance to establish the aeroplane on a stable glide slope. If the PAPI had been on, the pilots might have seen earlier the need to correct the flight path or to abandon the approach.
- 2.3 In spite of the operator’s procedures seeming to provide guidance to pilots for achieving a stable approach and for preventing CFIT accidents, the procedures were shown by this incident to be not completely effective.
- 2.4 There was no evidence that the pilots had felt compelled to expedite the flight for the benefit of the patient who was to be uplifted, or for any other reason.
- 2.5 The cause of the RPM anomaly, which remained until landing, was not determined, but might have been an intermittent propeller rigging discrepancy. There was no evidence that a full fuel bypass had occurred in the right engine, as happened at Auckland a few days later. The cause of that event was also not explained by an obscure electrical defect, and the 2 events were likely to have been unrelated.
- 2.6 The reason for the PF’s controllability problem was not positively determined. Compared with a single engine approach, neither an RPM difference nor even a full fuel bypass should have caused the PF an unmanageable control problem.
- 2.7 The above factors are explained further in the following sections.

### **The approach at New Plymouth**

- 2.8 The FDR data suggested that apart from a position report on the New Plymouth Aerodrome frequency when the aeroplane was passing 6000 ft in descent, no other recommended position report was made before landing. ATC had advised that there was no reported traffic, but the pilots could not assume there was no traffic, and should have made the recommended reports.

- 2.9 The PF positioned the aeroplane so that the briefed instrument approach procedure could have been flown if necessary, although the anticipated visual meteorological conditions were present for their arrival. The pilots might not have been alone in misconstruing the standard operating procedures that banned making a visual approach at New Plymouth. They might also have considered that they were complying with another standard procedure that dealt with the transition from an instrument approach to a night visual approach.
- 2.10 According to the pilots, the visual approach began when the aeroplane was about 6 nautical miles from the aerodrome, at 190 kts and 2000 ft. If the aeroplane had been in that position in the daytime, it should have been a comfortable manoeuvre to align the aeroplane with the extended runway centreline.
- 2.11 However, the FDR analysis suggests that the pilots were mistaken in their recollections of the approach profile and when the aeroplane became aligned with the runway. The base turn was much closer to the aerodrome and lower than normal, as one of the medical crew on board also observed. The FDR data showed that the aeroplane had descended to about 230 ft above the runway before achieving the runway heading. A comparison of their altitude with their distance from the aerodrome, as given by the distance measuring equipment associated with the instrument approach, was a basic cross-check that ought to have alerted the pilots, but appears not to have been done.
- 2.12 After the RPM anomaly became apparent, the PNF's attention was diverted to trying to resolve that issue rather than monitoring the flight path as required by standard operating procedures. However, the PF was similarly distracted by the RPM problem and he physically checked that both speed levers were fully forward in the HIGH position. The likely reasons were that both pilots had visual contact with the aerodrome, and they thought it was further away in distance and hence time.
- 2.13 The anomaly was a relatively minor event that was unlikely to have led to the crew shutting down the engine, as per the flight manual. Neither pilot suggested that the approach should be discontinued and the anomaly resolved at a safe altitude, and the operator's procedures did not discuss the options for dealing with an aeroplane problem that occurred on approach.
- 2.14 The combination of the PF manoeuvring for the approach from a point close to the aerodrome and both pilots being distracted to varying degrees by the RPM anomaly led to neither pilot monitoring the flight path adequately and to an unstable approach developing.
- 2.15 The FDR data showed that the rate of descent reached 2600 ft per minute towards the end of the base turn. Although the actual height above ground was not recorded, such a rate of descent below 1000 ft was enough to generate a GPWS warning and it was likely that both mode 1 and 2 warnings were heard, as the PNF initially recalled.
- 2.16 The PF was sure that the aeroplane's position was safe, and because the PNF did not challenge him he did not consider that a go-around was necessary. The PF increased power slightly to reduce the rate of descent and silence the GPWS warning, and continued the approach. Although the RPM difference was already apparent, the PF had no concern for aeroplane controllability at that stage.
- 2.17 Both pilots appeared to have had the same understanding of the standard operating procedure for CFIT prevention in force at the time. However, the procedure was ambiguous in regard to the expected response to a GPWS warning at night when pilots had visual contact with the terrain. In one paragraph, without consideration of the time of day, the procedure provided a case for ignoring a GPWS warning, and in another it stated the FSF's unequivocal stance that a go-around was mandatory at night or when in instrument meteorological conditions. This ambiguity with the CFIT prevention standard operating procedure might have contributed to the pilots' decision to continue with an unstable approach in spite of a GPWS warning.

- 2.18 The Commission has previously investigated a fatal CFIT accident that occurred when neither pilot was monitoring the vertical flight path of an unstable approach. Misperception by the Metroliner pilots of the aeroplane's position and flight path, and the unresolved system problem, had some similarities with the Palmerston North accident. When combined with the sanctioned dismissal of a GPWS warning, there was an increased risk of a CFIT accident. The operator had since amended its procedure to require an immediate go-around in the event of a GPWS warning at night or when in instrument meteorological conditions.
- 2.19 The trans-cockpit authority gradient was an indicator of the effective relative authority of flight deck crew members and was specific to the crew make-up under consideration. The legal authority of the captain aside, the optimum gradient should have the captain 'higher' than the co-pilot and that status was likely to be reinforced when the captain was the PF. If another pilot was PF, the captain should support the PF's operational decisions, but still be obviously in command.
- 2.20 An indirect object of CRM training is to avoid extremes of gradient, either too steep or too flat, which can hinder crew cooperation and safe operational practices, even though an operator has apparently adequate procedures. A gradient that is too flat or reversed can lead to a break-down in the expected command and crew performance, especially when faced with an operational challenge.
- 2.21 When 2 captains fly together, especially on other than a check or training flight, the gradient might be expected to be quite flat. Therefore, when an operator pairs captains to crew together, there is an element of increased risk. The counter to that is for the pilots to adhere strictly to standard procedures and to apply sound CRM techniques.
- 2.22 The aeroplane was low and close to the runway before the PNF realised that the flight path was unsatisfactory. Rather than assert the PNF role and advise the PF of what he saw, the PNF decided that the PF would be able to correct the approach and land on the runway, and said nothing. However, by not voicing his concern, the PNF could not have been sure that the PF was still in control of the aeroplane or whether he (the PNF) should have taken control. The pilots' lack of shared communication about a clearly abnormal approach suggested that a less than optimum trans-cockpit authority gradient might have existed and have inhibited them from applying effective CRM and monitoring.
- 2.23 The very short approach did not give the PF enough time to establish the aeroplane on a normal glide slope or for the pilots to diagnose the RPM anomaly. If an instrument approach had been flown as the operator's procedures intended, and a similar engine issue had arisen during the landing checks, the aeroplane would likely have been established on a stable approach and the pilots would have had more time to deal safely with the problem and evaluate their options.
- 2.24 The operator's standard operating procedure for achieving a stable approach did not, at the time, specify the acceptable parameter ranges and was therefore ineffective. The operator had since prescribed stable approach criteria for the Metroliner that were the same as those for the operator's other aeroplane types, and which were consistent with the FSF guidance.
- 2.25 The reason for the PAPI lights not being seen was most likely that the security guard simply chose the opposite runway. If the PAPI had been available, the pilots would have had an earlier indication of the aeroplane's position in relation to the nominal glide slope. Without the PAPI, they had to rely on the perspective of the runway lights to estimate the glide slope. An accurate perspective usually required a longer straight-in approach to be flown, or the final approach to be joined from the downwind leg of the circuit pattern.

- 2.26 The pilots did not advise the Life Flight Trust coordinator or the agent of their intended landing runway, which suggested that they had not considered the availability of the PAPI when they planned the flight. The operator had since amplified the responsibility of crews for ensuring that the appropriate aerodrome lighting was requested, although making use of the flight operations section, when established, would also be appropriate. Re-naming of the aerodrome remote lighting ‘vector’ switch to ‘runway’ could improve the likelihood that agents, often unfamiliar with aviation terminology, would select the desired runway and the associated visual aid.

### **The landing**

- 2.27 After completing the base turn, the PF had to correct the heading to align with the runway. The misalignment was unlikely to have been caused by the light cross-wind. The pilot said it was then that he experienced control difficulty when he increased the engine power.
- 2.28 The only instrument indication of a power-plant problem at New Plymouth was the RPM difference, which would be expected to cause a small, but manageable, thrust difference. The operator suggested that the RPM difference was sometimes caused by a slight, not uncommon, discrepancy in the power-plant control rigging. Although no engine control or propeller rigging discrepancy was found immediately after the incident, there was a significant and possibly relevant mis-rigging reported on 9 April 2009.
- 2.29 The minor discrepancies found with the previously installed FCU, fuel pump and propeller governor were unlikely to have caused the RPM difference or affected the power on approach.
- 2.30 Had the PF left the power setting of the right engine unchanged, a go-around ought to have been accomplished easily. It would also have been more manageable than if the engine had been shut down, because the propeller would have been in the flight range and producing thrust. The PF’s competence in conducting a single-engine go-around was not in doubt, but he evidently had too little time to clarify the situation. The quandary might have been removed had he recalled the flight manual advice and shut down the engine if he considered it unusable.
- 2.31 The lack of any other defect indication at New Plymouth contrasted with the effects seen later at Auckland when a fuel bypass was known to have occurred. Although the manufacturer stated that a fully open fuel bypass valve would cause a substantial degree of power asymmetry, there was no evidence that there had been reduced fuel flow at New Plymouth. Therefore, it was unlikely that a fuel bypass event had occurred at New Plymouth, and the 2 events were likely unrelated.
- 2.32 The operator’s trouble-shooting of the fuel bypass defect at Auckland isolated the SRL interface unit, and examination of the interface unit did find 2 intermittently defective variable resistors in near-identical circuits for each engine. Although the interface unit was replaced and there had been no similar bypass event on ZK-NSS since, the defective resistors could not have caused a bypass, because their only function was to modulate the brightness of the respective bypass light according to the signal sent to the fuel bypass valve by the temperature limiter.
- 2.33 The operator identified a stray voltage from the interface unit that could have sent an open signal to the right engine bypass valve, but the circuitry of the interface unit and the SRL system suggested that would be a very obscure defect. Therefore, the precise cause of the fuel bypass event was not determined.
- 2.34 Advice received from the manufacturer after the incident, in regard to whether the propeller would exhibit negative torque in the event the engine went to full fuel bypass, was different to that given in the flight manual. Although the final approach at New Plymouth was flown at minimum speed, the PF did not believe that negative torque had occurred, which tended to confirm that the propeller pitch had been in the flight range.

- 2.35 The possibility that the right power lever had moved slightly into the beta range and had caused the power asymmetry was examined. However, in response to the GPWS warning on the base leg, the PF had increased the power slightly which would have ensured that the power levers were in the flight range. He also said that he had pulled the powers levers back to flight idle after landing. Therefore, it was unlikely that the levers had been inadvertently moved into the beta range at any stage.
- 2.36 The approach remained unstable as the aeroplane became aligned with the centreline, only 230 ft above the runway and with the airspeed continuing to decrease. It was likely that full flap was not selected until the aeroplane was aligned, after which there was an increased rate of descent. The PF believed that he might not be able to control the aeroplane if he used more power, but he was confident that it would reach the runway with the power unchanged.
- 2.37 The aeroplane landed heavily at the beginning of the runway with the airspeed close to the estimated stall speed. That no stall warning was heard could suggest there was an error in either the stall warning system or the airspeed recorded by the FDR, or in both systems. The landing speed is normally 10-15 kts below the target threshold speed due to the flare manoeuvre before touchdown, but in this case it was likely that the PF had traded speed for a reduced rate of descent in order to make the runway, and that there had been little or no flare. As the aeroplane was heading right of the runway direction and the PF was not fully in control, a runway excursion followed. It was fortunate that the aeroplane remained within the runway strip, which was free of obstructions.

#### **Incident notification**

- 2.38 The cockpit voice recorder data was over-written during the ferry flight to Auckland. Although the PF had promptly advised the operator of the incident, the operator did not treat it as a serious incident and notify the CAA as soon as practicable. Had that happened, and the CAA had notified the Commission, the cockpit voice recorder data might have been preserved before the aeroplane left New Plymouth and been available to clarify the sequence of events and aural warnings.
- 2.39 Delays in the Commission being notified of serious incidents have occurred from time-to-time and have inhibited the opening or hindered the conduct of investigations. A possible reason for delays is reporters misunderstanding the need for 2 communications to the CAA: an initial notification and the later provision of written details. The CAR Part 12 requirement was clear, but might be confused with the incomplete information in *Advisory Circular 12-1*. Another reason could be inconsistent appreciation of the seriousness of an incident.
- 2.40 The Commission recommended to the Director of Civil Aviation that he address the safety issue of occasional delays in the notification of serious incidents to the CAA and the Commission.

### **3 Findings**

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

- 3.1 The landing was preceded by a rushed and unstable night visual approach commenced close to the aerodrome. The pilots did not have the benefit of PAPI lights, because they had not arranged for it or advised their intended landing runway.
- 3.2 The runway excursion occurred because the PF did not have full control of the aeroplane when it landed. The PF had earlier judged that a landing was preferable to attempting a go-around.
- 3.3 Although there had been a distracting engine speed anomaly during the approach, that should not have caused unmanageable control difficulty.



- 3.4 There was no indication that a fuel bypass had occurred in the right engine, as happened at Auckland a few days later, but if that had occurred, the power loss should also have been manageable.
- 3.5 The operator's standard operating procedure then in force for the prevention of controlled flight into terrain accidents was ambiguous and could have contributed to the incident, because it allowed the pilots to continue an unstable night approach after a ground proximity warning.
- 3.6 The operator's standard operating procedures then in force for achieving a stable approach in the Metroliner lacked sufficient detail of the acceptable ranges of approach parameters.
- 3.7 If the pilots had conducted an instrument approach, as required by the standard operating procedures, they likely would have been on a stable approach and managed a similar engine speed anomaly and completed a safe landing.
- 3.8 Better application by the pilots of crew resource management principles, such as sharing their perception of the flight path, would likely have prevented the approach and landing incident.
- 3.9 The Commission was notified of the serious incident too late to ensure preservation of potentially useful cockpit voice recorder data.

## **4 Safety Actions**

- 4.1 On 2 April 2009, the operator reminded its pilots that the *Route Guide Manual* did not authorise visual approaches at uncontrolled aerodromes, with the exception of Palmerston North.
- 4.2 On 8 December 2009, the operator advised the Commission of the following amendments made to the operator's manuals:

### **AIRPORT LIGHTING**

Prior to departure to any airport that has no Airways New Zealand remote controlled lighting, the crew are responsible in ensuring that advice is provided to the airport lighting operator (Security, etc.) for the operation of the runway lighting and the most likely runway to be utilised for the selection of the PAPI. (Airwork, 2008a, p.8-41, effective 7 December 2009).

### **RESPONSE TO GPWS WARNINGS**

Should there be a GPWS warning, by night or if not visual by day – execute an immediate “escape” manoeuvre to regain terrain clearance. (Airwork, 2008c, p.1-17, effective 8 December 2009).

### **STABILISED APPROACHES**

The criteria for a stable approach are now the same for all aircraft types in the operator's fleet, and are consistent with the FSF guidance. The revised page included the following points (Airwork, 2008c, p.9-7, effective 8 June 2009):

- all approaches should be stabilised by 1000 ft [above ground level] in [instrument meteorological conditions] and 500 ft [above ground level] in [visual meteorological conditions]
- initiate a go-around if the ... criteria cannot be maintained
- turns onto final approach are to be completed prior to 600 ft [above ground level].

- 4.3 On 26 January 2010, the operator advised the Commission:
- That it acknowledged ‘the requirement for a more structured CRM pilot training syllabus to be completed with reference to stabilised approaches, day and night GPWS warnings and situational awareness to be able to recognise all CFIT alert indicators for positive action prevention. A CRM training module is to be developed and will be introduced for the 2010 pilot refresher programme.’

- ‘As a result of this incident, the Company has established new procedures when a serious incident has taken place, to sequester the CVR prior to the aircraft being operated again.’

## **5 Safety Recommendation**

- 5.1 On 16 December 2009, the Commission recommended to the Director of Civil Aviation that he address the following safety issue:

The late notification of this incident hampered the Commission’s investigation, because potentially valuable CVR information was not preserved. The Commission has noted recently that other serious incidents have not been notified as soon as practicable to the CAA, and in some cases the delays have affected the Commission’s decision whether to investigate. The Commission and the CAA rely on being immediately notified of serious incidents in order to be able to conduct effective investigations and to learn the lessons to prevent accidents. Late notifications prevent the Commission from meeting its statutory obligations (008/10).

Approved on 25 March 2010 for publication

Hon. W P Jeffries  
**Chief Commissioner**

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