Report 95-004

Beech 65-A80-8800 Queen Air (Excalibur Conversion)

ZK-TIK

near Hamilton

29 March 1995

Abstract

At about 1225 hours on 29 March 1995, ZK-TIK stalled and spun from a low altitude after having both engines fail within a short space of time. The aeroplane had just departed Hamilton on a scheduled flight to New Plymouth. All six occupants died in the accident. Causal factors identified were a fuel tank mis-selection and failure to execute a forced landing. A contributing factor was a fuel management regime with potential for mismanagement. Safety issues discussed are checks and communications in emergency. Four safety recommendations concerning pilot education were made to the Civil Aviation Authority as a result of this investigation.

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Abbreviations

AD	Airworthiness Directive
ADF	Automatic direction-finding equipment
agl	Above ground level
AI	Attitude indicator
AIC	Aeronautical Information Circular
AIP	Aeronautical Information Publication
amsl	Above mean sea level
AOD	Aft of datum
ASI	Airspeed indicator
ATA	Actual time of arrival
ATC	Air Traffic Control
ATD	Actual time of departure
ATPL (A *or* H)	Airline Transport Pilot Licence (Aeroplane *or* Helicopter)
AUW	All-up weight
°C	Celsius
CAA	Civil Aviation Authority
CASO	Civil Aviation Safety Order
CFI	Chief Flying Instructor
C of G (*or* CG)	Centre of gravity
CPL (A *or* H)	Commercial Pilot Licence (Aeroplane *or* Helicopter)
DME	Distance measuring equipment
E	East
ELT	Emergency location transmitter
ERC	Enroute chart
ETA	Estimated time of arrival
ETD	Estimated time of departure
°F	Fahrenheit
FAA	Federal Aviation Administration (United States)
FL	Flight level
ft	Foot/feet
g	Acceleration due to gravity
GPS	Global Positioning System
h	Hour
HF	High frequency
hPa	Hectopascals
hrs	Hours
IAS	Indicated airspeed
IFR	Instrument Flight Rules
IGE	In ground effect
ILS	Instrument landing system
IMC	Instrument meteorological conditions
in	Inch(es)
ins Hg	Inches of mercurykgKilogram(s)
kHz	Kilohertz

KIAS	Knots indicated airspeed
km	Kilometre(s)
kt	Knot(s)
lb	Pounds
LF	Low frequency
LLZ	Localiser
Ltd	Limited
m	Metre(s)
M	Mach number (e.g. M1.2)
°M	Magnetic
MAANZ	Microlight Aircraft Association of New Zealand
MAP	Manifold absolute pressure (measured in inches of mercury)
MAUW	Maximum all-up weight
METAR	Aviation routine weather report (in aeronautical meteorological code)
MF	Medium frequency
MHz	Megahertz
mm	Millimetre(s)
mph	Miles per hour
N	North
NDB	Non-directional radio beacon
nm	Nautical mile
NOTAM	Notice to Airmen
NTSB	National Transportation Safety Board (United States)
NZAACA	New Zealand Amateur Aircraft Constructors Association
NZDT	New Zealand daylight time (UTC + 13 hours)
NZGA	New Zealand Gliding Association
NZHGPA	New Zealand Hang Gliding and Paragliding Association
NZMS	New Zealand Mapping Service map series number
NZST	New Zealand Standard Time (UTC + 12 hours)
OGE	Out of ground effect
okta	Eighths of sky cloud cover (e.g. 4 oktas = 4/8 of cloud cover)
PAR	Precision approach radar
PIC	Pilot in command
PPL (A *or* H)	Private Pilot Licence (Aeroplane *or* Helicopter)
psi	Pounds per square inch
QFE	An altimeter subscale setting to obtain height above aerodrome
QNH	An altimeter subscale setting to obtain elevation above mean
sea level	
RNZAC	Royal New Zealand Aero Club
RNZAF	Royal New Zealand Air Force
rpm	revolutions per minute
RTF	Radio telephone or radio telephony
s	Second(s)
S	South
SAR	Search and Rescue
SSR	Secondary surveillance radar
°T	True

TACAN	Tactical Air Navigation aid
TAF	Aerodrome forecast
TAS	True airspeed
UHF	Ultra high frequency
UTC	Coordinated Universal Time
VASIS	Visual approach slope indicator system
VFG	Visual Flight Guide
VFR	Visual flight rules
VHF	Very high frequency
VMC	Visual meteorological conditions
VOR	VHF omnidirectional radio range
VORTAC	VOR and TACAN combined
VTC	Visual terminal chart
W	West

Data Summary

Aircraft registration:	ZK-TIK
Type and serial number:	Beech 65-A80-8800 (Excalibur conversion), LD-249
Number and type of engines:	2 Lycoming IO-720-A1B
Year of manufacture:	1965
Operator:	
Date and time:	29 March 1995, 1225 hours[1]
Location:	Ngahinapouri, near Hamilton latitude: 37° 53.5' S longitude: 175° 13.4'E
Type of flight:	Scheduled Air Transport
Persons on board:	crew: 2 passengers: 4
Injuries:	crew: 2 fatal passengers: 4 fatal
Nature of damage:	Aircraft destroyed
Pilot's licence:	Commercial Pilot Licence (Aeroplane)
Pilot's age:	38
Pilot's total flying experience:	1099 hours 71 on type
Investigator-in-charge:	A J Buckingham

1 All times in this report are NZST (UTC+12).

Synopsis

The Transport Accident investigation Commission was notified of this accident at 1345 hours on 29 March 1995. Mr A J Buckingham was appointed Investigator-in-Charge (IIC) and investigation into the circumstances of the accident was commenced in Hamilton that evening.

Shortly after the aeroplane departed Hamilton on a scheduled flight to New Plymouth, both engines failed in quick succession, and the aeroplane stalled and spun at low altitude during an apparent attempt to return to Hamilton. The two pilots and four passengers died in the ensuing ground impact.

1. Factual Information

1.1 History of the flight

1.1.1 On the day of the accident, the two pilots reported for duty at Hamilton Airport in time to plan and prepare for a scheduled return flight to Napier via Gisborne in ZK-TAK, a Beech 65-B80 Queen Air operated by Kiwi West Aviation Ltd. Kiwi West operated these flights on contract to Eagle Airways Ltd, part of the Air New Zealand Link system. The flight departed Hamilton at 0702 hours, and all four sectors were completed uneventfully, the aircraft and crew arriving back in Hamilton at 1052 hours. Their next scheduled flight was in ZK-TIK, departing at 1210 for a return flight to New Plymouth. They were due to finish duty for the day on return from New Plymouth.

1.1.2 While ZK-TAK was operating the Gisborne/Napier sectors, ZK-TIK completed a return flight to New Plymouth, taking off from Hamilton at 0713 hours and returning at 0837. It was refuelled by the pilot in command on arrival and taxied to the premises of the company's maintenance contractor to have some minor maintenance items attended to. The aeroplane was taxied back to the terminal apron by a maintenance engineer on completion of the work.

1.1.3 At 1214 hours, ZK-TIK, operating as Kiwi West Flight 337, departed Hamilton on the scheduled flight to New Plymouth, a sector length of 88 nm. A slight delay in departure had occurred as the result of the last-minute addition of a passenger who had been required to travel at short notice. The flight departed with the two crew and four passengers, three adults and a child, on board.

1.1.4 After take-off on runway 36, the aeroplane was turned left to intercept the New Plymouth track, on climb to the intended cruise altitude of 6000 feet. At 1220 hours, shortly after radio contact had been established with Auckland Control, one of the crew reported "Kiwi West three three seven level five thousand, we've lost an engine", and in the same transmission the words "maximise power" could be heard.

1.1.5 The Auckland (Bay of Plenty sector) Controller, who was monitoring the flight on radar, responded with a clearance to turn left and approach straight in for runway 36, with no restriction on descent. At this stage the aeroplane was about 8 nm from the Hamilton DME, and close to the direct track to New Plymouth. The aeroplane continued on a southerly heading for a further 3 nm, then made a right turn, taking up a heading of approximately 360°M. Just prior to the turn, one of the crew advised that they would "descend in VMC to the north of the runway". The Controller asked if they still intended to join straight in for runway 36, to which the response was affirmative.

1.1.6 A witness, the holder of a PPL(A), who resided on a farm property about 8 nm from Hamilton Airport and close to the direct Hamilton - New Plymouth track, heard the sound of an aeroplane in cloud overhead as he came out of his house "about 12:25 pm". He thought it was under normal climb power at first, but within seconds, he heard a series of "backfiring" noises followed by an increase in engine rpm. He saw the aeroplane emerge from cloud, heading initially in the direction of New Plymouth, and make a right turn through about 180°. As the sounds he heard were consistent with the stopping of one engine and a subsequent increase in power to the remaining engine, he assumed that the crew was practising single-engine work, and thought no further of it at that time.

1.1.7 A number of residents of Pirongia heard and saw ZK-TIK in its right turn. Their observations were basically similar to each other, in that the engine noise, which sounded normal at first, changed to a series of backfires interspersed with brief surges of power. After one final backfire, the engine noise ceased altogether, and the aeroplane disappeared from sight, apparently gliding, towards the north. The sounds heard by the Pirongia witnesses were not heard by the witness referred to in paragraph 1.1.6. One witness at Pirongia was making a telephone call at the time she noticed the aeroplane in apparent difficulty, and was able to place the time at 1222 hours, from her telephone account.

1.1.8 At 1222:51 hours, Kiwi West 337 contacted Hamilton Tower and reported at 10 DME, passing 2000 feet, and was cleared to join straight in for runway 36. However, as observed on radar, the flight was not tracking directly towards Hamilton at this time. The northerly heading was maintained, with the aeroplane descending steadily, and the aeroplane disappeared from radar coverage at 600 feet, 6.5 nm DME on the 229 VOR radial (see Figure 1). At 1224:00 hours, the final transmission received from Kiwi West 337 (on the Hamilton Tower frequency) was: "ah (Controller's name) we've got (sic) lost both engines". Throughout this transmission, believed to have been made by the pilot in command, the sound of the aircraft's stall warning horn (a continuous note as against the intermittent note of the undercarriage warning horn) could be heard in the background.

1.1.9 Some children in the playground at Ngahinapouri School observed the aeroplane approaching from the approximate direction of Pirongia, and watched it fly past before returning to their play. One boy, however, continued to watch its progress, and observed that it seemed to be "coming down in steps" and was "wobbling from side to side". He saw it dive suddenly to the ground, doing "a couple of swirls" as it did so, and saw it "bounce back" after impact.

1.1.10 Another witness was driving westwards along Rukuhia Road, and saw a twin-engined aeroplane heading towards him from a south to south-westerly direction. He estimated that it was 250 to 300 feet above the ground, and was able to see that the left propeller was stationary, and that the right propeller was turning slowly. The aeroplane appeared to commence banking to the left, then suddenly dived straight down. He flinched instinctively when it appeared that the aeroplane must strike the ground, but it went out of sight below the skyline. Further along the road, the witness looked around to see if there was any sign of the aircraft, and seeing nothing, assumed that it must have pulled out of the dive and flown away. This witness's demonstration of the final manoeuvre, with the aid of a model, was consistent with the aircraft's "flicking" into a spin to the left. He estimated that the angle of bank had reached about 15° when the "flick" occurred.

1.1.11 A sharemilker who resided on Ohaupo Road, about 700 m to the south of the accident site, was sitting in his lounge when he heard what he took to be an aeroplane fly over or close to his house with a "whoosh". He heard a loud "thump" a few seconds later, and went outside to see what had happened, thinking there may have been a car accident nearby. He noticed that the neighbour's cattle had been startled and were running to one end of their paddock, but did not notice the aircraft wreckage, which was on a low rise near the cattle paddock, until the arrival of the emergency services 10 to 15 minutes later. This witness did not hear any sound of an aircraft engine under power prior to the "thump".

1.1.12 The first person to arrive at the scene was a qualified nurse, whose home was about 100 m from the accident site, and who had seen an aeroplane in the paddock behind her house when arriving home within a few minutes of the accident. After an initial look to confirm that there had been an accident, she called to her sister to telephone the Police, and approached the wreckage to look for survivors. She ascertained that there were no apparent survivors, and subsequently gave directions to the first emergency services crew to arrive.

1.1.13 The accident occurred in daylight on open pastureland, 5.5 nm on a bearing of 236°M from Hamilton Airport, Grid Reference NZMS 260 S15 056655, latitude 37° 53.5' S, longitude 175° 13.4' E, at an elevation of 200 feet.

1.2 Injuries to persons

	Fatal	Serious	Minor/None
Crew:	2	0	0
Passengers:	4	0	0
Other:	0	0	0

1.3 Damage to aircraft

1.3.1 The aircraft was destroyed.

1.4 Other damage

1.4.1 Small impact craters were made by the nose and engines at initial impact, and spillage of fuel resulted in the browning off of some 375 square metres of pasture.

1.5 Personnel information

1.5.1 The pilot in command, male, aged 38, held a New Zealand Lifetime CPL(A) and a Class 1 medical certificate valid until 7 June 1995. The CPL(A) included an Instrument Rating, which had last been renewed on 16 December 1994. His total flying experience at the time of the accident was 1099.25 hours, which included 752.95 hours on multi-engined aeroplanes. Flight time on the Beech 65-A80/B80 amounted to 71.15 hours, 49.15 hours on the A80 and 22 on the B80. His total flight time in the 90 days preceding the accident was 119.4 hours, which included all his time on the aircraft type.

1.5.2 He had joined Kiwi West five weeks before the accident, and during the first three days of his employment, completed his type rating training and Regulation 76 check. A period of supervised ("command practice") line flying with the Chief Pilot followed, and from 2 March, he was utilised as pilot in command on a progressively increasing basis, interspersed with copilot duties.

1.5.3 His cumulative duty time in the seven days preceding the accident date was 32 hours 50 minutes, and on two of those seven days, 25 March and 28 March, he had been rostered off duty.

1.5.4 The co-pilot, male, aged 35, held a New Zealand Lifetime CPL(A) and a Class 1 medical certificate valid until 15 February 1996. His last Instrument Rating renewal was completed satisfactorily on 1 March 1995 in conjunction with a Regulation 76 check.

1.5.5 His total flight experience was 587.5 hours, which included 283.55 on multi-engined aeroplanes. Most of the multi-engine time was co-pilot and dual, with less than 10 hours as pilot in command. He had been employed by Kiwi West since November 1994 and had been rated on the aircraft type shortly after joining the company. In view of his limited experience, he had been employed solely as a co-pilot up to the time of the accident.

①	DME distance from Hamilton
5000	Altitude
2000/130	Altitude/groundspeed
❶	Kiwi West 337 reports level at 5000 ft, having "lost an engine" at time 1220:04
❷	Approximate point of second engine failure (witness observations)
❸	Kiwi West 337 reports at 10 DME, joining straight in for runway 36
❹	Reports "lost both engines" (stall warning horn audible in background)
❺	Fades from radar at 600 ft, at time 1224:43
✥	Final impact point

Key to Figure 1

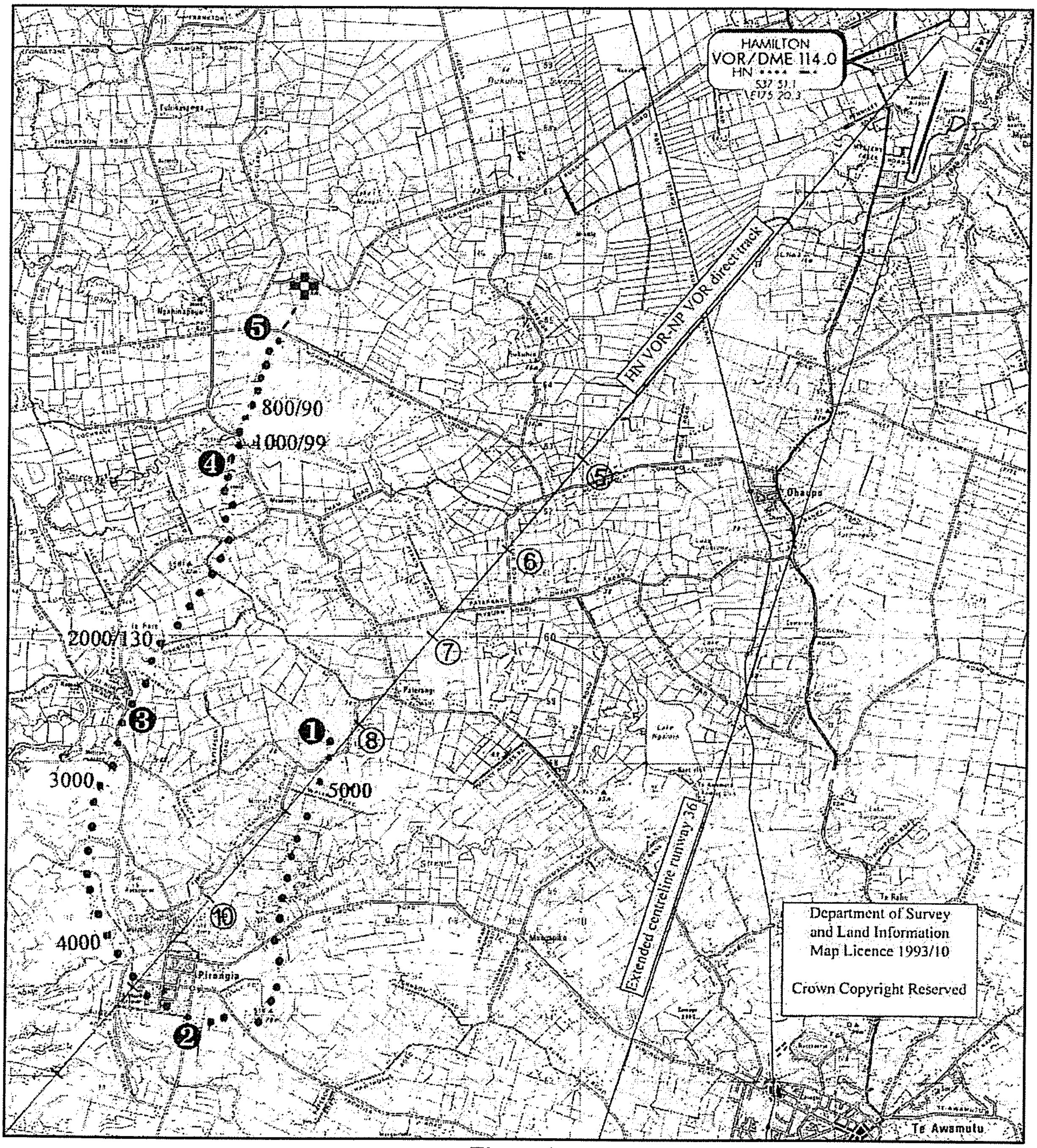


Figure 1
Radar plot of ZK-TIK's flight path subsequent to first engine failure

1.5.6 His duty time over the seven days prior to the accident was 25 hours, and days off duty in that period were 23, 25 and 26 March.

1.5.7 Both pilots were seen during the morning by the crew who had flown ZK-TIK on the earlier New Plymouth trip, and were reportedly their usual selves and in good spirits.

1.6 Aircraft information

1.6.1 Beechcraft 65-A80, serial number LD-249 was constructed in 1965 in the United States by the Beech Aircraft Corporation, Wichita, Kansas. At the time of manufacture it was equipped with two six-cylinder Lycoming IGSO-540-A1A engines. In January 1977, the IGSO-540 series engines were replaced by eight-cylinder Lycoming IO-720-A1B engines (the Excalibur conversion), and the aircraft maximum gross weight limit increased from 8500 pounds to 8800 pounds by the incorporation of an upgrade kit supplied by Beech Aircraft Corporation. The installation of the kit comprised the insertion of an angle bracket at the lower end of each nacelle rib/rear spar join, and the replacement of certain fasteners in this area. This changed the type designation to 65-A80-8800.

1.6.2 The aircraft operated on the United States register from manufacture until it was exported to Australia in April/May 1989, at which time it had accrued 6864 airframe hours. It was operated out of Townsville, Queensland until it was acquired by Kiwi West Aviation Ltd in September 1994, and ferried by the Chief Pilot and another company pilot (the Maintenance Controller) to New Plymouth. At the time of the aeroplane's arrival at New Plymouth, the accrued airframe hours were 9709.

1.6.3 An extensive refurbishment programme was performed at New Plymouth, to prepare the aeroplane for service with Kiwi West Aviation Ltd. The interior was refitted, the right engine was changed, both propellers changed, unfeathering accumulators fitted, fuel system components replaced or overhauled and numerous other items including a full repaint carried out. The aircraft was registered ZK-TIK and a non-terminating Certificate of Airworthiness issued. ZK-TIK was placed in Kiwi West service on 15 December 1994.

1.6.4 At the time of the accident, the following times in service had been accumulated:

Airframe, serial number LD-249: 10137.3 hours in service since manufacture.

Left engine, Lycoming IO-720-A1B, serial number L-1253-54A: 1782.7 hours since overhaul.

Right engine, Lycoming IO-720-A1B, serial number L-1413-54A: 691.4 hours since new.

(Engine TBO 2000 hours with provision to extend to 2200)

Left propeller, Hartzell HC-A3VK-2A, serial number BJ1487: 694.5 hours since overhaul.

Right propeller, Hartzell HC-A3VK-2A, serial number BJ1440: 594.7 hours since overhaul.

(Propeller TBO 2000 hours)

1.6.5 The most recent scheduled maintenance carried out on ZK-TIK was a 100-hourly inspection on 22 March 1995, at 10106.6 airframe hours. Maintenance Release number 019198 was issued, valid until 22 June 1995 or 10209.7 hours, whichever occurred earlier.

1.6.6 Other aircraft documents required to be carried were found on board, and were valid. These were: Certificate of Airworthiness, Approved Flight Manual and Radio Apparatus Licence.

1.6.7 Minor maintenance performed on the day of the accident comprised: replacement of the copilot's attitude indicator, the turning of the left main undercarriage tyre to equalise wear and the cleaning of the bulb contacts in the rear navigation light. No defuelling took place during this maintenance. The engineer who taxied ZK-TIK back to the terminal apron on completion of the maintenance could not recall the position of the fuel selector handles when he did so, but could only recall that the engines ran normally during that time.

1.6.8 The aircraft records indicated that ZK-TIK had been maintained in accordance with the appropriate maintenance schedules, and that the operator had been assiduous in having defects rectified as soon as practicable after they were noted. Normally, defects were recorded on a prepared Defect Record Card (Form MOT 2180), but an informal system was also in use, where defects were listed in a plain notebook, usually without dates or identity of the person making the entry. This appeared to be more of an "aide-memoire" system, where defects were noted as they arose, prior to being entered on the defect card or notified to the maintenance contractor. Most of the entries in the notebook had been cleared during recent maintenance, but three minor items, "autopilot switch", "flt inst knob - no dim" and "seat belts in front" could not be reconciled. (See paragraph 1.15.2.)

1.6.9 On the accident flight, the aircraft take-off weight as stated on the load sheet was 3468 kg (maximum permitted take-off weight is 3991 kg). Although this total was reasonably accurate, there were some anomalies noted in the method of arriving at the total. The OEW (operating empty weight) item on the load sheet was given as 2703 kg. Subtracting the aeroplane empty weight of 2563 kg leaves a crew weight of 140 kg, where in fact it was about 170 kg, based on the pilots' weights at their last medical examinations. The child's weight was recorded as 77 kg (standard adult weight) on the load sheet, but was actually about 27 kg (the standard child weight used by the company was 46 kg). A small quantity of fuel in the inboard tanks was not included in the computation. The landing weight had not been calculated, but as the landing weight limit is the same as the take-off weight limit on this aircraft, this was not a critical omission.

1.6.10 The centre of gravity was calculated using the corrected weights and found to be within limits.

1.6.11 ZK-TIK was operated on 100/130 octane Avgas, in accordance with the requirement in Section I (Operating Limitations) of the Approved Flight Manual. The fuel system itself is described in detail in this section, as it will be necessary to refer to it in later sections.

Aircraft fuel system

1.6.12 The Queen Air A80 fuel supply system as applicable to ZK-TIK is shown schematically in Figure 2. From the diagram, it can be seen that the inboard tanks and the outboard tanks are selected independently. On each side, the three outboard cells are interconnected to form, in effect, a single outboard tank. Further reference to an "outboard tank" means the group of three considered as one. The cells themselves are flexible rubberised fabric units.

1.6.13 Electric boost pumps are provided for priming and as a backup for the engine-driven pumps. The boost pumps are normally selected "on" for take-off, landing and when changing tank selections. On the A80, the boost pump selections need to correspond with the tank selections in order to fulfil their purpose. In the case of changing tanks, it is usual to turn on the boost pump applicable to the "new" tank before moving the actual tank selector.

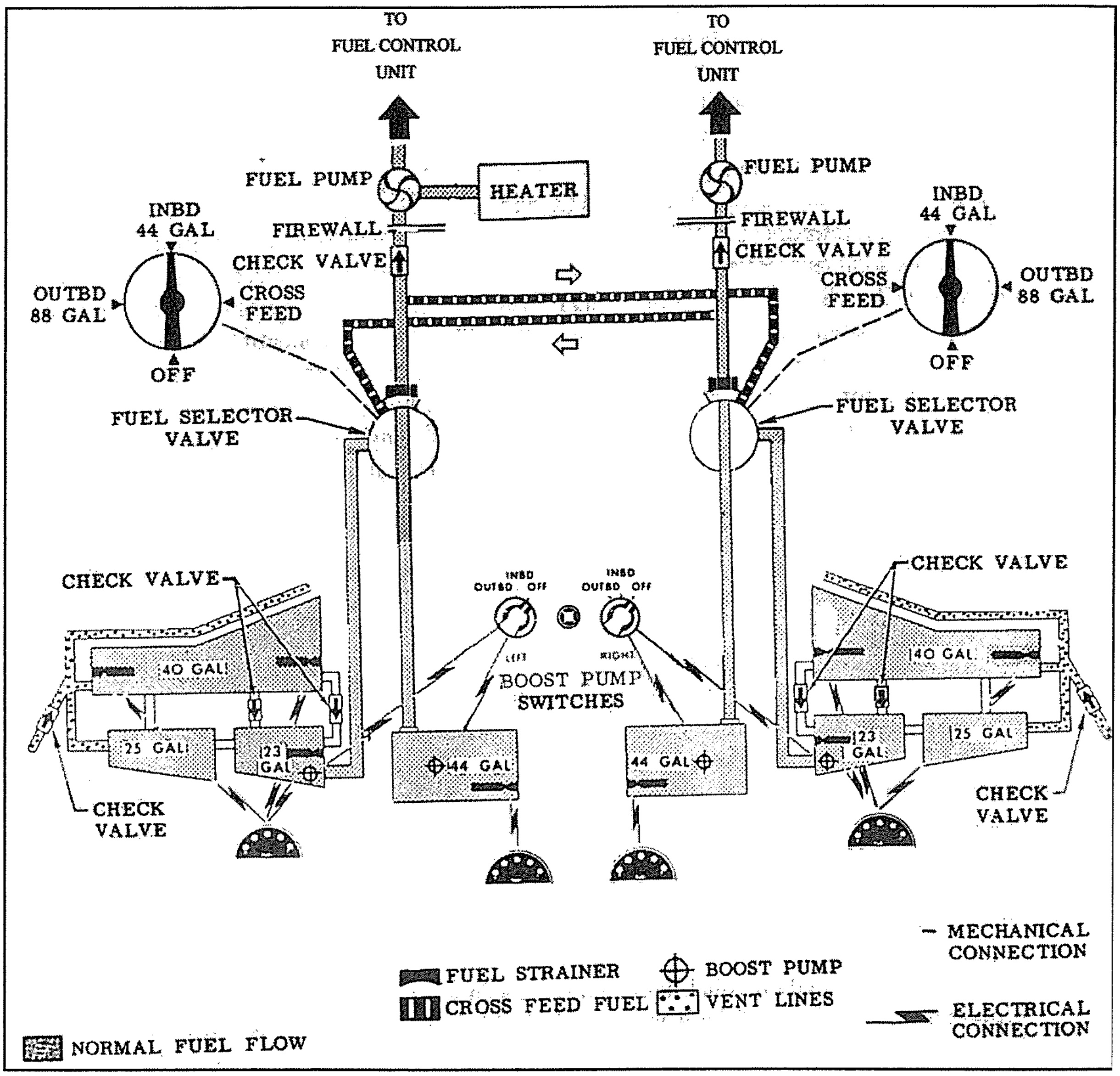


Figure 2
ZK-TIK (A80) fuel system

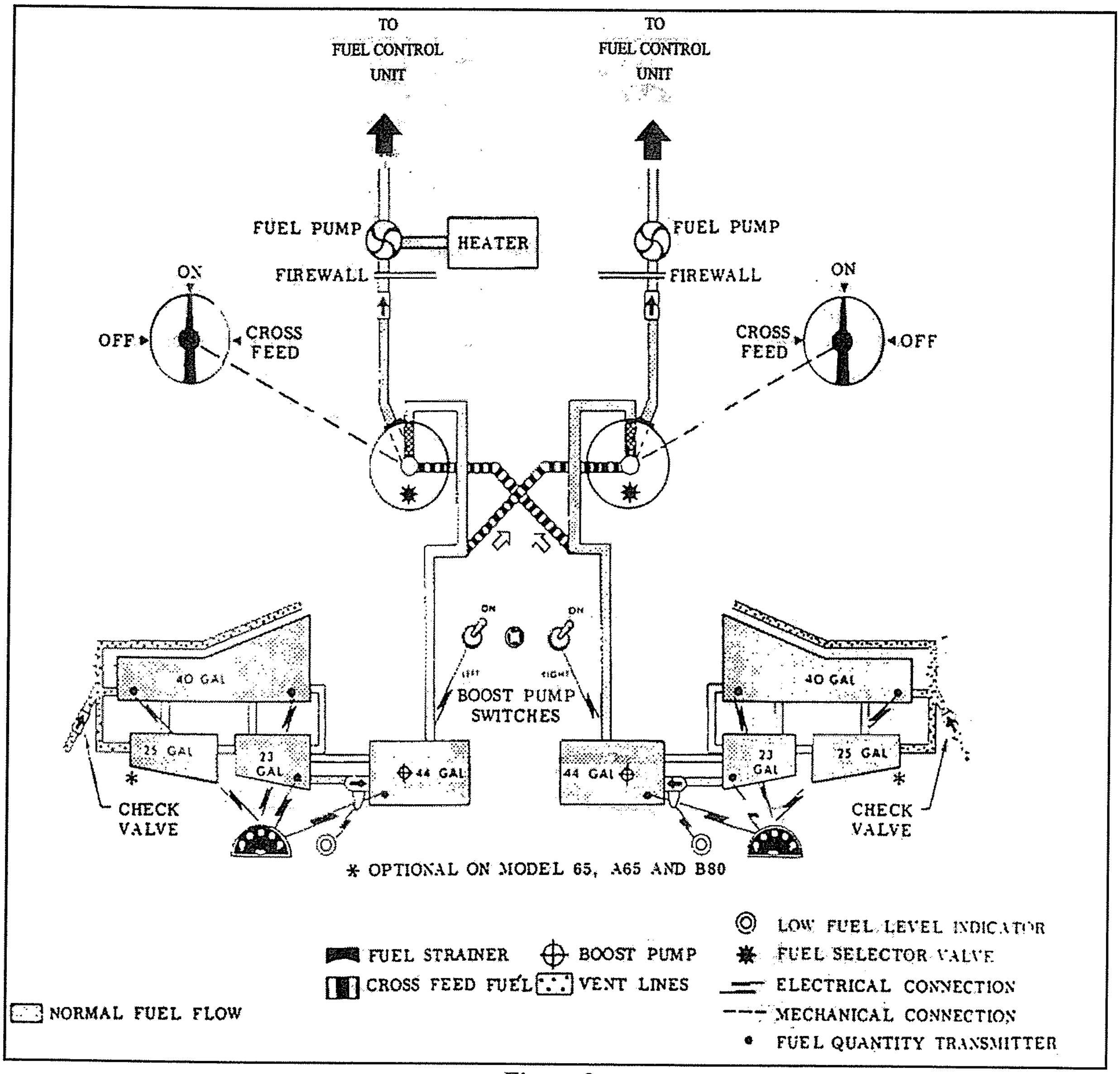
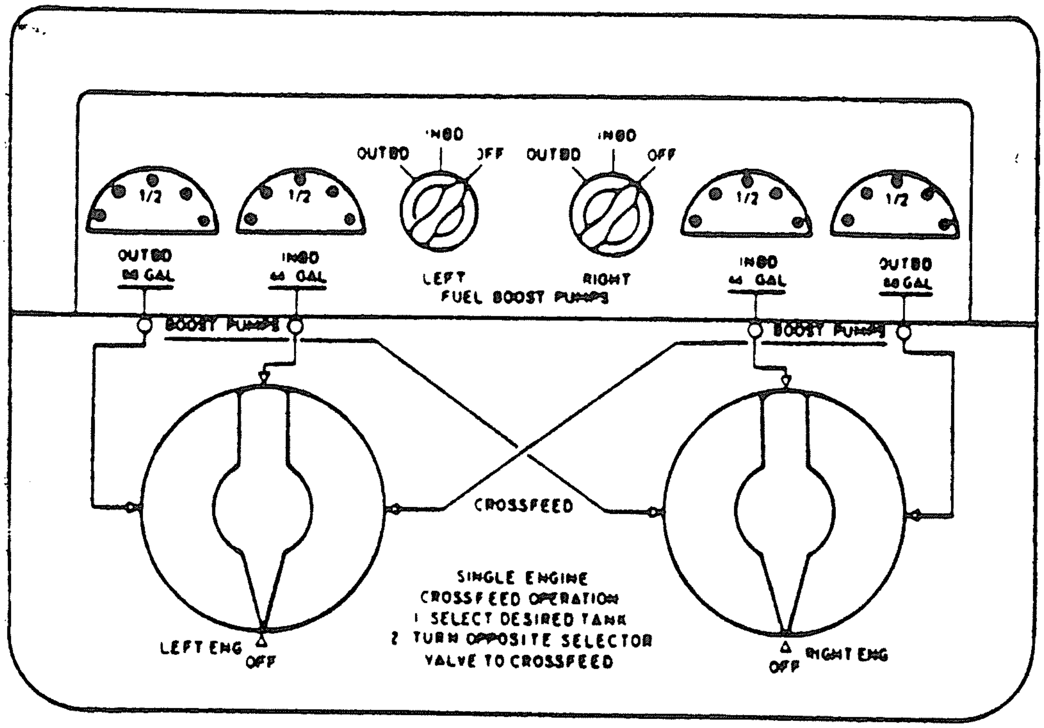
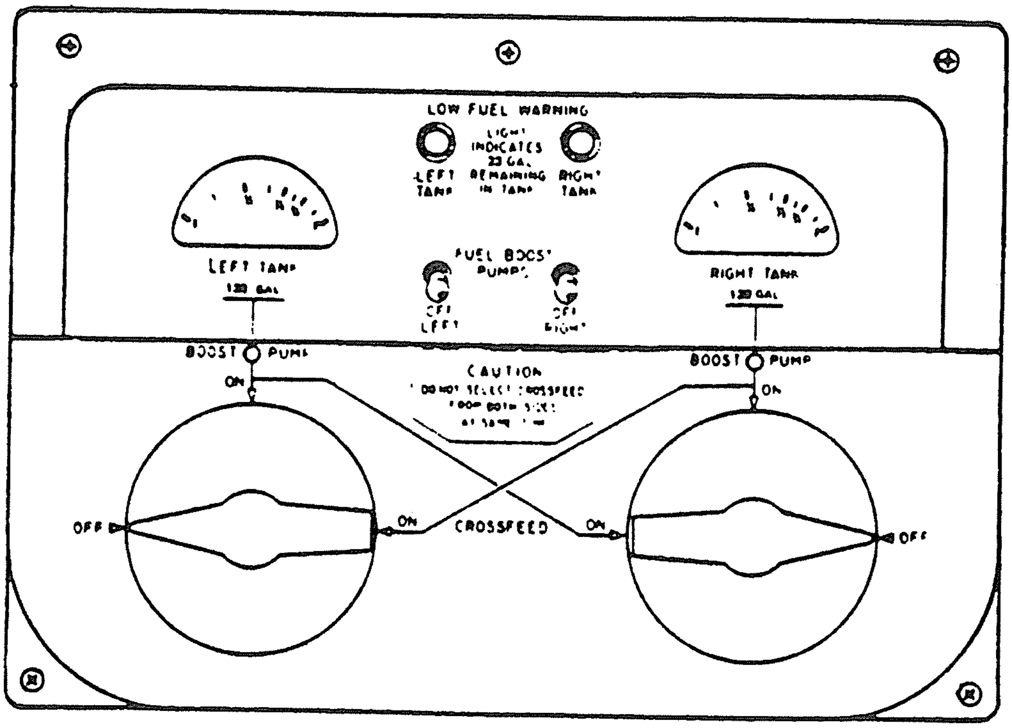


Figure 3
ZK-TAK (B80) fuel system
(For comparison)



ZK-TIK (A80)



ZK-TAK (B80)

1.6.14 The fuel panel, incorporating the selector handles, boost pump switches and contents gauges, is located on the cockpit left sidewall, immediately beneath the pilot's side window, and is accessible only to the pilot occupying the left seat (but visible to the pilot in the right seat). A representation of the panel is shown in Figure 4. Two placards were required by the Approved Flight Manual to be affixed above the fuel panel, "USE 100/130 OR NEXT HIGHER GRADE FUEL ONLY" and "USE INBOARD TANKS FOR TAKE-OFF AND LANDING". An additional placard was required on the panel itself: "SINGLE ENGINE CROSSFEED OPERATION (1) SELECT DESIRED TANK (2) TURN OPPOSITE SELECTOR VALVE TO 'CROSSFEED'". The latter caption was in fact engraved on the face of the selector panel at the time of manufacture.

1.6.15 Each fuel selector has four positions: outboard, inboard, crossfeed and off. The selector handles are linked mechanically by a cable and pulley system to their respective selector valves, which are located in the main wheel wells, on the aft face of the firewalls. The crossfeed lines are connected by a T-connection to the line between the selector valves and the engine-driven fuel pump, and are led across to the opposite selector valves. Crossfeeding requires that the fuel selector on the "source" side is selected to the required tank, and the selector on the "using" side is set to "crossfeed".

Comparison with the B80 fuel system

1.6.16 The Queen Air B80 fuel system and selector panel, as applicable to the operator's other aircraft, ZK-TAK, are shown in Figures 3 and 4 respectively. The number, location and capacity of the individual fuel cells are identical to the A80 system, but differences exist in the configuration and management of the system. The principal differences from the A80 system are:

a. All tanks in each wing are interconnected, forming in effect one tank in each wing.

b. This arrangement consequently requires only one boost pump per side.

c. The selector handles and valves have only three positions: on, crossfeed and off.

d. The crossfeed supply is sourced from a T-connection between the tank and the fuel selector valve, meaning that, when crossfeeding, the selector valve position on the "source" side is immaterial. It can be turned "off" without affecting the crossfeed supply.

e. The boost pump switches are on/off types.

f. The fuel management placards (use of inboard tanks and crossfeed procedure) are redundant, despite the flight manual requirement which does not differentiate between the A80 and B80.

g. A low fuel warning system is included, lights on the fuel panel illuminating when a total quantity of 23 US gallons or less remains on either side.

1.6.17 Both ZK-TAK and ZK-TIK carried identical Flight Manuals, which covered the Excalibur conversions of the A80-8800, B80 and 88. The cover page for TIK had the aircraft type as a B80, although the Certificate of Airworthiness had the correct designation of A80-8800. In the Normal Procedures section of the Flight Manual, the entire item "Fuel System" consisted of the following:

> "Use main tanks for take-off and landing. Auxiliary tanks should be used in level flight only. Electric fuel booster pumps are to be used for starting, take-off, landing and emergency. Cross-feed from the auxiliary tanks is controlled with the fuel tank selector valves. If auxiliary tanks run dry, turn booster pumps on when switching to main tanks."

Nowhere in the manual were the terms "main" and "auxiliary" defined.

1.6.18 The original Beechcraft Queen Air A80 Owner's Manual, applicable to the aircraft before the Excalibur conversion was performed, made the following reference (Section 1, Descriptive Information) to the selection of fuel tanks:

> During take-off and landing, use is restricted to the inboard cells only, unless the outboard cells are at least one-half full.

The flight manual applicable to the Excalibur conversion did not specifically permit the use of outboard tanks for take-off and landing (see reference to placards in paragraph 1.6.14). This is in spite of there being no difference in the fuel tank plumbing between the original configuration and the Excalibur conversion.

1.6.19 The advice of both Beech, the original manufacturer, and Excalibur, who performed the conversion, was sought for clarification. Beech advised that the Excalibur Flight Manual applied in this case, and that it did not provide for the use of the outboard tanks for take-off and landing. In response to a subsequent query, they advised that the reason for the limitation on the use of the outboard tanks existed only because they had not performed the necessary flight testing to validate their use at levels lower than half-full. Excalibur was unable to provide a reason why the provision for use of the outboard tanks for take-off and landing was not carried over into their Flight Manual.

1.7 Meteorological information

1.7.1 Meteorological Service of New Zealand Ltd (Metservice) briefing documents valid at the time of the accident indicated that the general situation included a humid northerly flow over the North Island, with the following forecast applicable north of a line from Taranaki to Gisborne:

> (In plain language) Areas broken cumulus 1800 (feet amsl), isolated tops above 10,000, base 1000 in showers. Areas broken stratocumulus 2500 tops 7000. Morning fog or drizzle patches with areas broken stratus 600 to 1200. Some heavy showers/thunderstorms in Northland, Auckland, Bay of Plenty. Isolated embedded cumulonimbus 1400, tops to FL350.
>
> Visibility 30 km, down to 3000 m in drizzle, 500 m in fog, 4000 m in showers/thunderstorms.
>
> Ice: nil below 10,000 feet
>
> Turbulence: nil significant
>
> Freezing level: 12,000 feet
>
> Forecast upper winds were given for Kaitaia, Rotorua, New Plymouth and Paraparaumu, and for Rotorua, the nearest of these points to Hamilton, the velocities (°T/knots) were: 3000, 345/16; 5000, 345/16; 7000, 340/17; 9000, 340/18.

1.7.2 The aerodrome forecast (TAF) for Hamilton, valid from 0900 hours to midnight, (again converted to plain language), read:

> Surface wind variable, 5 knots; visibility 25 km; rain showers, 2/8 stratus 1400 (feet agl), 3/8 cumulus 2000, 5/8 statocumulus 4000. TEMPO[2] between 1100 hours and midnight, visibility 7000 m, rain showers, 5/8 cumulus 1400; and 30% probability TEMPO between 1400 hours and midnight, visibility 4000 m, thunderstorm/rain, 5/8 stratus 1000,

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[2] Indicates that changes are expected to last for a period of less than one hour, and changes take place sufficiently infrequently for the prevailing conditions to remain those reported.

3/8 cumulonimbus 2000. 2000 foot wind 360/10. QNH minimum 1011, maximum 1020 (hPa).

The crew of ZK-TIK had in their possession standard weather briefing documents supplied by Metservice to Eagle Operations, including an earlier version of the Hamilton forecast which was still valid, and a valid route forecast for their planned flight.

1.7.3 The weather at the time of the accident was representative of the forecast conditions. The 1200 hours METAR for Hamilton Airport was :

> Surface wind 050/5, visibility 40 km, rain showers within sight of the field, 7/8 stratocumulus 2000 (agl), temperature 22°C, QNH 1015.5.

1.7.4 The Hamilton ATIS, issued at 1145 hours was information "Delta": runway 36, expect VOR/DME approach, surface wind 030°, 5 to 10 knots, visibility 40 km, haze, cloud 5/8 at 2000, high cover above, temperature 22, QNH 1015, 2000 foot wind 350°M, 10 knots. This remained current until superseded at 1320 hours by information "Echo", the only significant change being occasional reductions in visibility to 7000 m in passing showers.

1.7.5 ZK-TIK became visible to witnesses on the ground during its right turn following the initial engine failure, at a point approximately corresponding to its Mode C[3] altitude readout on radar of 4500 feet. Some witnesses said that the aeroplane disappeared back into cloud momentarily and reappeared, but there is no doubt that it was in VMC from shortly after its first emergence from cloud until it struck the ground.

1.7.6 A Saab 340 which was approaching Hamilton from the south shortly after the accident encountered a rain shower between 8 and 10 nm on the final approach to runway 36, but was able to discontinue the approach after breaking cloud, and join the search for ZK-TIK.

1.8 Aids to navigation

1.8.1 Navigation aids at Hamilton Airport are VOR/DME and NDB, and ZK-TIK was equipped with an avionics suite enabling all of these aids to be utilised. Additionally, the aeroplane was tracked by radar, with the primary radar installation located at Auckland International Airport, and SSR installations on the Waitakere Ranges 12.5 nm north-west of Auckland and on the Kaimai Range 27.5 nm to the east of Hamilton.

1.8.2 Recorded radar information was retrieved after the accident and data for the relevant period plotted. In addition to position information, the data recorded included time, altitude and groundspeed. A simplified trace of the radar plot is included in Figure 1.

1.8.3 Additionally, the radar recording was replayed for the IIC, together with a synchronised playback of the relevant radio and telephone conversations (as in paragraph 1.9.1).

1.9 Communications

1.9.1 During taxi and departure, routine communication took place between Kiwi West 337 and Hamilton Tower on the primary frequency 122.9 MHz, and post departure between Kiwi West 337 and Auckland Control on 125.3 MHz. All communications were tape-recorded, and transcripts made for the time period of the accident flight. Additionally, the telephone conversations between the Hamilton and Auckland controllers were available on the same tapes, and included in the transcripts.

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[3] The altitude reporting function of the SSR transponder on the aircraft.

1.9.2 A difference of 1 minute 40 seconds in the recording time bases of the Hamilton and Auckland tapes was discovered during analysis of the transcripts, and the times of the recorded Hamilton information were adjusted to coincide with the Auckland time base, using references common to both tapes.

1.9.3 An abbreviated transcript of relevant communications is shown as an Appendix.

1.9.4 A significant feature of the recorded communications from Kiwi West 337 is that at no time did the crew declare an emergency; the initial call consisted of a matter-of-fact statement that the aircraft was level at 5000 feet and had lost an engine. This gave rise to some confusion, evident in the telephone conversations between Hamilton Tower and Auckland Control, as to whether the aerodrome emergency services should be activated. Normally, alerting the emergency services will follow a request from a pilot, but the Manual of Air Traffic Services (MATS) does give the controller the latitude to assess the situation and alert the emergency services of his or her own volition. In this case, that option was in fact exercised.

1.9.5 Shortly after completing the initial right turn, Kiwi West 337 reported at 10 DME, passing 2000 feet, on approach for runway 36. Again, the call was made in a routine manner, with no indication that the aircraft was by this stage in actual distress. Only in the final transmission, when the aircraft had descended to about 1000 feet, was there any indication of the actual emergency, the failure of both engines, and even then neither of the key expressions "PAN PAN" or "MAYDAY" was transmitted.

1.10 Aerodrome information

1.10.1 Not applicable.

1.11 Flight recorders

1.11.1 The aircraft was not equipped with either a cockpit voice recorder or a flight data recorder. Under the terms of the current legislation, such recorders were not required to be carried.

1.12 Wreckage and impact information

1.12.1 ZK-TIK was found to have struck the ground nose-first in a steep nose-down attitude, at or close to the vertical, while rotating to the left. The aircraft had rebounded from the initial impact and come to rest upright, having rotated through some 70° about the right wingtip in the process. The heading at impact was 180°M, or approximately the reciprocal of the last observed direction of travel.

1.12.2 The fuselage sustained severe longitudinal compression damage, and both wings suffered corresponding chordwise crush damage, especially outboard of the engine nacelles. The outermost 1.6 m of the left wing had detached as a result of impact forces. All of the aircraft was accounted for at the site, the wreckage being reasonably compact, with only one item travelling any significant distance. This was the left main undercarriage wheel together with the lower portion of its associated leg, which landed 63 m to the north of the main wreckage.

1.12.3 Distinct "craters" were made by the left engine, the nose of the aeroplane and the right engine, to depths of approximately 535, 165 and 435 mm respectively. Additionally, a distinct full-span imprint of the leading edge of the wings was discernible on the ground. The left engine crater contained one propeller blade, which had been driven chordwise into the ground and had separated from the hub. The nature of the cuts from the other two blades and their angular relationship to each other indicated that the left propeller was feathered at impact. Two blades of the right propeller had detached on impact, and were embedded in the corresponding crater. The damage to the blades, in addition to their angular relationship, showed that the right propeller had been turning in low (fine) pitch, but with no power applied, at the moment of impact.

1.12.4 The flying controls were examined at the site, and continuity established. The elevator and aileron trim tabs were found set to the neutral position, and the rudder trim tab was set to 9° left, i.e. right rudder trim, corresponding to the direction it would be set to compensate for a failed left engine. It was not possible to establish either continuity or positions of the engine and propeller controls owing to the dislocation of both engines and damage to the control pedestal. Both the undercarriage and the flaps were retracted at the time the aeroplane struck the ground.

1.12.5 Little useful information was gained from the instrument panel, except that the undercarriage selector, although damaged, was in the "up" position, and both magneto switches were on "both". The subscale on the left (pilot's) altimeter was set to the area QNH of 1016 hPa, and the right (copilot's) to 1017. No airspeed reading at impact was discernible, although the stall warning light bulb showed hot stretch of the filament, indicating that it was illuminated at impact. (The stalling speed of the aeroplane at maximum gross weight, with undercarriage and flaps retracted, is 86 knots IAS. At a gross weight of 3453 kg, the stalling speed could be expected to be approximately 80 knots IAS.)

1.12.6 Both engines and propellers were later stripped and examined at an overhaul facility, under the supervision of the IIC. No pre-accident faults or signs of distress were found in either the engines or propellers, the engines exhibiting only normal wear commensurate with their recorded time in service. Engine accessories, comprising both pairs of magnetos, the fuel control units and the left engine-driven fuel pump were bench-tested and found to perform within specifications. Both propeller governors and the right engine-driven fuel pump had suffered impact damage and were unable to be tested. The unfeathering accumulators had retained their gas charge, indicating that they were capable of normal operation.

1.13 Medical and pathological Information

1.13.1 Post-mortem examination and toxicological tests revealed no evidence of any condition which would have adversely affected either pilot's ability to operate the aircraft.

1.14 Fire

1.14.1 Fire did not occur despite the forcible ejection of the contents of the outboard fuel tanks at impact.

1.15 Survival aspects

1.15.1 The accident was not survivable, owing to the high decelerative forces involved and the reduction of occupiable space within the cabin.

1.15.2 The decelerative loads exceeded the design loads for all occupied seats. The passenger seats became detached when the floor mountings failed, and the crew seats' lower legs failed, although the lap straps worn by the occupants remained intact. The crew seats were not equipped with shoulder harnesses, although the seats were each fitted with a shoulder harness inertia reel. "Seat belts in front shoulder straps" was however on the list of items to be attended to (see reference to notebook in paragraph 1.6.8). The aircraft was not required to be fitted with shoulder harness, being less than 5700 kg maximum certified take-off weight.

1.16 Tests and research

1.16.1 In the absence of any mechanical reason for the failure of both engines, the possibility of a fuel-related problem was considered, and appropriate investigation carried out. This focused initially on the installation from which the aircraft was last refuelled, then on the aircraft fuel system itself and its management.

The airport fuel installation

1.16.2 On the day of the accident, the Hamilton Police received a report that, following a bulk delivery, covers and locks had been left off the underground Avgas installation normally used by Kiwi West Aviation Ltd at Hamilton Airport. The Police requested the supplier to isolate the facility, placed it under guard and arranged for testing to be carried out the next morning. In the meantime, operators of other aircraft which had been refuelled from the same installation were contacted and advised by the supplier to cease operating those aircraft until the fuel testing was complete. Additionally, other installations which had received deliveries from the same tanker were similarly isolated.

1.16.3 The installation was duly tested for contaminants by a manufacturer's representative, in the presence of the IIC. No evidence of any contamination was found, and the fuel installation was placed back in service at the completion of the tests. The covers which were reportedly not replaced were ground-level steel plate covers which protected the recessed inlets to the underground tank, and the locks were the padlocks which normally secured the inlet caps.

1.16.4 The final reading displayed on the fuel pump before it was taken out of service for the tests was 194 litres, which was the amount placed in ZK-TIK by the pilot in command of the earlier flight from New Plymouth. This was verified by the fuel company records as a sale to Kiwi West at the corresponding time; the dispensing of fuel from this installation is controlled and recorded electronically, by the use of user-specific "swipe" cards. This fuel installation was the operator's primary fuel source at Hamilton, although another fuel company's installation was sometimes used.

Fuel system examination

1.16.5 At the site it was apparent that all three outboard fuel cells in each wing had ruptured on impact, and the contents ejected forcibly, leaving a large stain on the grass beneath. The dispersal pattern of the fuel suggested that the aircraft still had some momentum in the original direction of travel (about 360°M). Both inboard fuel cells were undamaged, and when cut open at the site, were found to contain only a trace of fuel (a maximum of 100 ml per side). The low fuel levels could not be accounted for by post-accident drainage, as the "low points" in the tanks (where the boost pumps/fuel outlets are mounted) in normal flight and ground attitudes were not the "low points" in the post-impact attitude. Had the tanks still contained a significant quantity of fuel, and had that fuel been able to drain from the tanks via the outlets, it could be reasonably expected that fuel below the original "low points" would be trapped in the tank.

1.16.6 Some fuel samples were taken from various points on the engine fuel systems, both at the site and during the strip inspection of the engines and ancillaries. Such samples as were obtained were all "clear and bright", uncontaminated by either water or solid matter, and all exhibited the normal characteristics of 100/130 Avgas. Samples obtained were all small in quantity, and were not consistent with the fuel delivery lines (between the selector valves and the injector nozzles, via the engine driven fuel pump and the fuel control unit) being fully charged at the time of the accident.

1.16.7 The fuel lines between the discharge ports on the outboard boost pumps and the fuel selector valves were identified and tested for obstruction. Except for an impact-flattened 450 mm section of the line to the right selector valve, the lines were found to be clear. The coarse screens over the boost pump inlets were clean, as were the filter elements associated with the selector valves. The lines from the inboard tanks were also tested and found to be clear, as was the right to left crossfeed line. Damage to the left to right crossfeed line precluded effective testing. The outboard boost pumps themselves were removed from the airframe and energised, and were found to run normally.

1.16.8 The fuel panel was badly damaged in the impact sequence, and the fascia separated from the underlying structure on which the selector handles were mounted. Damage to the portion of the fascia surrounding the right selector handle showed witness marks made by the handle itself during separation, indicating that the handle was set to the "12 o'clock" position at the time the damage occurred. The positions of the handles as first found were: left, "3 o'clock", right "2 o'clock". Tensioning followed by failure of the selector operating cables had occurred during the dislocation of the engines at impact, resulting in movement of the selector handles. The structure on which the left handle was mounted had distorted, in turn distorting the vinyl backing plate behind the handle. Gouge marks in the vinyl showed that the handle had been forced to both the 12 and 3 o'clock positions after the vinyl backing had begun to distort. An alternative explanation for the marks indicating that the handle had been in the 12 o'clock position, was that it was actually in that position when the distortion commenced. The right selector handle showed no similar evidence apart from the previously mentioned damage to the fascia.

1.16.9 The left and right fuel boost pump switches were selected to INBD and OUTBD respectively. The left switch had been struck heavily by an unidentified object, loosening the plastic knob on the metal spindle of the switch, and this could have resulted in a change to the selected position at impact. The right switch had received a blow of sufficient force to crack the plastic knob. Thus, neither position could be considered as reliable evidence of the pre-impact setting.

1.16.10 Both selector valves were found to be positioned "between selections" as a result of the damage to their operating cables. They functioned normally when tested in each position, and dismantling revealed no abnormalities.

1.16.11 Part of the investigation involved flying ZK-TAK, noting in particular the amount of fuel required to reach 5000 feet at normal climb power. From brakes release to 5000 feet took between three and four US gallons according to the fuel flow computer (which works in whole numbers). This figure did not include any taxi or run-up requirements. (On a later flight, it was noted that between seven and eight US gallons were required from startup to 5000 feet altitude.)

1.16.12 On the same flight, an engine was shut down experimentally by turning the fuel selector on that side to "off", with the engine set to cruise power. The engine stopped eight seconds after the fuel was turned off, and came back to life in under five seconds when the fuel was turned back on. The boost pump was switched on before the selector was returned to the "on" position.

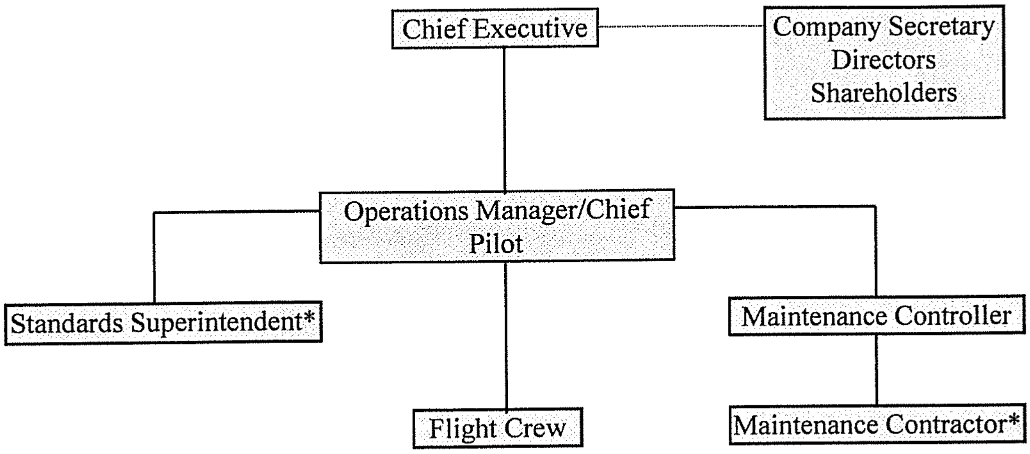
1.16.13 No sign of the placard relating to tank selection was found on or near the fuel panel during examination of the wreckage, nor was there any evidence of the recent presence of a placard. The Chief Pilot said that he was certain that there was no placard when he collected the aircraft, and the Chief Pilot of the former operator in Townsville could not recall having seen it. The placard was one of the items to be checked prior to the issue of a Certificate of Airworthiness, and there was no mention of its absence on the associated documents, although the Certificate of Airworthiness check sheet had been initially endorsed "B80" and later amended to "A80-8800".

1.17 Organisational and management information

Company structure and background

1.17.1 Kiwi West Aviation Ltd, essentially a family business, was constituted in 1992, and was structured as follows:

KIWI WEST COMPANY STRUCTURE



*These positions contracted to outside organisations

1.17.2 Not unusually for a company the size of Kiwi West, some individuals occupied more than one position in the organisation structure, for example, the Maintenance Controller was also a director and shareholder in addition to being a line pilot. The Operations Manager/Chief Pilot was responsible for most of the day-to-day running of the organisation.

1.17.3 In December 1992, the company acquired ZK-TAK as its first aircraft, although it was registered in the name of an Ardmore-based organisation, under whose aegis operations were commenced. That organisation was also responsible for training and checking of flight crews (see "Standards Superintendent" in organisation diagram), although Kiwi West employed its own Chief Pilot. Initially, Kiwi West operated only charter flights, based in New Plymouth, and utilised a local facility for its maintenance requirements.

1.17.4 In November 1993, Kiwi West entered into a charter agreement with Eagle Airways Ltd to provide a scheduled service between New Plymouth and Hamilton and other sectors as required from time to time. The operation was relocated to Hamilton Airport, where office space was made available to Kiwi West in the former rescue fire service building. Maintenance was still conducted for a time at the New Plymouth base, but in January 1995, was contracted to a Hamilton-based organisation.

1.17.5 Kiwi West Aviation Ltd obtained its own Air Service Certificate on 27 May 1994. Company personnel had been working for several months towards this end. The certificate was issued initially for six months, further renewal depending on a satisfactory safety audit and inspection by CAA during that six-month period.

1.17.6 Once Kiwi West was established as an operator in its own right, the checking and training arrangements changed. Training (e.g. type conversion) was done "in-house" and checking (Regulation 76 and Instrument Rating renewals) was done by a New Plymouth based organisation.

CAA auditing

1.17.7 Kiwi West was audited by CAA in November 1994, and the company's Air Service Certificate renewed for two years as a result. Only minor deficiencies were recorded during the audit, and these included: CASOs and Regulations did not contain the latest amendments, a fuel placard and alternate air placard missing from ZK-TAK, weight limitations not included on the load sheet, two non-applicable propeller AD's not referred to in the aircraft records, and some clarification of certain details required in the Operator's Maintenance Manual. The fuel placard cited in the audit was in fact one that was not applicable to ZK-TAK (see paragraph 1.6.14).

1.17.8 The previous CAA audit was conducted in February 1994, as part of an audit of the Ardmore-based company under whose auspices Kiwi West was still operating at that time. The audit report indicated that there were no adverse findings, but there were some details which required clarification. These were attended to in due course.

Crewing policy

1.17.9 From the outset, Kiwi West operated a two-pilot crewing policy, and structured the second pilot's duties so that the crew worked together as a team. Although the company undertook no formal CRM[4] training, the Standards Superintendent had considerable experience in this environment and was able to offer appropriate advice. Pilots with Kiwi West prior to the change in the checking and training arrangements had the benefit of this advice at first hand.

1.17.10 Flights were normally conducted using printed "challenge and response" checklists, which the pilot not flying (PNF) would read aloud as required, with the pilot flying (PF) responding appropriately after completing each checklist item. The PNF was required to monitor the actions of the PF as a check on whether each item had been performed correctly. For some of the more junior Kiwi West pilots, this was their first exposure to two-pilot operation, and when the other pilots were interviewed following the accident, the consensus was that the system had worked effectively, and had made for genuine crew interaction.

1.17.11 Crews often flew "leg-for-leg", i.e. took turns by sector, at PF and PNF duties, although it was at the discretion of the pilot in command as to which sectors were flown by whom. Junior copilots were normally permitted to fly only from the right seat, but more experienced copilots aspiring to command could fly from the left seat under the supervision of designated pilots. Flight time gained under the latter regime is classified as "command practice", and involves active participation in the planning and in-flight decision making.

Fuel management

1.17.12 For a period of some 23 months, Kiwi West operated only ZK-TAK, a B80 model. Fuel management was straightforward, requiring only that the fuel selectors were "on" for flight, and the boost pumps, when required, were "on". Crossfeeding was a simple matter of selecting "crossfeed" on the selector handle on the "using" side; the position of the handle for the "source" side was immaterial.

1.17.13 With the placing in service of ZK-TIK, some changes were necessary. All crews were briefed on the differences between the two fuel systems by the Chief Pilot, who in turn was familiarised with the A80 system in Townsville, when accepting the aeroplane from its former owner. It was decided at the outset that the fuel management on ZK-TIK would be based on the outboard tanks, for the following reasons:

a) The outboard tanks were larger than the inboards, and this was interpreted as the outboards being the "main" tanks and the inboards the "auxiliaries".

[4]Crew resource management (formerly called cockpit resource management).

b) Adequate fuel could be carried in the outboard tanks for the company's normal operations.

c) It would not be necessary to change tanks in flight.

1.17.14 As the fuel level in the outboard tanks was not visible below 65 US gallons per tank, that level became the "benchmark" when refuelling ZK-TIK, particularly in preparation for handing over to a new crew, or leaving the aeroplane ready for the next morning. Fuel requirements in excess of that amount could be accurately determined by observing the quantity dispensed from the refuelling pump. The inboard tanks were serviced from time to time with "a few gallons in each" to prevent drying out and deterioration of the cells.

1.17.15 However, it was found that when the left outboard tank was filled above about halfway (44 US gallons) a slight "weep" developed. Until the offending cell was replaced, it was necessary for a time to use the inboard tanks as well as the outboards, the latters' levels being kept down to less than half to avoid the "weep". The leaking cell was replaced on 17 February 1995.

1.17.16 During the time that both sets of tanks were used, it was found that confusion could arise in the computation of fuel on board. While the levels in the inboard tanks could be checked by dipstick, it was difficult to determine what fuel remained in the outboard tanks. It was possible to have on board a fuel weight of up to 350 kg with the level still not visible. The contents gauges, being of small size and having markings only corresponding to E - ¼ - ½ - ¾ - F, could not be read with the required degree of precision for this purpose. The intention of the Chief Pilot was to base fuel management on "sighted" fuel only.

1.17.17 Both ZK-TAK and ZK-TIK were equipped with digital fuel flow indicators, which also computed fuel remaining and fuel used. The fuel remaining figure was dependent on the correct input of the actual fuel quantity on board before flight. Use of the fuel computer made for accurate monitoring of the fuel used or remaining, provided that, on ZK-TIK, records were kept of the indicated totals displayed at the time tank reselections were made. It was found that the record keeping was prone to error.

1.17.18 Once the leaking fuel cell was replaced, the outboard tanks were utilised as planned. Thus the fuel management for ZK-TIK became similar to that for ZK-TAK, in that take-off, cruise and landing could be accomplished without the need to change tanks in normal flight. The most significant physical difference was the position of the selector handles: in ZK-TAK, both pointed to the "12 o'clock" position when selected to "ON"; on ZK-TIK, the left and right handles pointed to the 9 o'clock and 3 o'clock positions respectively when selected to "OUTBD" (see also Figure 5). Although the checklist carried in ZK-TIK was exactly the same as that in ZK-TAK, the "fuel" item in the before take-off checks (in fact listed in the line-up checks) was, according to the other company pilots, dealt with differently on each aircraft. For ZK-TAK, the PF response was "pumps on, cocks on, quantity verified" whereas for ZK-TIK, the response was "pumps on outboards, cocks on outboards, quantity verified".

1.17.19 The "few gallons" in the inboard cells reduced over time through normal evaporative losses and the daily sampling for water during the first pre-flight inspection of each day. Periodically, the Maintenance Controller would assess the need for adding fuel in order to keep the cells "wet". It was determined that no fuel had been added to the inboard cells for some weeks preceding the accident, and the last occasion on which the fuel levels had been dipped was probably on 22 March 1995. The pilot who did so recalled that the quantities were "three to four (US) gallons a side".

1.17.19A Although the original Owner's Manual for the Beech A80 permitted the use of outboard tanks for take-off and landing, this provision was not carried over into the Excalibur manual. In any event, the company's fuel management system did not include a strategy for ensuring that the outward tanks were at least half full for each take-off and landing.

Training in the handling of engine failures

1.17.20 The crew was confronted initially, in the failure of one engine, with what appeared to be a "familiar" emergency, i.e. one that they had practised from time to time. In the case of the pilot in command, single engine failures had been practised during his conversion onto type, and during his CA Regulation 76 check, five weeks previously. The training and checking was based on two-pilot crewing, with the pilot under training being expected to involve the training (or checking) pilot as he would a copilot, particularly in a simulated emergency situation.

1.17.21 The company's "non-normal" checklist listed the emergency procedure for the failure of one engine as follows:

"ENGINE FAILURE DURING CLIMB (above V_2)

1. KEEP STRAIGHT
2. CHECK SPEED "BLUE LINE"
3. MAXIMISE POWER
4. GEAR - UP
5. FLAP - UP
6. IDENTIFY "DEAD LEG"
7. VERIFY
8. FEATHER

* CLIMB AT BLUE LINE V_{yse}

AFTER POSITIVE CONTROL HAS BEEN ESTABLISHED

SECURE INOPERATIVE ENGINE

1.	MIXTURE	-	IDLE CUT OFF
2.	FUEL	-	PUMP OFF
			SELECTOR OFF
3.	ALTERNATORS(sic)		OFF
4.	MAGS	-	OFF

NOTE: MONITOR ELECTRICAL LOAD ON OPERATIVE ENGINE - REDUCE IF NECESSARY

ENGINE FAILURE IN CRUISE

ESTABLISH POSITIVE CONTROL OF AIRCRAFT AS PER ENGINE FAILURE DURING CLIMB

1. SECURE INOPERATIVE ENGINE

a)	MIXTURE	-	IDLE CUT OFF
b)	FUEL	-	PUMP OFF
		-	SELECTOR OFF
c)	ALTERNATORS(sic)		OFF
d)	MAGS	-	OFF

2. TRIM AIRCRAFT FOR SINGLE ENGINE OPERATION

3. MAXIMISE PERFORMANCE ON OPERATING ENGINE IF REQUIRED:
   a) MAX CONTINUOUS POWER
   b) SPEED - V_{yse}"

1.17.22 For the "engine failure in climb" situation, the immediate actions (1 to 8) were normally performed from memory. The checklist was produced when the situation was under control, and the securing checks performed, or , if they too had been performed from memory, verified against the checklist.

1.17.23 The "blue line" speed ($V_{yse,}$ or best single engine rate of climb speed) for ZK-TIK was 102 knots at maximum all-up weight. However, neither airspeed indicator had a blue line marking, although those in ZK-TAK incorporated this feature. The marking was not a requirement of the limitations sections of the Flight Manual.

1.17.24 Neither the Flight Manual nor the non-normal checklist referred to trouble checks in the engine failure procedures. Some organisations and some Flight Manuals for other aircraft types advocate checking such items as fuel, mixture, magnetos before securing the inoperative engine, if the failure is experienced above a certain altitude or speed. The criteria varied between organisations from "above 1000 feet agl" to "in cruise" to "in cruise or descent" as to when trouble checks should be performed, rather than simply securing the inoperative engine. An example of a procedure incorporating trouble checks (from the Cessna 404 Flight Manual) reads:

> "ENGINE FAILURE DURING FLIGHT (Speed above Air Minimum Control or Buffet Speed)
>
> 1. Inoperative Engine - DETERMINE. Idle engine same side as idle foot.
> 2. Operative engine - ADJUST as required.
>
> Before Securing Inoperative Engine:
>
> 3. Fuel Flow - CHECK. If deficient, position auxiliary pump switch to ON.
> 4. Fuel Selectors - MAIN TANKS (Feel for Detent).
> 5. Fuel Quantity - CHECK. Switch to opposite MAIN TANK if necessary.
> 6. Oil Pressure and Oil Temperature - CHECK. Shut down engine if oil pressure is low.
> 7. Magneto Switches - CHECK ON.
> 8. Mixture - ADJUST. Lean until manifold pressure begins to increase, then richen as power increases.
>
> If Engine Does Not Start, Secure As Follows........"

1.17.25 Even though trouble checks were not specified in the references available to pilots, the Chief Pilot said that they were standard practice in the cruise situation, and would have been appropriate for an engine failure in the climb at 5000 feet. He expected to see pilots use them in training situations, as did the checking pilot who had done the most recent Regulation 76 checks. The trouble checks were generally "fuel, mixture, ignition/instruments", to determine any obvious reason for an engine failure, such as a tank running dry or the failure of an engine-driven fuel pump.

1.17.26 Neither of the references available to the crew at the time listed the actions required for a double engine failure. The original Owner's Manual for the (unmodified) Queen Air A80, in Section 3, Performance Specifications and Limitations, did provide a table of glide performance, and for zero wind, at an IAS of 106 knots, the distance achievable from 5000 feet was 10.5 nm, and from 4000 feet, 8.4 nm. These figures are based on a "clean" configuration, (i.e. undercarriage and flaps up) and propellers feathered. Inferred from these figures is an average rate of descent of approximately 850 feet per minute. However, the company did not possess a copy of the original A80 Owner's Manual.

1.17.27 The Flight Manuals from a range of twin-engined aeroplanes were examined for procedures to follow in the event of a double engine failure. Out of a total of 14, only three listed a full procedure covering a forced landing, one listed a procedure to obtain best glide performance, and one provided only glide information in the form of a graph. In the absence of a specific procedure for double engine failure on a twin-engined aeroplane, one possible course of action is to revert to the procedure taught during initial training, for an engine failure in a single-engined aeroplane. This, typically, is:

Close throttle, apply carburettor heat (if applicable)
Convert excess speed to height
Establish glide, trim
Assess the wind direction and strength
Select a suitable landing area and plan approach
Carry out trouble checks:
- Fuel: contents, cock, boost pump
- Mixture
- Magnetos
- Instruments (engine temperatures/pressures etc.)

Partial power check
Distress call if checks unsuccessful in restoring power
Personal checks including passenger brief
Pre-landing checks
(Note: the order and content of these checks will vary slightly between training organisations.)

1.18 Additional information

1.18.1 Fuel management was discussed with a former Chief Pilot of an organisation which had operated ZK-TIK (as VH-NAU/VH-NQU) in Australia. He advised that during long flights (typically Townsville-Brisbane) it was common practice to run the outboard tanks dry once the aeroplane was established in level flight, before changing back to the inboard tanks. It was their practice to turn the inboard boost pump on before changing the tank selection, and the time taken to restore power to the engine was usually up to 15 seconds. If the boost pump were not turned on before the selector change, it could take up to 30 seconds to restore power.

1.18.2 He also described a situation which occurred during his conversion training on the aircraft, where a spin was entered inadvertently during a manoeuvre at altitude. The spin was described as very steep nose-down and difficult to recover from using the standard recovery technique. In-spin aileron and asymmetric power was used to assist in recovery, which was achieved after about six full turns.

1.18.3 On the "later flight" referred to in 1.16.11, a descent was performed in the clean configuration, with the left engine shut down and the propeller feathered, and with the right throttle completely closed (propeller windmilling). The airspeed was maintained at approximately 140 knots, and a 180° turn included in the manoeuvre. The rate of descent obtained was 2050 feet per minute, or roughly the rate of descent of ZK-TIK between 3900 and 1800 feet. To descend at 1200 feet per minute, as ZK-TIK had done from 4700 to 3900 feet, a power setting of 10 to 12 ins MAP was required on the right engine. Closing the right throttle completely gave a perceptible change in engine note, and a lower nose attitude was required to maintain speed. It was noted by the IIC, during the flight, that the characteristic backfiring of the engines sounded very muted from the cockpit.

1.19 Useful or effective investigation techniques

1.19.1 Nil.

2. Analysis

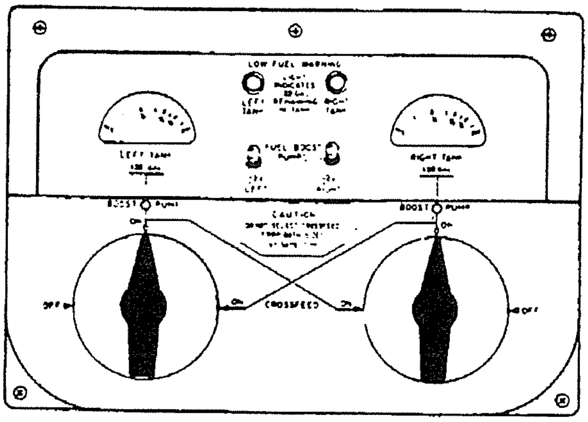
2.1 Two separate events require explanation, firstly the double engine failure, and secondly the subsequent loss of control.

The double engine failure

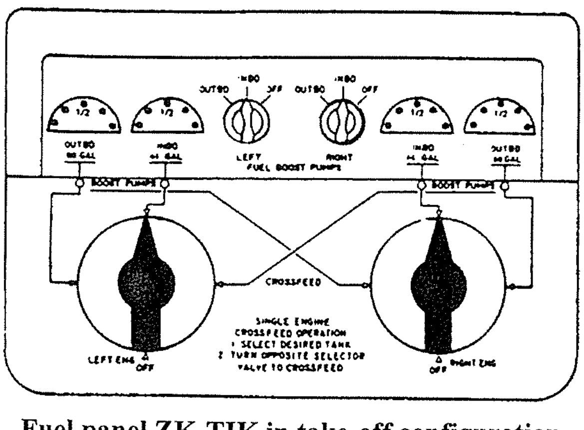
2.2 The possible causes considered were:

- Mechanical failure
- Fuel contamination
- Incorrect grade of fuel
- Fuel exhaustion[5]
- Fuel starvation[6]
- Fuel system mismanagement

2.3 Mechanical failure of both engines was ruled out by strip examination and the testing of the engine ancillaries, with the exception of both propeller governors and the engine-driven fuel pump from the right engine. The propeller governors could not have produced the effects experienced, and in the event of failure of an engine driven fuel pump, the flow to the fuel control unit can be maintained by the electric boost pump in the tank selected.



Fuel panel ZK-TAK in take-off configuration

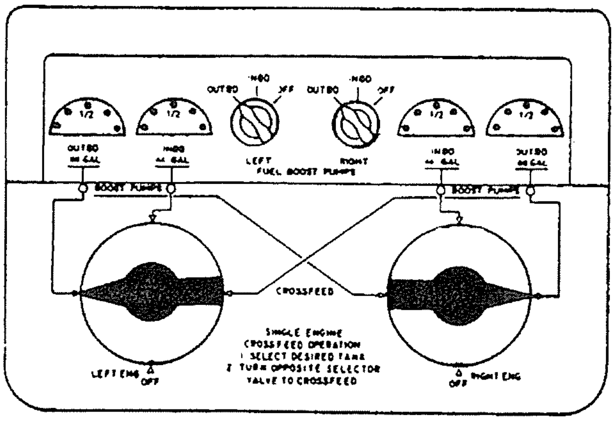


Fuel panel ZK-TIK in take-off configuration

[5] Having consumed all usable fuel on board.

[6] Fuel available on board, but for some reason fuel flow to the engine is interrupted, reduced or stopped completely.

(as intended by flight manual)



Fuel panel ZK-TIK in take-off configuration
(per company revised procedure)

Figure 5
Fuel panel configurations

2.4 Contamination of the bulk fuel supply was eliminated by detailed inspection of the installation by a supplier's representative, in the presence of the IIC. Fuel samples recovered from the aircraft showed no sign of contamination by water or solid matter and were identified as 100/130 Avgas.

2.5 Similarly, the possibility of loading an incorrect grade of fuel (Jet A-1 for instance) was eliminated. The final reading on the Avgas pump was consistent with the quantity placed on board ZK-TIK by the pilot in command of the earlier flight to New Plymouth, on which flight the aeroplane had performed normally in all respects.

2.6 Fuel exhaustion per se was incompatible with the evidence of a spillage of sufficient fuel at the accident scene to kill some 375 square metres of grass. The aircraft load sheet for Flight 337 indicated a fuel load of 353 kg, which equates to 130 US gallons, the level to which the aircraft was refuelled by the pilot in command of the previous flight. No defuelling was carried out when the aeroplane was at the maintenance base that morning.

2.7 The possibility of fuel starvation resulting from fuel system mismanagement was studied in some detail. The company had adopted a fuel management regime which, although providing a simplified procedure, was contrary to the intent of the aircraft Flight Manual procedures which were themselves unclear. The terms "main" and "auxiliary" were not defined, and the only direct reference to the use of inboard tanks was in the placard list in the Limitations section. The Flight Manual applied to three different models, and two different fuel systems, without differentiating between them.

2.8 The possibility of "negative transfer" occurring between aircraft was a real one, in that the fuel selector handle positions on one aeroplane (ZK-TAK) were "12 o'clock" for take-off (and all normal operations), and on the other, (ZK-TIK), "9 and 3 o'clock" (left and right respectively). (see Figure 5) The crew had just completed four sectors on ZK-TAK in which the handles were in the "12 o'clock" position on take-off, and it would have been easy to carry this over to ZK-TIK, particularly if the handles had been set to this position prior to their taking the aeroplane over. However, this possibility is partially offset by the physical differences in the fuel panels, particularly the three-position rotary switches for the boost pumps in ZK-TIK, as against the two-position toggle switches in ZK-TAK.

2.9 There was sufficient evidence to point to a take-off with the fuel selectors set to the inboard tanks. The quantities available in the inboard tanks were compatible with the time taken from take-off until the engines failed, the nature of the second failure in particular suggested that it was due to a tank being run dry, the position of the right fuel selector at impact was considered to be its pre-impact setting, and no evidence could be found of any other cause for the engine failures. There was sufficient fuel on board for the planned return flight, with reserves, and this was all carried in the outboard tanks. There was no impediment to this fuel's availability to the engines. The sequential, rather than simultaneous, engine failures can be attributed to slightly different fuel levels in the inboard tanks.

2.10 It could not be determined exactly when the fuel selectors were set to the inboard tanks. The maintenance engineer who taxied the aeroplane back to the terminal after maintenance could not recall the selector settings, only the fact that the engines ran normally during the taxiing. In any case, had the selectors been set to the inboard tanks by the engineer, it would have been correct procedure (in accordance with the intent of the Flight Manual) for him to do so. He was not a party to the company's fuel system operating procedure, nor was he required to be. The responsibility for compliance was on the flight crew. This highlights the need for particular vigilance on the part of the flight crews in any operation when accepting an aircraft back from maintenance.

Crew actions following the engine failures

2.11 From the available evidence, it was inferred that the left engine failed first, and that the failure was dealt with using the appropriate checklist. In the initial radio transmission, after the problem had been stated, the expression "maximise power" (Item 3 on the Engine Failure During Climb checklist) was heard, and the sounds heard by a witness almost directly below at the time are consistent with an increase of power on the "live" engine. The left propeller was feathered, and the rudder trim tab set to a position appropriate to a failure of the left engine. At this point, feathering the propeller and securing the engine was a reasonable decision, as the aeroplane was still close to Hamilton, and it would have been expedient to return for a landing and diagnose the problem once on the ground. In this regard, the crew acted in accordance with both the Flight Manual and Operations Manual procedures.

2.12 The securing checks appeared not to have been completed, in that the left boost pump was still selected to "inboard" (although it could not be stated with certainty that this was the pre-impact position) and the magneto switch was still on "both". However, the second engine may have failed less than two minutes after the first, giving the crew little time to complete the checklist before having to deal with a new problem.

2.13 The failure of two engines is not a problem which is encountered commonly by pilots of twin-engined aeroplanes, and one which is not generally practised. In fact, some aircraft manufacturers do not list procedures in their Flight Manuals to deal with the situation, or supply information on the glide performance of their aeroplanes. In this case, neither the Flight Manual nor the operator's "non-normal" checklist had any useful information available to the crew in flight. With the failure of the second engine, the crew was faced with two choices: accept that both engines had failed and plan for an off-airfield forced landing, or attempt to restore power to at least one engine and accept that some height will be lost in the process. The latter choice would require some confidence that the problem could be diagnosed and rectified before the situation became irretrievable.

2.14 It cannot be stated with certainty what the crew's actions were after the second failure, but at no time did the aeroplane appear to stabilise at its recommended glide speed of 106 knots (the radar plot shows groundspeed, which when compensated for the upper winds, will give an approximation of airspeed) and maintained an airspeed of about 130 knots down to 1400 feet. From this point, the airspeed progressively decreased until the stall warning activated. The aircraft target disappeared from radar shortly after this, the last indicated altitude shown being

600 feet and the groundspeed 87 knots. Up to this point, the track made good after the completion of the right turn over Pirongia was not compatible with joining final approach to runway 36 at Hamilton. This may have been influenced by the desire to remain in VMC, as the weather in the descent area appears to have been better than on the final approach to runway 36. With reference to the recommended glide speed, it is probable that this figure was unknown to the crew, as it was not readily available.

2.15 During the descent, which was in VMC following the second engine failure, the aeroplane was continuously above terrain that was suitable for carrying out a forced landing. There was a wide choice of open, grassed fields, and even a number of sealed roads which may have been suitable. The point where the accident occurred was on slightly undulating country, with flat ground suitable for a forced landing only a few hundred metres away, and over which the aircraft had just flown. This could imply that, up to the last minute, the crew were not anticipating having to make a forced landing, and this aspect is discussed in 2.21.

2.16 The evidence suggests that the crew either opted to try to restore power to at least one engine, or continued in the general direction of Hamilton without an effective appreciation of the glide performance being achieved. However, to restore power to the right engine, which was still windmilling at this stage, probably required only that the fuel selector be moved from "inboard" to "outboard" and that the boost pump be selected accordingly. Power should have been restored after only a matter of seconds. Once the right engine had restarted, the reason for the failure of the left would have become apparent; starting the left engine would have required setting the selector handle and boost pump switch to the correct positions, moving the propeller lever out of the feather detent (after ensuring that the mixture control and magneto switches were set) and waiting for the engine to fire. The unfeathering accumulator normally assures a rapid unfeathering, which will assist with a prompt restart once the propeller lever is moved from the feather detent.

2.17 The witness who heard the aeroplane fly over or close to his house heard only aerodynamic noise, with no sound of engine power before the sound of the impact. This, with the evidence of the right fuel selector, indicates that the crew did not manage to achieve a restart before the aircraft stalled and spun.

2.18 The reason the aircraft stalled and spun could not be determined. Even without engine power, it was still controllable. A possible explanation is that the crew became preoccupied with trying to establish what had gone wrong, in an endeavour to restore normal operation, and for a few critical moments, lost situational awareness. In any event, there is no doubt that at a late stage, they did not maintain control. The sound of the stall warning at 1000 ft, combined with the observation of one witness that the aeroplane was "coming down in steps" suggests that the aeroplane may have stalled (or have approached the stall) and recovered at least once before the final stall/spin sequence.

2.19 Prominent contributory factors in this accident were time and stress. From the first report of an engine failure to the final loss of control took a total of about five minutes. The second engine failure could have occurred as early as a minute and a half after the first, when the crew were already under a high workload and undoubtedly a certain amount of stress. It is a well-documented fact that a degree of stress improves human performance, but raising the stress level beyond a critical point results in rapid degradation of that performance. This is probably the situation in which the crew found themselves after the second engine failure occurred.

2.20 Other factors present which would have degraded performance included: unfamiliarity with the task (novel situation), information overload, inexperience on type, and possible passenger distress.

2.21 There is a possible explanation for the time interval between the second engine failure and the radio call notifying the loss of both engines. Had the "live" engine been throttled back rapidly to say 10 to 12 ins MAP, followed by a complete closing of the throttle, to facilitate maintaining VMC in the descent, these actions would almost certainly have been accompanied by backfiring from the engine exhausts - this is a characteristic of this series of engine. The reductions in power, if made at the same time the last of the fuel in the inboard tank was being consumed, could have masked the point at which the engine actually stopped delivering power. Had that occurred after the reduction in power, the resultant yaw, being slight relative to that experienced at a high power setting, may also have gone unnoticed. The only symptoms apparent at the low throttle setting would be the lack of fuel flow and the decreasing cylinder head and oil temperatures. Increasing the throttle setting would also increase the MAP, and moving the propeller lever would change the rpm - and not until the throttle was opened to set cruise power again, would the failure become apparent. This could have occurred when the aeroplane had descended to an altitude where the crew could be assured of maintaining VMC back to Hamilton, in which case there would have been a large element of surprise together with very little time in which to take effective action.

2.21 The difficulty with this explanation is reconciling the power surges and backfiring heard by the Pirongia witnesses, and how the crew would not have realised their significance, although it is possible that, once the surges stopped the crew then thought the engine was running normally, particularly if the throttle was closed. Also, diving the aeroplane in order to maintain VMC is at odds with the normal actions in the event of a single engine failure, where maintaining height, or at least minimising height loss initially, is an important consideration. Normally, height is conserved until a landing is assured. The desire to remain in VMC was not necessarily appropriate for a single engine failure, as the aeroplane was being operated under IFR, and to turn left in IMC to intercept the final approach track for the VOR/DME approach to runway 36 should have been well within the capabilities of the instrument-rated crew.

Crew training and emergency checklists

2.22 Neither the Flight Manual nor the Company Operations Manual detailed any trouble checks in the event of an engine failure. Both prescribed feathering the propeller and securing the engine, without any intermediate checks. However, the Chief Pilot said that the crew should have performed trouble checks as a matter of routine, in which case the cause of the initial engine failure should have been readily apparent, i.e. the fuel selector positioned to an empty tank. At this point, the error would have been realised, power restored, and the positioning of the right selector also detected in time to prevent the stopping of the right engine due to fuel starvation.

2.23 Initial training on twin-engined aeroplanes focuses largely on the ability to fly the aeroplane on one engine in a variety of situations. Few, if any, organisations specifically teach procedures for failure of both engines. Thus, it rests largely with the individual crew whether they formulate a clear plan of action in the event of a double engine failure.

Prioritising of Actions

2.24 The fundamental requirement of a crew in dealing with any abnormal situation while airborne is to maintain control of the aircraft. The second most important requirement is to maintain situational awareness, particularly in regard to the aircraft's position in relation to terrain. A third requirement is the timely notification of the situation to the appropriate agency. These actions are summarised in a well-known aviation maxim: "Aviate, Navigate, Communicate".

2.25 The first transmission from Kiwi West 337 indicating that there was a problem included an expression from early in the engine failure checklist. This suggests that the crew did not prioritise their actions, the communication at this point only serving to add to their workload. Instead of just flying the aeroplane and dealing with the emergency, they now had to share these tasks with the planning and decision making which should have come after the immediate actions, while maintaining a dialogue with ATC. While the response from ATC proposed a clear course of action, which in the event was not adopted, the call from the aircraft would have been better left until the emergency checks had been completed.

2.26 It was apparent from crew interviews that two-pilot procedures had worked well in the normal operating environment. With training and checking based on two-pilot crewing, the crew should have been well-prepared to work as a team to resolve an emergency situation.

Communications In emergency

2.27 While the crew did in fact notify ATC of their difficulties, neither of the expressions (PAN PAN and MAYDAY) which were appropriate (albeit at different times) were used. The initial and subsequent transmissions from Kiwi West 337 were made in a matter-of-fact manner which did not convey the true nature of the situation (assuming that, at the time, they were aware that the second engine had actually failed). This topic was discussed in a recent British accident report (AAIB Report 3/95) relating to a multiple engine failure accident, as follows:

> "This is a frequent aspect of emergency situations in which there is a reluctance to use the specified pro-words, perhaps in the belief that the emergency does not warrant it or the hope that the situation might improve. This is a generally false optimism which is likely to prejudice appropriate responses by those able to assist."

Two possibilities exist here: one, that the crew thought that the right engine was still operating, and two, that the radio call was made with the expectation that power would be restored in the very near future.

2.28 The statement by the crew that they would "descend in VMC to the north of the runway" was somewhat misleading, as it was incompatible with their implied intention of joining final approach for runway 36.

Active and latent failures

2.29 Using the terminology propounded by the Reason[7] method of accident analysis, **active failures** identified were:

- Failure to set the fuel selectors correctly before take-off;
- Failure to restore power to either engine;
- Failure to plan for a forced landing;
- Failure to maintain control.

2.30 The **latent failures** identified were:

- The use of two outwardly similar aeroplanes having significant differences between the fuel systems;
- Adopting a fuel management procedure on ZK-TIK contrary to the intent of the Flight Manual;
- Ambiguity in the Flight Manual terminology relating to fuel tanks;
- No trouble checks specified in either the Flight Manual or the Company Operations Manual procedures (although it was said that these checks would have been routine, even if unwritten);
- No procedures in either the Flight Manual or the Company Operations Manual to deal with a double engine failure;
- No information on glide performance readily available to crews.

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7 Professor James Reason, University of Manchester, England. Reason's methodology is explained in ICAO Human Factors Digest No 7, Investigation of Human Factors in Accidents and Incidents.

2.31 The only item in the two lists which has not already been discussed is the use of two aeroplanes with differing fuel systems. While it may have been desirable to have two the same, and thus not prone to confusion, practicality and economics dictated otherwise. The second aeroplane, ZK-TIK, was available to the company at a time when it was necessary to expand the fleet, and may well have been the only suitable option. The company drew the operating crews' attention to the differences in the fuel systems, and developed a check system which differentiated between the two. The fuel management system had its own logic (and the policy of "sighted" fuel was sound), but at the same time contained a serious pitfall in the form of the differing fuel selector positions. The difference between the PF callouts in the before take-off checklist should have alerted the crew, but in this case did not. This can be classed as a **failed defence**.

3. Findings

3.1 Both crew members were appropriately licensed, rated and medically fit to perform their duties.

3.2 The aeroplane had been maintained in accordance with an approved maintenance schedule, and was airworthy at the time of the accident.

3.3 The aeroplane's Maintenance Release and Certificate of Airworthiness were valid.

3.4 The all-up weight and centre of gravity were within limits.

3.5 There was adequate fuel on board, including reserves, for the planned flight.

3.6 The aeroplane took off with the fuel selectors set to the almost-empty inboard tanks.

3.7 The engine failures were due to fuel starvation, when the inboard tanks ran dry.

3.8 The company's fuel management system, where flight fuel was carried exclusively in the outboard tanks, was contrary to the intent of the Flight Manual that the inboard tanks be used for take-off and landing.

3.9 The Flight Manual used the terms "main" and "auxiliary" in relation to the fuel tanks, without defining which was which, but the placard descried in the Operating Limitations section of the approved Flight manual "Use inboard tanks for take-off and landing" was explicit as to which tanks were to be selected for take-off and landing.

3.10 The outboard tanks, having twice the capacity of the inboard tanks, could otherwise have been construed as being the main tanks.

3.10A Although in conflict with the Excalibur Flight Manual the use of the outboard tanks for take-off was approved in the Queen Air Owner's Manual provided that the tanks were at least half full.

3.11 The fuel management system gave rise to the situation where the fuel selector positions for take-off differed between the company's two aircraft, and introduced the potential for error.

3.12 Negative transfer probably occurred when the crew changed from ZK-TAK to ZK-TIK, resulting in the incorrect setting of the fuel selectors in ZK-TIK going undetected.

3.13 Exactly when the selectors were set to the inboard tanks could not be determined.

3.14 The use of "trouble checks" should have made the fuel mis-selection apparent to the crew, and averted the second engine failure.

3.15 After the second engine failure, the crew failed to plan effectively for a forced landing, and ultimately failed to maintain controlled flight.

3.16 Probable factors contributing to these failures include: workload, time pressure, unfamiliarity with the situation in which they found themselves and inexperience on type.

3.17 Latent failures identified were:

- Significant differences in the fuel systems of the company's two aircraft;
- The differing fuel selector settings between aircraft ;
- Ambiguity in Flight Manual terminology for fuel tanks;
- Lack of prescribed trouble checks;
- No procedures to deal with a double engine failure;
- Lack of readily available glide performance information.

4. Safety Recommendations

4.1 As a result of this investigation of this accident, it was recommended to the Director of Civil Aviation that he:

Produce educational material reminding operators of the importance of ensuring that procedures developed by the operator do not conflict with the mandatory provisions of the Aircraft Flight Manual (089/95);

Produce educational material discussing the ramifications of a double engine failure in a twin-engined aeroplane, with emphasis on the need for pilots to have an appreciation of the glide performance of the type(s) they are operating and the advisability of staying familiar with their basic forced landing training (090/95);

Promote the inclusion of trouble checks in the procedures for dealing with a single engine failure in a twin piston engined aeroplane, where these do not form part of the Flight Manual procedures (091/95); and

Remind pilots and operators of the correct meaning of the "Urgency" and "Distress" messages. The correct use of pro-words together with information about what actions will be taken by ATS on receipt of distress or emergency messages should be covered. The fact that a message can be easily cancelled, if the situation of the aircraft improves, should also be emphasised (092/95).

5. Safety Actions

5.1 As a result of a series of accidents and incidents attributable to fuel system mismanagement, the Civil Aviation Authority published an educational article entitled "Fuel (Mis)Management" in the June 1995 issue of *Flight Safety Supplement*. The article included a reference to operation of aircraft of the same type, but with subtly different fuel systems.

13 December 1995

MF Dunphy
Chief Commissioner

This report incorporates changes made as a result of an Addendum and an Erratum

13 March 1996

MF Dunphy
Chief Commissioner

Appendix

Communications between Auckland Control, Bay Sector ("Bay") and Kiwi West 337 ("337") on 125.3 MHz:

Time	From	
1217:08	337	Auckland, Kiwi West three three seven airborne Hamilton through two thousand four hundred, and two DME.
1217:18	Bay	Kiwi West three three seven climb to six thousand feet on track, [ ] area QNH is one zero one six.
1217:32	337	Six thousand and one zero one six, three three seven.
1218:06	Bay	Kiwi West three three seven you're not yet in radar contact, squawk five one two five.
1218:20	337	Kiwi West three three seven our transponder doesn't appear to be identing.
1218:29	Bay	Kiwi West three three seven roger.
1219:48	Bay	Kiwi West three three seven still no target, report established on the Hamilton one nine eight radial direct New Plymouth.
1219:56	337	Kiwi West three three seven.
1220:04	337	Kiwi West three three seven level five thousand, we've lost an engine, maximise power.
1220:14	Bay	Kiwi West three three seven understand you want to return to the field, you can make a left turn in your present position direct in for runway three six at Hamilton.
1220:21	337	Left three six direct Hamilton, three three six.
1220:27	Bay	Kiwi West three three seven, and no descent restriction into Hamilton, do you want any services at Hamilton?
1220:50	Bay	And Kiwi West three three seven just join final approach for the VOR/DME approach for runway three six.
1221:03	337	Kiwi West three three seven.
1221:08	337	We'll descend VMC to the north of the runway.
1221:15	Bay	Kiwi West three three seven roger, maintain terrain clearance descent in VMC and understand you're going to still join straight in for runway three six.
1221:24	337	Affirm.
1221:26	Bay	Roger.
1222:17	Bay	Kiwi West three three seven just confirm you're still VMC.

1222:19	337	Three three seven affirmative.
1222:23	Bay	Kiwi West three three seven thanks.
1222:51	Bay	Kiwi West three three seven when you have time, if you can advise if you require any services in Hamilton.
1223:33	Bay	Kiwi West three three seven still listening out? Contact Hamilton now please, one two two decimal nine, cheers.

Communications between Hamilton Tower ("Twr") and Kiwi West 337 on 122.9 MHz:

1222:51	337	Hamilton, Kiwi West three three seven's ten DME, descending through two thousand feet, on approach for three six.
1222:59	Twr	Kiwi West three three seven join straight in for runway three six, number one.
1223:04	337	Straight in for three six, Kiwi West three three seven.
1224:00	337	Ah, *Controller's name*, we've got lost both engines (stall warning audible in background).

[ ] denotes omission of non-pertinent word(s).

Recent Aviation Occurrence Reports published by the Transport Accident Investigation Commission

94-021	Embraer EMB-110P1 ZK-KIP Auckland International Airport, 28 September 1994
94-022	Aerospatiale AS350B ZK-HZP Needle Rock 10 nm north-east of Whitianga, 11 October 1994
94-023	Aerospatiale AS350B ZK-HWV Waikukupa Valley near Fox Glacier Westland National Park, 29 October 1994
94-024	Hughes 360HS ZK-HCT near Whangarei, 4 November 1994
94-025	Fletcher FU 24-950 ZK-EFO near Kaikohe Aerodrome, 5 November 1994
94-026	Piper PA32-260 ZK-ENZ half a nautical mile east of North Shore Aerodrome, 22 November 1994
94-027	Piper PA32-260 (Cherokee Six) ZK-DDF on Waiheke Island, 22 December 1994)
95-005	Cessna 152 II ZK-FJX at Matakana, 2 April 1995
95-007	Fletcher FU24-950 ZK-EMB 11 km north-west of Taupo, 8 May 1995
95-009	Bell 206B Jet Ranger III ZK-HDI Mt Stevenson 18 km north-east Glentanner, 6 June 1995