Report 98-008

Cessna 402C

ZK-VAC

double engine failure and ditching

Foveaux Strait

19 August 1998

Abstract

On Wednesday 19 August 1998, Cessna 402C aeroplane ZK-VAC was on a scheduled flight from Stewart Island to Invercargill when both engines failed. After the successful ditching in Foveaux Strait five passengers were rescued, but three passengers and the pilot, who were without lifejackets, did not survive. One passenger is missing presumed dead.

The cause of the double engine failure was not conclusively established but may have been associated with systemic fuel management.

Safety issues identified included:

- the need for operators to use a fuel quantity monitoring system to supplement fuel gauge indications, and
- the need for individual aircraft flight manuals to clearly indicate what optional equipment of operational significance is installed in the aircraft.

A safety recommendation was made to the Director of Civil Aviation on aircraft flight manuals.

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List of abbreviations

ADF	automatic direction finder
DME	distance measuring equipment
ELT	emergency locator transmitter
GPS	global positioning system
hpa	hectoPascal
HSI	horizontal situation indicator
IFR	instrument flight rules
METAR	aviation routine weather report
NDB	non-directional beacon
QNH	an altimeter subscale setting to obtain elevation above mean sea level
SAR	search and rescue
STOL	short take-off and landing
VDF	very high frequency direction finder
VFR	visual flight rules
VOR/DME	very high frequency ommi-directional range/distance measuring equipment

Transport Accident Investigation Commission

Aircraft Accident Report 98-008

Aircraft type, serial number and registration:	Cessna 402C, 0512, ZK-VAC
Number and type of engines:	Two Continental TSIO-520-VB
Year of manufacture:	1981
Date and time:	19 August 1998, 1643 hours[1]
Location:	In the sea, Foveaux Strait, 2.5 nm west of The Bluff Latitude: 46° 37' south Longitude: 168° 17' east
Type of flight:	Scheduled VFR air transport
Persons on board:	Crew: 1 Passengers: 9
Injuries:	Crew: 1 fatal Passengers: 3 fatal, 1 missing presumed dead 1 serious 4 minor/nil
Nature of damage:	Aircraft destroyed
Pilot-in-command's licence:	Commercial Pilot Licence (Aeroplane)
Pilot-in-command's age:	51
Pilot-in-command's total flying experience:	14564 hours 27 hours on type
Investigator-in-Charge:	J J Goddard

[1] All times in this report are NZST (UTC + 12 hours)

1. Factual Information

1.1 History of the flight

1.1.1 On Wednesday 19 August 1998, Southern Air Cessna 402C ZK-VAC was being used principally on scheduled visual flight rules (VFR) flights between Invercargill Airport and Ryans Creek, on Stewart Island. Starting at 0730 hours, the company's chief pilot flew four round trips from Invercargill. At 1200 hours a second company pilot took over the aircraft, and flew one round trip.

1.1.2 After the aircraft returned the next scheduled flight was not until 1500 hours, so the chief pilot carried out a routine instrument flight rules (IFR) check flight with the second pilot. A third company pilot, who was to complete the day's schedules to Stewart Island accompanied them as an observer. Before departure he refuelled the aircraft with 141 litres of Avgas, so that the fuel gauges indicated just under 300 pounds in each wing tank. The check flight, of 47 minutes, was completed without incident. After this flight the pilots noted that the fuel gauges indicated 190 pounds in each side.

1.1.3 The third pilot took over ZK-VAC, and completed the scheduled 1500 hour round trip between Invercargill and Ryans Creek without incident. The 1600 hour flight, with four passengers, was likewise flown to Ryans Creek.

1.1.4 The turnaround at Ryans Creek took about 10 minutes, with nine passengers being boarded for the return flight. The pilot did a walk-round of the aircraft, and closed the cabin entrance door after boarding. He started the engines before giving the passengers a routine safety briefing which covered the use of seat belts, the location of lifejackets and emergency exits, and the safety information cards. The aircraft took off normally from runway 22 at about 1630 hours. The departure flight path involved a left turn, climbing to about 1000 feet to set heading across Foveaux Strait for Invercargill Airport. During the departure, at 1636 hours, Invercargill Tower received a radio call from ZK-VAC, advising that the aircraft was airborne from Ryans Creek.

1.1.5 The flight initially proceeded normally, in clear weather conditions but with one or two showers in sight and some mild turbulence. At about mid-strait, some five or six minutes after departure, the aircraft yawed and banked to the right, turning off course some 20 or 30 degrees. At the same time the right engine appeared to slow down and lose power.

1.1.6 The passengers saw the pilot respond by moving engine control levers and the fuel selector knobs on the floor with his right hand, and some switches with his left hand. The right engine appeared to regain power, and the pilot turned the aircraft back on course.

1.1.7 A short but undetermined time later both engines appeared to lose power. The pilot again moved the engine control levers and the fuel selector knobs several times. The passengers also reported hearing a beeping warning tone for a few seconds.

1.1.8 The pilot then made a "Mayday" call on the radio, which was received by Invercargill Tower at 1643 hours.

1.1.9 After his "Mayday" call, the pilot turned to the passengers and said, "We have an engine failure, I am ditching the aircraft. Put your lifejackets on."

1.1.10 The passengers who subsequently survived found their lifejackets in the seat pockets in front of them. One man, travelling with his three children, got out of his seat to help them don their lifejackets, and returned to his seat just before the aircraft ditched on the sea surface.

1.1.11 The ditching was described by one passenger as "Just about copybook". A lot of water spray was reported, and the aircraft stopped abruptly, to float level. Some passengers received minor bruising from contact with the seats in front during the deceleration. All the passengers were able to evacuate the aircraft, either through the emergency exit window on the right side of the cabin or the main door on the left. The pilot got out through the crew door on the left side of the cockpit.

1.1.12 The occupants initially stood on the wings or cabin roof, while the aircraft was floating. The pilot and three passengers had not donned lifejackets, so the pilot re-entered the cabin to look for them. He did not find any, and had to get out again as the aircraft started to sink.

1.1.13 The aircraft sank three or four minutes after the ditching, leaving the occupants initially floating together in the water.

1.1.14 When the air traffic controller in Invercargill Tower received the "Mayday" call from ZK-VAC, he responded by asking the pilot to "report distance". The pilot replied "Heading for The Bluff, we've got thirteen (indistinct word *'thirteen'*) DME (distance measuring equipment)".

1.1.15 The Invercargill controller promptly made a 111 telephone call to the police, at 1644 hours, to initiate an emergency response. He reported the aircraft's "Mayday" radio call, thirty miles from Invercargill, both engines failed and heading for Bluff with 10 persons on board.

1.1.16 After making other alerting calls to the Christchurch Air Traffic Control Centre, the Invercargill chief controller and the Invercargill Airport Rescue Fire station, the controller telephoned the operating company, Southern Air, at 1650 hours, to advise of the emergency.

1.1.17 The company chief pilot responded by telephoning the controller back straight away, and they determined that the reported location was at 13 DME, on a bearing of 165° magnetic from Invercargill Airport, as noted by the controller on the Tower VDF (very high frequency direction finder) during the "Mayday" radio call.

1.1.18 The chief pilot and an observer got airborne in the company Cessna 172 aeroplane at 1654 hours to begin an aerial search, and reported in the search area at 1704 hours. They were joined in the search a few minutes later by three more aeroplanes from Invercargill, one equipped with a droppable liferaft.

1.1.19 The aerial search was conducted in the reported area, west and southwest of Bluff, from an altitude of 200 feet upwards. The first positive sighting, which was of wreckage or debris, was recorded at 1742 hours, and the global positioning system (GPS) position was relayed to boats involved in the marine search.

1.1.20 The marine search had been initiated at 1656 hours by a "Mayday Relay" radio broadcast from the Bluff marine search and rescue (SAR) operations room at Bluff Police Station, which was responded to by a number of vessels in the Foveaux Strait area. The first of several boats from Bluff Harbour sailed at 1705 hours for the search area, and after a short delay while the search area was determined, the Riverton Coast Guard rescue craft was alerted at 1706 hours, proceeding promptly from its base 18 nm away.

1.1.21 The Riverton Coast Guard craft, with two other boats, found and started rescuing the survivors in the location marked by smoke flares dropped by a search aircraft, at about 1800 hours. Seven of the occupants had been recovered by 1803 hours, and two more by 1810 hours. The search continued in darkness with floodlights until 2200 hours, and on subsequent days along the coastline, but one passenger, a seven-year-old boy, was not found.

1.1.22 The survivors were transferred promptly to hospital where they were treated for hypothermia of varying severity before being discharged after one to three days.

1.1.23 The accident occurred in daylight at about 1643 hours, in the sea in Foveaux Strait between Stewart Island and South Island, 2.5 nm west of The Bluff.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	1	4 (1 passenger missing presumed dead)	-
Serious	-	1	-
Minor/nil	-	4	-

1.3 Damage to aircraft

1.3.1 The aircraft was substantially damaged by the ditching and the subsequent sinking and immersion in the sea.

1.4 Other damage

1.4.1 Nil.

1.5 Personnel information

1.5.1

Pilot-in-command:	Male, aged 51 years	
Licence:	Commercial Pilot Licence (Aeroplane) Agricultural, Chemical, Instructor category D and E, Instrument	
Aircraft ratings:	Cessna 402C, BN 2, Group G (single-engine)	
Medical certificate:	Class 1, valid to 1 February 1999	
Last Regulation 76 check:	11 March 1998	
Last route check:	11 March 1998	
Last emergency evacuation check:	11 March 1998	
Flying experience:	Total all types:	14564 hours
	Total multi-engine types:	5107 hours
	Total on type:	27 hours
	Total all types, last 90 days:	77 hours
	Total on type, last 90 days:	21 hours
Duty time:	5 hours	
Rest period before duty:	17 hours	

1.5.2 The pilot had been employed by Southern Air since August 1986. He had flown some 5200 hours with the company, principally on the Stewart Island service on the BN 2 Islander type, with an estimated number of crossings of Foveaux Strait in excess of 10 000. Most of these flights had been daytime VFR, with some 15 hours as night IFR.

1.5.3 He had completed type conversion training on the Cessna 402C, ZK-VAC, in May 1998, and had principally flown it on the Southern Air service between Invercargill and Dunedin. He had flown 11 Foveaux Strait crossings on the Stewart Island service in ZK-VAC as pilot-in-command in July and August 1998.

1.5.4 He had done an instrument rating annual competency check in ZK-VAC, with the chief pilot, on 14 August 1998, which he had failed. The deficient items related to instrument procedures and use of the autopilot. His basic aircraft handling and procedures were reported as satisfactory. His previous 180 day instrument check, in January 1998 and on a BN 2 Islander aircraft, had been satisfactory.

1.5.5 He was an approved check and training pilot for single and multi-engine VFR operations. He had, in addition, been appointed to the position of maintenance controller for Southern Air in July 1998.

1.5.6 His previous flying experience, of some 9000 hours from 1969 to 1986, was as an agricultural pilot, on single-engine aeroplanes.

1.6 Aircraft information

1.6.1 ZK-VAC was a Cessna 402C twin-engined aeroplane, serial number 0512, manufactured in 1981. It had been imported to New Zealand in October 1996 from Papua New Guinea, where it had been operated since new. It was issued with a non-terminating Airworthiness Certificate in the standard category in November 1996. After being operated in Wellington, it was sold and registered to Southern Air in May 1998.

1.6.2 The Southern Air Operator's Maintenance Manual required the aircraft to be maintained in accordance with the Cessna Progressive Care programme. The last scheduled maintenance, an Operation No. 3 and special inspections as due, had been completed on 23 July 1998, and a Release to Service issued. The next scheduled maintenance, an Operation No. 4, was due on the earlier of 23 January 1999 or 13508 hours. No deferred defects or inoperative equipment had been recorded on the Aircraft Technical Log, but the cabin heater was reported as inoperative.

1.6.3 An annual review of airworthiness had been carried out on 5 June 1998, and a Certificate of Maintenance Review issued.

1.6.4 A review of the maintenance documents showed that all significant defects had been rectified or deferred as appropriate. No outstanding Airworthiness Directives were found.

1.6.5 The aircraft had accumulated a total of 13472 hours in service.

1.6.6 Two Continental TSIO-520-VB engines were fitted. The left engine, serial number 278373, had run 1239 hours since overhaul. The right engine, serial number 290452, had run 697 hours since new.

1.6.7 The engines were fitted with McCauley propellers, type 3 AF 32C505. The left propeller, serial number 921877, had 1472 hours since overhaul. The right propeller, serial number 952080, had 688 hours since new.

1.6.8 The aircraft had been modified early in its life by the installation of a Robertson STOL (short take-off and landing) kit, approved under a Supplementary Type Certificate. This modification replaced the aircraft's plain flaps with Fowler flaps, enabling improved take-off and landing performance, but not significantly affecting other performance aspects.

1.6.9 The aircraft was equipped and approved for single-pilot IFR operations.

Fuel system details

1.6.10 The Cessna 402C type has two main fuel tanks, one in each wing outboard of the engine. Each tank is an integral sealed part of the structure, occupying three bays of the wing. In normal use each tank supplies its respective engine.

1.6.11 An electric auxiliary fuel pump is located outside each tank, each controlled by a cockpit switch with "LOW", "OFF" and "HIGH" positions. The "LOW" position is used for priming during engine start, and during take-off and landing: The normal cruise position is "OFF". Fuel pressure to each fuel control unit is normally supplied by an engine driven pump, but in the event of a pump failure the auxiliary pump may be used in the "HIGH" position to maintain engine operation.

1.6.12 Two fuel selector controls are located on the cockpit floor, one for each engine, and operate selector valves in the wings. The selector knobs can be rotated to the marked positions "L MAIN", "R MAIN" and "OFF", which are oriented towards the respective tanks. Normal positions are: left selector to "L MAIN" and right selector to "R MAIN". Crossfeed positions are: left selector to "R MAIN" and right selector to "L MAIN". An emergency crossfeed shut-off control, located between the selector controls, is for use in the event of a fire or a wheels-up landing. The fuel supply to the cabin heater is from the right main crossfeed line.

1.6.13 The fuel intake line from each tank starts at three intake float valves, located in different areas of the tank. Each float valve closes when the fuel level is low in its area, to prevent entraining air with the fuel. Replacement of these float valves was required in accordance with Airworthiness Directive DCA/402/16. Those in ZK-VAC had been replaced with new valves in March 1998.

1.6.14 Each tank is vented to the atmosphere by a flush vent beneath the wing. A flush filler cap is located on the top surface, at the outboard end of each tank. Because of the wing dihedral and the length of the tanks, no fuel is visible below the filler orifice when the tank is less than about half-full.

1.6.15 The fuel quantity indicating system has three electrical capacitance sensing units in each tank, with one located in each bay. The three signals are fed through a signal conditioner on each side to a gauge on the instrument panel, where left and right needles indicate the quantity in pounds mass in each tank, on a scale from zero to 600 pounds.

1.6.16 An optional low level warning system illuminates amber warning lights on the pilot's annunciator panel when the fuel level falls below 60 pounds. This system was not fitted to ZK-VAC, and the annunciator panel had no "fuel low" captions displayed. The system description was in the Cessna 402C pilot's operating handbook, in the "airplane and systems" section which did not form part of the approved aircraft flight manual for ZK-VAC.

1.6.17 An Alcor digital fuel flow and fuel totalizer system was fitted to ZK-VAC in place of the standard fuel flow (pressure) gauges. A transducer at each engine fuel manifold valve measured the fuel volume flow. This was indicated in the cockpit for each engine, in pounds per hour. The gauge could be selected to indicate the total fuel consumed by each engine during a flight, either counting up from zero or down from a pre-set figure.

1.6.18 The capacity of each tank is 106.7 US gallons (640 pounds), of which 103 US gallons is usable. The minimum fuel for take-off is specified in the aircraft flight manual as 20 US gallons (120 pounds) in each main tank.

1.6.19 The fuel consumption figure used by Southern Air in their operation with ZK-VAC was 100 pounds per hour per engine. This was similar to the aircraft flight manual figure for a 65% power lean mixture setting, in standard conditions.

1.7 Meteorological information

1.7.1 A deep low lay to the north-east of North Island while a weakening ridge of high pressure from a stationary anticyclone in the South Tasman Sea extended across southern South Island. While North Island had rain and strong easterly winds, a light south-westerly flow over southern South Island gave mostly fine cool weather, with some cloud and a few showers on Stewart Island and the South Coast.

1.7.2 The 1600 hours METAR (aviation routine weather report) for Invercargill Airport was:

surface wind:	250° magnetic at 9 knots
visibility:	40 km
cloud:	few at 2000 feet, scattered at 3000 feet
temperature/dewpoint:	09/04° Celsius
QNH:	1016 hPa

1.7.3 Flying conditions between Invercargill and Stewart Island were reported as clear, with occasional showers in the area. Light turbulence near Stewart Island was mentioned.

1.7.4 Sunset at Invercargill on 19 August was at 1800 hours.

1.7.5 The water surface temperature in Foveaux Strait was 9° Celsius. The sea state during the search was reported as a swell or chop of 1 m. The surface wind was south-west at 15 knots.

1.8 Aids to navigation

1.8.1 Invercargill Aerodrome was equipped with a co-sited very high frequency omni-directional range/distance measuring equipment (VOR/DME), and a non-directional beacon (NDB).

1.8.2 Invercargill Tower was equipped with a VDF, which displayed to the controller the bearing of any radio station transmitting on the aerodrome control frequency.

1.8.3 No radio navigation aids were sited on Stewart Island.

1.9 Communications

1.9.1 Normal radio communications between ZK-VAC (callsign "Southern Charlie"), and Invercargill Tower took place on 118.5 MHz. An Air Traffic Services tape recording of radio and telephone communications was available for the period from the departure of the aircraft from Stewart Island on the accident flight.

1.9.2 The pilot of ZK-VAC, in his "Mayday" call, in response to the controller's request, reported his distance from Invercargill with the indistinct word "thirteen", rather than the normal pronunciation of such numbers by separate digits, e.g. "one three".

1.9.3 During the controller's subsequent telephone calls to the police and to the Christchurch Air Traffic Control Centre, he also did not use separate digits to report the distance. The word he used at that time was "thirty". Eight minutes later, after the discussion with the chief pilot, he made further calls amending this distance to "one three".

1.10 Aerodrome information

1.10.1 Not applicable.

1.11 Flight recorders

1.11.1 No flight recorders were installed, or required to be installed, in ZK-VAC.

1.12 Wreckage and impact information

1.12.1 After the aircraft was ditched in Foveaux Strait it floated for three or four minutes before sinking. During the marine search and the subsequent coastline search several minor items of floating wreckage were recovered. These included nose locker and avionics bay hatches, and the inflated lifejacket of the missing passenger.

1.12.2 The aircraft sank to the seabed, where it was located at a depth of 35 m by a Royal New Zealand Navy vessel using sidescan sonar, on 24 August 1998. It was lying inverted in an area subject to strong tidal currents. Divers were able to attach strops, and it was finally recovered by barge and crane on 26 August 1998. During the recovery operation, both engines and propellers were inadvertently separated from the airframe.

1.12.3 The aircraft wreckage was landed after extending the landing gear using the emergency blowdown system. The aircraft was stored under cover, where it was examined with the assistance of a representative from Cessna Aircraft Factory.

1.12.4 The engines and propellers were taken to an approved overhaul shop where they were examined with the assistance of a representative from Teledyne Continental Motors.

1.12.5 The aircraft had suffered significant damage to the cabin roof, nose cone, fin and rudder, consistent with being inverted on the seabed for a week and moving about with the tidal flow. The fuel tanks in the wings, and the engine sumps had collapsed under hydrostatic pressure. The tanks were punctured top and bottom as the metal skins were pressed on to the fuel quantity sensing units in the collapse. Some undersurfaces of the fuselage and wing were distorted in a manner consistent with the ditching. The recovery caused some wing skin damage, and engine mount, propeller control cable and fuel hose damage occurred during separation of the engines. The wreckage was essentially complete, however. Apart from the aircraft flight manual, a fire extinguisher and the crash axe, no loose items, such as luggage, lifejackets or passenger briefing cards were found in the cabin or nose lockers.

1.12.6 The aircraft, as recovered, was configured with the landing gear and flaps retracted. Both propellers were feathered, with slight bending on two blades. All three cabin doors or hatches were open.

1.12.7 The throttle, propeller and mixture levers were all forward, in the maximum position. Cowl flap and alternate air controls were closed. Both the left and right fuel selector controls were in the "L MAIN" positions. The emergency crossfeed shut-off control was in the "open" (down) position.

1.12.8 The trim control positions were:

Elevator:	approximately 20 ° nose down
Rudder:	approximately 5° nose left
Aileron:	approximately 5° roll left.

The additional elevator trim spring handle, installed as part of the Robertson STOL kit, was in the nose-down (aft CG) position.

1.12.9 No significant indications were captured on instruments on the pilot's panel. The altimeter subscale was set to 1016 hPa. The horizontal situation indicator (HSI) course selector (NAV 1) was set to 345°, while the heading bug was set to 170°. The DME was on, and selected to "NAV 1". Both ADF (automatic direction finder) receivers were on and tuned to 214 MHz, the frequency of Invercargill NDB. The emergency locator transmitter (ELT) remote switch was in the "ARM" position. The high frequency radio, transponder and weather radar were off. The GPS status was not determined.

1.12.10 All four magneto switches, the battery and alternator, and the avionics switches were on. All other switches, including the auxiliary fuel pump switches, were off. The switch on the ELT, in the rear fuselage, was found in the "ARM" position.

1.12.11 The examination of the engines and propellers showed that no mechanical failure of any component had occurred. The propellers were fully feathered, and showed no evidence of rotation at ditching. The engines showed a normal amount of wear, consistent with their hours run. No fuel staining was evident around any fuel component.

1.12.12 Testing of the magnetos was not possible because of sea water damage, but the magneto timing was correct, and the condition of the spark plugs indicated that normal combustion had been taking place. The engine driven fuel pumps functioned normally on test. The fuel manifold valves functioned normally at low pressure settings, but were out of calibration at high flow rates. One manifold valve initially leaked fuel, which was stopped by tightening the cover screws. The cover plate showed some damage, probably incurred during the recovery from the sea. The auxiliary fuel pumps and fuel control units could not be tested because of sea water damage, but strip examination indicated that they had been capable of normal operation.

1.12.13 The aircraft fuel tanks, and associated plumbing and fuel components contained sea water, with only traces of fuel found at the crossfeed drain valves. No obstruction, rupture or dislocation of any plumbing was found, other than that associated with the separation of the engines from the airframe during the recovery. This had caused the flexible hoses to the engine driven fuel pumps, and between the fuel control units and the fuel manifold valves to separate. A normal small quantity of clean trapped fuel was found in each valve.

1.12.14 The crushing damage to the fuel quantity sensing units, and sea water damage to the other components, precluded testing the fuel gauge system and the digital fuel flow and totalizer system. The digital totalizer system contained no recoverable memory logic.

1.12.15 The fuel intake float valves and the tank vent systems functioned normally under test. The fuel selector valves and the crossfeed shut-off valves functioned normally, and their rigging was correct with respect to their controls.

1.13 Medical and pathological information

1.13.1 The post-mortem and toxicological examinations revealed no abnormalities which might have affected the pilot's ability to conduct the flight.

1.13.2 The occupants who lost their lives were probably affected by hypothermia, which reduced their swimming ability or caused them to lose consciousness, leading to drowning. There was no evidence of any significant injury which might have influenced anyone's survival.

1.14 Fire

1.14.1 Fire did not occur.

1.15 Survival aspects

1.15.1 The configuration of the aircraft for the ditching was with landing gear and flaps retracted, and propellers feathered. The heading was approximately north, across the wind and swell. The approach and ditching were flown with no engine power.

1.15.2 The cabin occupants were restrained by lap belts, while the pilot, and the passenger in the copilot seat, had full harness. Only minor or no injuries resulted from the moderate deceleration forces in this successful ditching.

1.15.3 Egress from the aircraft was unimpeded and prompt, with all three exits being used. The aircraft floated level so that the occupants were able to stand on the wings or cabin top, out of the water, for three or four minutes before it sank.

1.15.4 The aircraft was reported to have been equipped with 14 lifejackets, so that sufficient might be available when extra children were carried in adult seats. Only six of the ten occupants found lifejackets, in the seat pockets in front of them. It was not established why more lifejackets were not found. The pilot re-entered the floating aircraft to search for more lifejackets, but got out again as it started to sink.

1.15.5 All five survivors wore lifejackets, while the four non-survivors did not. The missing seven-year-old boy had worn a lifejacket, but this was found floating without him during the search. How he became separated from it was not known.

1.15.6 Expert medical opinion was that swimming and efforts to stay afloat would have become impossible for immersed swimmers without lifejackets in approximately 15 minutes, given the sea state and temperature of 9°C. Survival for longer than this period would have required the use of a lifejacket. With lifejackets, and with the quite light clothing worn by most passengers, hypothermia would have presented an increasing risk to survival after approximately 40 minutes. (See Figure 1).

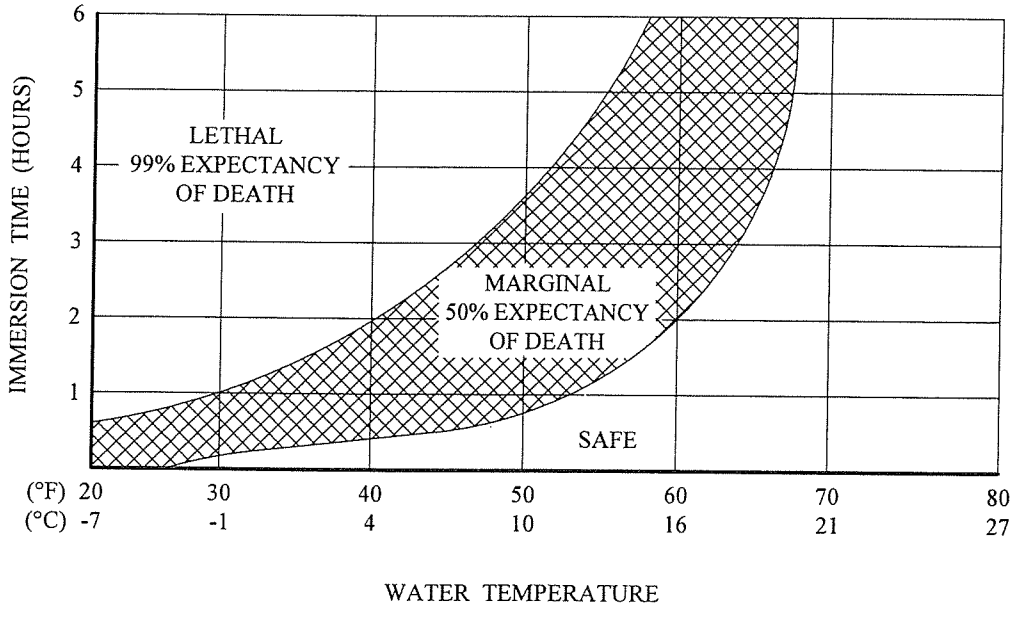

Figure 1
Life expectancy of uninjured survivors immersed in seawater at various temperatures

This graph is derived from mathematical models of body cooling, and shows the time for body core temperature to fall below 34° C, which represents moderate hypothermia.

1.15.7 No ELT signal was reported around the time of the event, either from other aircraft or from the satellite monitoring system.

1.16 Tests and research

1.16.1 Engine component tests are reported in 1.12.

1.17 Organisational and management information

1.17.1 Southern Air (1997) Limited was formed from Southern Air Limited in December 1997, when the ownership of the company changed, and a new managing director was appointed. All the operational staff and pilots were retained and the operation and equipment continued essentially unchanged. The company employed six full-time pilots and four management or administrative staff. The chief pilot/operations manager had been with the company since 1984, and in this role since 1990.

1.17.2 Southern Air Limited had been formed in the late 1970s to operate the service to Stewart Island with land aeroplanes. An amphibian service was in existence previously, but this had been withdrawn, leaving a need for public transport other than ferry boats across Foveaux Strait. The airstrip at Ryans Creek was built by the company to enable a regular landplane service. No other aerodrome existed on Stewart Island, although beaches had been used sporadically for private operations.

1.17.3 After 1983 the Stewart Island operation settled on the use of the Britten-Norman Islander after various other types had been tried, and this remained the principal type with three aircraft approved for use.

1.17.4 The company had at various times also operated a scheduled service between Dunedin and Invercargill. The Cessna 402 ZK-VAC had been purchased principally for this, as well as for ambulance flights to Christchurch and Dunedin, and for charter flights, because it was considered more suitable than the Islander for these purposes. The Dunedin service with ZK-VAC had not prospered as intended, and consequently had been discontinued in July 1998, after three months.

1.17.5 ZK-VAC had not been specifically intended for use on the Stewart Island service, but the take-off and landing performance with the Robertson STOL kit enabled it to comply with performance requirements at Ryans Creek. After the Dunedin service was discontinued, it was decided to use ZK-VAC to supplement the Britten-Norman Islanders when needed.

1.17.6 The company flight operations manual required all over-water air transport flights to carry lifejackets for each person on board, and in practice equipped its 10-seat Britten-Norman Islander and Cessna 402 aircraft with 14 lifejackets. Civil Aviation Rules part 91 required lifejackets on multi-engined aircraft if proceeding more than 50 nm from shore.

1.18 Additional information

1.18.1 The type rating training on the Cessna 402 for the company pilots was done by the chief pilot, who held a D category instructor rating and flight examiner rating. The ground training consisted of instruction on general knowledge of the aircraft and its systems, limitations, normal and emergency procedures, performance and weight and balance. A written examination was completed on these topics.

1.18.2 The flight training covered aircraft and engine handling, and normal and emergency procedures. It was mostly carried out en route on the Dunedin service, while the aircraft was being positioned without passengers. After completing this, the pilots flew ZK-VAC on the Dunedin service and on charter flights before operating it to Stewart Island.

1.18.3 The chief pilot had received his Cessna 402 type rating training from the chief pilot of the previous operator of ZK-VAC.

1.18.4 It was evident from discussions after the accident that the other company pilots rated on the Cessna 402, and the chief pilot, believed that ZK-VAC had a low fuel warning system which would illuminate a warning light on the annunciator panel if the fuel level in either tank fell below 60 pounds. The aircraft was not so equipped.

1.18.5 The company aircraft were almost exclusively refuelled by the company pilots from a mobile tanker at Invercargill Airport. The tanker had a calibrated meter giving total and trip readings, in litres. A check of the meter after the accident verified its accuracy. The tanker was refilled, mostly daily, from an Avgas installation at Invercargill Airport.

1.18.6 Fuel samples from the Avgas installation, and from the mobile tanker, were subjected to laboratory analysis. This confirmed that the fuel met the specifications for Avgas.

1.18.7 A fuel sheet was kept in the tanker, to be completed on each refuelling operation with the total meter readings, and the amount dispensed in the appropriate aircraft column. This was the only record of fuel uplifts by aircraft, apart from infrequent occasions when an aircraft was refuelled away from Invercargill.

1.18.8 The 13 fuel sheets from 1 May 1998 to the accident date were checked. The fuel metered from the Avgas installation into the tanker correlated well with the total meter readings for the period. There were 320 entries for fuel dispensed from the tanker, and of these 30 showed a discrepancy between the difference in the relevant total meter readings and the amount entered on the sheet in the specific aircraft columns. The sum of the amounts dispensed to aircraft was 1330 litres less than the grand total difference (48 293 litres) for the period. It was not generally possible to establish which aircraft may have received quantities different from those recorded because of some incomplete entries.

1.18.9 Between 1 and 19 August 1998 the record of fuel dispensed to ZK-VAC came to a total of 2517 litres. During the same period the total flight time for ZK-VAC, recorded on the company daily flying records, was 16.3 hours. The first flight in this period was on the Stewart Island service, and its load sheet showed a fuel load of 116 kg, similar to the load sheet fuel figure of 128 kg for the last flights of 19 August.

1.18.10 The fuel sheet record for 19 August 1998 showed that ZK-VAC was refuelled twice; with 260 litres and later with 141 litres. The aircraft fuel gauge reading before the first refuel was reported as "just under 65 litres (100 pounds) per side". There were two fuel sheet discrepancies on 19 August, of 7 and 8 litres. One of these affected ZK-VAC, which could have received 268 litres rather than the 260 litres recorded.

1.18.11 The last fuel sheet entry for 18 August 1998 showed that ZK-VAC was refuelled with 90 litres. Shortly after the accident company personnel had stated that the first refuel on 19 August was the 260 litres, but subsequently averred that the 90 litres was the first refuel on 19 August 1998 with the date incorrectly entered, and that the 260 litres was put in the aircraft later in the morning.

1.18.12 Load sheets for each flight sector on the Stewart Island service were prepared by ground staff at Invercargill and Ryans Creek for the pilot to check and sign. They contained spaces for "fuel on board" and "burn-off". The amounts entered were generally standard figures, irrespective of a changing total, such as when an aircraft was fuelled sufficiently to fly several sectors. The standard "fuel weights" used were 128 kg ex Invercargill and 99 kg ex Ryans Creek, with a "burn-off" for each sector of 29 kg.

1.18.13 The company operations specifications and the flight operations manual required a trip record/operational flight plan to be carried on all air transport operations. On the Stewart Island service this was not done, and had not been done for many years. The company had numbered "flight record" forms for this purpose which were kept in the office, where ground staff entered standard times for each sector, with a cumulative hours total for maintenance record purposes. The "uplifted fuel" and "total fuel" columns were not used. No operational record other than the load sheet was carried on these scheduled VFR flights. On IFR flights a navigation log/operational flight plan was carried.

1.18.14 The total time flown by ZK-VAC on 19 August, up to the accident flight was 3.9 hours. This comprised one Stewart Island round trip, which included a scenic tour, of 0.9 hours, five standard round trips of 0.4 hours, the IFR check flight of 0.8 hours, and the last Invercargill to Stewart Island leg of 0.2 hours.

1.18.15 The company practice with the Britten-Norman Islander aircraft, rather than to solely use fuel gauge indications, was for pilots to dip the fuel tanks as a routine, to directly measure the fuel quantity, at Invercargill prior to each Stewart Island round trip. A special dipstick was used, calibrated normally in litres, and also in the number of round trips (including reserve fuel) represented by the fuel quantity measured.

1.18.16 The fuel tank configuration on the Cessna 402C aircraft precludes the use of a dipstick when a tank is less than about half-full. The company had conducted tests to measure fuel consumption and establish fuel gauge function, but had not developed any strategy with ZK-VAC to take the place of the routine dipstick fuel measurement used on the Islander, relying on the fuel gauge indications to monitor the fuel quantity.

1.18.17 A common operational practice with aircraft where a dipstick cannot be used is to employ a fuel totalizer on each sector. A typical technique would be to zero the totalizer before engine start, then record its reading for each engine on the fuel log on shutdown. This figure, subtracted from the starting fuel total, would give an independently sourced fuel-remaining figure to compare with the fuel gauges. The lesser of the two figures would be used for the next sector.

1.18.18 The minimum fuel requirement for VFR operations specified in the company flight operations manual was the planned fuel for the sector plus 10%, plus 45 minutes reserve. With ZK-VAC on the Stewart Island service, this was expressed as a minimum gauge indication of 150 pounds in each tank to commence a round trip.

2. Analysis

2.1 The initiating event in this accident sequence was, as reported by the pilot in his "Mayday" call and by the surviving passengers, the loss of power from both engines. Once this had occurred, with engine power unable to be regained, the only course of action remaining to the pilot was to glide the aircraft down to a forced landing or ditching. Given the location and altitude of ZK-VAC when the power loss occurred, some 1000 feet over Foveaux Strait and out of gliding range of land, a ditching was the only option available.

2.2 After the power loss the pilot had less than a minute before the aircraft descended into the sea. In this time he did some engine checks to establish that he could not regain power, made a "Mayday" call, briefed the passengers in time for lifejackets to be donned, feathered the propellers and flew the glide descent so that a controlled ditching could be made. His success in doing this was worthy of note, because a ditching cannot be practised and has significant potential to go wrong, resulting in the aircraft ploughing in or cartwheeling on the sea surface with the probability of severe injuries. The ditching he achieved was probably as good as possible, with only minor injuries occurring and all occupants being able to evacuate the cabin in good order.

2.3 The cause of the loss of power from both engines could not be conclusively established by the investigation. There was no evidence of mechanical failure of either engine or of critical ancilliaries such as fuel system components and magnetos. The engine controls and fuel selector controls had been connected correctly and functioned normally. The position of the fuel selectors, as found, was consistent with the likely actions of the pilot after the first reported loss of power from the right engine. These actions would have included turning the fuel selector of the inoperative engine to the crossfeed position, as well as switching the auxiliary fuel pumps to the "LOW" position, and adjusting the mixture controls.

2.4 The most likely system to be implicated in a double engine failure is the fuel supply system. This is because other systems such as ignition, induction, compression and exhaust/turbocharging are essentially separated between engines, and thus very unlikely to incur two separate simultaneous failures. In addition, failure of these systems usually produces mechanical evidence, which was not present with ZK-VAC. Weather was clearly not a factor, with the aircraft flying in clear air at a temperature unlikely to cause induction icing.

2.5 Types of fuel system failures include fuel contamination; fuel starvation resulting from tank vent or plumbing blockage, air entrained in the fuel, or fuel control mishandling; and fuel exhaustion resulting from total consumption of the fuel available, or from leakage.

2.6 The fuel supply systems to each engine are normally separated, but become common when crossfeed is selected, so that both engines are supplied from one tank. The other common area between engines is the refuelling source; if contamination were to be introduced at source, it would probably be similar in both tanks.

2.7 No samples of fuel were available from ZK-VAC to indicate by analysis whether contamination was present, but the small quantity from the fuel manifold valves was clean. The fuel in the mobile tanker used for company aircraft was uncontaminated and met the specifications for Avgas, the correct fuel for the aircraft type. In addition, no other company aircraft encountered any fuel problem that day. It was probable that fuel contamination had not occurred.

2.8 Fuel starvation could have arisen without providing specific evidence. However, the plumbing in the wreckage was not obstructed or disrupted, and the intake float valves, the potential source of fuel unporting and air entrainment, functioned normally on test, as did the tank vent systems. These tests could not be conclusive, however, because of the substantial hydrostatic pressure changes involved in the aircraft's sinking and recovery from the sea bed. This could have affected any blockage, if one had occurred.

2.9 Fuel starvation has occurred in some incidents and accidents when a pilot, in responding to a failure of one engine has selected an inappropriate tank, resulting in the other engine losing its fuel supply. In the case of the Cessna 402C, unlike earlier Cessna 402 models, the fuel system has only one main tank in each wing, making mis-selection less likely. Although the passengers reported that the pilot of ZK-VAC moved fuel selector knobs several times, the as-found positions were appropriate.

2.10 The fuel quantity in the aircraft when the third pilot took it over at 1500 hours was reported to be 190 pounds in each tank, as indicated by the fuel gauges. No subsequent fuel gauge readings were reported or observed by witnesses. This quantity would have appeared to be adequate for the next two round trips, each of 0.4 hours, and with a fuel burn of 40 pounds per side. The expectation thus would have been that the gauges would read 150 pounds in each tank at the commencement of the 1600 hours flight from Invercargill, giving an appropriate reserve of fuel, and meeting the company minimum for a round trip.

2.11 A breakdown of the flying hours, planned fuel usage and reported fuel uplifts on 19 August for ZK-VAC, based on available records, shows a different result:

approx. time	**event**		**pounds fuel per tank**
before first flight	reported gauge readings (126 litres total)		100
c 0710	refuel - 90 litres (18 August sheet)		+ 71
			171
0730-0845	1 round trip + scenic	0.9 hour	-90
			81
c 0900	refuel - 260 litres (first on 19 Aug. sheet)		+206
			287
0900-1145	3 round trips	1.2 hour	-120
			167
1200-1245	1 round trip	0.4 hour	-40
			127
1300	refuel - 141 litres		+112
	(reported gauge readings <300 per tank)		239
1340-1430	IFR check flight	0.8 hours	-80
	(reported gauge readings 190 per tank)		159
1500-1545	1 round trip	0.4 hour	-40
			119
1600-1620	½ round trip	0.2 hour	-20
			99
1630-	accident flight		

2.12 This cumulative analysis shown in the table above of the fuel status of the aircraft suggests that sufficient fuel to complete the accident flight was present, albeit below company and aircraft flight manual minima for take-off. The analysis does depend on the reported fuel quantity before the first flight, based on the gauge readings at the time. Since the gauge readings reported later in the day differ from this table, it infers that some fuel gauge error may have developed, unknown to the pilots of the aircraft. The total reported fuel uplift for the day, of 491 litres would have provided 3.89 hours endurance at the planned fuel consumption figure of 100 pounds per hour per engine, similar to the 3.89 hours flown by the aircraft before the accident flight. The fuel on board before the first flight, as indicated by gauge readings, of 126 litres brought the total fuel available to 617 litres. This would have provided a total endurance of 4.89 hours at the planned fuel consumption figure of 100 pounds per hour per engine.

2.13 However, the company records for August showed that the aircraft had received 2517 litres of fuel while flying for a total of 16.3 hours. These figures give an average fuel consumption of 154 litres per hour, or 124 pounds per hour per engine. These figures[2] take no account of any difference in fuel quantity in the aircraft before and after the period, but any such difference was probably small because of the similar operational use of the aircraft and load sheet fuel weights recorded at the start and end of the period and would be likely to change the average consumption rate by a small amount.

2.14 What these figures demonstrate is a typical average fuel consumption figure in the company's operation based on the company's methods of recording flight time and fuel uplifts. This fuel consumption figure would have given an endurance of 3.19 hours for the fuel uplift of 491 litres. The fuel on board before the first flight, as indicated by gauge readings, of 126 litres brought the total fuel available to 617 litres. At 154 litres per hour, 617 litres would have given a total endurance of 4.01 hours, which is very similar to the total flight time recorded on 19 August up to the accident.

2.15 The company had a well-established strategy with the Britten-Norman Islander aircraft of taking routine dipstick readings on each round trip to confirm fuel quantity, rather than rely on gauge readings. The absence of a parallel strategy with ZK-VAC did mean that the company operation was at risk of incurring a fuel quantity management problem if any subtle gauge malfunction occurred. This risk was exacerbated by the Stewart Island operation, with short sector lengths, and the consequent desire to operate near minimum fuel reserve levels to optimise the aircraft payload and performance.

2.16 The practical use of the fuel totalizer in ZK-VAC on each sector, or round trip, to provide a back-up fuel quantity indication independent of the fuel gauges, would have required the pilots to keep a written fuel log on the flight record form in the aircraft, and update it with fuel data. The operational practice with the Islander aircraft on the short distance Stewart Island service had developed, understandably, where the ground staff kept the flight record forms, and entered standard times for each flight. This practice did not affect fuel management, because the dipstick technique was simple enough not to require written records. It had carried over to the Cessna 402C operation, however, and may have inhibited the adoption of a routine system of using the fuel totalizer in this way, to the detriment of operational safety.

2.17 This operational practice of not using flight record forms on air transport flights did not comply with the company's operations specifications or flight operations manual, and had not done so for many years. The company's acceptance of this situation, rather than applying for approval for an alternative system for the Stewart Island service, did indicate a casual attitude to good operational practice with flight records. While it may not have been significant with the Islander aircraft operation, it may have contributed to less safe practice with the Cessna 402C.

2.18 Load sheet records were prepared by ground staff for each flight, for pilots' confirmation and signing. The entries for "fuel on board" and "burn-off" were mostly standard figures, however, which often bore little relationship to actual fuel quantities on board the company's aircraft. This was unhelpful to the investigation, because it invalidated a potential source of record of the fuel quantity in ZK-VAC, and it also further indicated a casual company attitude to record keeping.

[2] The conversion used is based on an Avgas density of 0.72. 1 US gallon = 6 pounds; 1 litre = 1.584 pounds.

2.19 The mobile tanker fuel sheets were another company record which was inaccurately kept. In this case, the shortcoming affected the economic management of the company, since over the three months of records examined, some 1330 litres of Avgas were unaccounted for. It also affected the investigation, since there was no reliable record of fuel uplifts for ZK-VAC to enable an independent assessment of fuel quantity in the aircraft before the first flight on 19 August, or to confirm the long-term average fuel consumption in the company's operation. The two recorded fuel uplifts on 19 August, of 401 (or 409) litres total did appear consistent with the total meter readings, and were probably reliable.

2.20 Some company pilots, including the chief pilot, wrongly believed that ZK-VAC had a low fuel warning system which would illuminate a warning light on the annunciator panel if the fuel level in either tank fell below 60 pounds. This belief may have arisen from the description of such a system being located in the "airplane and systems" section of the pilot's operating handbook rather than the "supplements" section, but it was clearly described as "optional", however. The belief was not supported by the actual annunciator panel, which had no "fuel low" warning captions visible. It was not known whether the pilot of ZK-VAC shared this belief, but he probably did.

2.21 A result of this belief may have been that pilots had an unfounded expectation that the system would compensate to some extent for their inability to dip the fuel tanks, by providing an independent warning of a low fuel state before it became critically low.

2.22 The absence of clear information in the aircraft flight manual about whether or not the low fuel warning system was installed in ZK-VAC was undesirable, and may have contributed to the erroneous belief. A recommendation was made to the Director of Civil Aviation that he require individual aircraft flight manuals to list those optional equipment items of operational significance which are installed in the aircraft.

2.23 After the ditching and the subsequent sinking of the aircraft, a key factor in the survival of some occupants, and the loss of life of others, was whether or not a lifejacket was worn. Given the water temperature and sea state, it is probable that no one would have survived without a lifejacket unless rescued within about 15 minutes of entering the water. The survivors, rescued after 70 to 80 minutes in the sea, suffered from varying degrees of hypothermia, and may not have survived for much longer, even with lifejackets.

2.24 The carriage of lifejackets in multi-engined aircraft on this short (less than 50 nm) over water operation was not required by Civil Aviation Rules, but was a company requirement. In the circumstances of this accident it was appropriate and fortunate. It was not established why four of the ten occupants did not find their lifejackets. The Civil Aviation Rule was appropriate for most multi-engined operations with a low proportion of flight time over water, but on an operation such as the Stewart Island service, with a large part of the flights over water at low altitude, the company requirement was prudent.

2.25 The emergency response was promptly initiated after the pilot's "Mayday" call. It was unfortunate that the pilot, in reporting his distance from Invercargill, used the word "thirteen" rather than " one three", but he was acting under considerable stress at the time. The indistinct word "thirteen", with some radio distortion and background noise, was heard and initially relayed as "thirty". The standard aviation pronunciation of such numbers by separate digits is specifically intended to prevent such ambiguities.

2.26 In the practical circumstances of this search, little time was lost by this misinformation since the chief pilot had resolved with the controller the correct location, and was airborne to begin the aerial search within four minutes of being advised of the "Mayday" call.

2.27 The incorrect distance was relayed to the Bluff marine SAR operations room, and temporary uncertainty about the correct search area did result in the Riverton Coast Guard rescue craft not being dispatched as soon as it could have been. This delay of about 10 minutes probably did not significantly affect the time of rescue, because the rescue craft arrived very shortly after the first positive sighting from the air. Other boats involved in the marine search were dispatched from Bluff Harbour without delay.

2.28 The observers in search aircraft reported great difficulty spotting people, lifejackets or debris in the prevailing sea state and light, and the first positive sighting was at 1742 hours, 38 minutes after the aerial search began. This was the major impediment to an earlier rescue, and any other delays had little or no effect on the rescue as a result.

2.29 No ELT signal was reported from around the time of the accident, and it is possible that it was not automatically triggered by the well-controlled ditching. The remote switch on the instrument panel was found in the "ARM" position, probably because the pilot had no opportunity to switch it on before the ditching. If it had been switched on, its signal would have ceased anyway when the aircraft sank after three or four minutes. The potential value of the ELT would have been to guide the first search aircraft when it got airborne 10 minutes after the ditching. However, if ZK-VAC had remained afloat, thus enabling the ELT signal, the visual search would also have been much simpler, with the aircraft to be seen on the surface.

3. Findings

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

3.1 The pilot was appropriately licensed and rated for the flight.

3.2 The pilot was very experienced on the operation, with the Britten-Norman Islander aeroplane type.

3.3 None of the company pilots was experienced on the Cessna 402C type.

3.4 The aircraft had a valid Airworthiness Certificate and had been appropriately maintained.

3.5 There was no evidence of a mechanical malfunction of any component which could have led to the double engine failure.

3.6 While it could not be conclusively established, fuel exhaustion may have caused the double engine failure.

3.7 The company fuel quantity monitoring system used with the Britten-Norman Islander type, of direct measurement by dipstick, was not practicable with the Cessna 402C type.

3.8 The company failure to implement an alternative fuel quantity monitoring system to supplement fuel gauge indications with the Cessna 402C type was unsafe.

3.9 Incorrect fuel system knowledge by company pilots may have influenced the company policy on fuel monitoring.

3.10 The long-standing company practice of not using flight record forms on this operation may have inhibited the adoption of an alternative fuel quantity monitoring system.

3.11 The pilot's actions in handling the ditching were commendable.

3.12 The company requirement for the carriage of lifejackets on this operation was appropriate, but it was not established why four occupants did not find their lifejackets.

3.13 The success of the search and rescue operation in rescuing five passengers resulted from the prompt and diligent response.

3.14 Some delays in dispatching the Riverton Coast Guard, resulting from mis-communications, probably did not affect the outcome of the rescue.

3.15 The best possible response time of the rescue was well beyond the potential survival time of those people without lifejackets.

4. Safety Actions

4.1 After the accident Southern Air (1997) Limited instigated several changes in policy to rectify identified or potential shortcomings in procedure. These included:

- completely redesigning the fuel sheet to include all required data
- daily flight records are now carried on all operations, with fuel uplifts recorded
- the pilot on all over-water flights now wears a pouch-type lifejacket
- flares and smoke canisters are carried on all flights
- liferafts are carried on all single-engine over-water flights
- the company has established its own SAR plan in co-operation with other operators in the area.

5. Safety Recommendations

5.1 On 19 April 1999 it was recommended to the Director of Civil Aviation that he:

5.1.1 require individual aircraft flight manuals to list those optional equipment items of operational significance which are installed in the aircraft. (018/99)

5.2 On 29 April 1999 the Director of Civil Aviation responded as follows:

5.2.1 This Recommendation seems to be a general response to a specific problem that existed because of the design features of the aircraft involved, i.e. reliance on the fuel contents indicating system, including optional low level warning lights that were not actually fitted, when dipping of tanks was not a practical capability.

The Recommendation, whilst it may go some way to preventing a further occurrence of this kind, will nevertheless bring with it a number of other considerations which, on balance, may show that it is not cost beneficial and imposes a significant workload to bring up to date the large number of existing aircraft Flight Manuals. There is also likely to be a degree of difficulty in defining both *optional* and *operational significance*, as used in the Recommendation.

It should also be born in mind that the responsibility for ensuring that a pilot undergoing a type conversion is competent rests with the (industry) instructor giving that endorsement training. That training is not limited to flight time but should also include extensive discussion, briefing and training on the aircraft and all its fitted systems. The endorsement is not complete until the instructor has ensured that the endorsee is fully familiar with all systems and operating parameters of the aircraft.

Notwithstanding these comments, the CAA is prepared to adopt this Recommendation in principle as a petition for rule-making and submit it to the rule-making process.

The action will be initiated within a month, but no time frame can be given for its completion.

Approved for publication 26 April 1999

Hon. W P Jeffries
Chief Commissioner