



Report 00-005

Hughes 369FF

ZK-HJN

wire strike

West Arm, Lake Manapouri

28 March 2000

Abstract

On Tuesday 28 March 2000 at 1014 hours, ZK-HJN, a Hughes 369FF helicopter, was on a charter flight from Te Anau Aerodrome to West Arm, Lake Manapouri. Approaching to land, the helicopter struck a power line and impacted the ground heavily. The pilot and 4 passengers on board died in the accident and the helicopter was destroyed.

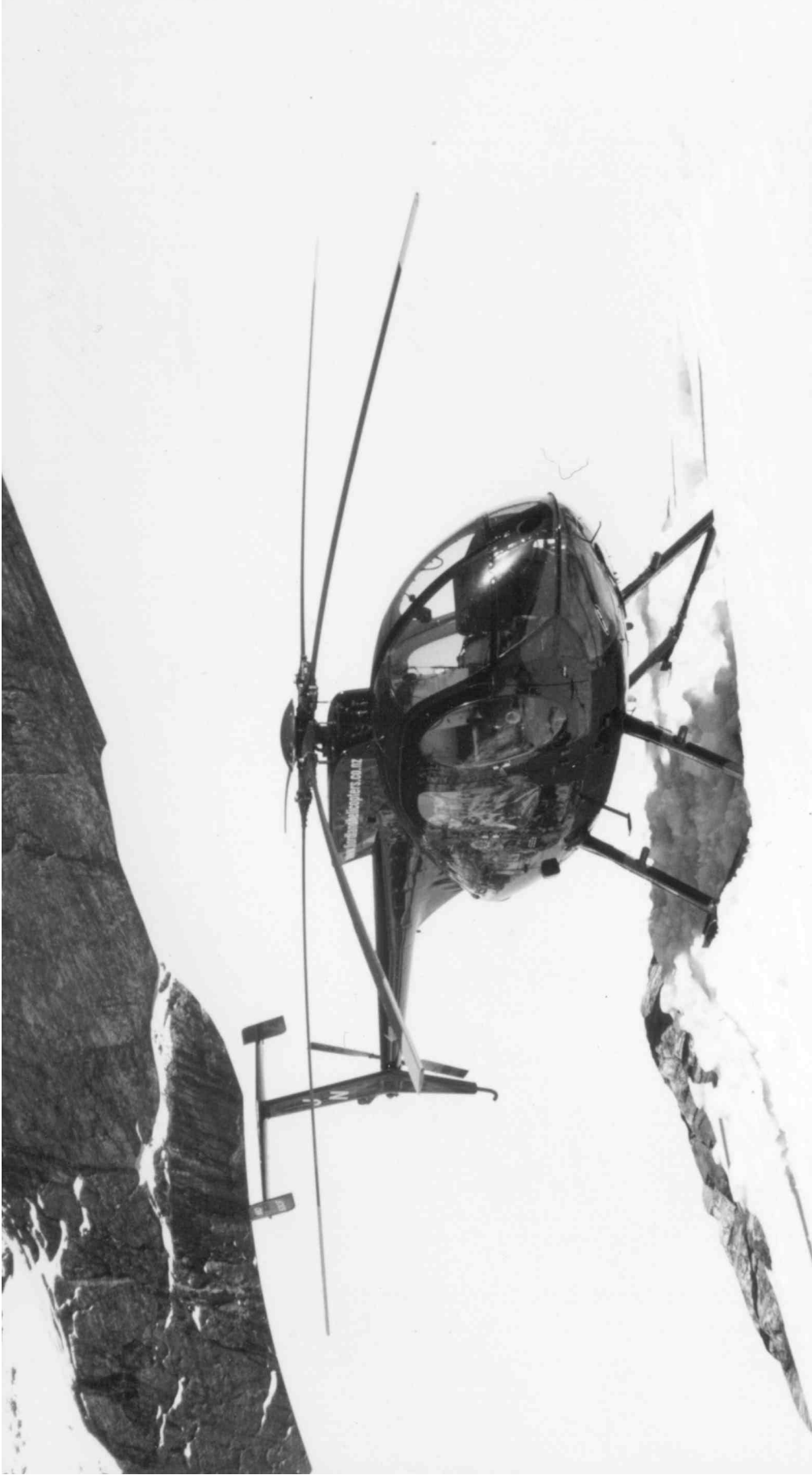
Safety issues identified were the criteria for the marking of wires and overhead structures, and the requirement to expedite amendments to Civil Aviation Rules for wire marking.

Safety recommendations were made to the Director of Civil Aviation.

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Hughes 369
ZK-HJN

Contents

List of Abbreviations ii

Data Summary iii

1. Factual Information 1

 1.1 History of the flight 1

 1.2 Injuries to persons 3

 1.3 Damage to aircraft 3

 1.4 Pilot information 3

 1.5 Aircraft information 4

 1.6 Meteorological information 4

 1.7 Recorders 5

 Video recording 5

 Global positioning system data 5

 1.8 Wreckage and impact information 7

 1.9 Medical and pathological information 8

 1.10 Fire 8

 1.11 Survival aspects 8

 1.12 Additional information 8

 Witnesses 9

 Power line information 9

 Wire marking 9

2. Analysis 10

3. Findings 12

4. Safety Recommendations 13

Figures

Figure 1 West Arm, Lake Manapouri 2

Figure 2 Global positioning system approach track flown by ZK-HJN 6

List of Abbreviations

C	Celsius
CAA	Civil Aviation Authority
cm	centimetre(s)
GPS	global positioning system
kg	kilogram(s)
kts	knots
m	metre(s)
mm	millimetre(s)
NPRM	Notice of Proposed Rule Making
UTC	Coordinated Universal Time

Data Summary

Aircraft type, serial number and registration:	Hughes 369FF, 003F, ZK-HJN
Engine type and serial number:	Allison 250-C30, CAE 890143
Year of manufacture:	1983
Date and time:	28 March 2000, 1014 hours ¹
Location:	West Arm, Lake Manapouri latitude: 45° 31' south longitude: 167° 17' east
Type of flight:	air transport, charter
Persons on board:	crew: 1 passengers: 4
Injuries:	crew: 1 fatal passengers: 4 fatal
Nature of damage:	aircraft destroyed
Pilot's licences:	Commercial Pilot Licences (Helicopter and Aeroplane)
Pilot's age:	28
Pilot's flying experience:	1498 hours (594 helicopter) 445 hours on type
Investigator-in-Charge:	I R M ^c Clelland

¹ All times in this report are New Zealand Standard Time (UTC + 12).

1. Factual Information

1.1 History of the flight

- 1.1.1 On Tuesday 28 March 2000 at 0850 hours, the owner and chief pilot of Fiordland Helicopters Limited (the operator) returned to his home base from a venison recovery flight in ZK-HJN, a Hughes 369FF helicopter. At about 0900 hours the owner received a telephone call from a local hotel, asking to charter ZK-HJN to deliver a party of 4 from Te Anau to West Arm. The 4 people were from a tour group and had missed the bus delivering the group to Manapouri, from where they were to travel by ferry to West Arm. The 4 passengers wished to meet up with the remainder of the group when it landed at West Arm at about 1030 hours, before travelling to Doubtful Sound.
- 1.1.2 West Arm was the site of a small settlement at the western end of Lake Manapouri. The settlement supported tour groups travelling by road to Doubtful Sound, and workers at a nearby underground power station. Commissioned in 1969, the power station was located on the northern side of the arm. Above the power station was a switchyard from where power lines, comprising multiple conductors and earthwires, ran south-east across the lake to the southern side of the arm (see Figure 1).
- 1.1.3 The owner arranged for the 4 passengers to be delivered to Te Anau Aerodrome from where they would be uplifted by the helicopter. A fixed price was agreed for the charter. The owner together with the second company pilot (the pilot) prepared ZK-HJN for the charter flight. After cleaning the helicopter and replacing the doors and headsets, the owner briefed the pilot on the task. After delivering the passengers to West Arm, the pilot was to refuel the helicopter at Te Anau Aerodrome before returning to the home base to prepare for another task at about 1100 hours.
- 1.1.4 The owner reported that after the pilot had started ZK-HJN, he leaned into the helicopter and reminded the pilot “to watch those wires”, referring to the high-tension power lines that crossed the eastern approaches to West Arm. The pilot acknowledged the owner’s comment.
- 1.1.5 ZK-HJN lifted off from the operator’s base at 0952 hours and flew to Te Anau Aerodrome, where the passengers were waiting. The pilot landed adjacent to the fuel pump at 0955 hours and after off-loading spare fuel containers, commenced refuelling the helicopter. A total of 139 litres of fuel was added. The pilot introduced herself to the passengers and gave them a safety briefing before boarding. The passengers discussed the seating positions and it was agreed that the passenger with a video camera would sit in the front right-hand side of the helicopter with a second passenger in the centre. The remaining 2 passengers were to be seated in the rear seats.
- 1.1.6 At 1003 hours the pilot lifted ZK-HJN off from Te Anau Aerodrome for West Arm. At 1013 hours ZK-HJN arrived overhead West Arm and travelled up the valley behind the settlement for a short distance before descending and turning left to fly downwind along Spey River. Approaching the mouth of the river, the helicopter turned left again back towards the landing area.
- 1.1.7 As ZK-HJN turned through a northerly heading, the main rotors struck one pair of conductors of the high-tension power lines spanning West Arm. The helicopter then fell, out of control, impacted the ground and rolled down a small bank, coming to rest on its side near the edge of the lake.

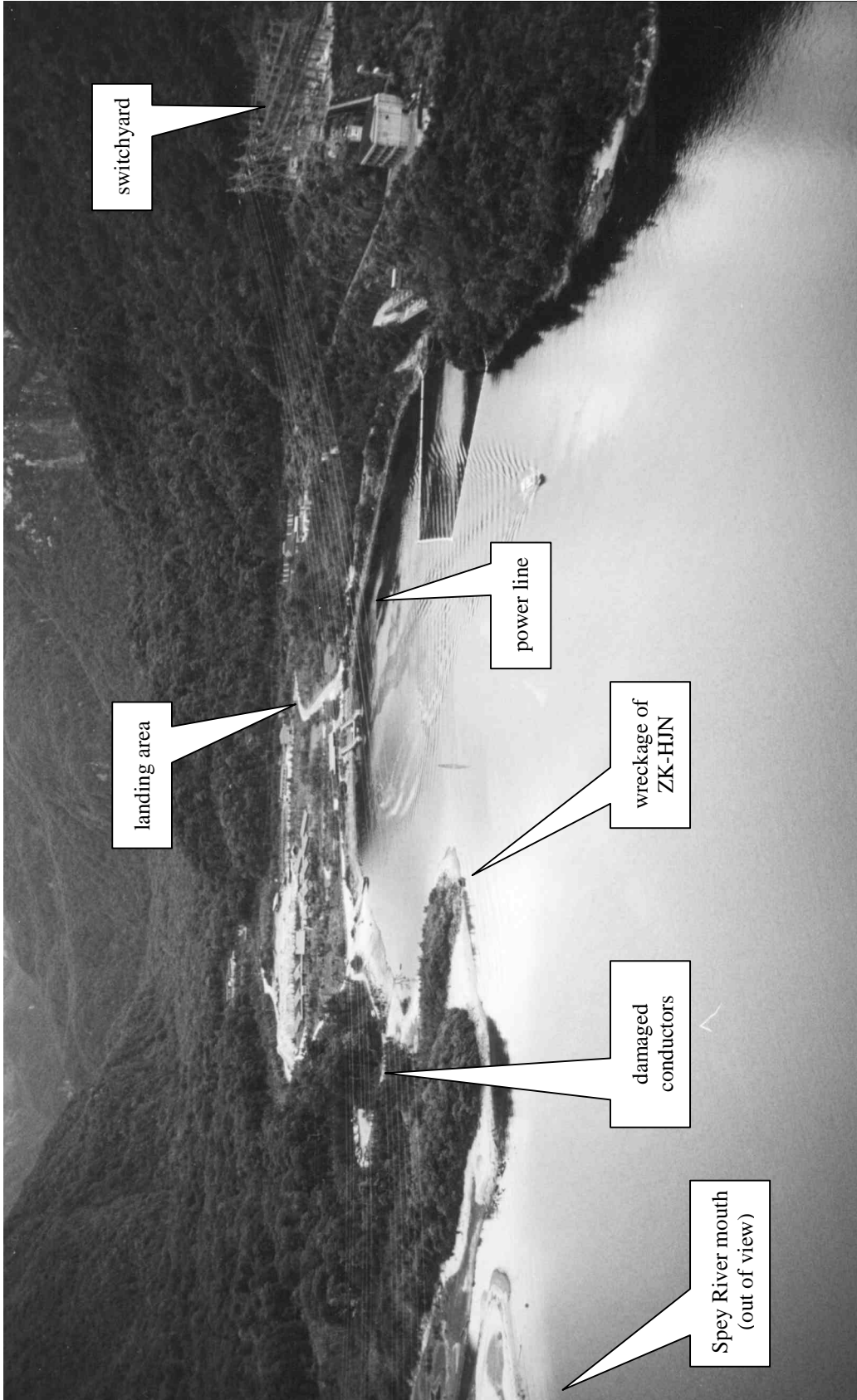


Figure 1
West Arm, Lake Manapouri

- 1.1.8 After the accident, many of the nearby witnesses raced to ZK-HJN. However, no assistance could be given to the occupants, who had died on impact. Local rescue services reached the accident site shortly after and the scene was then isolated until the Police arrived at about 1040 hours.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	1	4	-
Serious	-	-	-
Minor/nil	-	-	-

1.3 Damage to aircraft

- 1.3.1 The helicopter was destroyed.

1.4 Pilot information

- 1.4.1 The pilot was a female, aged 28. She held valid Commercial Pilot Licences for both helicopter and aeroplane, and was rated on the Hughes 369FF helicopter. She held a Class 1 medical certificate valid until 17 September 2000. The last Regulation 76 and 77 annual pilot competency checks and biennial flight review assessment were recorded as being completed on 20 May 1999.
- 1.4.2 The pilot had completed her initial pilot training in the Queenstown region, obtaining her commercial aeroplane licence in November 1994. She then flew for a local operator for about 8 months, during which time she completed her commercial helicopter training. In October 1995 she moved to Mount Cook and flew ski-planes for about 18 months, before joining the operator in May 1997.
- 1.4.3 The pilot worked full-time for the operator as a second pilot, helicopter crew member and vehicle driver. The owner was training her to become a fully operational utility pilot. The owner said the pilot was competent in most aspects of operating a utility helicopter, including the carriage of passengers and confined area operations. When not flying she would often accompany the owner on the more difficult tasks to observe and assist where required. The pilot had also flown a Hughes 369D helicopter occasionally for another local Te Anau operator when one of his pilots was not available.
- 1.4.4 Examination of the pilot's logbook showed that she had accrued 1498 flying hours, comprising about 904 hours in aeroplanes and 594 hours in helicopters. The pilot had about 445 hours' experience on Hughes 369 helicopters, including 429 hours on the 369FF model.
- 1.4.5 The pilot had not worked the day before the accident. She had flown 1.45 hours in the previous 7-day period, 7.05 hours in the previous 28-day period, 34.1 hours in the previous 90-day period and 132.25 hours in the last year. Her logbook did not specifically record the last time she had landed at West Arm. A number of logbook entries indicated that the pilot flew in the general area of West Arm as recently as 15 January 2000.
- 1.4.6 The pilot was held in high regard by the owner, other local pilots and previous work associates. She was considered to be motivated to becoming an operational helicopter pilot in the Fiordland region. She was known to be conscientious in her work and to set high standards for herself. The owner considered her to be competent and confident, without being over confident.

- 1.4.7 The owner believed the pilot to be familiar with operating in the vicinity of wires and had been trained that when crossing wires, to always fly over a pole or pylon, thereby ensuring positive separation from the conductors and earthwires. After a heavy snow-storm in 1998, the pilot had accompanied the owner during aerial surveys of power lines in the area, locating fallen lines and ferrying repair crews.
- 1.4.8 A previous ski champion and bicycle racer, the pilot would often go on bicycle rides to keep fit. On the day before the accident, she had taken the ferry from Manapouri to West Arm and cycled over the Percy Saddle and back towards Manapouri. Before she boarded the ferry, the owner had suggested that she take the opportunity to “recce the area” as she cycled back. The road out of West Arm followed the general track of the power lines originating from the switchyard at West Arm. The pilot took several photographs of the scenery during the bicycle ride – the power lines featured prominently in many of these.

1.5 Aircraft information

- 1.5.1 ZK-HJN was a Hughes 369FF, single-engine helicopter manufactured in the United States in 1983. Hughes Helicopters became a subsidiary of McDonnell Douglas in 1984 and the helicopter was then marketed as the MD530F model. Designed for operation at high altitudes and at high ambient temperatures, the 369FF had higher engine ratings and longer rotor blades than previous models.
- 1.5.2 ZK-HJN was registered to the operator in February 1994 and had been issued with a non-terminating Certificate of Airworthiness in the standard category. A locally based aircraft engineer had maintained the helicopter until October 1999 when, due to his unavailability, engineering support was moved to a Dunedin-based maintenance firm. The helicopter had amassed some 6585 flying hours since manufacture and 33 hours since its last inspection, which was recorded as having been completed on 29 February 2000. The inspection, a 300-hour check, was performed in accordance with the approved maintenance schedule.
- 1.5.3 ZK-HJN was fitted with an Allison 250-C30 engine, which had accumulated about 4715 hours’ running time. Since the last scheduled maintenance the starter motor and voltage regulator had both been replaced. The owner reported that the helicopter was fully serviceable on the morning of the accident flight.
- 1.5.4 ZK-HJN had a basic weight of 1653 pounds (750 kg). With 5 people on board and a fuel load of about 400 pounds (181 kg), the helicopter was calculated to have been about 200 pounds (91 kg) below its maximum allowable weight, and within its centre of gravity limits at the time of the accident.
- 1.5.5 The main rotor was 27.35 feet (8.34 m) in diameter and 8.2 feet (2.5 m) above the level of the skids. The helicopter had 5 seats, 3 front and 2 rear, with the pilot station in the front left-hand seat. The helicopter was fitted with one set of flight controls only.

1.6 Meteorological information

- 1.6.1 The weather on the day of the accident was described by witnesses as fine and mild, with a high overcast sky and no wind on the surface. One witness, who was fishing on Spey River at the time of the accident, reported the weather as bright but no sunshine, shadows or glare. He thought the temperature would have been about 18°C at the time of the accident.
- 1.6.2 Further evidence collected indicated that there was a slight westerly breeze aloft which occasionally reached the surface in exposed places, but otherwise it was calm. In addition to the broken high cloud there was some cap cloud along the tops of the nearby mountains, at about 5000 feet.

- 1.6.3 At the time of the accident, the sun was about 30° above the horizon and on a bearing of 024° magnetic from the accident site.

1.7 Recorders

- 1.7.1 Two damaged still cameras were found at the accident site. The films were developed and some prints were recovered. The prints were able to confirm the seating positions of the passengers before the accident.

Video recording

- 1.7.2 A video camera was found at the accident site, near where ZK-HJN had impacted the ground. Although the camera was damaged, the videotape was extracted and its information able to be viewed. The video recording had been taken by the passenger in the front right-hand seat and showed some of the accident flight.
- 1.7.3 The relevant recording lasted about 5½ minutes and showed the arrival of ZK-HJN at Te Anau Aerodrome, the pilot briefing the passengers and some of the flight to West Arm. The recording also showed the final approach and flight into the power lines.
- 1.7.4 The recording indicated that the weather was calm with a high overcast sky. The recording showed that the flight to West Arm proceeded without incident, with the pilot briefing the passengers on some aspects of the flight on the way. At about Lake Lois, 4 nautical miles east of West Arm, ZK-HJN was observed to fly past the ferry carrying the tour group. The helicopter was flying on the south side of the arm and maintaining a moderate height above the lake at this time. Shortly after passing the ferry, the helicopter then passed the regular barge service also heading for West Arm. The recording indicated the helicopter had descended as it approached the switchyard.
- 1.7.5 The next segment of the recording showed ZK-HJN flying down Spey River in a moderate left turn at about the same level as the centre of the power line span across the arm. As the helicopter moved away from the river in the turn, the angle of bank was increased slightly. The recording showed ZK-HJN flying between the conductors and earthwires to fly tangential to the second pair of conductors. After entering the power lines the helicopter descended slightly and then rolled rapidly to the right, at which point the recording stopped.

Global positioning system data

- 1.7.6 ZK-HJN was fitted with a global positioning system (GPS) that was used by pilots to assist in aircraft navigation. The GPS was recovered from the accident site and the stored information downloaded for viewing. Data for 28 March 2000 showed ZK-HJN flew directly from the operator's home base to Te Anau Aerodrome, where the helicopter spent about 8 minutes. The helicopter departed the aerodrome at 1003 hours and flew directly towards West Arm. The average groundspeed for this leg of the flight was 110 to 115 knots (kts).
- 1.7.7 ZK-HJN flew about overhead the switchyard and continued on a westerly heading for some 500 m (see Figure 2). The helicopter then entered a left turn with a groundspeed of about 85 kts. As the helicopter approached the river, the rate of turn decreased and a short downwind leg of about 8 seconds was then flown. Groundspeed during this segment of the flight was about 80 kts. At about 200 m west of the mouth of the river, the helicopter turned left again and groundspeed continued to decrease to be about 70 kts. The final recording was at 1014 hours and 9 seconds.

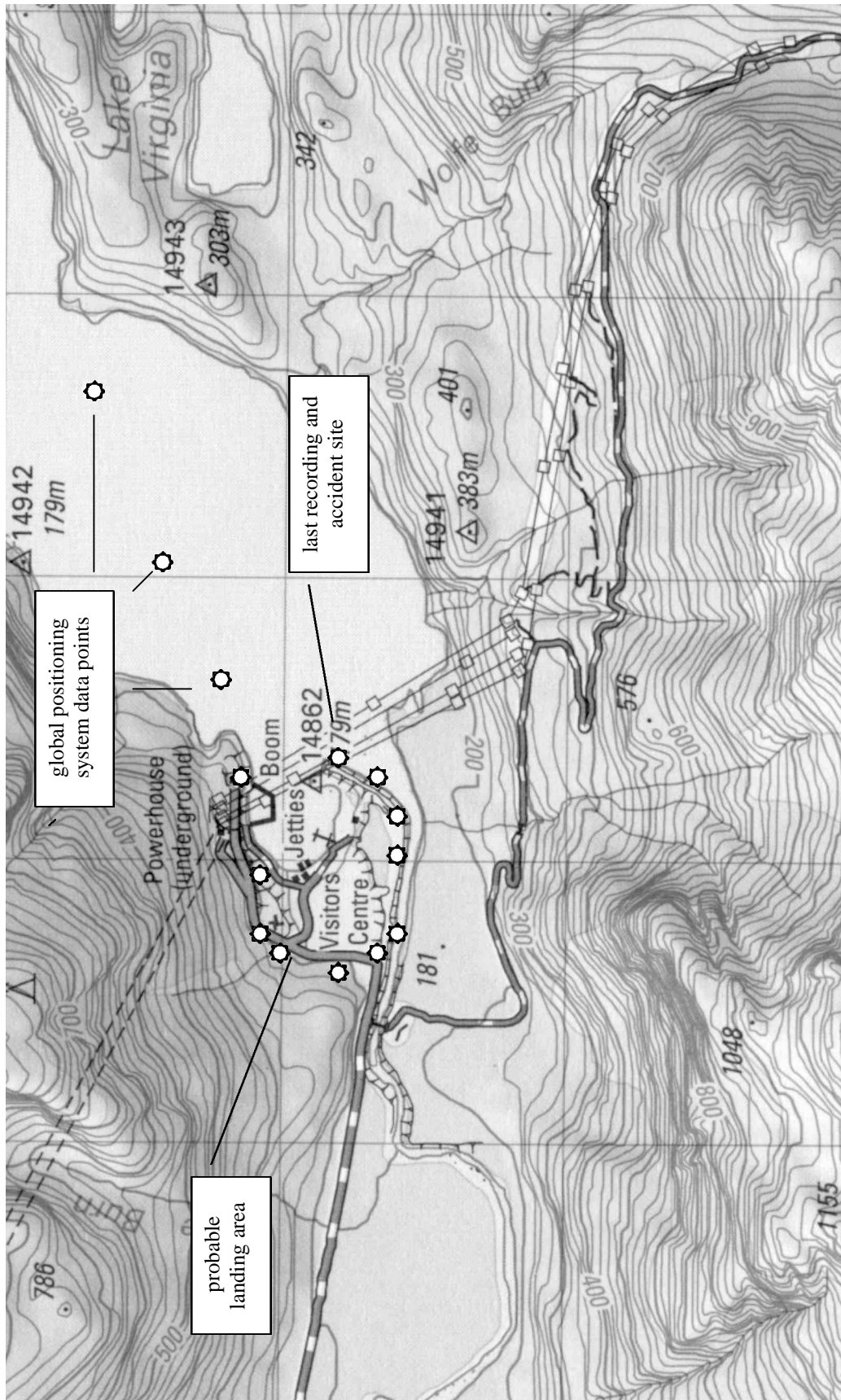


Figure 2
Global positioning system approach track flow by ZK-HJN

1.8 Wreckage and impact information

- 1.8.1 The accident occurred on a small peninsula extending into West Arm, about midway between the mouth of Spey River and 2 jetties where ferry boats would pull in. The centre of the peninsula was raised above the surrounding area and was covered in native bush, reaching 15 to 18 m above the level of the lake. The wreckage of ZK-HJN was lying on its side on the lake edge, about 40 m north of a damaged section of power line.
- 1.8.2 Damage to the power lines was confined to one pair of conductors. The damaged pair was the second pair of conductors in from the western side of the power lines. The 2 conductors had been stripped of their aluminium conductor wrapping material with only the high tensile steel core remaining intact. Several graze marks were evident along the surface of the 2 cores. The broken aluminium windings had been pushed along the conductors towards the north for 2 or 3 m, compressing them into 2 bunches. Ground and aerial inspections of the remaining conductors and earthwires revealed no other damage.
- 1.8.3 After striking the conductors the helicopter had travelled about 40 m northward along the direction of the power lines before impacting the ground. Some debris, including the left front door and support pillar, headset, 3 main rotor blades and loose sheets of paper from several aviation documents, was scattered between the damaged section of power line and initial ground impact point.
- 1.8.4 The initial impact marks indicated that the helicopter had struck the ground heavily nose down. The force of the impact was sufficient to break the tail rotor pedals off and lodge them in the ground. The tail rotor assembly had broken off just forward of the vertical stabiliser and was lying near the impact point. A fourth main rotor blade lay about 5 m to the north of the impact point. After impacting the ground, the helicopter had rolled about 8 m down a small bank coming to rest on its left-hand side. The pilot and 2 rear seat passengers had been ejected from the helicopter and were lying near the main wreckage, while the front 2 passengers were retained in the fuselage by their seat belts.
- 1.8.5 All major components of the helicopter were accounted for at the site, with the exception of one of the 5 main rotor blades. The 4 blades found had all separated from the mast at their blade roots, while the missing blade had separated at the blade strap pack. The tip section of one blade was located about 80 m from the main wreckage in the direction of the jetties. Three of the blades displayed marks consistent with having struck wires. The marks commenced between 1.5 and 2 m in from the tips and ran outboard. One of the blades had been twisted through nearly 360°, and was found to have marks that were consistent with having struck the upper front surface of the helicopter cabin before separating.
- 1.8.6 The forward section of the fuselage had been severely disrupted during the initial impact. The mast, main rotor head and both skids were still attached to the fuselage, with the front tips of the skids bent down. The swash plate had several items, including pneumatic tubing and coaxial cable, wrapped around it for about one turn. The engine had broken loose from its mountings but had been retained in the engine bay by its electrical and mechanical attachments. The harnesses for the pilot and right-rear passenger appeared to have failed as a result of the disruption to the fuselage structure or massive overload. The left-rear harness was intact and fastened, but there was significant deformation of the surrounding cabin area to permit the passenger to slide from the harness.
- 1.8.7 Examination of the wreckage disclosed no pre-impact abnormalities. The instrument panel displayed no useful readings, however, the switch positions were consistent with normal flight selections. Flight control integrity was established through to the swash plate, where the pitch change links showed indications of overload.

1.8.8 On completion of the site examination, the wreckage and engine were removed for further inspection. An engineer approved to work on the Allison 250-C30 engine assisted in the disassembly and inspection of the engine. The engine compressor and turbine were free to turn. Some partly incinerated debris was found on the compressor and stator blades, indicating the engine was functioning at the time of impacting the ground. Marking was evident on the outer race of the over-running clutch, indicating the engine was providing some power at the time the main rotors struck the conductors. The drives to the governor and fuel pump were determined to be functioning as designed. The fuel filter and a fuel sample taken were both found to be free of any foreign matter.

1.9 Medical and pathological information

1.9.1 Post-mortem examinations of the occupants indicated that they died as a result of severe trauma.

1.9.2 The pilot had undergone 3 operations, in July 1990, September 1992 and March 1994, to remove a malignant thyroid tumour and subsequent local recurrences. Examination revealed no evidence of secondary deposits from the thyroid tumour in the brain, in the neck at the site of the thyroid prior to removal, or elsewhere. There was no evidence that the pilot was incapacitated or impaired in any way. Toxicological results were negative.

1.9.3 The pilot was observed to be in good health and spirits and behaving normally in the days preceding the accident. On the morning of the accident she was noted to be alert and did not appear fatigued. She did not need spectacles to aid her vision and she was not wearing dark glasses at the time of the accident.

1.10 Fire

1.10.1 Other than the partial burning of some ingested material in the engine, there was no evidence of fire.

1.11 Survival aspects

1.11.1 The passengers and the pilot all sustained severe head and chest injuries during the initial longitudinal deceleration on impacting the ground.

1.11.2 The 3 occupants who were ejected from the helicopter after it struck the ground did sustain additional peripheral injuries as a result, but these were minor in relation to their main injuries that caused their deaths. The accident must therefore be considered to be not survivable.

1.12 Additional information

1.12.1 Helicopters landing at West Arm would normally use one of 3 established landing areas or pads. Helicopters operating in support of the power station used the landing pad near the switchyard above the arm. The second landing pad was a clear area near the lakefront, where a barge service would pull in. This was about 100 m to the south of the 2 jetties. The third landing pad was an open area near the road intersection on the north-western side of the settlement. The pad was clear of the road and within a short walking distance of the jetties and tourist information centre. The pilot had been briefed to use this latter landing pad.

Witnesses

- 1.12.2 The accident, or segments of it, was witnessed by about a dozen people located around West Arm. One witness, who was fishing on Spey River, about 400 m from the mouth, observed ZK-HJN fly past the settlement to the west at a moderate height and speed. The helicopter then returned, flying down the line of the river at a lower height and speed. As the helicopter flew overhead, the witness became concerned about the proximity of the helicopter to the power lines. The helicopter was then seen to enter a left turn. A short time later the witness saw the helicopter “falling”. After the helicopter disappeared behind bush, the witness heard a loud bang. He immediately went to the accident scene.
- 1.12.3 The fisherman was familiar with helicopters, having crewed on them for many years. He recalled no unusual noises or other movements associated with ZK-HJN as it approached overhead and flew in the direction of the power lines. Other than the proximity of the power lines, the witness considered the approach and movements of the helicopter to be completely normal.
- 1.12.4 Two people working on the jetty saw ZK-HJN fly overhead the general area of the switchyard and disappear up the valley behind the settlement. They recognised the helicopter as one belonging to a local operator. The witnesses next saw the helicopter through the tops of trees as it flew back down the valley and along Spey River. One of the witnesses said he commented that he thought the helicopter was “going to hit the wires”. The second witness initially thought the helicopter was going to fly under the power lines, but then saw the main rotor blades strike the conductors as the helicopter was turning to the left. As ZK-HJN began to fall, the witnesses saw “bits flying everywhere”, including the main rotor blades.
- 1.12.5 The 2 witnesses observed no significant changes in flying attitude as ZK-HJN approached the power lines during its left turn. They heard no sudden change in helicopter noise until the main rotor blades struck the conductors.

Power line information

- 1.12.6 The high tension power lines were owned by Transpower New Zealand Limited and consisted of 24 conductors, each of 220 000 volts. The 26 mm diameter conductors were held in pairs, supported by 4 towers. The conductors in each pair were held about 18 cm apart, with each pair about 6 m apart. The conductors were constructed of a high-tensile steel core with strands of aluminium conductor wrapped around the core. Strung about 6 m above the conductors were 8 earthwires, each 9 mm in diameter. The span across West Arm measured 1179.5 m between the towers. The conductors at the northern end of the span were supported about 93 m above the level of the lake, while the southern end was about 209 m above the lake. On a standard day the conductors would sag in the middle to a height of about 31 m above the lake. This height would vary by a metre or so depending on ambient temperature.
- 1.12.7 The power lines were marked on maps of the area. The 1:500 000 scale aeronautical chart included an aerial warning next to West Arm. The warning stated that the span height was 885 to 1285 feet (290 to 422 m) above sea level, or about 285 to 685 feet (94 to 225 m) above the level of the lake.

Wire marking

- 1.12.8 According to Civil Aviation Authority (CAA) statistics for all aircraft types, there had been 96 occurrences involving wires, poles, fences or the like, between 1978 and April 2000, resulting in 46 fatalities and 30 seriously injured. Of these occurrences, 68, or about 70%, had involved power or telephone lines. There had been 35 fatalities and 25 seriously injured, giving an average of 3 accidents and nearly 2 fatalities every year.

- 1.12.9 Statistics for high-tension power line strikes were not available. However, a review of all fatal accidents indicated that most power line strikes involved local 11 000 volt conductors. There were 2 fatal accidents in 1987 and 1992 involving high-tension power lines. The pilots in each case were aware of the power lines before the accident.
- 1.12.10 In May 1992, CAA released a Notice of Proposed Rule Making (NPRM) for discussion. The NPRM contained proposals for the marking of wires in an attempt to reduce the number of wire strikes. The NPRM drew some criticism, in particular for the cost of marking all the wires identified as posing a significant hazard for air navigation. Further, a contention was put forward that there may have been a possible legal impediment affecting access to already established power lines. A working party was then established to review the NPRM. The working party consisted of representatives from CAA, general aviation, power distribution and supply companies and electrical engineering organisations.
- 1.12.11 At the time of the investigation, a second NPRM was being drafted for circulation. The new NPRM concerned the assessment of new or altered overhead wires or cables and their effect on aircraft navigation. The assessment of existing structures was to be dealt with under a later amendment to Civil Aviation Rules. The criteria for the marking of wires would, however, possibly be the same for new or existing power lines. CAA advised that before the accident, the power line struck by ZK-HJN would not have met the criteria for marking. Despite the length and height of the span, and the close proximity of the 3 landing pads, CAA contended that there was insufficient traffic flying past the power lines to warrant line marking.

2. Analysis

- 2.1 The accident flight was an unscheduled charter to take 4 passengers from Te Anau Aerodrome to West Arm. Despite having to prepare ZK-HJN for the carriage of passengers, the owner determined that there was ample time to uplift the passengers and deliver them to West Arm in time to meet the ferry at 1030 hours. Further, the task could be completed without affecting a second pre-planned task due to commence at 1100 hours.
- 2.2 In considering the task and prevailing weather conditions, the owner determined that the task was well within the capabilities of the pilot. He, therefore, allocated her the flight. The owner's additional reminder to the pilot about the power lines reflected his vigilance and care. His comment was not a result of any concern about the pilot's ability to undertake the flight.
- 2.3 The pilot was familiar with the accident area, having flown into West Arm a number of times before and having bicycled through the settlement the previous day. From this experience, and the reminder given by the owner, it was almost certain that the pilot was aware of the presence of the power lines originating from the switchyard on the northern side of West Arm.
- 2.4 After refuelling the helicopter and briefing the passengers, the flight to West Arm proceeded normally. The video recording indicated that the helicopter was at about 1000 feet above the level of the lake as it flew toward West Arm. Approaching West Arm the pilot manoeuvred the helicopter from the south side of the arm to the north side, to fly over the area of the switchyard, thereby ensuring positive separation from the power lines. The pilot had also descended to about 500 feet above the lake at this time.

- 2.5 The approach track flown on the accident flight was similar to an academic approach pattern that the pilot would have been taught during her training. Pilots were instructed to keep a landing pad on their side of the helicopter wherever practicable during the approach. This enabled a pilot to continually monitor the progress of the helicopter relative to the landing area. As a pilot initially flew past the landing pad, ideally into the prevailing wind, they would assess the landing and approach areas. The helicopter would then be turned downwind to position for an in-to-wind approach and landing. The helicopter would normally be flown level during the downwind leg until the correct approach angle was intercepted.
- 2.6 On 28 March, the pilot would have been able to make a good assessment of the landing area as she flew west up the valley. The initial left turn was made immediately after passing the landing pad, possibly earlier than would be expected. Consequently, the downwind leg started about abeam the landing pad and not further into wind as would normally be flown. The downwind leg was spaced about 400 m south of the landing pad. Having descended to about 200 feet above the lake level by the time ZK-HJN was established downwind, the pilot needed to fly the helicopter about level until established on the final approach heading west again.
- 2.7 As the pilot commenced the descending left-hand turn after passing the switchyard, she would have been able to keep the landing area in view for most, if not all, of the approach. Had the landing pad been temporarily unavailable there would have been ample opportunity to vary the flight path of the helicopter and delay her approach, perhaps by extending into wind or orbiting, or select another landing pad. Despite some changes in the angle of bank and consequent rate of turn, the gradual reduction in groundspeed to about 70 kts and the track flown would suggest that she continued the left-hand turn around base as if to land at the designated landing pad. There was no evidence to suggest the landing pad was not available, even temporarily.
- 2.8 As ZK-HJN approached Spey River and straightened to fly downwind, the power lines would have initially been about 600 m in front of the helicopter, reducing to about 200 m when it entered the base turn. The helicopter striking the conductors may have been due to a number of reasons. Firstly, the pilot may have looked ahead and not seen the conductors as she flew down the river. Secondly, without being able to clearly see the towers on either side of the arm, she may have seen the conductors but over estimated her distance from them. Thirdly, she may have become preoccupied with the approach and continued to look towards the landing area as she flew around the landing pattern, thus not observing the proximity of the power lines to her approach path and, finally, a combination of the above.
- 2.9 With 24 conductors, each of 26 mm, the power lines provided an imposing sight. During an aerial inspection of the accident site and area on the day following the accident, at a similar time of day, the conductors were easily seen from several hundred metres away. Although the sun was almost directly ahead of the pilot as she flew down the river, it was about 30° above the horizon. With the helicopter flying essentially level, and with the sun partially obscured by the high overcast conditions, the pilot's view of the power lines should not have been inhibited.
- 2.10 Although the conductors were easily seen during the inspection, assessment of distance was difficult. The observers generally believed that the conductors were closer than they actually were. Only by locating the towers and monitoring the conductors during the approach, was a reasonably accurate assessment of distance possible. During post-accident inspection of the power lines from a helicopter flying along the conductors, a power company observer who was on-board reported that the pilot of that helicopter had difficulty maintaining a constant distance from the wires, and had to break away several times.

- 2.11 When approaching to land, a helicopter pilot would continue to monitor the landing area to ensure that the approach was correctly managed. The pilot of ZK-HJN would, therefore, probably have been looking out to the left side of the helicopter, the side on which she was also seated, as she turned onto the downwind leg along the river and towards the power lines. The pilot would have again needed to look towards the landing pad to update her assessment as she entered and flew around the 180° base leg turn. The halfway point around the base turn coincided with the helicopter flying between the conductors and earthwires.
- 2.12 By flying about level, the helicopter was able to fly between the earthwires and the conductors. The main rotor rotated anti-clockwise when viewed from above. The bunching of the aluminium conductor towards the switchyard indicated that the right-hand side of the rotor disc came in contact with the conductors.
- 2.13 The force of the main rotor blades striking the conductors resulted in the separation of the blades from the mast. The separation of the blades, at least one of which struck the cabin, caused some initial disruption to the fuselage, allowing the pilot's door, a headset and some aviation documents to fall from the helicopter. Despite extensive searching, the missing main rotor blade could not be located. The blade probably fell into the lake after separating from the mast.
- 2.14 After striking the wires, the forward momentum of ZK-HJN resulted in the helicopter travelling about a further 40 m before impacting the ground. The pilot and rear seat passengers were ejected some time between the helicopter initially impacting the ground and coming to rest near the edge of the lake. Their being ejected from the helicopter did not in this case affect the survivability of the accident.
- 2.15 Witness observations, video evidence and post-impact inspection indicated that the helicopter was performing normally up until the time it struck the conductors. There was no evidence of a power loss or any loss of control before striking the conductors. There was no evidence the pilot attempted an avoidance manoeuvre to prevent the helicopter from striking the conductors. The probability of any pilot incapacitation due to the thyroid cancer was negligible. The video recording was steady for the duration of the recording and indicated no obvious distractions or other factors that may have affected the pilot's ability to control the helicopter.
- 2.16 Helicopters operated into West Arm on a semi regular basis, and aircraft frequently flew in the vicinity of the switchyard when returning from or heading to local tourist or hunting destinations. The presence of wires across the arm was clearly annotated in the various aeronautical charts of the area, and the number and size of the conductors meant that they were a lot easier to see than smaller power lines. However, with a span of 1179 m and the towers positioned well up each side of the arm, the distance from the conductors was difficult to assess. If high visibility markers had been placed on the power lines, the pilot may have been better able to see the wires and better able to judge her distance from them.

3. Findings

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

- 3.1 The pilot was appropriately licensed, authorised and fit to conduct the flight.
- 3.2 The helicopter was appropriate for the type of operation being conducted.
- 3.3 The helicopter had a valid Certificate of Airworthiness, and its records indicated that it was serviceable at the time of the accident.

- 3.4 There was no evidence of any mechanical failure or a loss of control, prior to the wire strike, that contributed to the accident.
- 3.5 The helicopter weight and balance were within limits and appropriate for the flight.
- 3.6 The weather conditions were suitable for the flight.
- 3.7 The pilot was familiar with the general area and knew of the location of the power lines before the accident.
- 3.8 The helicopter flew into the power lines causing its rotors to strike the conductors.
- 3.9 The pilot may have misjudged her approach and extended further downwind than she intended.
- 3.10 The pilot was probably concentrating on flying her approach and looking towards the intended landing area and away from the power lines when the helicopter flew around the base turn and struck the conductors.
- 3.11 After striking the wires the helicopter was uncontrollable.
- 3.12 The accident was not survivable.
- 3.13 The size and number of conductors in the power lines made it relatively easy to detect, but the long span between towers made it difficult to correctly judge distance from them.
- 3.14 Had high visibility devices been fitted to the power lines, the pilot may have been able to more accurately judge her distance from the wires.

4. Safety Recommendations

- 4.1 On 9 August 2000 it was recommended to the Director of Civil Aviation that he:
 - 4.1.1 Review the planned criteria for the marking of overhead wires and structures, to give increased priority to large spans, like West Arm (058/00).
 - 4.1.2 Include “established structures” in the Notice of Proposed Rule Making on assessment of new or altered structures that comprise overhead wires or cables, and to expedite the production of a draft final Civil Aviation Rule to the Minister (059/00).
- 4.2 On 21 August 2000 the Director of Civil Aviation replied:
 - 4.2.1 **Final Safety Recommendations 058/00 and 059/00 (wire marking)**
The Director of Civil Aviation will adopt both these final safety recommendations. It is expected that the Final Rule will be submitted to the Minister by the end of this year.

Approved for publication 2 August 2000

Hon. W P Jeffries
Chief Commissioner