TRANSPORT ACCIDENT INVESTIGATION COMMISSION
TE KOMITENA TIROTIRO ĀTIKUA MATEA

AIRCRAFT ACCIDENT REPORT

No. 89-104

HUGHES 269A ZK-HQY
Near Long Sound,
Fiordland National Park
9 December 1989

Transport Accident Investigation Commission
Wellington - New Zealand

Price $12.50 (including G.S.T.)

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Transport Accident Investigation Commission
Wellington

Chief Commissioner
Transport Accident Investigation Commission

The attached report summarises the circumstances surrounding the accident involving Hughes 269A ZK-HQY near Long Sound, Fiordland National Park on 9 December 1989 and includes suggested findings.

This report is submitted pursuant to Section 8(2) of the Transport Accident Investigation Commission Act 1990 for the Commission to review the facts and endorse or amend the findings to the contributing factors and causes of the accident.

7 March 1991

R CHIPPINDALE
Acting Chief Executive

APPROVED FOR RELEASE AS A PUBLIC DOCUMENT

20 March 1991

M F DUNPHY
Chief Commissioner

AIRCRAFT:	Hughes 269A	**OPERATOR:**	J.A. Kane
REGISTRATION:	ZK-HQY	**PILOT:**	J.A. Kane
PLACE OF ACCIDENT:	3.5 km south-west of Arnett Peak (Near Long Sound), Fiordland National Park, Southland Province	**OTHER CREW:**	Nil
		PASSENGERS:	Nil
DATE AND TIME:	9 December 1989, 1045 hours		

SYNOPSIS:

The Senior Inspector of Air Accidents based at Christchurch Airport was advised of this accident on the afternoon of 10 December 1989. Mr D.G. Graham was appointed Investigator in Charge and commenced an on-site investigation the following day. The helicopter's engine was heard misfiring and subsequently the aircraft was seen descending rapidly. A plume of smoke indicated that an accident had occurred. The pilot was assisted from the burning wreckage but succumbed to his injuries later in the day.

1.1 HISTORY OF THE FLIGHT:	1.2 INJURIES TO PERSONS:	1.3 DAMAGE TO AIRCRAFT:	1.4 OTHER DAMAGE
See page 4.	Pilot: 1 Fatal	The aircraft was destroyed	Impact damage to upper part of trees, broken branches and foliage. Minor fire damage to confined area of bush.

1.5 PERSONNEL INFORMATION:

See page 5.

Flight Times

	Last 90 days	Total
All Types	N/K	+13 000
On Type	N/K	+ 4 000

1.6 AIRCRAFT INFORMATION:

See page 6.

1.7 METEOROLOGICAL INFORMATION:	1.8 AIDS TO NAVIGATION:	1.9 COMMUNICATION:
See page 7.	Not applicable	See page 7.

1.10 AERODROME:	1.11 FLIGHT RECORDERS:	1.12 WRECKAGE AND IMPACT INFORMATION:
Not applicable	Not applicable	See page 8.

1.13 MEDICAL AND PATHOLOGICAL INFORMATION:	1.14 FIRE:	1.15 SURVIVAL ASPECTS:
See page 9.	See page 9.	See page 10.

1.16 TESTS AND RESEARCH:	1.17 ADDITIONAL INFORMATION:	1.18 USEFUL OR EFFECTIVE INVESTIGATION TECHNIQUES:
See page 11.	See page 13.	Not applicable.

2. ANALYSIS:	3. FINDINGS:
See page 14.	See page 16.

* All times in this report are NZDT

1. FACTUAL INFORMATION

1.1 History of the flight

1.1.1 On the morning of the accident the pilot flew ZK-HQY from his farm property near Ohai to the Lillburn Valley, where he picked up the shooter at about 0815 hours. The pilot and shooter (who had worked with the pilot for seven months), then flew to their base at the head of Lake Hauroko where they completed various chores remaining from the previous day's hunting and refuelled ZK-HQY.

1.1.2 The pilot had been allocated "South Block", Park Block No. 5, as an area for hunting in the Fiordland National Park and after departure from Lake Hauroko, the pilot and shooter flew via the Hay River, to the Princess Burn and thence to Big River.

1.1.3 After shooting a deer on the east side of Big River, two deer were seen on the saddle lying between Blacklock Stream and Dawson Burn. These were subsequently shot and following his usual custom, the pilot dropped the shooter off high on the side of the ridge and hovered briefly above the animals to indicate their location, at an elevation of approximately 2800 feet above mean sea level (amsl).

1.1.4 The shooter had just gutted and stropped the first animal and was leaning over it when he heard ZK-HQY coming in, as he expected, to lift the carcass out. The shooter was wearing a protective helmet and earplugs and was initially facing away from the helicopter but as it approached and passed above him, he recognised that the engine sounded abnormal. He reported "It certainly wasn't right. I looked around and it was coughing and misfiring". On turning round, he observed the helicopter some 40 m away, descending rapidly, banked slightly and curving towards the left.

1.1.5 The shooter was presented with a view of the rear left side of the helicopter, as it descended and he saw "sparks" coming from the area of the exhaust and the lower part of the engine. He stated that the "sparks" were not "electrical" in appearance. The helicopter disappeared from his view and shortly afterwards he saw a plume of smoke rising from beneath the brow of the hillside.

1.1.6 He immediately ran down the hillside and made his way down the steep tree covered slope. He estimated that it took about one and a half minutes to reach the accident site, where he found the helicopter burning fiercely; the intensity of the fire increasing after his arrival. He retrieved the fire extinguisher, which lay adjacent to the main wreckage and discharged it into the flames but it had little effect.

1.1.7 The seriously injured pilot had managed to vacate the helicopter and was leaning against a nearby log. The shooter assisted him from the immediate vicinity of the fire and endeavoured to make him as comfortable as possible, on a small relatively flat area of the steeply sloping undergrowth, covering him with a foil "survival" blanket. He searched for the helicopter's emergency locator transmitter (ELT) but it had been consumed in the fire.

1.1.8 The pilot's chest injuries were such that he could speak only briefly and with difficulty. He told the shooter that he "tried to flare (the helicopter) but it went in too quickly". He did not know what had happened to cause the

accident but commented "it might have been the belts". Despite the shooter's efforts to assist him, the pilot succumbed to his injuries and died at 1520 hours.

1.1.9 The shooter subsequently climbed back up the hillside and later observed an aircraft some 5 or 6 miles away. He set fire to the tussock slope and set off his emergency flares, but these efforts to attract attention were unsuccessful.

1.1.10 At 0650 hours on the following morning the New Zealand Police Department at Te Anau were informed that ZK-HQY was overdue. No ELT signals were received but at 0824 hours, while at a height of 10 000 feet, the pilot of the searching helicopter saw smoke on a distant ridge in the area of the allocated hunting block. This proved to be a tussock fire lit by the shooter at daybreak to attract the attention of any searching aircraft.

1.1.11 The accident occurred at about 1045 hours. The accident site was 3.5 km south-west of Arnett Peak, near Long Sound, Fiordland National Park at an elevation of 2400 feet amsl. National Grid Reference 072415 (NZMS1 Sheet S166 "Cameron") Latitude 46°01'35"S, Longitude 166°51'05"E

1.5 Personnel information

1.5.1 James Anthony Kane, 42, held Commercial Pilot Licence (Helicopter) [CPL (H)] number 280. The Validity Certificate associated with this licence was valid from 20 March 1989 to 9 September 1989. Mr Kane had been assessed fit to CPL standard for six months from 28 August 1989 (the date of his most recent medical examination), but no application for the renewal of his licence had been received by the Aircrew Licensing section of the Air Transport Division of the Ministry of Transport, as at the date of the accident. (It was reported that other applications sent from Te Anau about the same time were not received by the Ministry of Transport and were presumed to have gone astray in the mail.)

1.5.2 Mr Kane had commenced flying training in fixed wing aircraft in November 1970 and had obtained Private Pilot Licence number 9281 in November 1971. He had commenced flying training in helicopters during January 1973 and had received a Type Rating on the Hughes 269B type in March 1973. In November 1973 he had been issued with Commercial Pilot Licence number 2732 (restricted to Private Pilot Licence privileges on fixed wing aircraft).

1.5.3 After obtaining his initial helicopter type rating Mr Kane was employed in deer shooting and capture and he subsequently flew helicopters almost exclusively on such operations over a period of some 15 years until the occurrence of the accident. The majority of his flying was carried out in the Fiordland area. He obtained ratings on the Hiller UH12 and Hughes 369HS helicopters and flew these types extensively on deer recovery operations, in addition to operating the Hughes 269 helicopter type. He was also rated on the Enstrom F28 helicopter.

1.5.4 Mr Kane regularly renewed his Commercial Pilot Licence and at the time of changes to the licencing format in September 1979, when he was issued with CPL (H) number 280 in place of his existing CPL, his total flight times were recorded as 6796 hours.

1.5.5 The most recent entry in Mr Kane's current Pilots Logbook was dated 6 March 1986, at which time he had recorded a total of 11 464.5 hours flying time. The distribution of hours flown per aircraft type when regular logbook entries ceased was approximately as follows:

Hughes 369 series	5610 hours
Hughes 269 series	3930 hours
Hiller UH12 series	1750 hours
Enstrom F28	15 hours
Fixed Wing aircraft	160 hours

1.5.6 Due to the lack of logbook entries after March 1986 the total hours flown by Mr Kane at the time of the accident was not established, nor was it possible to establish the precise number of hours flown by him in Hughes 269 helicopters, or specifically in ZK-HQY. The most recent application received by the Air Transport Division for the renewal of his CPL (H) in March 1989 stated that, at the date of the application, he had accumulated 13 070 hours total flight time. He had probably flown in excess of 4000 hours in the Hughes 269 helicopter type.

1.5.7 The number of hours flown by Mr Kane during the 90 day period immediately preceding the accident could not be established. Diary entries indicated that he had flown 22 hours and 30 minutes in ZK-HQY on deer recovery operations within the seven days preceding the accident.

1.6 Aircraft information

1.6.1 Hughes 269A helicopter, serial number 580875 was manufactured in the United States in 1975. It was imported into New Zealand in August 1987 and initially registered as ZK-HYP. This registration was subsequently cancelled and in January 1988 the helicopter was re-registered as ZK-HQY, being issued with a Certificate of Airworthiness (C of A) in the "Standard" category on 16 March 1988. The C of A was non-terminating unless cancelled or suspended, provided the aircraft was inspected and maintained in accordance with (IAW) the following schedules: (reproduced in part only)

Daily and/or Pre-flight: IAW Hughes 269A Owners Manual

Periodic: 50/100/200/300/600/1200 Hour Inspections
IAW Hughes 269 Series HMI Appendix B

1.6.2 ZK-HQY had received periodic maintenance in accordance with the required schedule. The latest recorded entries in the airframe and engine logbooks were dated 28 November 1989. As of this date, ZK-HQY had flown a total airframe time of 5998 hours. The logbook entries indicated that of this total 222 hours had been recorded since the importation of ZK-HQY into New Zealand.

1.6.3 At the time of importation the helicopter's Avco Lycoming engine, type HIO-360-B1A, serial number L2262-51A had run a total of 6125 hours since new and 513 hours since complete overhaul. At the last recorded entry in the engine logbook the engine had run a total of 6347 hours, which included 735 hours since overhaul.

1.6.4 The last maintenance inspection prior to the accident was a 50 hourly inspection carried out between 28 November 1989 and 1 December 1989. Maintenance Release number 319848 was issued following that inspection and remained in force until 1 March 1990 or the accumulation of 6048 total aircraft hours in service, whichever occurred first. From entries recorded in the pilot's diary, approximately 22 hours and 30 minutes had been flown in ZK-HQY since the 50 hourly inspection up to the time of the accident.

1.6.5 During the 50 hourly inspection, the engine oil had been changed and one spark plug had been replaced. The engine lower coupling driveshaft had been inspected for correct alignment (in accordance with the required special inspection procedure). Among other work carried out, a new starter solenoid was fitted and the associated wiring was repaired. In addition, wiring to the cargo hook was repaired and a new down-limit microswitch was fitted to the clutch actuator assembly.

1.6.6 ZK-HQY was a Hughes 269A model, but had been modified to incorporate an electric clutch actuator. A 24 volt electrical system had been installed, with the battery mounted on the aft right side of the helicopter. The starter vibrator/starter solenoid installation had been modified to include a diode assembly preventing inadvertent action of the starting vibrator circuit.

1.6.7 The gross mass of the helicopter at the time of the accident was estimated to have been approximately 655 kg and the longitudinal centre of gravity (CG) 2486 mm aft of the datum. The maximum authorised mass of the helicopter was 760 kg and the permitted range of the CG 2413 to 2540 mm aft of the datum.

1.6.8 As a Hughes 269A helicopter, ZK-HQY was flown from the right seat. The pilot had installed a lower "half-door" on the right side, which afforded some protection from the elements yet allowed the pilot the freedom of an open configuration over the upper section of the doorway.

1.7 Meteorological information

1.7.1 An anticyclone west of Fiordland was moving north east, extending a ridge onto New Zealand. No significant weather was forecast for the area in which the accident occurred.

1.7.2 The shooter reported that "it was a perfect day". Some patches of fog were encountered while flying earlier in the morning, but conditions in the area of the accident were completely clear. The shooter indicated that the weather was sunny with a very light breeze.

1.9 Communications

1.9.1 ZK-HQY was equiped with a King KY195B VHF transceiver. The severity of impact and the fierce fire which consumed the helicopter shortly after the accident resulted in the destruction of this equipment.

1.9.2 The emergency locator transmitter, which was located on the structure of the helicopter beneath the shooter's seat, was also destroyed by fire.

1.12 Wreckage and impact information

1.12.1 The wreckage of ZK-HQY was located on a steep bush clad slope in rugged mountainous terrain at an elevation of approximately 2400 feet amsl. The helicopter had descended into the trees and had struck and severed the upper trunk and branches of a substantial mountain beech. The diameter of the trunk at the point of major impact was about 250 mm and the helicopter had struck with sufficient force to leave the right "half-door" frame suspended in the tree, together with a significant portion of the lower forward fairing including the air filter assembly and other items from the cockpit structure.

1.12.2 The overall bush canopy varied in height from 15 to 20 m with a lower "understorey" of first growth shrub, resulting in dense cover over the slope. Following impact, ZK-HQY had fallen some 10 m to the ground and had slid and bounced about 30 m down a natural gully with an average slope of approximately 55°. A trail of small items of wreckage defined the ground slide on a heading of 150°M. A substantial section of the exhaust assembly which had fractured at a repaired section adjacent to the Number 2 cylinder and at a cross-tube repair, had separated from the remainder of the exhaust system and lay on the forest floor some 10 m above the main wreckage. In the final stages of the slide, the left skid assembly had become detached and ZK-HQY had toppled over a steeper bank to the right and rolled inverted before coming to rest.

1.12.3 An intense fire had destroyed the cockpit and engine compartment of ZK-HQY, including the mast and rotor head assembly and the inboard portion of the three main rotor blades. As a result of the extensive fire damage the integrity of the helicopter's control systems could not be positively confirmed. Examination of the unburnt outer sections of the main rotor blades disclosed little damage to the leading edges. All three blades had remained attached to the rotor head. The tail boom had fractured approximately one metre inboard of its aft end. The tail rotor blades and tail rotor gearbox assembly lay downslope of the main wreckage and had escaped the severity of the fire. The tail rotor gearbox was still securely attached to the tailboom and none of the components of the tail rotor or drive assembly exhibited any evidence of any pre-impact malfunction.

1.12.4 The remains of the engine and structure of ZK-HQY were lifted from the accident site by helicopter and examined at a maintenance facility. The electric clutch actuator was found to be in the "fully engaged" position. The associated clutch actuating cable had failed. See Paragraph 1.16.1 Tests and research.

1.12.5 The main fuel shut-off valve was found in the "OFF" position. The available evidence however suggested that the valve had been pulled to the closed position due to impact forces. The fuel drain valve was closed. The main oil filter was clean and free from any metal contamination. The condition of the cylinders, valves and associated running gear was consistent with impact and fire damage. Both magnetos were consumed by fire, but the remains of the accessory drive installation showed no evidence of malfunction. No useful evidence could be obtained from the fuel control unit.

1.12.6 The fuel lines between the four-way "distributor" and the fuel nozzle in each cylinder were examined prior to removal from the engine. A circumferential crack was observed in the line to the number 3 cylinder close

to the fuel nozzle although the line itself was still firmly connected to the nozzle. The line fractured completely when the adjacent connector fitting was loosened to remove it from the fuel nozzle. There was no evidence that this line had been subject to impact during the accident sequence and it was later submitted to the Christchurch Department of Scientific and Industrial Research/ South Island Development Division (DSIR/SIDD) for detailed metallurgical examination. See paragraph 1.16.2, Tests and research.

1.12.7 The exhaust assembly had sustained considerable damage during the accident sequence, but had been subject to a number of previous weld repairs of varying degrees of quality. There were indications of electrical "arcing" and burning on the surfaces of the exhaust and holes burned through the pipe in various locations. See Paragraph 1.16.3 Tests and research.

1.12.8 The lower output drive shaft and associated couplings exhibited considerable wear, but examination of the external and internal splines, disclosed no evidence to suggest that the lower coupling assembly had been running while misaligned, or that it had malfunctioned in any way.

1.12.9 The burned out and melted remains of the ELT were found in the ashes of the inverted wreckage of ZK-HQY. The location of these remains suggested that the ELT had not been dislodged from its installed position during the impact sequence and ground slide.

1.13 Medical and pathological information

1.13.1 Post mortem and toxicological examination did not reveal any pre-existing medical condition likely to have adversely affected the ability of the pilot in command to control the aircraft.

1.13.2 The shooter reported that the pilot appeared to be in normal health and good spirits on the morning of the accident.

1.13.3 Pathological examination showed that the pilot had sustained only minimal burns from the post accident fire, but had multiple rib fractures of the right chest wall. The cause of death was found to be haemorrhage from severe injuries to the right lung. (See also Survival aspects paragraph 1.15.3).

1.14 Fire

1.14.1 During the accident sequence, the fibreglass encased aluminium fuel tank of ZK-HQY, which probably contained some 55 litres of Avgas, broke open down the left side of its forward face. The helicopter came to rest inverted and the ensuing fire would have been supported and intensified by fuel spillage from the ruptured tank. The source of ignition was not determined. However, in view of the probability of in-flight leakage from a fuel injector line and the deteriorated condition of the engine exhaust system, the fire may have initiated during the latter part of the helicopter's descent, or during the post impact ground slide.

1.14.2 The helicopter was equipped with a hand held fire extinguisher containing two pounds of "dry chemical" extinguishant. The shooter attempted to control the fire using this extinguisher within an estimated one and a half minutes of the occurrence but reported that the capacity of the extinguisher was insufficient to have any lasting effect on the fire.

1.14.3 The intensity of the fire was such that the majority of the aluminium alloy components of the helicopter, within range of the fire's effect, were reduced to a molten state.

1.15 Survival aspects

1.15.1 On the morning of the accident, Mr Kane was wearing the shoulder harness and lapbelt installed at the pilot's station of ZK-HQY. He did not wear a safety helmet. He was suitably attired for the conditions, wearing warm protective clothing and gloves. Sufficient equipment including some spare clothing, rifle and ammunition, was carried on board ZK-HQY to enable the crew to be self-sufficient in the event of a forced landing, or unexpected delay in returning to base.

1.15.2 ZK-HQY was not expected to return to base until late in the evening on the day of the accident. In view of the settled fine weather, no undue concern was felt for the safety of the flight until the helicopter failed to arrive early the next morning.

1.15.3 The Rescue Coordination Centre in Wellington was advised and a Class II search procedure was initiated. It was established through the Department of Conservation (DOC) Park Headquarters at Te Anau that the pilot of ZK-HQY had been allocated Block No. 5 and a helicopter departed from Te Anau at approximately 0750 hours to commence a search within this area.

1.15.4 Mr Kane survived for some four and a half hours following the accident to ZK-HQY. He had managed to extricate himself from the wreckage and although he sustained some burns, was able to move a short distance away from the fiercely burning helicopter. However Mr Kane had received a severe injury to the right side of the chest during the accident sequence. It was probable that this occurred as ZK-HQY descended into the bush, striking a substantial tree trunk. The resultant massive lung injury caused progressive bleeding into the chest cavity, with respiratory failure, aggravated from blood loss, developing over the subsequent four hour period.

1.15.5 Although the accident was survivable, the extent of the pilot's injuries, the remote location of the accident site and the destruction of the ELT by fire, prevented assistance being sought or provided with sufficient dispatch to save the pilot's life. Faced with such difficult circumstances, the shooter's actions were limited to caring for the pilot and seeking to attract attention as best he could by lighting tussock fires and using the emergency flares. In the event, the fire lit by the shooter successfully alerted the searching helicopter to the accident location.

1.15.6 A brief report from the Acting Director of Civil Aviation concerning emergency locator transmitters contained the following information (reproduced in part only):

"EMERGENCY LOCATOR BEACON

All ELTs fitted to New Zealand aircraft are required to meet a laid down standard in:

(a) Manufacture
(b) Installation
(c) Maintenance

The manufacturing standards ensure operation over a wide range of accident variations, assuming installation is correctly carried out.

These ELTs are not designed to withstand fire, but to survive a large deceleration.

The installation greatly influences the beacon's survival. Fixed wing installation is generally in the rear fuselage area which experience has shown to separate after impact and so escape any subsequent fire. As helicopters have no fuselage as such, their installation is much more difficult to plan.

It is not considered practical to construct a radio beacon to survive an intense fire and still function, for a cost which the aircraft industry would be prepared to bear."

1.15.7 The ELT installed in ZK-HQY was known to have been capable of transmitting an emergency signal prior to the accident as it had been the subject of inadvertent transmissions and consequent aerial search activity, approximately one week before the accident.

(**Note:** A Class II Search and Rescue action, is one which the Police control but need to obtain the assistance of other departments or persons.)

1.16 Tests and research

1.16.1 The clutch actuating cable had failed 340 mm from the adjustable turn-buckle eye-end. Microscopic examination of the failed cable indicated that some strands had broken under tension, but others showed evidence of high temperature burning or "arcing". Whether the cable had failed in flight, or solely as a result of ground impact forces and the subsequent fierce fire, was not established. The drive belt tensioning system was such that failure of the actuating cable would have resulted in loss of belt tension and drive to the main rotors.

1.16.2 The injector fuel line/nozzle assemblies from each of the engine's four cylinders were examined by the Christchurch DSIR/SIDD. A detailed metallurgical inspection was made of the fractured area of the fuel line to the number three cylinder. The Director reported as follows:

"Comments:

1. The chemical analysis of the number 3 fuel line indicates AISI 304L austenitic grade of stainless steel was used for the fabrication of the fuel line.

2. The general microstructure of the failed section of fuel line was satisfactory. The absence of grain boundary 'ditching' after etching in accordance with ASTM A 262-81, is indicative that the fuel line had not been 'sensitised' during brazing.

   Sensitisation of austenitic stainless steel results in the impairment of the corrosion resistance due to chromium carbide precipitation, which results in embrittlement. This phenomenon occurs within the temperature range of 540 — 870°C, which are those generally encountered during welding, or brazing when silver based filler alloys are used.

To eliminate or reduce the possibility of this type of failure mechanism, extra low carbon austenitic grades are utlised (AISI 304L is an extra low carbon grade which would have been employed for this purpose).

3. The elements indicated by the qualitative x-ray analysis of the fracture surface coating resulted from contamination with braze metal, perhaps during the fire.

4. The quantitative x-ray analysis result of the braze material at the junction between the fuel line and nipple connector, did not conform to the AMS 4768 silver braze specification specified by Textron Lycoming.

   This would seem to indicate that the joint was repaired subsequent to supply, using a differing grade of brazing alloy to that specified by Textron Lycoming.

5. The element responses generated by the qualitative x-ray analysis of the intergranular films, observed within the stainless steel, yet adjacent to the fracture surface of the broken fuel line, are indicative of penetration by the copper from the brazing filler, which would have resulted in embrittlement of the brazed joint.

   This type of embrittlement occurring with silver brazing alloys containing copper or cadmium, is the consequence of overheating or heating for an excessive period of time during brazing.

6. The evidence of fatigue striations adjacent to the intergranular fracture was indicative of fatigue as the failure mechanism of the fuel line.

   The intergranular embrittlement of the brazed joint would have functioned as an initiation zone for the failure mode of fatigue.

Conclusion:

The in-service failure of the number 3 fuel injector line was the result of fatigue initiation at the embrittled brazed joint, due to either overheating or heating for an excessive period of time during brazing.

The brazing alloy used to make this joint did not comply with the manufacturer's specification."

Notwithstanding the above findings and conclusion of the DSIR, it was not practicable to establish with certainty at what stage in the history of the helicopter the fuel line to the number 3 cylinder fuel nozzle had been repaired.

1.16.3 The damaged components of the exhaust system from ZK-HQY were inspected at the Air New Zealand Christchurch Base Workshops by a group comprising Quality Assurance, Non-Destructive Testing and Welding Departments, who reported as follows:

"The following conclusions were reached by this group, based on their assessment of the exhaust system relative to normal aircraft maintenance practices.

1. At the time of the last repair the right hand components of the exhaust system were in a condition not suitable for patch repair.

2. The workmanship used in the patch repair was of a very poor standard.

3. Incompatible repair materials were used.

4. The repairs carried out would not have returned the exhaust system to a condition fit for service."

1.17 Additional information

1.17.1 Mr Kane kept a diary in which he recorded daily flight times and a brief note of defects arising in the operation of ZK-HQY, together with details of other matters concerning his deer hunting activity. Recent entries relating to defects included the following:

"6 Jun 1989	Starter problem
26 Jul 1989	Left mag drop
28 Jul 1989	Right mag drop
25 Sep 1989	Spark plug
4 Oct 1989	Fuel pipe leaking
5 Oct 1989	'Put fuel pipe ... on'
28 Nov 1989	Crook wires"

1.17.2 Regular maintenance of ZK-HQY was undertaken by an approved aircraft engineering organisation and "unscheduled" maintenance was carried out if rectification of defects was required between prescribed checks. The Worksheets detailing both periodic maintenance and unscheduled maintainence during 1989 showed that two 50 hourly inspections and one 200 hourly inspection had been undertaken up to the date of the accident. In addition, Mr Kane had brought ZK-HQY in for unscheduled work to be done on seven separate occasions.

1.17.3 A review of the relevant worksheets, correlated with Mr Kane's diary entries concerning defects, indicated that most defects had been rectified by the approved engineering organisation either in the course of a subsequent periodic inspection or relatively soon after their occurrence, at Mr Kane's request, on an "unscheduled" basis.

1.17.4 There was no reference, however, to any request for rectification of a "fuel pipe leakage" problem, nor for repair work to be carried out on the engine exhaust system at any stage. The available evidence indicated that in these two instances Mr Kane may have elected to carry out repairs himself, or arranged for such work to be done at a location other than the approved aircraft engineering facility.

1.17.5 The Pilot's Flight Manual for the Hughes 269 helicopter included the following information in regard to the Pilot's Preflight Inspection: (reproduced in part only)

"— Visual check the following items for obvious damage. Damage is defined as any condition that is not normal or not within limits. Examples of conditions to look for are: inoperable equipment, excessive leakage, discolouration due to heat, dents, cracks, punctures, abrasion, chaffing, galling, nicks or evidence of corrosion. These are the most common types of damage; however, do not limit inspection to the above conditions. ...

... ENGINE — LEFT SIDE: Check ... engine and components, exhaust and intake tubes, fuel and oil lines ...

ENGINE — RIGHT SIDE: Check ... belt drive lower pulley bearings ... Clutch control cable, clutch engaged, clutch disengaged ... general engine area for loose wires, fittings or damage".

2. ANALYSIS

2.1 Mr Kane was an experienced pilot who had accumulated most of his helicopter flying time on deer hunting and recovery in the Fiordland area. Approximately one third of his flying had been in Hughes 269 series helicopters and he was in current flying practice in this type. All of his recent flying had been in Hughes 269A ZK-HQY, which he had owned and operated for some 12 months and which he was flying when the accident occurred.

2.2 Mr Kane had worked in the helicopter and deer recovery industry for about 15 years. In addition to his familiarity with the flying techniques required for the task his general experience in the Hughes 269 type helicopter and exclusive use of ZK-HQY in the months preceding the accident, would have rendered him aware of many of the malfunctions and defects likely to be encountered during practical operation of the helicopter, in regard to both engine and airframe.

2.3 It was evident that certain defects which had occurred in ZK-HQY during hunting operations were noted by Mr Kane in his diary. Following the helicopter's return to base, Mr Kane had then arranged for the necessary repairs or maintenance to be undertaken by an approved aircraft maintenance organisation, which also carried out the required periodic maintenance on the aircraft.

2.4 A significant exception to this procedure appeared to have occurred in relation to the "fuel pipe leaking" which Mr Kane had recorded in his diary as a defect on 4 October 1989. No information was available to identify precisely the affected component of the fuel system (which included a number of fuel pipes and lines), or to determine by whom, or in what manner, repairs were made, but it was clear that the previously defective pipe or line was re-installed the following day and that ZK-HQY was operated without further recorded fuel system problems.

2.5 ZK-HQY had flown some 22 hours since the last periodic inspection and on the morning of the accident, had been operating normally. In view of his experience, Mr Kane could be expected to be very familiar with the pre-flight inspection procedure for the Hughes 269 type. Had there been any readily visible evidence to suggest an impending problem, whether in the fuel system, or any other component or assembly of ZK-HQY, Mr Kane was likely to have observed this and to have modified the day's flying programme accordingly. The shooter confirmed that the helicopter was performing satisfactorily.

2.6 Although the wreckage of ZK-HQY was substantially consumed by fire, there was no indication to suggest that any abnormality or malfunction of the control system had occurred prior to the accident, or that Mr Kane's ability to operate the helicopter had become impaired in any way.

2.7 The available evidence was, however, consistent with an engine malfunction which had originated at some stage after the shooter had vacated the helicopter to prepare the deer carcases on the slope for lifting out. The shooter, who was well used to the normal sound of ZK-HQY, described the

engine as "coughing and misfiring" and reported that as the helicopter descended away from him there were "sparks" from the area of the exhaust and lower part of the engine.

2.8 Severe fire damage to the engine compartment of ZK-HQY which resulted in destruction of the accessories, including the magnetos and fuel control unit, rendered it impracticable to determine with certainty the reason for the "misfiring" of the engine, or to eliminate a number of possible causes of engine malfunction and associated power loss. Tests and research established however that the stainless steel fuel line to the fuel nozzle of the number three cylinder had fractured prior to the occurrence of fire damage. The Director of the DSIR/ SIDD concluded that this was an in-service failure which had occurred due to fatigue initiation at an embrittled brazed joint. The evidence indicated that the failure had occurred as a result of repair work carried out on the fuel line. It could not be established whether the failed fuel line to the number 3 cylinder fuel nozzle was in fact associated with the "fuel pipe leaking" defect and apparent repair work carried out on or about 5 October 1989 (see Paragraphs 1.17.1, 1.17.4 and 2.4)

2.9 While initial development of a fatigue crack in the fuel line would have been difficult to detect visually, rapid failure of the line was likely once such a crack reached critical length. An in-flight fuel line fracture was likely to have resulted in "rough runnning" and a loss of available engine power, together with considerable vibration, but also held potential for a hazardous fuel leakage from the affected line (which normally supplied fuel under pressure to the associated fuel nozzle).

2.10 In the absence of other evidence to account for the accident, it was probable that an unexpected loss of engine power occurred, due to fracture of the fuel line to the number three cylinder, as Mr Kane flew ZK-HQY towards the steep hillside. The subsequent flight path of the helicopter, in which Mr Kane turned away from the hillside and entered a descent, was consistent with such an event. Within the confines of the dense bush clad gully above which the helicopter had been operating, there was little option for an attempted landing other than to descend into the trees.

2.11 The significance of the "sparks", seen by the shooter as ZK-HQY descended, could not be determined. He reported that they did not appear to be "electrical" in nature. The exhaust system of the helicopter was in poor condition and the possibility existed that engine vibration and/or misfiring may have resulted in a discharge of incandescent material from the exhaust. Alternatively, partial disruption of the exhaust system due to vibration may have permitted some exhaust flame(s) to become more readily visible.

2.12 It was possible that the condition of the exhaust system or the observed "sparks", together with fuel leakage from a fractured fuel line, contributed to the development of a fire within the engine compartment in flight, with consequent "arcing" and burning of wiring and other components. If such conditions had resulted in a pre-impact failure of the clutch actuating cable the subsequent loss of drive belt tension may have prompted Mr Kane's comment that the cause of the accident "might have been the belts".

2.13 Although the Validity Certificate of Mr Kane's Commercial Pilot Licence had expired, he had completed the medical and flight times for its renewal. The invalidity of his licence at the time of the accident was not a factor in the accident.

3. FINDINGS

3.1 The pilot held a Commercial Pilot Licence — Helicopter and a type rating for the Hughes 269 type.

3.2 The Validity Certificate associated with the pilot's Commercial Pilot Licence had expired.

3.3 The helicopter's Certificate of Airworthiness and Maintenance Release were rendered invalid by the unsatisfactory repairs to the exhaust assembly and number three clinder's fuel line.

3.4 The helicopter's gross mass and centre of gravity were within the specified limits.

3.5 An engine power loss occurred in flight resulting in the helicopter descending into the trees.

3.6 A likely cause of the power loss was a fatigue fracture of the fuel line to the number three cylinder.

3.7 The shooter took all practical steps to improve the pilot's chance of survival after the accident.

3.8 The destruction of the ELT in the post-impact fire delayed the location of the aircraft wreckage.

3.9 The probable cause of this accident was an in-flight partial loss of engine power over terrain which rendered a forced landing hazardous. A contributing factor was the standard of the repair work carried out on the helicopter's fuel and exhaust systems.

20 March 1991

M F DUNPHY
Chief Commissioner