TRANSPORT ACCIDENT INVESTIGATION COMMISSION
TE KOMITI TAI HAPORO AITUA WAKA

AIRCRAFT ACCIDENT REPORT

No. 89-065

ROBINSON R22 ZK-HYX

Whitford Forest

1 August 1989

Transport Accident Investigation Commission
Wellington - New Zealand

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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 Robinson R22 Beta helicopter ZK-HYX in Whitford Forest, near Auckland on 1 August 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 as to the contributing factors and causes of the accident.

16 May 1991

R CHIPPINDALE
Acting Chief Executive

APPROVED FOR RELEASE AS A PUBLIC DOCUMENT

21 May 1991

M F DUNPHY
Chief Commissioner

AIRCRAFT:	Robinson R22 Beta	**OPERATOR:**	Helicarr Consolidated Limited
REGISTRATION:	ZK-HYX	**PILOT:**	J.F. O'Grady
PLACE OF ACCIDENT:	Whitford Forest, Near Auckland	**OTHER CREW:**	Nil
DATE AND TIME:	1 August 1989, Approx 1522 hours	**PASSENGERS:**	One

SYNOPSIS:

The Senior Inspector of Air Accidents based at Christchurch Airport received information at 1708 hours on 1 August 1989 that a Robinson R22 Helicopter was overdue on a local flight from Ardmore Aerodrome. At 1805 hours advice was received that an accident had occurred. Mr D.G. Graham was appointed Investigator in Charge and commenced the field investigation the following morning. The pilot and passenger departed from Ardmore Aerodrome in Robinson helicopter ZK-HYX for a twenty minute local flight. The aircraft failed to return. Later in the day the wreckage of ZK-HYX was located in a bush covered gully. The pilot and passenger had received fatal injuries in the accident.

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 **Pax:** 1 Fatal	Destroyed	Nil.

1.5 PERSONNEL INFORMATION:

See page 5.

Flight Times

	Last 90 days	Total
All Types	2 hr 45	285
On Type	2 hr 05	275

1.6 AIRCRAFT INFORMATION:

See page 6.

1.7 METEOROLOGICAL INFORMATION:	1.8 AIDS TO NAVIGATION:	1.9 COMMUNICATIONS:
See page 7.	Nil	See page 8.

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

1.13 MEDICAL AND PATHOLOGICAL INFORMATION:	1.14 FIRE:	1.15 SURVIVAL ASPECTS:
See page 11	Fire did not occur	See page 11.

1.16 TESTS AND RESEARCH:	1.17 ADDITIONAL INFORMATION:	1.18 USEFUL OR EFFECTIVE INVESTIGATION TECHNIQUES:
See page 12.	See page 12.	Nil

2. ANALYSIS:	3. FINDINGS:
See page 14.	See page 18.

4. SAFETY RECOMMENDATIONS:	5. APPENDICES:
Nil	**See page 20.**

* All times in this report are NZST

1. FACTUAL INFORMATION

1.1 History of the flight

1.1.1 About a week before the accident occurred, the pilot had agreed to take the daughter of a friend for a helicopter flight from Ardmore Aerodrome. Details were to be finalised when a suitable booking was confirmed.

1.1.2 On the morning of 1 August 1989 the pilot booked Robinson helicopter ZK-HYX for a flight during the afternoon and the necessary arrangements were made for the passenger to come to the aerodrome. The pilot, who was self-employed, spent the morning at the aerodrome continuing his study for the Commercial Pilot Meteorology examination which he was to sit next day.

1.1.3 The pilot and two close friends had lunch together at a local restaurant. The pilot who was relaxed and in good spirits, enjoyed the meal, which included some wine. He then returned to his studies at the aerodrome.

1.1.4 The Chief Flying Instructor (CFI) of Helicarr Limited (The helicopter operator with whom the pilot had carried out all his flying training) was aware from the booking sheets that the pilot had arranged to make a private flight with a passenger in ZK-HYX at about 1500 hours. On his return to the company base at this time, after completing a training exercise in ZK-HYX with a student, the CFI observed the pilot and passenger waiting at the landing pad.

1.1.5 The pilot signalled to the CFI to keep the engine and rotors of ZK-HYX running after landing. The student vacated the helicopter and the pilot seated himself in the empty right seat, (the normal position from which the Robinson helicopter is flown), fastened his seatbelt and took over control.

1.1.6 The CFI then disembarked and after escorting the passenger to ZK-HYX, assisted her to seat herself comfortably on the left side. He briefly explained the operation of the headset and intercommunication and the method of securing the door. In response to a query from the CFI, the pilot indicated that the dual controls on the passenger side should be left in place.

1.1.7 At the time of the change-over, the pilot informed the CFI that he intended to fly ZK-HYX for a period of about 30 minutes. The CFI confirmed with him that sufficient fuel remained on board ZK-HYX for approximately one and a half hour's flying.

1.1.8 ZK-HYX departed uneventfully from the company pad and flew the short distance across the grass and nearby runway to the helicopter operating area on the northern side of the aerodrome. Approximately one minute later (see Section 1.9 for communication details) ZK-HYX departed for Whitford Forest.

1.1.9 ZK-HYX was scheduled for a Maintenance Inspection and it was decided that at the completion of the private flight the helicopter should be flown directly to the operator's maintenance organisation located on another part of the aerodrome. Accordingly the CFI requested Ardmore Tower to pass a message to this effect to the pilot of ZK-HYX on his return. The CFI then proceeded by car to the maintenance facility to be available to transport the pilot and passenger back to Helicarr Limited after they returned.

1.1.10 The non-arrival of ZK-HYX at the maintenance facility within the expected time prompted the CFI to inquire from Ardmore Tower as to the helicopter's whereabouts. ZK-HYX was subsequently declared overdue. Light aircraft which were already operating locally commenced a search for the missing helicopter.

1.1.11 Emergency locator transmitter (ELT) signals from the Whitford Forest region narrowed the search to a small area but considerable difficulty was experienced in locating the wreckage of ZK-HYX due to the dense bush cover. At approximately 1705 hours the CFI of Helicarr Limited and his crewman who were flying a Robinson helicopter on a low level search observed some scattered components from ZK-HYX in the trees. A further low level search resulted in the discovery of the main wreckage. After landing in the nearest suitable area to enable his crewman to disembark, the CFI returned to the wreckage and hovered overhead and assisted the crewman to find the site.

1.1.12 The accident occurred at about 1522 hours, some 10 minutes after the helicopter departed from Ardmore Aerodrome. The accident site was in a bush clad gully in Whitford Forest approximately 10 km north-north-east of Ardmore Aerodrome, at an elevation of about 650 feet amsl. National Grid Reference 897706 (NZMS 260 Sheet R11), Latitude 36°57'30"S, Longitude 175°01'E

1.5 Personnel information

1.5.1 At the time of the accident the pilot in command, John Francis O'Grady, 35, held Private Pilot Licence (Helicopter) number 1115, with no limitations or endorsements and Student Pilot Licence (Aeroplane) number 12540. The Validity Certificates associated with these licences were valid from 13 October 1988 to 12 October 1990.

1.5.2 Mr O'Grady commenced formal helicopter training in October 1986 and obtained Private Pilot Licence (Helicopter) number 1115 in June 1987. All his initial flying training was on the Robinson R22 helicopter type. He had subsequently obtained ratings for the Hughes 269 and the Bell 206 helicopter types.

1.5.3 Since May 1987 Mr O'Grady had undertaken five dual instructional lessons in a variety of fixed wing aircraft for a total of 3.75 hours fixed wing flying.

1.5.4 It was Mr O'Grady's intention to obtain a Commercial Pilot Licence (Helicopter). Accordingly over the preceding two years he had sat and passed four of the written examinations and was on the eve of attempting the remaining required examination when the accident occurred.

1.5.5 Mr O'Grady's recorded total flying experience amounted to 285.6 hours. This included a total of 15.4 hours flown at night in helicopters, with 44.75 hours dual and 221.6 hours solo, in helicopters by day, prior to the accident flight.

1.5.6 The major portion of Mr O'Grady's helicopter flying was in the Robinson R22 helicopter type amounting to a total of 275.75 hours. He had flown 3.75 hours in the Hughes 269 and 2.3 hours in the Bell 206. Logbook records showed that he had flown 41.5 hours in Robinson R22 Beta ZK-HYX.

All of his helicopter training had been undertaken with Helicarr Limited most of which was flown from Ardmore Aerodrome.

1.5.7 During the first three months of 1989 Mr O'Grady had flown on a regular basis. However, between 27 March 1989 and the accident flight, he had carried out only two flights in helicopters, scenic flights on 9 June and 18 June respectively and one training flight in a fixed wing aircraft on 6 July. His flight time within the last 90 days amounted to 2.1 hours on helicopters.

1.5.8 Specific entries in Mr O'Grady's Pilots Logbook indicated that on at least 14 separate occasions part of his flight training, or practice flying, in the Robinson helicopter, had taken place in the Whitford Forest area. In addition it was probable that he had flown in this area on other occasions in relation to "mountain" flying training and practice, and during "confined area" training sorties.

1.5.9 Mr O'Grady's most recent medical examination for the renewal of his flight crew licences had been undertaken on 23 September 1988. He had been assessed "fit" to the standards required for the issue of a Commercial Pilot Licence.

1.6 Aircraft information

1.6.1 Robinson R22 Beta helicopter, serial number 0666 was constructed in the United States in June 1987 and logged 16.5 hours flying prior to importation and reassembly in New Zealand in October 1987. It was registered as ZK-HYX and a Certificate of Airworthiness (C of A) in the Standard Category valid until 29 October 1991, was issued for the aircraft on 30 October 1987. The validity of this C of A was dependent on the aircraft being maintained in accordance with the approved Maintenance Programme.

1.6.2 ZK-HYX had received periodic maintenance in accordance with the approved programme. The last Maintenance Inspection prior to the accident was carried out on 28 July 1989. This inspection, which resulted in the issue of Maintenance Release number 317456, valid to 16 December 1989, permitted a 10% extension of flying hours enabling the next 100 hourly inspection to be deferred until ZK-HYX had accumulated a total time of 726.5 hours.

1.6.3 The last 100 hourly inspection and replacement of parts as appropriate, had been carried out in June 1989. Subsequent to that inspection the dual tachometer which indicated engine and main rotor rpm was replaced on 26 June 1989 and the same unit changed again on 4 July 1989. A 50 hour routine inspection on the engine was carried out on 10 July 1989. There were no recorded defects outstanding on ZK-HYX at the time of the accident flight.

1.6.4 The CFI reported that ZK-HYX performed satisfactorily during the training exercise that he flew with a student immediately prior to the accident flight. The sole defect the CFI recalled was that the cylinder head temperature gauge was not working at the time. ZK-HYX incorporated a "10 hole" instrument panel and suitable instrumentation, enabling the aircraft to be utilised, when required, in an instrument training role.

1.6.5 At the time of the accident ZK-HYX had flown a total of 720.3 hours since new and 11 hours since the last maintenance inspection. Lycoming model O-320-B2C engine, serial number L-14509-39A had also run 720.3 hours since new and 11 hours since the most recent inspection.

1.6.6 ZK-HYX was equipped with a main fuel tank and a reserve tank. It was estimated that 38 litres of fuel was on board at the time of the accident.

1.6.7 The mass of the helicopter at the time of the accident was estimated to have been approximately 50 kg below the maximum authorised mass of 622 kg. The centre of gravity was estimated to have been within limits both longitudinally and laterally.

1.6.8 The requirements of Airworthiness Directive (AD) DCA/R22/17A Main Rotor Spindle - Inspection and Modification, which had an effective date of 6 February 1989, had been communicated to the operator in a letter from the Air Transport Division of the Ministry of Transport, dated 1 February 1989. Compliance with the provisions of the AD was required within the next 50 hours time in service or by 31 March 1989 whichever was the sooner.

1.6.9 ZK-HYX was affected by the AD but there was no record in the Maintenance Documentation of the aircraft to indicate that the AD had been complied with, either by the due date or during subsequent inspections. There was no record of any concession, deferring the requirements of AD17A with respect to ZK-HYX, being granted to the Operator by the Air Transport Division.

1.6.10 The Main Rotor Spindles and Journals of ZK-HYX were inspected following the accident. There was no suggestion that any failure had occurred in these components. However, non-compliance with the requirements of an Airworthiness Directive would have rendered the aircraft's Certificate of Airworthiness and Maintenance Release technically invalid.

1.7 Meteorological information

1.7.1 On 1 August 1989 an intense anticyclone lay to the east of New Zealand and a moderate north-easterly airflow covered the Auckland area.

1.7.2 The weather conditions at Ardmore Aerodrome 10 km south-south-west of the accident site at 1500 hours were recorded as follows:

Wind:	050°T/10 knots
Visibility:	60 km in haze
Cloud:	2 octas cumulus at 3500 feet
QNH:	1026 hPa

1.7.3 The pilot of a Robinson helicopter taking part in the search, who located the wreckage of ZK-HYX at approximately 1705 hours, described weather conditions at that time as "reasonably fine - plenty of visibility". The cloud base was at least 1500 feet above the forest area. He estimated the wind as about 15 knots from the east, with light to moderate turbulence at low level in the lee of the forested slopes. There was no drizzle or low cloud in the area at the time.

1.7.4 The owner of a property located some 4 km south-east of the accident site was felling trees. He reported that there was a "gusty breeze from the east or north-east, the gusts were quite strong". At one stage a tree which he had scarfed was blown down prematurely by a strong gust.

1.7.5 In an aftercast of the low level weather situation at the time of the accident the General Manager of the New Zealand Meteorological Service reported in part as follows:

"I estimate the winds at 1000 feet to have been north-easterly about 20 knots. This is for a gradient wind flow unaffected by terrain. There would have been some increase in wind speed across the tops of the hills over which the helicopter was flying ... I believe there would have been moderate turbulence close to the hills with downdraughts in the lee of the ridges. ... the temperature in the Whitford area, at about the time of the accident is estimated to have been 15°C at the surface and 12°C at 1000 feet. The respective dew points are estimated to be 10°C and 8°C. During the afternoon visibilities of 40 km or more were reported with scattered cumulus at about 3500 feet. Cloud increased in the late afternoon and drizzle probably fell after 1900 hours local time. It is unlikely that there was any precipitation at the time of the aircraft crash."

1.7.6 Reference to a Carburettor Icing Probability Chart showed that the prevailing meteorological conditions were conducive to serious induction system icing at any power range.

1.9 Communications

1.9.1 ZK-HYX was equipped with a King KX 165/KI525A, very high frequency (VHF) transceiver. Using this equipment the pilot initiated and maintained normal radio telephone (RTF) communications with Ardmore Tower on 118.1 mHz. He first established communications at 15.09.18 hours and was cleared to proceed from his position at Helicarr Limited to the helicopter operating area on the northern side of runway 07/25.

1.9.2 At 15.11.40, approximately 1 minute after reaching this area, the pilot transmitted the following message; "Ardmore Tower Yankee X-ray leaving circuit area - Forest Area". In response to a question from the Tower he indicated that the duration of the flight would be about 20 minutes.

1.9.3 The last transmission from ZK-HYX was the pilot's acknowledgement of Ardmore Tower's request to, "Call rejoining" at the conclusion of the local flight.

1.9.4 The absence of any communication from ZK-HYX by 1605 hours (more than 30 minutes after the anticipated time for the aircraft's return), and a request from the operator as to its whereabouts resulted in numerous unsuccessful attempts by Ardmore Tower and other aircraft, to establish communications with ZK-HYX.

1.9.5 At 1610 hours ZK-HYX was declared overdue. Aircraft in the local area were alerted and at 1628 hours signals from an emergency locator transmitter (ELT) received by a searching aircraft were identified as emanating from the region of the Whitford Forest.

1.12 Wreckage and impact information

1.12.1 The fuselage of ZK-HYX lay about 3 m above the bottom of a dense bush clad gully in the Whitford Forest area uphill from a small stream.

The west side of the gully, which the aircraft had struck, sloped upwards at approximately 45°. ZK-HYX had come to rest on a heading of 310°M and had struck the slope in a nose-down attitude, while laterally level, with little forward speed. Absence of damage to surrounding tall tree ferns and other bush foliage indicated that the descent angle had been within some 20° of vertical.

1.12.2 The area surrounding the accident site comprised numerous intersecting gullies clad with native bush, with an afforested area of pines and other exotic species lying mainly to the east and north. The low hills, some 600 feet to 800 feet high, which surrounded the region, were bordered by cleared patches of pastureland. The Whitford non directional beacon (NDB) aerial mast was located on a cleared hill-top approximately 500 m north-west of the accident site. A forestry and farmland access road lay to the north of the beacon installation.

1.12.3 The severe "near vertical" impact on the steep slope had bent the left skid assembly of ZK-HYX upwards and splayed the right skid outwards. The understructure and engine had been forced upwards and the mast assembly had fractured at its base and was bent to the left. There was considerable downwards deformation of the pilot's and passenger's seats and the forward section of the helicopter, including the instrument pedestal was extensively disrupted.

1.12.4 Both main rotor blades remained attached to the rotor head. Damage to the blades was characteristic of low rotational energy at the time of ground impact. One main rotor blade had revolved 180° in its pitch bearings. It was bent in an "upwards" direction when positioned correctly in relation to the opposite blade, which had bent downwards. Both pitch links had bent before failure. The rotor mast was slightly bent at the top, but there was no significant evidence of "mast bumping" on the mast itself. The metal "droop stops" which served to limit downwards movement of the main rotor blades in the vertical (flapping) plane had sheared under overload.

1.12.5 The tail boom, vertical and horizontal stabiliser, and whole rear assembly had been dislodged from the aircraft in flight and the tail rotor assembly with almost the complete length of the drive shaft still attached was located in the upper part of a tree some 80 m to 100 m upstream north-west from the main wreckage. The mid-section of the tail boom was in another tree about 30 m to 40 m, also upstream. Some items from the helicopter, including a portion of the left door and perspex fragments were located in a radius up to 15 m from the main wreckage. The location of all these components defined a "wreckage trail" approximately 100 m in length, in the general downstream direction of the valley system.

1.12.6 The heading on which the fuselage had come to rest showed that the helicopter had rotated horizontally at least 180° prior to ground impact. However, the relative positions of the separated tail rotor and drive shaft assembly and the tail boom mid-section, which appeared to have been flung from the helicopter into the trees in which they were lodged, suggested the likelihood that ZK-HYX gyrated through a number of revolutions while still in flight, as a result of the loss of directional control.

1.12.7 The anti-collision beacon had been torn from the tailboom. Marks on one main rotor blade indicated that this had occurred due to a main rotor

strike before the aft section of the tailboom and the drive shaft assembly had separated from the helicopter. Severe damage to the inboard end of the middle section of the tailboom and matching paint smears on the main rotor blades indicated that this section had been struck by the blades while the helicopter was still in flight. This was consistent with the progressive sequence of tailboom failure and separation.

1.12.8 It was evident that at the time of separation of the drive shaft and tail boom aft section, the tail rotor was being driven with considerable rotational energy. The drive shaft had failed under severe torsional loading, 150 mm aft of the rear flexible coupling, with evidence of tension and sideways loading on the coupling. There was heavy scoring of the internal skin in the area of the fuselage/tailboom attachment indicating continued rotation of the transmission drive when deformation occurred. In addition, the pitch change control rod had been wrapped helically around the drive shaft.

1.12.9 Both tail rotor blades had been dented close to their outboard ends, over the final 125 mm of their length. One blade had been bent approximately 30 mm inwards towards the tailboom, and had a dent 70 mm wide and 10 mm deep, extending 40 mm chordwise from the leading edge. The opposing blade exhibited two smaller dents in the same area with flattening of the leading edge. The relative symmetry of the damaged areas on each blade and the severity of the denting, with an absence of "rotational" marking, suggested that the outer portion of the tail rotor had struck a branch or tree trunk which was sufficiently substantial to stop the tail rotor within one or two revolutions.

1.12.10 An aerial reconaissance of the area showed that a tree, adjacent to that in which the tail rotor assembly was lodged and just to the north, had been struck by some part of the helicopter. Marks on the eastern side of the tree (the valley side) were indicative of a tail rotor strike on an upper branch about 80 mm in diameter. The difference in elevation between the tree strike and the downstream location of the main wreckage was approximately 50 feet.

1.12.11 Inspection of the wreckage established continuity of the cyclic and control circuits of ZK-HYX. The forward sections of the tail rotor control linkage had sustained severe impact damage. Continuity was established between the tail rotor pedals and the pitch change control rod. There was no evidence to suggest that the cyclic, collective, or tail rotor controls had been obstructed in any way, preventing or limiting their operation prior to the accident.

1.12.12 The lower part of the engine compartment was substantially disrupted on impact. The right magneto had broken off downwards, as had the oil cooler assembly and the left magneto crankcase mount was also broken due to impact. The throttle and mixture controls were correctly attached at the engine. The throttle butterfly valve was in the fully closed position. (There was considerable forest floor debris in the induction air box, but no debris downstream from the throttle butterfly valve). The carburettor bowl had broken off but both floats were intact. The main gascolator still held a small amount of fuel. The fuel filter was clear of contamination as was the engine oil filter. The engine sump contained an ample supply of oil.

1.12.13 The main and auxiliary fuel tanks had ruptured on impact and were empty. Both fuel tank caps were securely fastened. A quantity of fuel remained in the line to the fuel selector. The clutch actuator was in the "ENGAGED" position. The overrunning clutch operated satisfactorily when

checked and no deficiencies were found in the lower drive bearing assembly.

1.12.14 Instrument readings and control positions at the accident site were recorded as follows:

Collective lever:	fully up
Fuel selector:	"ON"
Mixture:	Full "RICH"
Carburettor Heat:	Full "COLD"
Magnetos:	On "BOTH"
Master Battery Switch:	"ON"
Alternator:	"ON"
Clutch:	"ENGAGED" (guard on)
Strobe Lights:	"ON"
Navigation Lights:	"ON"
QNH:	1026 Hpa
Radio (KX 165):	"ON" (Volume control to 3/4 position)
ADF:	"ON" (ADF Needle reading 058°)
Hobbs Meter:	720.5

No other readings of significance to the investigation were obtained from the instrumentation.

1.13 Medical and pathological information

1.13.1 The post mortem examination did not reveal any medical condition which may have affected the pilot's ability to control the aircraft.

1.13.2 The pilot had sustained a massive head injury and significant injuries to the upper torso indicative of having been thrown forward at the time of impact. The passenger did not exhibit head injury but had sustained multiple injuries also consistent with the severe impact forces involved in the accident.

1.13.3 Blood alcohol concentrations in samples taken from the pilot's body were assessed as 10 mg per 100 mls blood. The level of blood alcohol present was consistent with the reported evidence that the pilot had consumed some alcohol at lunch time, approximately 2 hours prior to the accident flight.

1.13.4 The pilot's blood alcohol concentration was below the level of 20 mg per 100 ml considered by the Royal Air Force Institute of Pathology and Tropical Medicine to be associated with significant impairment of flying performance. However some degradation of his judgement and awareness would have resulted inevitably from the alcohol consumed.

1.13.5 The pilot was due to sit an examination on the day following the accident. While the outcome was important to him, there was no indication that the pilot was under stress concerning the impending examination. He was reported to be in normal good spirits at the time of the accident flight.

1.15 Survival aspects

1.15.1 The pilot and passenger were both wearing the standard safety harness installed in the Robinson R22 helicopter which comprised a lapbelt and diagonal upper torso restraint. The doors on the pilot's and passenger's sides were in place at the commencement of the flight. Neither the pilot nor the passenger wore a protective helmet.

1.15.2 In-flight loss of the tailboom and tail rotor assembly would have deprived the pilot of directional control and also resulted in a nose-down pitch change. The distribution of the wreckage indicated that horizontal rotation of ZK-HYX occurred prior to ground impact. Rotation of the helicopter due to loss of the tail rotor was likely to have disoriented the pilot and may have rapidly developed to an irretrievable extent. In the event, the high vertical descent rate at impact and extensive disruption of the cockpit area made this accident unsurvivable.

1.15.3 The Pointer 3000 ELT had remained in its mounting bracket in the upper rear compartment despite the severe impact forces. Some initial difficulty was experienced in pin-pointing the location of the helicopter due to signal fading. Nevertheless the ELT transmitted signals of sufficient strength and duration to enable the approximate position of ZK-HYX to be determined and the wreckage found, within 2 hours of the occurrence of the accident.

1.15.4 On arrival at the accident site the crewman removed the passenger from her seat and attempted resuscitation but without success.

1.15.5 An RNZAF Iroquois helicopter arrived overhead a short time later and RNZAF personnel who were winched into the site assisted the crewman in a further unsuccessful attempt to resuscitate the passenger.

1.16 Tests and research

1.16.1 Before disassembly and removal of the main rotor blades, the rotor head of ZK-HYX was subject to detailed inspection. The flapping hinges and teetering hinge were installed in accordance with the manufacturer's requirements. No indication was found of any defect within the rotor head and rotor blade assembly likely to have contributed to the accident.

1.16.2 Examination of the light bulbs from the instrument panel warning lights showed that the filament of the "LOW RPM" light had stretched very markedly. It was concluded that this warning light was illuminated at impact. There was no indication that any other warning light was on at the time of ground impact.

1.16.3 The airframe and engine were stripped and examined.

1.16.4 No evidence was found to suggest that any pre-impact mechanical defect or failure had occurred in any component of ZK-HYX.

1.17 Additional information

1.17.1 Helicarr Limited, the operator of ZK-HYX, had permission from the owners of Whitford Forest to operate in and out of "confined areas" in the region, for training purposes. Mr O'Grady was familiar with the general features of the area and had carried out training and practice flights including use of the "confined areas". These were not located, however, in the precise region where the accident occurred. It was not known whether Mr O'Grady had any prior detailed knowledge of the valley systems or other terrain features in the vicinity of the accident site. This particular area was not utilised by the operator for training due to its relative proximity to the Whitford NDB installation.

1.17.2 Whitford Forest lay within the control zone surrounding Auckland International Airport. It also lay within a specific segment of this airspace, designated "Victor 1/S", which extended from 0 to 1500 feet, facilitating the operation of light aircraft and helicopters under visual flight rules in the area. Mr O'Grady had made no arrangement prior to the flight, nor was any radio communication received during the flight to request that ZK-HYX operate other than in "Victor 1/S" during the local flight, or while in the Whitford Forest area.

1.17.3 Eleven months prior to the accident a pilot who was undertaking helicopter flight training had accompanied Mr O'Grady, as a passenger, on a flight in the Whitford Forest area.

1.17.4 Mr O'Grady was carrying out various exercises, as part of his Commercial Pilot Licence training syllabus, including revision of operations into and out of a confined space which was surrounded by trees apart from an entry and exit path.

1.17.5 The pilot recalled that during this practice session, following a steep approach and subsequent overshoot, Mr O'Grady would climb the helicopter to approximately 75 feet, lower the collective lever and carry out a 180° quick stop before once more descending to the confined area.

1.17.6 Although Mr O'Grady appeared competent it was of concern to the other pilot that the helicopter was manoeuvred in close proximity to the trees and that speed was reduced to a hover in the quick stop, before the helicopter was descended again to the confined area.

1.17.7 He considered that the manoeuvre, as conducted, had the potential for a tail strike to occur and also resulted in operation of the helicopter outside the recommended parameters of the height/velocity curve.

1.17.8 The Civil Aviation Regulations (1953) stated:

"Regulation 38 Minimum Safe Heights

(1) Subject to the provisions of these regulations, no aircraft shall be flown over any city, town, or populous area except at such altitude as will enable the aircraft to complete a safe landing should engine failure or other cause necessitate a forced landing.

(2) Without limiting the provisions of subclause (1) hereof, no aircraft shall be flown over —

(a) Any city, town, or populous area at a lower height above the area than 1000 feet, or

(b) Any other area at a lower height above the area than 500 feet.

(2A) A height specified in subclause (2) hereof is the height above the highest point of the terrain or any obstacle thereon, within a radius of 2000 feet of a line extending vertically below the aircraft.

(3) The provisions of subclauses (1) and (2) of this regulation shall not apply if —

(a) Through stress of weather [encountered enroute] or any other unavoidable cause it is essential that a lower altitude be maintained,

(b) The aircraft is engaged [in] operations of a nature which necessitates low flying and approval has been given by the Director either for all flights or for a specific flight [or flights to be made at a lower altitude, and the flight is in accordance with such conditions as the Director may prescribe],

[(c) The aircraft is being flown in an area designated by the Director for use as a low flying area by the operator of the aircraft and the flight is in accordance with such conditions as the Director may prescribe,]

(d) The aircraft is landing or taking off."

1.17.9 The Civil Aviation Regulations (1953) stated (in part):

"Regulation 56 Intoxicating Liquor and Drugs

(1) No crew member while acting in his official capacity shall be in a state of intoxication ... in which his capacity so to act would be impaired by reason of his having consumed ... any intoxicant ..."

1.17.10 Much information has been published for the benefit of pilots concerning the hazards of flying after the consumption of alcohol. Reference to this subject was included in the syllabus for the Private Pilot Licence examination.

1.17.11 Some deterioration of pilot performance was likely to occur even when relatively small concentrations of blood alcohol were involved. A commonly accepted guide suggested that a period of 12 hours after the consumption of any alcohol should be allowed to ensure no adverse effects were experienced as a result.

1.17.12 Civil Aviation Information Circular - Gen Series No. A5 dated 11 May 1987 contained the following information (reproduced in part only):

"6. Alcohol has similar effects to tranquilisers and sleeping tablets and may remain circulatory in the blood for a considerable time, especially if taken with food ...

10. Pilots should therefore not fly for at least eight hours after taking even moderate amounts of alcohol: larger amounts need a longer recovery period ..."

2. ANALYSIS

2.1 The flight path of ZK-HYX and any manoeuvres carried out by the pilot, after departing from Ardmore Aerodrome, remain unknown. The pilot had informed Ardmore Tower that he was proceeding to Whitford Forest and indicated that the duration of the flight would be about 20 minutes.

2.2 The Whitford Forest area was a reasonable choice for a brief introductory helicopter flight from Ardmore Aerodrome. The flight time in ZK-HYX to reach the area would have been little more than 5 minutes and although maximum altitude was restricted to 1500 feet amsl (if the pilot remained within Victor 1/S), general views of Auckland, the Waitemata Harbour, Rangitoto Island and other islands across Tamaki Strait were likely to be obtained.

2.3 The sparse habitation and the variety of terrain provided by bush-clad hills and gullies rendered Whitford Forest a convenient and suitable location for "confined area" helicopter training and basic mountain flying exercises from Ardmore Aerodrome. The pilot of ZK-HYX had undertaken some of his training in the area. It was probable that this provided an incentive for him to fly to this location, particularly if in addition to any scenic aspects of the flight he intended to demonstrate to his passenger some of the capabilities of the Robinson helicopter.

2.4 The hour meter installed on ZK-HYX provided evidence that the accident occurred within approximately 12 to 15 minutes of departure from Ardmore Aerodrome. There were no witnesses to the accident itself, nor any confirmed sightings of the helicopter, after it left the aerodrome. It was not practicable to determine whether the pilot had flown a short distance beyond the accident location and was returning over the area, or whether he had spent some minutes flying, possibly at a lower level, within the area itself, when the accident occurred. The elapsed flight time allowed for either possibility.

2.5 ZK-HYX had performed satisfactorily during a flight training sortie completed immediately before the accident flight and had given no indication of any impending problem. If any malfunction had occurred during the short flight to the Whitford Forest, the pilot had the option of returning promptly to Ardmore Aerodrome and/or informing the Tower regarding any such event.

2.6 The absence of any radio transmission from ZK-HYX advising of an in-flight emergency, or precautionary descent and landing, suggested that the accident occurred with little warning, allowing no opportunity for an RTF distress transmission and/or that the helicopter was operating at low level at the time.

2.7 Although only some 10 km from Ardmore Aerodrome, the terrain in the vicinity of the accident site was likely to have masked, or considerably reduced, the effectiveness of VHF transmissions from an aircraft or helicopter at low level in the area. Alternatively, irrespective of the helicopter's operating height, the pilot may have been occupied with an emergency to the extent that he was unable to initiate any radio transmission, particularly if he was attempting to maintain, or regain control of ZK-HYX following some unexpected occurrence.

2.8 The temperature and humidity at the time of the accident was conducive to serious induction system icing. If significant carburettor icing had resulted, undetected by the pilot, with a consequent marked loss of engine power or had a serious engine malfunction occurred due to mechanical or other failure, the pilot would have been obliged to carry out an autorotational descent and landing in the most suitable area, within reach. However the nature of the damage incurred, the distribution of the wreckage and the location of the accident site did not support such a scenario. On the contrary, the defined wreckage trail, extending over some 100 m suggested that ZK-HYX was in forward flight under power when separation of the tail boom and tail rotor drive shaft occurred.

2.9 Aerial inspection of the accident area confirmed that a significant section of the tailboom with the tail rotor assembly and the almost complete tail rotor drive shaft still attached, had separated from ZK-HYX and had

lodged in the upper part of a tree. An adjacent tree bore evidence of impact/ strike marks on a substantial branch. The outer sections of both tail rotor blades from ZK-HYX were dented, most likely as a result of contact with this tree. Leading edge damage which was confined mainly to one blade and the lack of evidence to indicate continued rotation suggested that this impact was sufficiently severe to have stopped the tail rotor within one to two revolutions.

2.10 The wreckage distribution and damage was consistent with an accident sequence involving a tail rotor strike, consequent failure of the tail rotor drive system and subsequent inflight loss of the tailboom and tail rotor assembly. As a result the pilot would have been deprived of directional control and the helicopter would have commenced rotating to the right.

2.11 The gyration of ZK-HYX, once developed, was likely to have disoriented the pilot. In these circumstances, at a low height above the trees, although he was likely to have closed the throttle, the pilot may have been reluctant to lower collective promptly. If the collective lever was not lowered immediately the main rotor rpm would have decayed rapidly in flight and ceased to provide any effective lift or drag to slow the helicopter's descent. The distribution of the wreckage and the final trajectory of the helicopter together with indications of low rotor rpm indicated that this was what occurred.

2.12 In the absence of witness information to describe the flight path and/ or manoeuvres carried out by the pilot of ZK-HYX immediately prior to the accident, no conclusive reason for the tail rotor strike was determined.

2.13 There was evidence that at least one main rotor blade had struck the helicopter's anti-collision light and its mounting at some stage of the accident sequence, before the aft section of the tailboom separated from the helicopter. This may have occurred as a result of distortion of the tailboom toward the main rotor disc at the time of the tail rotor strike, particularly if the helicopter was in a "flare" attitude with the rotor disc inclined aft and the tail low.

2.14 The tree struck by the tail rotor was located at the side of a small valley. If the pilot had chosen to operate at low level and was conducting a "quick stop" or similar manoeuvre within the confines of the valley system when the accident occurred, the tail low attitude presented in such a manoeuvre produced a potential for a tail rotor strike which would have increased considerably if either inadvertently or deliberately, the helicopter was permitted to descend. The distance covered in flight by ZK-HYX between the initial tree strike and ground impact suggested, however, that the helicopter's forward speed when the tail rotor strike occurred was likely to have been in the region of 25 knots or above.

2.15 The alternative possibility existed that the tail rotor strike occurred as a secondary event in the accident sequence. It was evident that if one or both main rotor blades had flapped downwards in flight and struck the anti-collision light and mounting, resulting control difficulties or pilot induced responses may have precipitated a subsequent tail rotor strike, especially if the helicopter was already operating close to the trees.

2.16 The Robinson Helicopter Company had issued Safety Notice number 24 (Appendix 1) warning pilots against the inherent dangers of "Low rotor rpm stall". The Safety Notice emphasised a feature of rotor stall in which the retreating main rotor blade may dive as it travelled aft while the advancing

blade was still climbing, leading to a rapid aft tilting of the rotor disc. As a result of this "rotor blowback", the nose-down pitch as the helicopter descends, and compensating aft cyclic input by the pilot, the main rotor blades were likely to contact and sever the tailboom, further compounding an already catastrophic situation.

2.17 The pilot of ZK-HYX could have been expected, at his level of training, to be aware of the necessity to maintain main rotor rpm within safe limits throughout all flight regimes, or to take prompt action to regain rotor rpm if he allowed it to decrease inadvertently. It was possible, however, that main rotor rpm may have decreased in flight to the extent that one or both blades flapped downward, struck the anti-collision light and mounting and led to a tail rotor strike, with the subsequent sequence of events as already described.

2.18 No reason was established during the investigation, for the pilot of ZK-HYX to have descended to a low level in the Whitford Forest area (below the minimum height permitted by Civil Aviation Regulations - see paragraph 1.17.3), or to have manoeuvred the helicopter in such a manner that there was risk of a main rotor or tail rotor blade strike at any stage of the flight. Previous accident history has indicated, however, that there is potential for an accident to occur when a pilot has decided during the course of a flight, either deliberately or on impulse, to operate at a low level, to demonstrate the versatility or manoeuvrability of an aeroplane or a helicopter, or to provide a close view of wildlife or natural features.

2.19 The cause of the accident to ZK-HYX could not be established with certainty. There were several factors however, which may have contributed directly to the occurrence of a tail rotor strike, or affected the pilot's handling of the helicopter and resulted in a subsequent tail rotor strike, if the pilot chose to operate the helicopter at a relatively low level in the area.

2.20 Almost all of the pilot's training had been undertaken on the Robinson R22 helicopter and he had accumulated a total of some 275 hours on the type. However, he had made only two flights, prior to the accident flight, within the preceding four months. Both of these flights were recorded as "scenic" flying. Lack of recent practice may have reduced his ability to perform certain manoeuvres with the precision to which he had been accustomed during training. There was a consequent risk of infringing any self-imposed vertical or horizontal margins of safety if he had elected to manoeuvre the helicopter within close limits of the bush clad valley.

2.21 The overall height of the bush canopy in the accident area varied significantly. Some trees, including those in which the tail rotor assembly and tail boom mid section had come to rest and the tree probably struck initially by the tail rotor, rose above the general bush cover in their vicinity. The pilot may have been misled by the terrain and assumed that a greater clearance existed from the trees beneath the helicopter, or to the side, than was actually the case.

2.22 Analysis of the reported weather conditions suggested that the prevailing north-east wind may have produced "moderate turbulence close to the hills with downdraughts in the lee of the ridges". While the conditions were suitable for a local scenic flight, it was apparent that some turbulence may have existed at low levels. The orientation of the wreckage trail indicated that the helicopter was proceeding in a downwind direction when the accident occurred.

In the event that ZK-HYX was being flown and manoeuvred close to the bush covered slopes of the valley, the aircraft may have been affected by an unexpected gust or downdraught which the pilot may have been unable to counter in sufficient time to prevent a tail rotor strike. Alternatively, in such conditions, the possibility existed that the main rotor blades were overpitched, or a cyclic overcorrection made, as the pilot attempted to maintain or regain a given flight path, which may have resulted in a main rotor blade striking the tailboom anti-collision light.

2.23 The pilot had consumed some wine during lunch on the day of the accident. The degree to which the resultant impairment of his judgement and awareness contributed to the accident could not be determined.

2.14 It was not practicable to conclude whether any of the foregoing factors, or a combination of some, or all, of them contributed to the accident.

3. FINDINGS

3.1 The pilot held a valid Private Pilot Licence (Helicopter) and a Type Rating for the Robinson R22 type.

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

3.3 No record was found to indicate that AD17A had been complied with, in respect of the helicopter's main rotor spindles.

3.4 Non-compliance with AD17A compromised the validity of the aircraft's Certificate of Airworthiness and Maintenance Release.

3.5 There was no indication of any pre-impact failure or malfunction of any component of the helicopter.

3.6 The pilot had only flown a helicopter on two occasions in the four month period prior to the accident.

3.7 The pilot had consumed alcohol within three hours of the accident flight.

3.8 The prevailing weather may have produced moderate turbulence close to the hills with downdrafts in the lee of the ridges.

3.9 During the flight one or both main rotor blades flapped downwards striking the anti collision light and its mounting.

3.10 While still in flight the tail rotor blades struck a tree branch.

3.11 The main rotor blade strike and the tail rotor blade strike resulted in structural damage to the tailboom and failure of the tail rotor drive shaft.

3.12 A complete loss of the tail rotor assembly, including the vertical and horizontal stabiliser and tailboom, occurred in flight.

3.13 The loss of the tail rotor assembly deprived the pilot of directional control of the helicopter and produced a nose-down trim change.

3.14 The main rotor RPM had reduced to the extent that the "low RPM" warning light was illuminated when ground impact occurred.

3.15 The loss of main rotor RPM in flight led to a rapid and uncontrolled descent.

3.16 The rapid descent made the accident unsurvivable.

3.17 The pilot had demonstrated a tendency to manoeuvre the aircraft in confined spaces with insufficient allowance for tail rotor clearance on an earlier occasion.

3.18 The probable cause of this accident was a decision by the pilot to descend the aircraft below the minimum approved height above the ground in order to demonstrate manoeuvres at which he had no recent practice. Contributing factors may have been local turbulent conditions and downdraughts and an erosion of his natural caution due to recent consumption of a modest amount of alcohol.

21 May 1991

M F DUNPHY
Chief Commissioner

APPENDIX

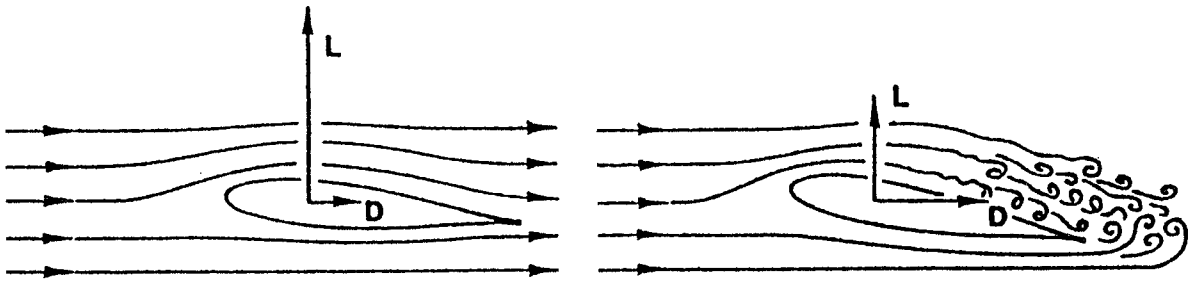
The Robinson Helicopter Company had issued R22 Safety Notice No. 24 (dated 8 September 1986), which was included in the Pilot's Operating Handbook carried on board ZK-HYX. This Safety Notice contained the following information:

"LOW RPM ROTOR STALL CAN BE FATAL

Rotor stall due to low rpm is still involved in more helicopter accidents, both fatal and non-fatal, than any other contributing factor. Frequently misunderstood, rotor stall is not to be confused with retreating tip stall which occurs only at high forward speeds when stall occurs over a small portion of the retreating blade tip. Retreating tip stall causes vibration and control problems, but the rotor is still very capable of providing sufficient lift to support the weight of the helicopter. Retreating tip stall has not been a problem with the R22.

Rotor stall, on the other hand, can occur at any airspeed and when it does, the rotor stops producing the lift required to support the helicopter and the aircraft literally falls out of the sky. Fortunately, rotor stall most often occurs close to the ground during take-off or landing and the helicopter only falls four or five feet. The helicopter is wrecked but the occupants survive. However, rotor stall also can and does occur at higher altitudes and when it happens at heights above 40 or 50 feet it is most likely to be fatal.

Rotor stall is very similar to the stall of an airplane wing at low airspeeds. As the airspeed of an airplane gets lower and lower, the nose-up angle or angle-of-attack of the wing must be higher and higher for the wing to produce the lift required to support the weight of the airplane. At a critical angle, (around 15 degrees or so) the airflow over the wing will separate and stall causing a sudden loss of lift and a very large increase in drag. The pilot recovers by adding power and diving the airplane to recover the lost airspeed.



Airplane wing or helicopter rotor blade unstalled and stalled

The same thing happens during rotor stall with a helicopter except it occurs due to low rotor rpm instead of low airspeed. As the rpm of the rotor gets lower and lower, the nose-up angle-of-attack of the rotor blades must be higher and higher to generate the lift required to support the weight of the helicopter. Even if the collective is not raised by the pilot to provide the higher blade angle, the helicopter will start to descend until the upward movement of air through the

rotor provides the necessary increase in blade angle-of-attack. Again at a critical angle, as with the airplane wing, the blade airfoil will stall resulting in a sudden loss of lift and a large increase in drag. The increased drag on the blades acts like a huge rotor brake causing the rotor rpm to quickly decrease even more, further increasing the rotor stall. As the helicopter begins to fall, the upward rushing air continues to increase the angle-of-attack on the slowly rotating blades making recovery virtually impossible even with full down collective.

When the rotor stalls it does not do so symmetrically because any forward airspeed of the helicopter will produce a higher airflow on the advancing blade than on the retreating blade. This causes the retreating blade to stall first allowing it to dive as it goes aft while the advancing blade is still climbing as it goes forward. The resulting low aft blade and high forward blade become a rapid aft tilting of the rotor disc sometimes referred to as "rotor blow-back". Also, as the helicopter begins to fall, the upward flow of air under the tail surfaces tends to pitch the aircraft nose-down. These two effects, combined with aft cyclic by the pilot attempting to keep the nose from dropping will frequently allow the rotor blades to blow back and chop off the tailboom as the stalled helicopter falls. Due to the magnitude of the forces involved and the flexibility of rotor blades, hub flapping stops will not prevent the boom chop. The resulting boom chop, however, is somewhat academic, as the aircraft and its occupants are already doomed by the stalled rotor before the chop occurs.

To prevent rotor stall and its catastrophic results the pilot must always do whatever is required to maintain a safe rotor rpm. It must take precedence over all other considerations, even if it means landing short in a swamp instead of trying to stretch your glide to the dry road beyond.

Remember the power output of the engine is proportional to rpm and when the rpm is low you have less power available from the engine with which to regain the lost rpm. The power-on low rpm recovery procedure of simultaneously rolling on throttle while lowering collective must be practiced until it becomes an automatic reaction to any indication of low rpm. Low airspeeds combined with high sink rates must always be avoided and full collective must never be pulled until the helicopter is within one foot of the ground."