TRANSPORT ACCIDENT INVESTIGATION COMMISSION
TE KOMIHANA TIROTIRO AITUA WAKA

NO. 93-001

ROBINSON R22 BETA

ZK-HCT

PALMER STREAM, SEAWARD KAIKOURA RANGE

38 KM WEST-NORTH-WEST OF KAIKOURA

11 JANUARY 1993

A B S T R A C T

The pilot was to fly the helicopter between two homesteads on a large property. Some two hours after his departure signals from an emergency location transmitter were received and the wreckage of the aircraft was located two hours later. The pilot lost his life in the accident. No cause was established for the accident.

TRANSPORT ACCIDENT INVESTIGATION COMMISSION

AIRCRAFT ACCIDENT REPORT NO. 93-001

Aircraft Type, Serial Number and Registration:	Robinson R22 Beta, 1517 ZK-HCT
Number and Type of Engines:	1 Lycoming O-320-B2C
Year of Manufacture:	1986
Date and Time:	11 January 1993, 0851 hours
Location:	Palmer Stream, Seaward Kaikoura Range, 38 km west-north-west of Kaikoura Latitude: 42°19'S Longitude: 173°15'E
Type of Flight:	Private
Persons on Board:	Crew: 1
Injuries:	Crew: 1 Fatal
Nature of Damage:	Substantial
Pilot in Command's Licence:	Private Pilot Licence (Helicopter)
Pilot in Command's Age:	41
Pilot in Command's Total Flying Experience:	More than 900 hours, all on type
Information Sources:	Transport Accident Investigation Commission field investigation
Investigator in Charge:	Mr D G Graham

All times in this report are NZDT (UTC + 13 hours)

1. NARRATIVE

1.1 The owner of Robinson R22 ZK-HCT had purchased the helicopter new in 1990 to assist in the development of a large property, Clarence Reserve Station, situated west of Kaikoura. This property included a wide area of mountainous terrain and extended across the inland Waiau-Kaikoura road, over the seaward Kaikoura Range to the Clarence River. The owner of ZK-HCT was the sole pilot and operator, and used the helicopter extensively for mustering purposes, and as a convenient means of personal transport to reach the remoter parts of the station. He frequently operated ZK-HCT from an outlying homestead at Quail Flat on the Clarence River, about 20 km north of the Clarence Reserve homestead.

1.2 On the day of the accident, after spending the weekend at Quail Flat, the pilot had departed in ZK-HCT at approximately 0700 hours. He was the only occupant of the helicopter, but had two dogs with him, carried in an aluminium dog box which was mounted temporarily on the left side skid supports. His precise flight route was not specified, but it was understood that he would be surveying various areas of the property, checking for cattle, before proceeding to the Clarence Reserve homestead. He was expected to arrive at the Station at about midday. At about the same time during the morning, a Nissan Patrol vehicle was to proceed from Quail Flat to the Clarence Reserve, following the overland four-wheel drive track.

1.3 At 0854 hours, Christchurch Area Control was advised that emergency location transmitter signals were being received by the crews of two airliners transitting the Kaikoura area. At 0908 hours the COSPAS/SARSAT system identified signals from an ELT in the region of the Clarence River/Seaward Kaikoura Range. The Rescue Co-ordination Centre in Wellington was activated, and at 1010 hours a rescue helicopter from Christchurch, carrying a winchman and two paramedics in addition to the pilot, was tasked to locate the source of the ELT transmissions.

1.4 At 1155 hours, the crew of the rescue helicopter observed the wreckage of ZK-HCT lying on its right side, at the edge of an open river flat of Palmer Stream, 1.7 km upstream from its junction with the Clarence River. The pilot had received fatal injuries. His body remained in the right seat of the helicopter, restrained by the diagonal/lapbelt harness which he was wearing. One of the dogs lay dead, 15 m to the west of the wreckage. The other dog, apparently uninjured, roamed nearby.

1.5 There were no known witnesses to the accident. The helicopter's electrically powered clock, which had stopped, indicated 0751 hours. Impact forces had dislodged the battery from its mounting in the engine compartment, resulting in broken connections, and this evidence, together with reception of ELT transmissions from ZK-HCT, first reported at 0854 hours, rendered it probable that the accident occurred at about 0851 hours. It was likely that the helicopter's clock had not been adjusted to show New Zealand Daylight Time, explaining the one hour discrepancy in its indication.

1.6 ZK-HCT was lying semi-inverted, on an easterly heading, some 45 m east of the Palmer Stream. It had fallen onto the stone strewn surface of a sparsely vegetated terrace, which was slightly above the shingle river flat. The floor of the valley in the area presented an unobstructed level expanse of river flats some 1.5 km long and 300 m wide, at about 1750 feet amsl. The valley was oriented north/south, and bounded on the east, west and south by ridges and mountains rising to more than 4000 feet. About 100 m north of the accident site a rocky bluff protruded across the end of the valley, forming a natural entrance to a narrow gorge through which Palmer Stream flowed before reaching the Clarence River. The mountainous terrain to the north rose to over 7000 feet amsl.

1.7 The cockpit of ZK-HCT, including the side doors and the forward transparencies, had been completely demolished. Portions of the left door lay 17 m to the south-west, and other small items including part of the left skid forward attachment and the lens from the rotating beacon, together with perspex fragments, were scattered in a wide arc around the fuselage and up to 25 m from it. The pattern of distribution indicated that these items had detached from the helicopter while it was still airborne, and supported the probability that it was rotating horizontally to the right before it struck the ground.

1.8 The absence of ground scars or any disturbance of the surrounding loose stones, and the extensive damage to its right side, indicated that the helicopter had fallen heavily on a steep descent angle and essentially had

remained where it first struck the ground. Both main rotor blades were still attached to the rotor head. One rotor blade was bent downwards while the other had been bent upwards just outboard of mid-span. The metal droop stop of the latter blade, which normally limited the downwards movement in the vertical (flapping) plane had sheared under overload. Damage to the blades was characteristic of low rotational energy at the time of ground impact.

1.9 Inspection of the wreckage established continuity of the cyclic and collective control circuits of ZK-HCT. The rotor head pitch links had bent before failing in overload. 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 to prevent or limit their operation prior to the accident.

1.10 Minimal impact damage had occurred within the engine compartment of ZK-HCT, and following an engineering inspection and some minor rectification an engine test run was carried out. The engine started and ran smoothly. All temperatures and pressures were normal. There was no evidence to suggest that an engine malfunction or defect had contributed to the accident.

1.11 The clutch actuator was in the fully engaged position. The over-running clutch operated satisfactorily when checked and no deficiencies were found in the lower drive bearing assembly. No significant information was obtained from the instrumentation. Switches and controls were in positions corresponding to normal flight. The collective pitch lever was approximately three-quarters of its travel to the fully up position. The throttle was half opened. The Hobbs meter indicated 859.9 hours.

1.12 The tailboom of ZK-HCT had been torn open approximately 1500 mm from its forward end, and remained attached to the fuselage solely by the tail rotor drive shaft and pitch change control rod, which were both bent approximately at right angles to the forward section of the tailboom. The upper vertical fin and horizontal stabiliser were skewed and flattened as a result of ground impact but both tail rotor blades were undamaged, indicating that the tail rotor had ceased rotating before the helicopter struck the ground.

1.13 One tail rotor blade had a dent in the leading edge 100 mm outboard of its hub attachment. The dent was 15 mm long, 8 mm wide and approximately 3 mm deep. The leading edge skin had cracked at the base of the dent. Microscopic examination of the dent failed to disclose any clue as to its origin.

1.14 Severe damage to the internal formers of the tailboom, and detachment of the hanger bearing and its bracket showed that the tail rotor drive shaft had been flailing and gyrating within the tailboom. The extent of damage inflicted suggested that it was being driven under power for an extended period while this occurred. Twisting of the pitch change rod and wiring wrapped around in the tailboom indicated continual rotation of the transmission drive at the time that external deformation of the tailboom took place. The flexible coupling (Part Number A947-2) aft of the over-running clutch, had failed in overload.

1.15 The empty dog box lay on the riverbed 96 m south of the main wreckage. The two leather straps which had held the lid closed were freshly broken and the lid was open. The location in which the dog box had come to rest suggested that it had separated from the structure while the helicopter was still at a significant height. Deformation of the forward end, including a deep dent bearing yellow paint smears, indicated that it had been forcibly struck by a main rotor blade.

1.16 Installation of the dog box, even on a temporary basis, constituted an alteration to the design of the helicopter as certificated and required approval from the Civil Aviation Authority. There was no evidence that the pilot had sought approval for this modification.

1.17 The dog box had been supported on two longitudinal aluminium tubes which were attached fore and aft to the left side skid cross-tubes of ZK-HCT using "U" brackets and hose clips. Bending and twisting of the rear brackets showed that the dog box assembly had tilted upwards and rearwards before separating. One of the forward hose-clips, and a fractured portion of the forward skid cross-tube to which the dog box had been clamped, was recovered in the wide arc of items distributed around the main wreckage. This evidence, and the position of the dead dog within the wreckage pattern, indicated that the dog box had been flung from the gyrating helicopter during the latter stages of the accident sequence.

1.18 Examination of ZK-HCT at the accident site disclosed severe damage to the left skid support structure which was unrelated to the inverted final impact. The left skid front support crosstube had been forced rearward and upward, and loads had been transmitted through the left skid rear support crosstube of sufficient magnitude to crack

and buckle the welded tube cluster at the attachment point. The damage was indicative of a heavy landing at some stage prior to the accident. In addition to the likelihood that a potentially disastrous tail rotor drive condition was induced by such an event (see paras 1.22 onwards), deformation and impact loads were likely to have weakened significantly or failed, the left skid front cross-tube. The forward tubes of the dog box assembly had been clamped to this member and its severe deformation or failure at this time provided a reasonable explanation for the subsequent in-flight separation of the dog box during the accident sequence.

1.19 The flight path of ZK-HCT and the occurrence of any manoeuvring, or landing, carried out after departure from Quail Flat remained unknown. It was likely however that the pilot had proceeded to an area of the property located to the south-west, which encompassed the headwaters of Palmer Stream, to survey the area for cattle which were to be brought out later in the week. In addition, it was probable that he had landed to inspect a cattle trap, located some 2 km upstream from the accident site, which was to be used during the cattle muster. It was considered likely that, during the morning, the pilot intended to return to the Quail Flat area and overfly the four-wheel drive route to check on the progress of the Nissan Patrol, which had exhibited engine problems earlier in the weekend.

1.20 The available evidence suggested that the helicopter was returning from the south-west, probably following Palmer Stream to proceed towards Quail Flat or to the eastern saddle which the Nissan Patrol was likely to be negotiating at about the time of the accident.

1.21 In the course of the flight some event occurred which caused the severe damage sustained by the left skid assembly of ZK-HCT. The cause of this damage could not be established. A search on foot and by air failed to disclose any sign of ground contact by ZK-HCT in the area of the accident site, but the dry, scrub covered and rocky nature of the surrounding slopes and flats rendered it impossible for any such search to be conclusive.

1.22 No reason was established to account for the dent in the leading edge of the tail rotor blade nor was it determined when this damage may have occurred. However, the severe damage to the skid structure which, by its magnitude, would have been apparent to the pilot immediately, was likely to have been of very recent origin. Engineering personnel confirmed that none of the damage existed at the time of the most recent Maintenance Inspection, a 50 hour check, carried out on 22 December 1992.

1.23 Shortly before the accident arrangements had been made for a 100 hour inspection to be performed on 13 January 1993 (two days after the accident) at the engineering facility where ZK-HCT was normally maintained. No information had been received from the pilot regarding damage which would have required repair or rectification at that inspection.

1.24 It was evident that either a heavy landing, or damage to a tail rotor blade, causing a sudden jolt to the installation, held potential for the long tail rotor drive shaft in the Robinson helicopter to run out of true. Experience had proved that subsequent "whipping", whether due to a bent shaft and/or overspeeding of the rotor, could result in substantial damage to the helicopter, loss of tail rotor control, and the likelihood of an accident.

1.25 This had been identified as a problem in the early history of the Robinson helicopter. Mandatory Service Bulletins Numbers 7, 20 and 21 were issued by the manufacturer which introduced special inspection of the tail rotor drive shaft and damper, and specified replacement with an improved design of shaft and a new aft flexible coupling by 31 August 1982. In addition to other provisions, Service Bulletin Number 20 required a special inspection of the shaft to verify its straightness following any suspect overspeed or hard landing.

1.26 ZK-HCT had been fitted with the improved type tail rotor drive shaft and flexible coupling at the time of its manufacture. However the potential for "whipping" of the shaft as a consequence of a hard landing or overspeed still applied, albeit to a lesser degree, in the case of the new type of shaft.

1.27 From the indications that ZK-HCT had been subject to a hard landing, or had otherwise sustained substantial damage to the skid structure, probably shortly before the accident, it was reasonable to conclude that the tail rotor drive shaft could have sustained some distortion.

1.28 If the terrain did not permit an immediate landing continued flight, to reach a suitable flat area, held a serious risk that "whipping" of the shaft would occur, leading to severe damage to the tailboom and possible complete loss of tail rotor control while still airborne. The damage observed within the tailboom of ZK-HCT, indicative of extensive and prolonged flailing of the drive shaft, suggested that this had occurred.

1.29 If initially power was maintained following a loss of tail rotor control, the helicopter would have commenced rotating to the right, and the continued gyration would have been likely to disorient the pilot. In such circumstances even if the throttle was reduced promptly, any delay in lowering collective could have caused the main rotor rpm to decay rapidly and led to "rotor blow-back" in which the rotor disc tilted aft and one, or both, main rotor blades flapped downwards sufficiently to strike the tailboom and other parts of the helicopter's structure. Previous accidents had shown that if the helicopter was at any significant height when it occurred, rotor blow-back had catastrophic consequences.

1.30 The evidence of in-flight damage to the main rotor blades and other components of ZK-HCT, the wreckage distribution pattern, and the probable final trajectory of the helicopter supported such a sequence of events.

1.31 The pilot/owner had commenced flying training in May 1990 and had obtained his Private Pilot Licence (Helicopter) in December 1990, some two months after purchasing ZK-HCT. Since that time he had flown ZK-HCT exclusively. The majority of his flying had taken place on Clarence Reserve Station. His Pilot's Logbook was not recovered but entries recorded in connection with the maintenance of ZK-HCT and the Hobbs meter readings enabled the hours he had flown during the last five months, and his total hours, to be calculated with reasonable accuracy.

1.32 He had flown some 850 hours total on ZK-HCT and an average of about 28 hours per month over the last four months. In the three weeks preceding the accident he had flown approximately 23 hours in ZK-HCT. Thus he was in current practice, and familiar with the helicopter's operating and handling characteristics under normal flying conditions. It was not known whether he had recently practised emergency procedures involving autorotational landings or simulated loss of tail rotor control. He had undertaken a Flight Test for the renewal of his Private Pilot Licence in April 1992 at which time he had demonstrated emergency procedures to the required standard.

1.33 The experience the pilot had obtained in operating ZK-HCT during the preceding two years in the mountainous terrain of the property, and in varied weather, including strong north-westerly conditions, should have rendered him aware of many of the pitfalls of flying the Robinson helicopter in the area, and enabled him to develop considerable skill in its handling.

1.34 The weather conditions in the specific location at the time of the accident were not established. At about midday, when the wreckage of ZK-HCT was located, the crew of the rescue helicopter reported clear skies, with a fluctuating and variable wind, intermittently calm, then gusty in excess of 15 knots. The crew experienced strong north-westerly conditions during their return flight from the area.

1.35 The South Island General Aviation Weather Forecast valid from 0400 to 1600 hours on the day of the accident provided the following forecast winds for the Christchurch and Nelson areas:

at 3000 feet amsl:	Nelson	275° / 33 knots
	Christchurch	275°/ 31 knots
at 5000 feet amsl:	Nelson and Christchurch	280°/ 37 knots
Turbulence:	Occasional moderate about and east of the main ranges. Isolated severe turbulence as per Sigmet.	

Sigmet Number 7 valid from 0628 to 1028 hours forecast isolated severe turbulence/downdraughts below flight level 120 (approximately 12000 feet amsl) about and east of ranges south of latitude 41°S. However, Sigmet Number 8, valid from 0808 to 1208 hours indicated that the isolated severe turbulence and downdraughts were likely to be limited to south of a line between Hokitika and Christchurch. This excluded the accident site.

1.36 At about 0900 hours a strong but decreasing westerly airstream covered New Zealand. A cold front lay over the southern part of North Island while a second front had just moved onto the south-west of South Island. In an aftercast of the situation, the Director of the New Zealand Meteorological Service commented:

> "Wind: The undisturbed wind flow is estimated to have been westerly about 15 knots at 1750 feet (the height of the accident). However because of the extremely mountainous nature of the surrounding terrain the winds at the accident site were likely to be very much different. It was probably too early in the day for convection to be taking place although katabatic effects may have ceased. It seems most likely that as atmospheric pressure was lowest towards the head–waters of the Clarence winds on the valley floor would have been upstream. That is they would probably have

been light northeasterly or northerly.

Turbulence: It is probable that there was little or no turbulence near the surface at that time of the day."

1.37 The aftercast suggested that, despite the prevailing westerly winds, the weather conditions were unlikely to have contributed to the accident. Nevertheless, the possibility could not be excluded that the many steep ridges and gullies surrounding the accident site may have influenced the conditions and produced unexpected local gusts or turbulence which, at the least, may have made it more difficult for the pilot to control or manoeuvre the helicopter with precision.

1.38 Although no definitive evidence was available to explain the initiating event(s) of the accident to ZK-HCT the probability existed that damage to the tail rotor blade set up a vibration, or induced other symptoms which were sufficiently alarming to prompt the pilot to make a landing without delay. Ensuing damage during such a landing, or resulting from a heavy ground strike while manoeuvring the helicopter was likely to have precipitated the final accident sequence if, as the evidence suggested, the pilot continued the flight in an attempt to reach a more suitable area.

1.39 The pilot had been assessed medically fit at the time of renewal of his Private Pilot Licence (Helicopter) in April 1992. Medical evidence indicated that he received injuries in the final impact that were unsurvivable. Post mortem examination revealed no indication to suggest that he was physically incapacitated prior to the accident. Toxicological analysis, however, disclosed alcohol levels of 5 mg%, indicative of previous significant alcohol consumption. This level of alcohol would not, of itself, have caused any significant impairment, however there may have been some "hang-over" effect from alcohol consumption the previous night.

2. FINDINGS

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

2.2 The pilot was in current flying practice and was experienced in operating the Robinson R22 helicopter type in the area.

2.3 The helicopter's gross weight was within the specified limits.

2.4 The dog box attached to the left skid assembly of the helicopter was not an approved modification.

2.5 One of the tail rotor blades had sustained leading edge damage prior to the accident.

2.6 A heavy landing or inadvertent ground contact had damaged the left skid support structure, and probably distorted the tail rotor drive shaft.

2.7 The tail rotor drive shaft showed evidence of "whipping" in flight.

2.8 Failure of the tail rotor drive deprived the pilot of directional control of the helicopter.

2.9 Decay of main rotor rpm in flight led to the main rotor blades flapping downwards to strike the tail boom and other parts of the structure resulting in a rapid and uncontrolled descent.

2.10 The rapid descent rendered the accident unsurvivable.

2.11 The factor(s) which initiated the accident were not determined. Probable contributing factors included pilot disorientation following an in-flight loss of tail rotor control and decay of main rotor rpm while the helicopter was at a significant height above the ground.

9 August 1993

M F Dunphy
Chief Commissioner