Report 08-005, Kawasaki-Hughes 369D, ZK-HWE, un-commanded yaw and loss of control, Maori Saddle, near Haast, Westland, 11 August 2008

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Report 08-005

Kawasaki-Hughes 369D
ZK-HWE

un-commanded yaw and loss of control

Maori Saddle, near Haast, Westland

11 August 2008

Executive Summary

On 11 August 2008, a Kawasaki-Hughes 369D helicopter, registered ZK-HWE, departed Haast in support of a Department of Conservation track-maintenance task. On board were 3 track workers, the pilot and over 150 kilograms of equipment. The pilot had flown a similar series of flights during the previous week.

The first planned landing was at the Maori Saddle Hut, which was surrounded by high trees that restricted the approach direction. During the final approach, there was a tail wind in the range of 11 knots to 21 knots. Nearing the landing site, the pilot brought the helicopter to an out-of-ground-effect hover, where it started an un-commanded right yaw. The pilot attempted to correct the yaw, but the helicopter struck a tree and fell to the ground. There was no fire, but one passenger and the pilot received serious injuries.

The investigation found the pilot had been complacent in regard to the following aspects of flight preparation:

- not being fully involved with the loading of the helicopter, which meant he did not assess the accuracy of the cargo weight
- not ensuring that the shoulder harnesses were accessible and worn by the occupants
- not determining that the passengers were familiar with the safety briefing.

The investigation determined that the helicopter's engine and flight controls were operating normally, and found no evidence that a technical malfunction contributed to the accident. The helicopter was heavily loaded, but not overweight, and the flight manual charts showed that it had the performance capability to hover out of ground effect at that altitude.

The investigation determined that the un-commanded yaw and loss of control resulted from the approach being attempted under conditions that were noted in the flight manual to be conducive to a loss of tail rotor effectiveness.

The precipitating factors for a loss of tail rotor effectiveness can occur singly or in combination, and several were present. The most significant were the weathercock stability and the loss of translational lift during a downwind approach, and the high power demand as the helicopter came to a hover.

The Transport Accident Investigation Commission identified no systemic issue that contributed to the accident, and made no safety recommendations.

Kawasaki-Hughes 369D, ZK-HWE
(photograph courtesy of Heliventures Limited)

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Abbreviations

CAA	Civil Aviation Authority
CAR	Civil Aviation Rule(s)
Commission	Transport Accident Investigation Commission
DOC	Department of Conservation
ft	feet
GPS	global positioning system
kg	kilogram(s)
km	kilometre(s)
kt	knot(s)
lb	pound(s)
LTE	loss of tail rotor effectiveness
m	metre(s)
RPM	revolution(s) per minute
UTC	co-ordinated universal time

Glossary

collective lever	the pilot's control that changes the pitch of all the rotor blades equally and simultaneously, and consequently, the amount of thrust or lift generated
cyclic stick	the pilot's control that changes the pitch of each rotor blade individually as it rotates through one revolution, which causes the rotor disc to tilt and consequently changes the direction of horizontal movement
density altitude	the altitude in the standard atmosphere at which the air density would be equal to that at the place of observation. In general, as density altitude increases, aircraft performance decreases
flare	to incline the rotor disc rearwards so that the rotor thrust acts to decelerate the helicopter
ground effect	a condition of improved performance owing to the airflow through the rotor disc combining with the cushion of higher-pressure air over the surface below the helicopter
hectopascal	the pascal is the unit of pressure in the International System of Units. A hectopascal is 100 pascal
translational lift	an improvement in performance caused by increased airflow across the rotor. The effect is present over an airspeed range of approximately 15-25 knots
yaw	movement about the helicopter vertical axis

Data Summary

Aircraft registration:	ZK-HWE
Type and serial number:	Kawasaki-Hughes 369D, 6701
Number and type of engines:	one Rolls-Royce (Allison) 250-C20B turboshaft
Year of manufacture:	1977
Operator:	Heliventures Limited
Date and time:	11 August 2008, 1106[1]
Location:	Maori Saddle, near Haast, Westland latitude: 43° 48.8´S longitude: 169° 16.4´E
Type of flight:	commercial transport operation
Persons on board:	crew: one passengers: 3
Injuries:	crew: one serious passengers: one serious, one minor
Nature of damage:	substantial
Pilot's licence:	commercial pilot licence (helicopter)
Pilot's age:	39
Pilot's total flying experience:	about 1466 hours total, and 350 hours on type
Investigator-in-charge:	P R Williams

[1] Times in this report are New Zealand Standard Time (UTC + 12 hours) and are expressed in the 24-hour format.

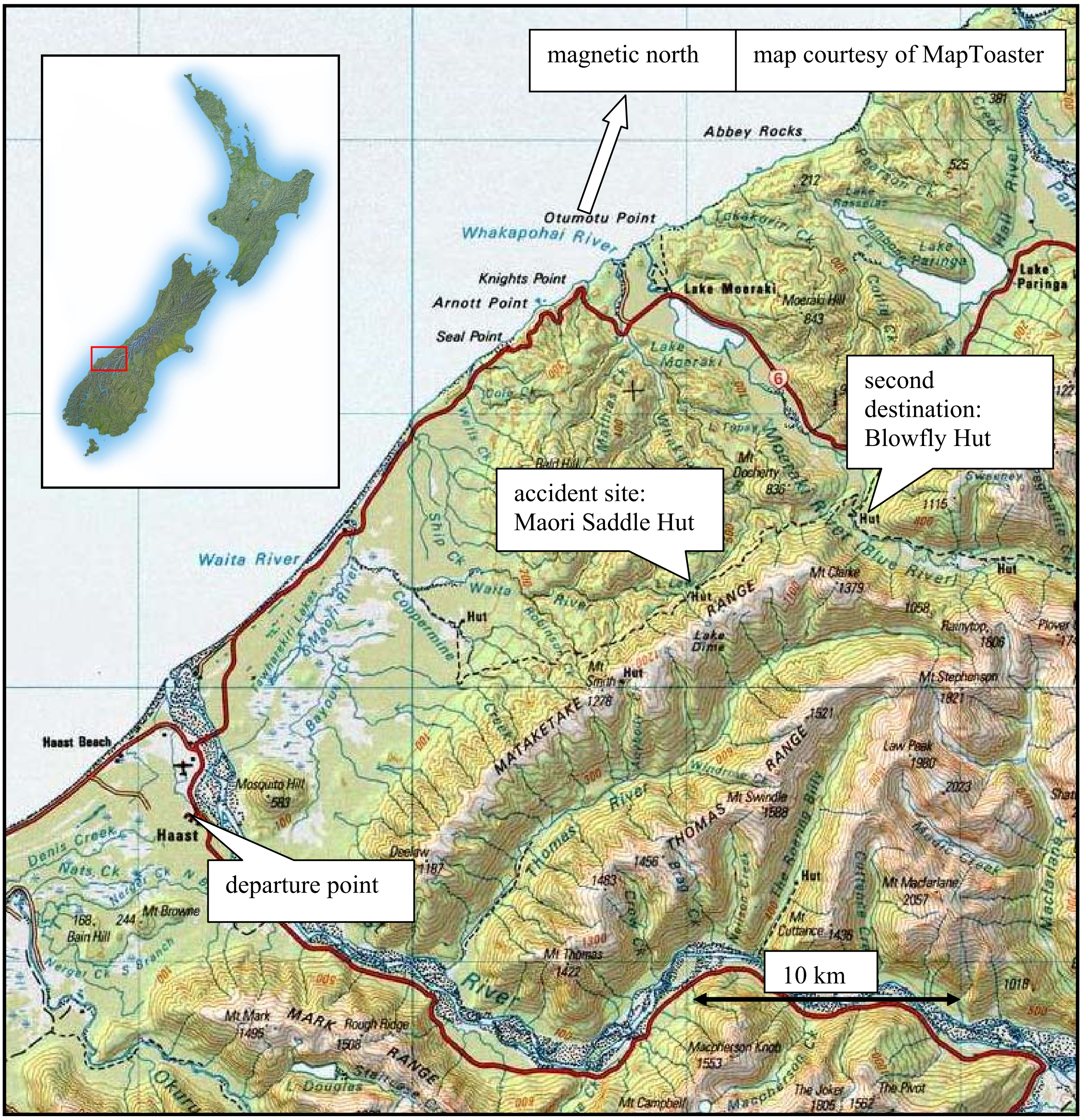

Figure 1
Accident location

1 Factual Information

1.1 History of the flight

1.1.1 At about 0800 on 11 August 2008, the pilot of a Kawasaki-Hughes 369D[2] helicopter, registered ZK-HWE, arrived at his Haast base for a planned flight at 0900 in support of a Department of Conservation (DOC) task. DOC staff contacted the pilot soon afterwards and advised that the departure was delayed until 1100.

1.1.2 The task was to fly 3 track-maintenance workers and their equipment to the Maori Saddle Hut, about 20 kilometres (km) north-east of the departure point, and other supplies to the Blowfly Hut, a further 6 km north-east (see Figure 1). In the previous week, the pilot had flown an almost identical task for DOC, including taking the same workers to the Maori Saddle Hut. The pilot said that he had landed at that site many times before.

1.1.3 The DOC workers met the pilot at about 1045 then loaded the rear cabin of the helicopter and the external cargo pod mounted beneath, while the pilot carried out other preparations. DOC had advised the load details to the operator the previous day, but the workers thought it was unusual that the pilot did not involve himself fully with the loading so that he could check the weight of items. The pilot told the Transport Accident Investigation Commission (the Commission) that he did load most of the cargo and its weight was not an issue. However, he later told a DOC investigation into the accident that he thought the equipment weighed more than the 150 kilograms (kg) advised by DOC.

1.1.4 The pilot said that he put about 200 pounds[3] (lb) (91 kg) of fuel into ZK-HWE, but this could not be verified because the operator did not keep a record of the fuel uplifts for its helicopters. The pilot completed the load sheet and flight-following[4] details per the operator's procedures.

1.1.5 Shortly before 1100, the helicopter took off into what the pilot described as a reasonable northerly wind. He said he required about 70% to 75% power[5] to hover. The pilot sat in the usual front-left seat, and 2 workers sat in the front-centre and right seats. The third worker was seated behind the pilot in the rear cabin.

1.1.6 The workers noted that a low height was maintained for much of the climb towards Maori Saddle. En route, they encountered light turbulence and gustiness, and the pilot commented that the global positioning system (GPS) suggested that there was a 30 knot (kt)[6] headwind, but neither he nor any of his passengers noticed any sign of a wind that strong on the trees.

1.1.7 The Maori Saddle Hut and adjacent landing pad were just north of the Saddle, in a basin with dense undergrowth and surrounding trees up to 20 metres (m) high (see Figure 2). The pilot flew overhead the Hut, with the pad on his left side so that he could assess its condition, then made a descending left turn to approach from the north-east. He said he was aware that the approach would be down wind, and that he correlated the airspeed with the GPS ground speed.

1.1.8 The pilot said the operator had advised that the pad could only be approached from the north-east. He said that he normally chose a decision point where he would commit to the landing or else abandon the approach, but he did not do so this time. The landing site met the minimal Civil Aviation Rule (CAR) requirements for remote helicopter landing sites[7].

[2] Although Hughes had not manufactured the model 369 helicopter since 1984, and the type certificate, after several changes, was now held by MD Helicopters, Inc., the model 369 was commonly referred to as a Hughes 500.
[3] The pound was the unit of weight used in the flight manual.
[4] Advice of the flight details and expected completion time, after which, if no contact had been received from the aircraft, search and rescue action would be initiated.
[5] The primary power reference for the Hughes 500 was the torque gauge, with units expressed in pounds per square inch, not as a percentage. The upper limit of the normal power range was 82 pounds per square inch.
[6] One knot or nautical mile per hour is approximately 0.5 metre per second.
[7] CAR 91.127, Use of aerodromes.

Figure 2
Maori Saddle Hut and pad, and approximate final approach path

1.1.9 The DOC workers said that on the flights to the Maori Saddle pad the previous week, they had felt some unease because the pilot had seemed nervous and under-confident, and he had mentioned that he had not flown recently and did not like landing at the Maori Saddle pad. However, because the flights had been uneventful and the workers knew of other pilots who did not like the pad, they did not feel inclined to report their unease to DOC or the operator.

1.1.10 The final approach angle was shallow, such that the pilot said he did not see the Hut or pad again until he crossed the trees around the western side of the site. One front-seat passenger described the helicopter "pulling up" to slow down on the final approach. The pilot flew between some high trees and kept the helicopter pointed slightly to the right so that he could see the pad.

1.1.11 The pilot said that he was still over trees and using about 80% power as the airspeed decreased to zero. He did not recall the shudder felt usually when passing through the speed range of translational lift. The pilot had begun to descend towards the pad when the helicopter began yawing to the right. He attempted to counter the right yaw with further left pedal, but the helicopter spun quickly to the right and completed one turn before momentarily stopping. The workers had differing recollections of the spin direction, but they all said the spin was very fast.

1.1.12 The pilot attempted to recover the situation by reducing the left pedal input and using the cyclic control to fly away in the direction of the turn. The helicopter drifted towards trees, so he raised the collective lever a small amount in an attempt to clear them. The helicopter then spun suddenly, perhaps 2 or 3 times, before hitting a tree, nosing forward and tumbling to the ground. The pilot did not notice the engine parameters as he lost directional control, but at some point the low-rotor RPM (revolutions per minute) alarm sounded. He had no time to warn his passengers to brace.

1.1.13 The accident occurred at approximately 1106, at an elevation of 2000 feet (ft) (610 m).

1.1.14 The pilot and the passenger in the front-right seat each suffered a fractured leg, and the other front-seat passenger received minor cuts and bruising. The third passenger was not injured. All the passengers got out of the wreckage, but the pilot remained in his seat until rescuers arrived.

1.1.15 The engine wound down immediately, but the hot exhaust pipe, which was buried in the wet, mossy ground, generated steam and a smell that, along with leaked fuel, led to fears of a fire. The workers discharged the helicopter portable fire extinguisher into the exhaust space.

1.1.16 At about 1110, one of the workers made an emergency radio call to the DOC Haast office, which alerted Police. About 70 minutes after the accident, rescuers from Haast arrived by helicopter. A dedicated rescue helicopter and medical team from Greymouth arrived about 20 minutes later. The 2 helicopters shared the landing site.

1.1.17 The emergency locator transmitter fitted to the helicopter activated and remained on for approximately 90 minutes until switched off by rescuers. However, the Rescue Coordination Centre reported that no signal was received by the satellite-based detection system.

1.2 Wreckage and impact information

1.2.1 The helicopter came to rest in dense undergrowth, pointing upwards, at the base of a tree that was approximately 15 m high and had a few high branches broken (see Figure 3). All of the wreckage was located within a radius of about 8 m of this tree, which was about 35 m from the intended landing site. No evidence of prior rotor strike was found outside that area.

1.2.2 The hit tree was among scattered trees of similar height, and was not easily seen against the bush background. The helicopter had approached from the western side of the valley, whereas the surrounding trees were lower when approaching the pad from the centre of the valley.

1.2.3 The forward end of the cargo pod was broken open and its contents were spilled very closely around the wreckage, which indicated that the helicopter had fallen nearly vertically through the trees. Rain since the accident had wet most of the cargo, especially personal packs.

1.2.4 The main rotor blades were destroyed, with 3 of the 5 blades stacked and the retention straps on some blades pulled apart. This damage was indicative of the rotor having been driven by the engine when the first blade impacted. The continuity of the main rotor controls was established.

1.2.5 The tail boom, which was completely detached and lying adjacent to the fuselage, had been hit multiple times by the main rotor blades. The T-tail assembly, including the tail rotor, was nearby and largely undamaged. The tail rotor turned freely and quietly, and the gearbox oil level was full. The tail rotor and stabiliser surfaces had minor damage, consistent with low-speed impacts with trees. The break in the tail rotor drive shaft had occurred while the shaft was being driven. The continuity and proper functioning of the tail rotor controls were confirmed as far as the wreckage allowed.

1.2.6 The passengers did not hear or see anything unusual prior to the sudden spin and the pilot said that he had no concerns for the engine operation, which had been normal until the helicopter hit a tree. It was after that that he had heard the low-rotor RPM warning. The collective lever was found fully raised. The twist-grip throttle was fully open and the pointer at the fuel control unit was consistent with that. Because there was no concern for the engine performance, it was not further examined.

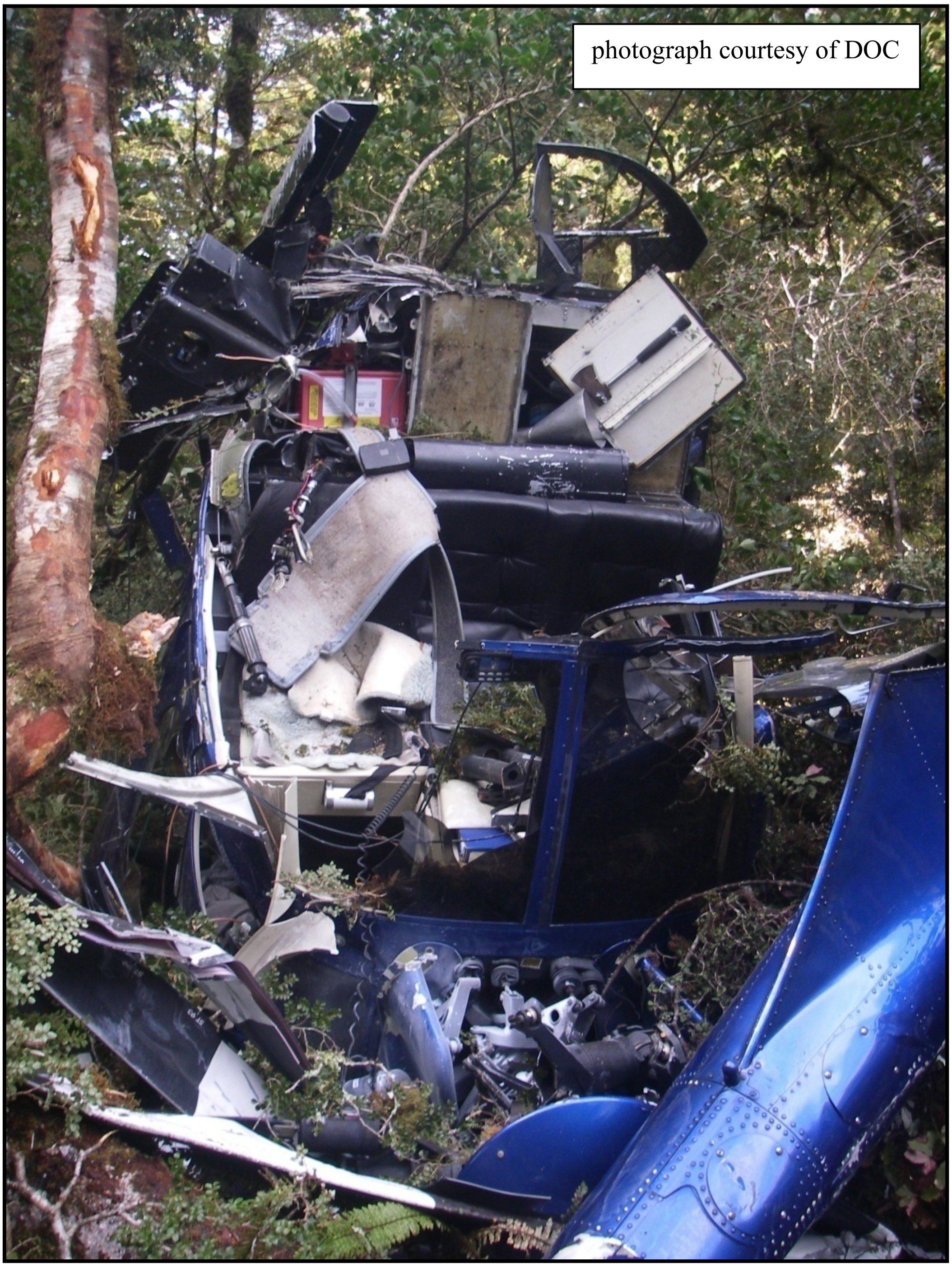

Figure 3
Wreckage of ZK-HWE

1.2.7 Although the cabin retained its protective shape, the front left of the cockpit had taken a heavy impact. The cyclic stick was broken at its base, which the pilot said he thought was caused by his pushing against the stick, during the tumble, to prevent receiving a severe chest injury.

1.2.8 The instrument panel was dislodged and the instrumentation offered few reliable readings. All circuit breakers were made, the emergency locator transmitter was in the armed position, and the battery and auto re-ignition switches were OFF. The altimeter sub-scale setting was 1014 hectopascal.

1.3 Personnel information

1.3.1 In August 2002, the pilot obtained a private pilot licence (helicopter). He obtained a type rating for the Hughes 500 model in November 2002. On 13 March 2003, on his third attempt, he passed the flight test for, and was later issued with, a commercial pilot licence (helicopter).

1.3.2 The pilot said that tail rotor emergencies, including loss of tail rotor effectiveness (LTE), had been covered during his training. As a commercial pilot, he had experienced a few LTE situations, usually when operating at higher altitudes, but he had always had an escape route available that allowed him to fly away and to attempt the intended manoeuvre differently.

1.3.3 The pilot had been employed as a casual pilot by the operator between October 2003 and early 2006. In January 2004, he had obtained a category C helicopter flight instructor rating and set up a small helicopter training organisation under appropriate instructional supervision. In May 2008, after the Civil Aviation Authority (CAA) had queried his compliance with the CAR for flight training, he did not renew his instructor rating. The operator then employed him again and approved him to self-authorise tasks and operate without restriction.

1.3.4 On 29 January 2008, the pilot completed an annual competency check in a Hughes 500. He had logged a total of 1467 flying hours up to the day of the accident, with an estimated 350 hours on the Hughes 500 model[8]. He had flown about 126 hours in the first 5 months of 2008, and 10 hours between 1 June 2008 and the day of the accident.

1.3.5 His most recent Hughes 500 flights, and his first since 4 June 2008, were the DOC tasks on 5 and 8 August, totalling 3.2 hours. He had flown a further 2.3 hours in a Robinson R44 in the week prior to the accident, but had not flown on the 2 days prior to the accident.

1.3.6 The pilot held a class 1 medical certificate, which was valid until 20 March 2009, with no conditions, restrictions or endorsements. He said that he had been fit to fly on 11 August 2008.

1.4 Helicopter information

1.4.1 The Kawasaki-Hughes 369D was a 5-seat turbine-powered helicopter manufactured in Japan by Kawasaki Heavy Industries Limited under licence from Hughes Helicopters of the United States. The accident helicopter was manufactured in 1977 and imported into New Zealand in 1999 and registered as ZK-HWE. The operator took possession of the helicopter in May 2002.

1.4.2 The Hughes 500 had a 5-bladed main rotor that rotated anti-clockwise when viewed from above. The main rotor pitch controls were the conventional collective lever and cyclic stick. The torque of the main rotor was countered by the thrust of a 2-bladed tail rotor (in the case of ZK-HWE), the pitch of which was controlled with yaw pedals.

1.4.3 The flight manual, in the section that provided in-ground-effect hover ceiling data[9], noted that:

> Controllability during downwind hovering, sideward and rearward flight has been demonstrated to be adequate in winds up to 17 kt.

However, the manual also noted that the out-of-ground-effect hover ceiling and directional controllability had not been determined for winds greater than 3 kt[10].

[8] The totals are estimated because the pilot said that his original log book had been stolen in May 2007.
[9] MD500D Rotorcraft Flight Manual, section V, Performance Data.
[10] MD500D Rotorcraft Flight Manual, section VIII, Additional Operations and Performance Data.

1.4.4 Under "Low speed manoeuvring" the flight manual included the following advice[11]:

> Manoeuvres that exceed thrust capability of the tail rotor should be avoided.
>
> NOTE: Conditions where thrust limits may be approached are: high density altitude, high gross weight, rapid pedal turns, and placing the helicopter in a downwind condition. These conditions may exceed the thrust capability of the tail rotor.

1.4.5 ZK-HWE was issued with a non-terminating airworthiness certificate, provided the helicopter was maintained (and operated) in accordance with CAR and pertinent limitations. A review of the helicopter log books showed that the helicopter had been maintained in accordance with the operator's manuals. The helicopter had been last flown on the day before the accident, by a different pilot, and had then accrued 7628.2 flight hours. The next scheduled maintenance events were a 100-hour check due in 80.3 hours and a tail rotor swash plate re-grease due on 6 October 2008. The next annual review of airworthiness was due on 29 November 2008.

1.4.6 The engine was manufactured in 1978 and had accrued 5931.2 hours and 8585 cycles by 10 August 2008. A review of the engine log book showed that the engine had been maintained in accordance with the operator's manuals. The most recent maintenance had been a 100-hour inspection completed on 11 July 2008 that included an engine performance check. The next scheduled maintenance was due in 80 flight hours.

1.4.7 In the event of an engine failure or rapid reduction in power, the helicopter would yaw to the left, which would require the pilot to apply right tail rotor pedal in order to keep straight. The helicopter was fitted with an engine failure warning system and a low-rotor-speed warning system, each of which gave aural and visual indications.

1.4.8 The weight and balance data sheet, calculated on 9 January 2008, recorded the basic weight for ZK-HWE as 1514.7 lb (687 kg). That weight included the extended landing gear and cargo hook, but not the external cargo pod, which weighed 70 lb (32 kg).

1.4.9 The load sheet completed for the accident flight had the basic weight of ZK-HWE shown as 1544 lb (700 kg). As completed for the accident flight, the load sheet used the passenger and cargo weights provided by DOC the previous day. However, the DOC investigation found that the cargo weight was the same as that from the similar flight the previous week, and suggested the actual cargo weight on the accident flight could have been up to 234 lb (106 kg) more. CAR required that 4 kg (9 lb) be added to each passenger-declared weight, but that was not done.

1.4.10 The cargo was removed from the wreckage the day after the accident and the personal gear weighed back at the operator's base. The weight of fuel in plastic containers was calculated. A nominal 10% of the wet weight, 31 lb (14 kg), was deducted to give an estimated total weight of cargo loaded onto the helicopter at Haast of 182 kg (401 lb). After applying these corrections, the take-off weight of the helicopter was estimated to have been 2916 lb (1323 kg), compared with the certificated maximum weight of 3000 lb (1361 kg). The centre of gravity was estimated consequently to have been within flight manual limits.

1.4.11 After deducting the fuel burn on the short flight to Maori Saddle, the helicopter weight at the accident site was estimated to have been 2900 lb (1315 kg). Reference to the flight manual showed that at that weight, the helicopter should have been able to hover out of ground effect at an altitude more than 6000 ft (1828 m).

1.4.12 A TracPlus GPS was installed in ZK-HWE. However, the operator's selected sampling rate was too low to allow the turning flight path in the vicinity of the accident site to be determined.

1.4.13 A 406-megahertz emergency locator transmitter was installed in July 2008. The single antenna was located above and behind the passenger cabin.

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[11] MD500D Rotorcraft Flight Manual, section IV, Normal Procedures.

1.5 Meteorological information

1.5.1 On 11 August 2008, a ridge of high pressure lay over most of the country, ahead of a complex depression west of the South Island. The south Westland region was affected by north-east winds and patchy rain associated with some fronts. The temperature and air pressure at Haast at mid-day were about 11^{o}C and 1013 hectopascal respectively.

1.5.2 The pilot said that looking up from the wreckage he saw the tree tops moving and that there had obviously been a tail wind. Apart from the worker who made the emergency radio call and reported that the wind was calm where he was, the passengers had no clear recall of the wind at the site, although one said he thought the wind was from the west as they flew to the Hut. The pilot of the Greymouth rescue helicopter said it was quite a nice day when he arrived at the site, with a light southerly wind.

1.5.3 The modern Beaufort Scale describes the following effects for the selected wind speeds[12]:

Beaufort Number	Speed range (kt)	Description	Visible effects
3	7-10	gentle breeze	leaves and smaller twigs in constant motion
4	11-15	moderate breeze	small branches begin to move
5	16-21	fresh breeze	smaller trees sway

1.6 Medical and survival aspects

1.6.1 The operator's pro forma that was faxed to DOC requesting details of the passenger and cargo weights also included a safety briefing sheet, which the operator expected that intending passengers would read before the flight. The DOC workers had not read the briefing sheet, but were familiar with a comprehensive guide to helicopter safety that DOC had published for its staff. The operator's safety briefing included the following comment:

> The location of the axe, fire extinguisher and survival equipment (where applicable) will be indicated to you upon entering the aircraft prior to lifting off.

1.6.2 The pilot did not give the workers a safety briefing prior to any of the flights, or confirm their understanding of the briefing on the pro forma, or point out the location of emergency equipment carried on board. CAR allowed a passenger safety briefing to be given, under certain conditions, by other persons or means, and a briefing could be omitted if the pilot-in-command determined that all the passengers were familiar with the contents of the briefing[13].

1.6.3 The pilot and the passenger in the front-right seat each suffered a fracture to the leg closest to their respective side of the helicopter. The fractures were likely caused by the intrusion of tree branches during the impact sequence. The first aid kits that were on board the helicopter were not found by the passengers, so they used DOC kits from the nearby hut.

1.6.4 DOC reported that the 2 passengers who received minor injuries were not assessed medically before leaving the scene. DOC resolved that, in future, any staff who were involved in a vehicle accident would be required to have a medical assessment before leaving the scene.

1.6.5 One of the pilot's required pre-start cockpit checks was to ensure that seat belts and shoulder harnesses were properly fitted and fastened. All of the occupants had fastened their seat lap belts. The front seats were fitted with shoulder harnesses with operable inertia reels, but the shoulder straps had been tucked behind the seat-back cushions.

[12] http://www.metservice.co.nz/public/staticResources/Winds_poster_webVersion.pdf, accessed 27 July 2009.
[13] CAR 91.211, Passenger briefing.

1.6.6 The pilot said that he habitually did not wear a shoulder harness, because it hindered his movement when engaged in venison shooting or recovery flights, and he thought it was common for pilots to not wear shoulder harnesses. He said he was not aware that CAR required him and the front-seat passengers to wear the shoulder harnesses fitted to the helicopter[14].

1.6.7 On 18 December 2008, the Commission advised the Director of Civil Aviation of the following:

> The Commission has determined that there is evidence that the purpose of approved seats and berths and the value of seat belts in helicopters are not understood or are disregarded, and that in some operations there could be a culture of non-compliance with [CAR] relating to passenger restraint. The Commission recommends that the Director of Civil Aviation addresses this safety issue[15].

The CAA advised then that it had no issue with the recommendation, but has yet to advise what action had been taken.

1.6.8 After this accident, the CAA advised that its surveillance of the industry led it to believe that non-compliance with these CARs was uncommon.

1.6.9 The DOC workers had a number of radios for their own purposes. DOC had established procedures for flight-following and emergencies, which had been recently exercised in the Westland region in a scenario that had involved the Haast office. Both DOC and the helicopter operator responded promptly once notified of the accident.

1.6.10 The post-impact attitude of the helicopter had put the emergency locator transmitter antenna down into moss and debris, rather than in the optimum upright position for satellite reception.

1.7 Organisational and management information

1.7.1 The operator was a family-owned and -run company with a long history of helicopter operations in south Westland. In April 2008, a court decision led to the operational management team stepping aside and to the appointment of an interim Chief Pilot.

1.7.2 The interim Chief Pilot did not live in Haast and, although he knew the accident pilot, he had not flown with him before the accident. The interim Chief Pilot said that he did not know the Maori Saddle pad and he was unaware of the detail of the DOC tasks, in part because the previous management team had been in Haast at the time and had provided some operational oversight. He had not heard of any DOC concern for the pilot's level of skill or confidence, and felt that many of the region's landing sites could be described, like Maori Saddle, as difficult to operate into.

1.7.3 The accident pilot said that he had flown into the Maori Saddle pad with the previous Chief Pilot within the previous 6 months. During the period of the DOC tasks in August 2008, both the previous Chief Pilot and his father, who had vast experience as a helicopter pilot, had discussed the tasks with the pilot. They had advised the pilot to descend directly to a touchdown when he had a tail wind, rather than terminate the approach in a hover first.

1.7.4 DOC had previously used the operator as a preferred supplier of helicopter services, but had discontinued the contract in October 2007. On 28 July 2008, DOC and the operator signed a new contract that approved the interim Chief Pilot and the accident pilot only for DOC tasks.

1.7.5 The CAA advised that, as at 1 July 2009, the operator had suspended operations.

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[14] CAR 91.205, Crew members at stations, and CAR 91.207, Occupation of seats and wearing of restraints.
[15] Report 06-007, Kawasaki-Hughes 369HS, ZK-HDJ, collision with terrain, Mt Ruapehu, 11 December 2006, Safety Recommendation 035/08.

1.8 Additional information

1.8.1 LTE is an aerodynamic characteristic that can occur at airspeeds less than 30 kt on any single-rotor helicopter that has a tail rotor to counteract the torque of the main rotor[16]. If the required tail rotor thrust is not available, the pilot will find it difficult to maintain the desired heading and the helicopter will yaw, to the right in the case of the Hughes 500. A prepared pilot will know that LTE is a normal operating limitation and will plan and conduct the flight so that control is maintained. Planning should include having an escape route identified.

1.8.2 LTE can be encountered at any altitude if conditions are unfavourable, and in some cases can lead to a rapid yaw and loss of control[17].

1.8.3 Conditions that demand a high main rotor driveshaft torque, such as high helicopter mass and hovering out of ground effect, will require increased tail rotor thrust and therefore decrease the margin before LTE might occur. A decrease in main rotor RPM, such as a transient power droop caused by a rapid power application, will reduce the tail rotor thrust and therefore reduce the ability to counter any yawing tendency.

1.8.4 The following conditions increase the potential for LTE:

- weathercock stability, when the relative wind is more than about 5 kt within a sector 60^{o} either side of the tail
- tail rotor vortex ring state, when the relative wind is more than about 7 kt and from the left between 210^{o} and 330^{o} relative to the heading
- main rotor disc vortex interference, when the relative wind is more than about 10 kt from the left between 285^{o} and 315^{o} relative to the heading
- loss of translational lift (all directions), which affects both main and tail rotors.

1.8.5 The conditions that can lead to LTE can act singly or in combination. Avoidance of LTE requires a pilot to have an accurate appreciation of the wind speed and direction, and to:

- avoid tailwinds when the airspeed is below 30 kt, as loss of main rotor translational lift increases the power demand and therefore the anti-torque requirement
- maintain maximum rotor RPM, as tail rotor effectiveness is directly proportional to RPM
- avoid out-of-ground-effect operations when airspeed is below 30 kt, because of the higher power demands
- be attentive to directional control when hovering in winds of about 8-12 kt, as the loss of translational lift may go unnoticed
- be aware that if considerable left pedal is already being applied, there may not be enough to counter an unanticipated right yaw.

1.8.6 The correct and timely response by a pilot to an un-commanded yaw is critical to retaining control. The recommended action is to apply and maintain full pedal against the rotation and to ease the cyclic stick forward until the tail rotor moves out of its disturbed air flow and regains effectiveness. If that action is ineffective or space is unavailable to move forward, the collective lever will have to be lowered or autorotation entered, with a consequent loss of height.

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[16] Information from Federal Aviation Administration Rotorcraft Flying Handbook, FAA-H-8083-21, 2000 edition.
[17] See, for example, the Commission report 91-004, Robinson R22 Beta, ZK-HDD, Bay of Islands, 21 February 1991.

1.8.7 In the Commission's report 91-004, the Commission recommended to the Director, Civil Aviation Safety, Ministry of Transport[18], that he:

> Incorporate in the helicopter training syllabus for [private pilot licence] and [commercial pilot licence] an item dealing with uncommanded yaw…

1.8.8 The CAA advised that since January 2004, LTE had been a specific topic in the CAA syllabus of training for the private pilot licence (helicopter)[19]. Before that date, the subject had been taught and tested as one of a number of "tail rotor emergencies".

1.8.9 The CAA syllabus of training for the commercial pilot licence (helicopter) specifically mentioned LTE in the context of mountain flying, and the topic was implied in theory elements dealing with wind and tail rotor control.

2 Analysis

2.1 This accident occurred after the helicopter had come to an out-of-ground-effect hover over trees near a landing site at an altitude of about 2000 ft. The helicopter began a sudden un-commanded yaw that stopped after one complete rotation. The pilot's attempt to regain control and fly away was unsuccessful because the helicopter struck trees.

2.2 No technical reason was found for the sudden yaw, and the evidence indicated that the helicopter's engine and the controls had been operating normally.

2.3 The helicopter was heavily loaded, but not overweight, and the flight manual charts showed that it had the performance capability to hover out of ground effect at that altitude.

2.4 The pilot was familiar with the Maori Saddle landing site and the preferred approach to it. The previous week he had indicated a dislike for the site, but he later played that down. The site met CAR requirements and was considered acceptable by the operator. The site's suitability was shown by 2 rescue helicopters sharing it after the accident.

2.5 The task should have been routine, and a safe landing ought to have been achieved, but the approach was attempted under adverse conditions that the pilot had not recognised and allowed for.

2.6 The flight manual warned of 4 conditions that could lead to tail rotor thrust capability being exceeded. Two of these conditions, high gross weight and being down wind, were present.

2.7 The pilot offered that he had been complacent in the way he carried out the approach, but this self-assessment also could have been applied to the following aspects of his flight preparation:

- not being fully involved with the loading of the helicopter, which meant he did not assess the accuracy of the cargo weight
- not ensuring that the shoulder harnesses were accessible and worn
- not determining that the passengers were familiar with the safety briefing and knew the location of the helicopter's emergency equipment.

2.8 The pilot's reliance on the advised weights showed his trust in DOC, or some complacency. After the event, the cargo weight was estimated to have been more than advised. Had the pilot been more involved in the loading and considered the cargo weight with other performance-related aspects of the task, such as temperature, altitude and wind, he might have opted to fly to the Blowfly Hut first. By reducing the helicopter weight before attempting the landing at Maori Saddle, he would have had a lower power requirement on that approach.

[18] The relevant safety authority in 1991.
[19] CAA advisory circulars (AC) 61-3, Pilot Licences and Ratings – Private Pilot Licence, and AC61-5, Pilot Licences and Ratings – Commercial Pilot Licence.

2.9 The pilot should have ensured that he and the front-seat passengers wore shoulder harnesses, although he expressed ignorance of the applicable CAR. If the pilot himself had been properly restrained, he might have had less concern for being impaled on the cyclic stick. Passengers cannot be expected ordinarily to know if a harness should be fitted. However, DOC made an internal recommendation that showed that such frequent users of helicopters gain eventually enough knowledge of applicable rules that they insist upon operator and pilot compliance.

2.10 In 2008, the Commission made a safety recommendation to the Director of Civil Aviation regarding the safety issue of passengers not wearing restraints in helicopters. Therefore the Commission made no further safety recommendation regarding passenger and crew restraint in respect of this accident.

2.11 The pilot did not give a safety briefing to the DOC workers. Although it was reasonable that he considered the workers competent to work around helicopters, he could omit the briefing only if he had determined that they were familiar with its content, which he did not do that day and had not done the previous week. The operator's briefing sheet said that its pilots would show passengers, before every flight, the location of on-board emergency equipment. The need for this was shown by the workers being unable to find the helicopter first aid kits after the accident.

2.12 The flight departed from Haast into a northerly wind that generated some turbulence en route, which suggested that the wind was gusting at times and could have been close to the 30 kt that the pilot deduced from the GPS. The pilot was aware that the approach to the pad would be more or less down wind, and after the accident he saw from the tree movement that it had been. Compared with the Beaufort Scale, the observed tail wind could have been between 11 kt and 21 kt. The helicopter was also likely affected by turbulence while at low speed and low level over the trees. The wind direction was not accurately determined, and one passenger said it was more westerly than northerly. If that was so, the wind on the approach was probably within 60^{o} of the tail of the helicopter.

2.13 The rescue pilot's recollection that the wind 90 minutes after the accident was a light southerly suggested that a weak front had crossed the area. In any event, the wind in mountainous areas such as the accident site is likely to differ in strength and direction from the overlying general flow.

2.14 Downwind approaches require care, but need not be hazardous. The previous Chief Pilot had stressed to the pilot, during the period of the current DOC tasks, a technique for a safe downwind landing and had advised him not to come to a hover first. Although one passenger described the helicopter "pulling up", there was no other evidence to suggest that the pilot had slowed the helicopter by performing a flare manoeuvre.

2.15 However, the pilot's description of the approach and the very confined wreckage suggested that the helicopter had reached zero airspeed before reaching the clearing, and had zero, or near zero, ground speed when still over the trees. This led to the heavy helicopter losing translational lift and entering an out-of-ground-effect hover, with a consequential need for the pilot to apply more power and left yaw pedal input to maintain the desired heading.

2.16 The helicopter's directional controllability when hovering in ground effect had been demonstrated to be adequate in winds up to 17 kt, but the controllability when hovering out of ground effect had not been determined and published for winds greater than 3 kt. However, pilot experience should have expanded the range of tolerable wind speed.

2.17 The precipitating factors for LTE can occur singly or in combination, and several were present. The most significant in this accident were the weathercock stability and the loss of translational lift during a downwind approach, and the high power demand as the helicopter came to a hover.

2.18 Although the accident occurred as the helicopter approached the hover, if the pilot had determined the wind more accurately and chosen a decision point, he might have identified earlier that the power requirement was increasing and opted to discontinue the approach and try again, perhaps after landing elsewhere and offloading some weight.

2.19 The pilot had completed his flight training before LTE was a specific topic in the CAA training syllabi, but his training in tail rotor emergencies did cover the subject, at least in respect of the reduction in tail rotor thrust at altitude and how the wind direction affected net thrust. His later encounters with LTE during operational flights had possibly created a misperception that LTE was always controllable and primarily a power and altitude consideration.

2.20 Because the pilot had not determined accurately the wind direction and strength for the approach, he had not realised that the helicopter was entering a potential LTE situation. He had not noted the yaw pedal position when taking off from the Haast base nor when on the approach to Maori Saddle, so he was unsure of the margin of yaw control remaining. His recollection of the torque requirement showed that the demanded power was close to the normal limit as he entered the high hover, but the corresponding yaw pedal position could not be determined and would have varied as the wind varied.

2.21 The reason the helicopter momentarily stopped after one rotation was likely due to a combination of the previous yaw pedal input taking effect and the varying wind direction. When the helicopter again started to yaw right, the rate would have been aggravated by the pilot reducing, rather than maintaining, full left yaw pedal and by his increasing the power to try to avoid the trees.

2.22 The emergency locator transmitter activated, but the wreckage attitude resulted in no signal being received. With only one antenna required and fitted, reception of a signal cannot be guaranteed. The flight-following practices of both DOC and the operator would have activated about 50 minutes after the accident had the passengers been unable to raise the alarm.

3 Findings

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

3.1 The helicopter began a sudden un-commanded yaw event as a result of an adverse tail wind while hovering at a heavy weight.

3.2 The pilot attempted the recommended recovery action, but that was unsuccessful because he did not apply full yaw pedal in the direction opposite the turn, and the helicopter struck trees.

3.3 The pilot was aware of the problem of LTE and how to avoid it in respect of normal performance decrements, but he did not correctly assess the likely effect of the wind prior to the approach.

3.4 The helicopter was airworthy, suitable for the task, and had the performance capability to permit the intended landing at the site.

3.5 The approach to the landing site, and the site itself, demanded care, but they were adequate for the intended task. A safe landing should have been achievable under the prevailing conditions had the pilot assessed the wind more accurately and applied the correct approach technique.

3.6 The pilot was complacent in his preparation for the flight in that he had not assessed the actual cargo weight, did not make the shoulder harnesses accessible, and did not ensure that the passengers were familiar with the safety briefing.

Approved on 15 October 2009 for publication

Hon W P Jeffries
Chief Commissioner

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Price $22.00 ISSN 0112-6962