CIVIL AVIATION AUTHORITY
OF NEW ZEALAND

AIRCRAFT ACCIDENT REPORT

OCCURRENCE NUMBER 03/2

BELL 204 (UH-1E)

ZK-IUE

PAPARANGI STATION

3 JANUARY 2003

Glossary of abbreviations used in this report:

CAA	Civil Aviation Authority
E	east
ELT	emergency locator transmitter
kg	kilogram(s)
km	kilometre(s)
m	metre(s)
NZDT	New Zealand Daylight Time
rpm	revolutions per minute
S	south
US	United States (of America)
USMC	US Marine Corps
UTC	Coordinated Universal Time
WGS 84	World Geodetic System 1984

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Aircraft type, serial number and registration:	Bell 204 (UH-1E), 6205 (Bell), 155350 (USMC), ZK-IUE
Number and type of engines:	1 Lycoming T53-L-13B turboshaft
Year of manufacture:	1968
Date and time:	3 January 2003, 1500 hours[1] (approx)
Location:	Paparangi Station, 37 km SE of Opotiki Latitude[2]: S 38° 12.05' Longitude: E 177° 36.92'
Type of flight:	Heli-logging
Persons on board:	Crew: 1
Injuries:	Crew: 1 fatal
Nature of damage:	Aircraft destroyed
Pilot-in-command's licence:	Commercial Pilot Licence (Helicopter)
Pilot-in-command's age:	50 years
Pilot-in-command's total flying experience:	16,000 hours (approx), 3000 on type
Information sources:	Civil Aviation Authority field investigation
Investigator in Charge:	Mr A J Buckingham

[1]Times are NZDT (UTC + 13 hours)

[2] WGS 84 co-ordinates

Synopsis

The Civil Aviation Authority was notified of the accident at 1545 hours on Friday 3 January 2003. The Transport Accident Investigation Commission was in turn notified shortly thereafter, but declined to investigate. A CAA site investigation was commenced next day.

The helicopter was on logging operations, and had just delivered a log to the milling site. As the pilot applied power to climb away after releasing the log, the automatic grapnel re-engaged on the log when the lifting longline tautened. The resulting jerk caused the line to pull free at the lower end and flick up into the path of the main rotor. The tail rotor separated when struck by the flailing line, and control of the helicopter was lost. It struck the ground a short distance from the landing site and was destroyed by impact and fire. The pilot died in the accident.

1. Factual information

1.1 History of the flight

1.1.1 The pilot, who was also the principal of the operating company, had been contracted to extract salvage[3] timber from a block of native forest on Paparangi Station, some 16 km to the north-north-east of Matawai.

1.1.2 He flew the helicopter to the property on the morning of 3 January 2003, arriving shortly before midday. Logging operations were commenced about 1330 hours, and several sections of a rimu log were flown out to the milling site, about 200 m from the station homestead.

1.1.3 The pilot was using a self-engaging/self-releasing grapnel, on a 230-foot Vectran®[4] longline. The grapnel assembly was designed to close on a log as the weight was taken up, and release as the weight came off. It had been working normally until about the sixth lift, when the pilot found that the release mechanism was slightly bent. He had a spare assembly on hand, and made a brief landing to fit the spare.

1.1.4 On the fourteenth lift, the pilot landed the log, and the grapnel appeared to release normally. As he began to climb away for the next lift, the grapnel re-engaged on the log, resulting in a sudden jerk on the longline. The longline separated from the grapnel assembly and flicked up into the main and tail rotors of the helicopter.

1.1.5 The tail rotor separated complete with the 90° gearbox, and landed about 80 m to the left of the hover point. The helicopter had been facing west at the time the line struck; after a perceptible pause, it began rotating or spinning to the right, while moving across the ground to the south-east.

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[3] Fallen or standing dead timber

[4] Registered trademark of Celanese AG

1.1.6 Witnesses reported that it "went quiet" as if the pilot had shut off the engine, but the helicopter appeared to be out of control. It struck the ground heavily on the side of a small steep-sided gully, and caught fire immediately.

1.1.7 The accident occurred in daylight, at approximately 1500 hours NZDT, at Paparangi Station, at an elevation of 1475 feet. Grid reference 260-X16-142232, latitude S 38° 12.05', longitude E 177° 36.92'.

1.2 Injuries to persons

Injuries	*Crew*	*Passengers*	*Other*
Fatal	1	0	0
Serious	0	0	0
Minor/None	0	0	

1.3 Damage to aircraft

1.3.1 The aircraft was destroyed.

1.4 Other damage

1.4.1 A small area of grass was burnt by the post-impact fire, and a fence post was broken by a flying piece of main rotor blade.

1.5 Personnel information

1.5.1 The pilot, aged 50, held a New Zealand Commercial Pilot Licence (Helicopter) and a current Class 1 medical certificate.

1.5.2 He had approximately 16,000 helicopter hours, including 3000 on type, and was regarded as one of New Zealand's most experienced pilots in the heli-logging role.

1.6 Aircraft information

1.6.1 Bell model 204, manufacturer's serial number 6205, was constructed in 1968 as a UH-1E Iroquois (also commonly known as a "Huey") variant for the US Marine Corps, and allocated military serial number 155305. This variant featured dual hydraulic systems and the Bell model 540 "door-hinge" rotor.

1.6.2 The helicopter was disposed of as military surplus in 1986 to a US operator, and was accepted on to the US civil register in 1988 under Smith Helicopters type certificate number H8NM. The New Zealand operator acquired the machine in 2002, and it was registered ZK-IUE and issued with a restricted category airworthiness certificate by CAA in December 2002.

1.6.3 The original powerplant was a Lycoming T53-L-11 turboshaft engine, but this had been upgraded to a T53-L-13B while the helicopter was still on the US register.

The powerplant upgrade effectively made the helicopter configuration identical to that of the UH-1L variant. The helicopter had also been modified for operation from the left pilot seat, with the fitting of a bubble window to the left door and ancillary instruments in the left door sill.

1.6.4 The operator also had another UH-1L, operated on Garlick Helicopters' type certificate, and given the support he had received from the type certificate holder, had applied to CAA to have the type certificate changed from Smith Helicopters to Garlick Helicopters. This action had been approved prior to the accident.

1.7 Meteorological information

1.7.1 The weather was reportedly fine and clear at the time of the accident, with a light westerly breeze.

1.7.2 Weather was not a factor in this accident.

1.8 Aids to navigation

1.8.1 Not applicable.

1.9 Communications

1.9.1 Not applicable.

1.10 Aerodrome information

1.10.1 Not applicable.

1.11 Flight recorders

1.11.1 Not applicable.

1.12 Wreckage and impact information

1.12.1 The sequence of events was reconstructed from witness observations and the physical evidence at the scene. As the helicopter began climbing away for the next load, the slack in the longline was taken up and the grapnel re-engaged the log that had just been placed on the ground. The resulting jerk caused the longline to part from the grapnel assembly.

1.12.2 The tension in the longline caused it to flick upwards, where it was picked up by both main rotor blades. The main rotor turns at 320 rpm, and the linear speed of the point on the blades where the line struck was about 220 knots. The line wiped off one right navigation light lens, the pitot-static head on the cabin roof, two whip antennae and the right-hand windshield wiper stop. These components, except for the wiper stop at 40 m, were found within an 11-metre radius of the drop-off point.

1.12.3 The flailing line struck the tail rotor, causing the 90-degree gearbox to fail just above its mounting flange, and the tail rotor and gearbox flew about 80 m to the left of the helicopter. At some point, the tail rotor had also picked up the rope and flailed it once against the right-hand synchronised elevator.

1.12.4 The line wound around the main rotor mast and swashplate numerous times, causing failure of the main rotor vertical control rods, and several turns wedged between the rotating and stationary elements of the swashplate.

1.12.5 With the loss of the tail rotor, the helicopter began spinning to the right (clockwise from above), while moving in a generally south-easterly direction (or about 7 o'clock from the original westerly heading). Before ground impact, the rotation appears to have been arrested, as the helicopter struck the ground on the lip of a small gully while moving left and forward on a heading of about 070° M.

1.12.6 The main rotor blades struck the ground twice in the impact sequence, the second driving deep enough into the slope to stop the rotor and anchor the helicopter in place on the edge of the gully. The angle of the strikes indicated a nose-up attitude of about 20° and a similar amount of left bank. Immediately to the left of the impact point was a small area of flat ground, where a forced landing may have been possible.

1.13 Medical and pathological information

1.13.1 Post-mortem examination found that the pilot died instantly of injuries consistent with a high-energy impact, and that the fire played no part in his death.

1.13.2 Toxicological tests revealed nothing of significance.

1.14 Fire

1.14.1 An intense fire consumed the entire fuselage (except for the right cockpit and cabin doors) and part of the tail boom. Also burnt was most of the main transmission casing, leaving only the transmission upper case, mast, rotor head and the remains of the blades. As the fire progressed, molten metal, ash and unburnt components, including the engine, dropped into the gully. The origin of the fire could not be determined.

1.14.2 One spliced end and a considerable length of the rope were destroyed by fire, and it was not possible to determine whether the remaining end was from the top or bottom of the longline.

1.15 Survival aspects

1.15.1 The pilot was sitting in the left seat, and was restrained by only a lap belt. He had shoulder harness available but normally did not use it on lifting operations. He was not wearing a helmet. Damage to the lower seat frame was consistent with impact on the left side of the helicopter.

1.15.2 Even without the post-impact fire, this was not a survivable accident.

1.15.3 The helicopter was equipped with a Narco ELT 10 emergency locator transmitter, however given the intensity of the fire, the ELT would have been destroyed within a very short time. No signal was detected by satellite or reported by other aircraft.

1.16 Tests and research

1.16.1 Enquiries were made as to the rope type and properties. The supplier reported that it was a Vectran® line, used principally in yacht rigging, and that he had told the pilot it was not intended for lifting longline use. The pilot had told the sawmilling crew that it was a Kevlar®[5] line, with a breaking strain of 6500 kg. He had said that using the synthetic rope longline in place of his previously-used wire rope longline gave an extra 60 or so kilograms useful load, and was some 30 feet longer. He also commented that he was encountering some "bounce" while transporting the logs with the new longline.

1.16.2 The 12-mm rope consisted of a braided inner core of Vectran®, encased in a 24-braid red polyester sheath. The sheath provided both abrasion and ultra-violet light protection. Two properties of the rope that were of interest to the pilot were its high strength to weight ratio and its low stretch, of the order of 3% before breaking. However, the low stretch applied only to the Vectran® core, not to the sheath, which will elongate about 20% before failure.

1.16.3 Both ends of the rope had been terminated in an eye splice, which is normal practice for braided rope. The lower eye had been formed around a teardrop-shaped cast alloy thimble, with a peripheral groove in which the rope lay. The thimble was solid, with a bolt-hole drilled through the centre.

1.16.4 As noted by one of the witnesses at the sawmill, a bolt was passed through the hole in the thimble in order to attach it to the grapnel assembly. The bolt was described as having up to two inches of shank visible on either side of the thimble.

1.16.5 Investigation of the rope properties found two cautions of interest – these apply to all rope types. One is to avoid sudden shock loads; the other is to avoid sharp angles. Either, or a combination, of these can cause the rope to snap at a load considerably less that its rated load. A weak link can be used at the upper end of the lifting longline; this ensures any overload failure occurs at the weak link, and minimises the risk of upward recoil. However, in this case, a weak link may not have served its intended purpose.

1.16.6 Additionally, with the core breaking after only 3% elongation, and the sheath stretching up to 20%, a large amount of recoil can result from the sheath.

1.16.7 Another operator reported having used similar rope in helicopter external load operations, but not as the primary longline. Instead, the rope had been used to connect multiple lifting points on a single load to the longline hook. The operator said that there was considerable heat build-up during the lift, after which the rope was found to be too hot to touch.

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[5] Registered trademark of E I du Pont de Nemours and Company

1.17 Organisational and management information

1.17.1 The pilot was the Chief Executive of his own limited liability company, and in practice operated as a sole trader. He performed most of the company piloting functions, and maintenance was contracted to outside organisations.

1.18 Additional information

1.18.1 CAR 133.255 *External load equipment* requires that: "Each operator performing a helicopter external load operation shall ensure that the helicopter is equipped with … external load equipment that … is appropriate and of a standard that will prevent breakage to it or damage to the helicopter".

1.19 Useful or effective investigation techniques

1.19.1 Nil.

2. Analysis

2.1 The investigation established conclusively that the accident was not due to any defect or problem with the helicopter, but to an unexpected parting of the lifting longline and its recoil up into the main rotor.

2.2 The longline itself was of Vectran®, but its make-up was not of a type normally used in lifting applications. The braided polyester outer sheath had considerably more elasticity than the actual Vectran® core, and this was undoubtedly what propelled the line upwards once it parted from the grapnel.

2.3 With an extra 30 feet of line, and this being the first day on which the pilot had used his new longline assembly, it is possible that during the drop off of the 14th log, he inadvertently descended to a height more appropriate to the old longline. This would result in a significant amount of slack, which would be taken up as he flew away. If he had not realised that there was slack present, a reasonable speed could have built up before the slack was fully out.

2.4 This would provide the mechanism for the sudden jerk, and if by this time the rope was at an angle to the long axis of the lower eye, the rope could easily pull off the thimble and bear against the through-bolt, which was of considerably smaller radius than the thimble. The combination of sudden shock load and very small radius would cause the rope to fail well below its rated strength. In this event, it is probable that a weak link at the upper end of the lifting assembly would not have served its intended purpose.

2.5 The failure at the upper end was probably due at least to the shock load imparted by the taking up of the rope by the main rotor, at a point where the linear speed is about 220 knots.

2.6 The initial direction of travel after the helicopter lost its tail rotor and began spinning suggests that the pilot may have been attempting a forced landing away from the drop-off point, to minimise danger to persons on the ground. The

witness observations that the helicopter “went quiet” and the mode of impact are compatible with the closing of the throttle by the pilot. This removes engine torque from the main rotor mast and will thus arrest the tendency for the machine to rotate.

2.7 However, it appears that the damage inflicted by the longline on the main rotor vertical control rods ultimately deprived the pilot of control of the helicopter, and resulted in an uncontrolled impact with the ground.

2.8 Other than the prompt advice to industry of the circumstances of this accident (see 4.1), no new safety actions or recommendations were developed as a result of this investigation.

3. Conclusions

3.1 The pilot was appropriately licensed, rated and fit to undertake the task being performed.

3.2 The helicopter was airworthy and operating normally up to the time of the accident.

3.3 The lifting grapnel was operating normally, and its re-engagement of the log was as designed.

3.4 The pilot probably did not perceive that the grapnel was in a position to re-engage before taking up slack in the longline.

3.5 The sudden jerk when slack was taken up, probably in combination with a sharp angle that developed in the sequence, caused the rope to fail at the lower end.

3.6 The longline core was Vectran®, with inherent low elasticity, but the elasticity of the outer polyester sheath was sufficient to project the line through the main rotor.

3.7 The type of rope used for the longline was not intended for this application, and thus did not comply with CAR 133.255.

3.8 Damage to the main and tail rotors effectively deprived the pilot of control of the helicopter.

3.9 The resulting ground impact was not survivable.

4. Safety actions

4.1 Within several days of the accident, the nature of the accident and the part played by the rope longline were relayed to the president of the Aviation Industry Association, who circulated a suitable caution to industry.

4.2 Although CAA has previously investigated an accident (98/1250) with a similar cause, the circumstances differed slightly in that the lifting strop in the previous case consisted of a 20-foot nylon rope with a 20-foot chain at the lower end. In that accident, the chain snagged on a tree, stretching the nylon rope, which then catapulted the chain upward into the main rotor. A *Vector* article was published as a result of the earlier investigation.

Report written by:

(Signed)

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5 January 2005

Authorised by:

(Signed)

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