

**AIRCRAFT ACCIDENT REPORT
OCCURRENCE NUMBER 98/8
HUGHES 269C ZK-HHS
NGONGOTAHA
10 January 1998**



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Aircraft Type, Serial Number and Registration:	Hughes 269C, 1230259, ZK-HHS
Number and Type of Engine:	One Lycoming HIO-360-D1A
Year of Manufacture:	1973
Date and Time:	10 January 1998 at 1925 hours*
Location:	5 km north of Ngongotaha Latitude: 38° 01.9' S Longitude: 176° 12.1'
Type of Flight:	Aerial Work
Persons on Board:	Crew: 1 Passengers: 1
Injuries:	Crew: Fatal Passenger: Minor
Nature of Damage:	Destroyed
Pilot-in Command's Licence:	Commercial (Helicopter)
Pilot in Command's Age:	30 years
Pilot in Command's Total Flying Experience:	1555 hours
Information Source:	Civil Aviation Authority field investigation
Investigator in Charge:	Mr O J Stewart

* All times in this report are in New Zealand Daylight Time (UTC + 13 hours)

Abstract

The helicopter was patrolling an 11,000-volt (11 kV) power line, which had been suffering from some unexplained power interruptions. During the patrol, the helicopter's main rotor blades struck one conductor of a three-conductor, 110 kV transmission line, which crossed about six metres above the 11 kV line being inspected. The helicopter was destroyed, the pilot was fatally injured and the observer sustained minor injuries.

The primary cause of this accident was the failure by the pilot to detect another power line, which crossed above the line being inspected. Contributory factors were:

- The pilot and the observer were not adequately trained
- A number of briefings were omitted or inadequate
- The lack of a formal system for the selection, direction and control of the aerial work undertaken by the contracting organisation
- Environmental factors
- The suitability of the available helicopter

Several Safety Recommendations made as the result of this accident are being negotiated with interested parties.

Synopsis

The Civil Aviation Authority (CAA) was notified of this accident at 2005 hours on 10 January 1998. In accordance with the legislated requirements, the CAA notified the Transport Accident Investigation Commission (TAIC) which declined to investigate the accident. Mr O. Stewart of the Civil Aviation Authority was appointed Investigator in Charge (IIC). The investigation into the circumstances of the accident commenced the next day and included an on site inspection, interviewing witnesses and persons associated with the operation, and detailed examinations of the helicopter, its engine and the power lines.

Factual Information

History of the Flight

After a period of inclement weather, the power company electrical network suffered a number of unexplained interruptions. The cause of these interruptions could not be identified by ground inspection so the power company control room elected to use a helicopter patrol in an effort to locate the fault(s).

On the day of the accident, the pilot's day started at 0545. He flew the helicopter from Rotorua to Tauranga, arriving at about 0640, when he was briefed on the job requirements. The pilot and two observers then departed at approximately 0715 to carry out various patrols. At the conclusion of the patrols, the pilot returned to Rotorua, arriving at about 1040.

Shortly thereafter, a 25-minute photographic session was undertaken south west of Rotorua Airport. The pilot and his father flying in ZK-HHS, were filmed from an accompanying helicopter, while they carried out a power line patrol. Later, the pilot carried out two instructional flights.

At 1545 the power company control room contacted the helicopter operator and requested a patrol of the Kaharoa feeder, a section of the 11 kV power system north of Lake Rotorua. A power company linesman based in Rotorua was to fly as the observer on this patrol. The pilot elected not to carry an additional observer, due to cabin size constraints. The helicopter was refuelled to about 75% full tanks.

The only briefing undertaken prior to departure was that the power company observer indicated that it was the Kaharoa feeder to be patrolled.

At about 1615, ZK-HHS departed from Rotorua Airport for the patrol, which commenced at Mourea and proceeded to Tauranga Direct Road. A number of spur roads were checked and trees were found to be interfering with the 11 kV power line on one of these roads. The helicopter was landed close to this fault and the observer radioed for a ground crew to come and attend to the interfering trees.

At this time, the pilot indicated to the observer that the helicopter was getting low on fuel and would require more, if patrolling was to continue. The observer said that further patrolling was necessary so the pilot returned to Rotorua to refuel. Approximately 40 litres of fuel were added. The pilot then returned to the observer's location and the patrol continued.

Up to this time, the helicopter's low-level operations had lead to several complaints to the police. One person took videotape of the helicopter, after it had passed close to her house and then as it operated about 300 metres away.

The patrol resumed at the intersection of Tauranga Direct Road and Jackson Road, about seven kilometres north of Ngongotaha township. At this point, the observer noted that the pole-mounted, air brake switches, which are isolating devices in the power lines, were closed. This meant that the power line along Jackson Road was alive and needed to be patrolled. The observer was surprised by this and checked with the control room by radio to confirm that this observation was correct.

The Jackson Road patrol was undertaken with the helicopter flying parallel to, and 1-2 m above the 11 kV line. Midway along Jackson Road the 11 kV line crossed from the south to the north side of the road. Up to that point the helicopter was flying over paddocks to the south of the line. After the line crossed over the road, the pilot flew above the road to give the observer an unobstructed view out of the right-hand side of the helicopter.

They approached a pole which the observer wanted a closer look at, so the pilot slowed the helicopter to allow the observer to view the insulators and cross arms on the pole. This pole was directly beneath the 110 kV transmission line. The standard technique used up to this point had been to hover parallel with the 11 kV line and back from the pole to be inspected. This enabled the observer to look forward and to the right at about 45°, looking down. The skids would normally be 1-2 metres above the conductors.

The observer was satisfied that the pole insulators and cross arms were not defective and signalled the pilot to continue with the patrol. The usual method of signal was a nod or pointing forward with one hand. Just as the helicopter began to move forward, the observer heard a loud bang. The helicopter spun around to the right and came to a sudden stop. At this point, the observer was aware of debris falling from the helicopter. The helicopter tipped over onto its left side, so that the observer was looking past the pilot, directly at the ground. It then dropped vertically to an embankment above the road, at the base of the 11 kV pole that had been inspected.

The observer was restrained by his harness during the impact sequence. He waited until the 11 kV line had time to trip off and made a conscious decision to wait until all movement had stopped. However, when a fire started in front of him and he could feel heat behind him, he undid his harness and moved clear. Prior to moving clear, he saw that the pilot was clear of the wreckage.

The observer ran down from the embankment to flag down a passing motorist. By this time a number of local residents had arrived on the scene. The pilot was dragged from his position adjacent to the burning wreckage and the observer was given assistance at the roadside. Later, the observer remembered lying at the roadside, a few minutes after the accident, and looking up to see the remaining two conductors of the 110 kV line. This was the first time he had seen them.

Injuries to persons

<i>Injuries</i>	<i>Crew</i>	<i>Passengers</i>	<i>Others</i>
Fatal	1	0	0
Serious	0	0	0
Minor/None	0	1	

Damage to aircraft

The helicopter was destroyed by the impact forces and the resulting fire.

Other Damage

The main rotor severed one conductor of the three-conductor, 110 kV line. This line, which supplied Tauranga area, was out of commission for about 8 hours.

One pole supporting the 11 kV line was demolished in the impact.

The severed conductors from both sets of power lines fell across a number of wire fences. One or both of these conductors may have been livened with electricity and caused heat damage to the fence wires, which started a number of small grass and scrub fires in the vicinity before the electricity supply tripped off.

Personnel information

The pilot held a valid Commercial Pilot Licence (Helicopter) endorsed with a Hughes 269 type rating and a Class 1 Medical Certificate valid to 6 September 1998. His flying experience totalled approximately 1555 hours, all but about 2 hours of this on helicopters. He had been carrying out power line inspection work for approximately four years.

The operator's Operations Manual prescribed a maximum duty time of 11 hours. This limit could be extended to 12 hours where necessary, but had to be immediately followed by a rest period of 12 hours. The pilot arrived at Tauranga at about 0640. Allowing for about 20 minutes flight time from Rotorua and half an hour preparation prior to flight, the pilot began his duty at about 0600 to 0615. This meant that the pilot should have completed his (extended) day's duty at about 1815. The accident occurred at about 1925, which meant that the pilot's duty period at that time was about 13 hours 10 minutes and he had probably flown about 5-7 hours during that duty period.

The observer, an employee of the power company, was experienced in power line construction, inspection and rectification work. He had previous experience in helicopter power line patrols.

There was no specific CAA or industry training and/or information for pilots or observers carrying out power line surveys or low-level patrols. The pilot's father indicated that his son had reviewed another power company's procedures on the use of helicopters in this role.

Aircraft information

The Hughes Helicopters 269C, serial number 1230259, was constructed in 1973 and had accrued 9616.8 total airframe hours up to the 9 January 1998. The aircraft had a valid non-terminating Certificate of Airworthiness and the most recent maintenance inspection had been completed on the 9 January 1998.

The engine, Lycoming HIO-360-D1A serial number L-17932-51A, had accrued 308.4 hours since overhaul.

Meteorological information

Conditions at Jackson Road at the time of the accident were fine and clear, with scattered cloud and a southwest wind estimated at 5-10 knots. The observer stated that, up to the time of the Jackson Road patrol, the helicopter had been buffeted by the wind. The Jackson Road patrol had been noticeably smoother and both the pilot and the observer had commented on this during the flight.

At the time of the accident, it was still daylight and the helicopter was flying almost directly towards a setting sun.

Aids to navigation

Not applicable

Communications

Radio transmissions between the pilot and Rotorua Tower consisted of advisory messages of position and intention. The Air Traffic Controller in the tower reported that the pilot sounded confident and relaxed.

Only the pilot wore a headset during the flight, to provide radio communication between him and other radio station operators. The intercom system in the helicopter was not used on this flight.

Aerodrome information

Not applicable

Flight recorders

Not applicable

Wreckage and impact information

Site examination found that the helicopter main rotor blades had struck and severed one of the three conductors of the 110 kV line. This line crossed about six metres above the line being inspected. The main rotor blades and the rotor head sustained substantial damage. Pieces of rotor blade were later found up to 100 metres from the impact point.

The helicopter had then spun to the right through approximately 270° before the tail boom struck a power pole supporting the lower line, demolishing the pole and severing the tail boom. The helicopter fell vertically to the ground, impacting on the left side of the cabin in a left bank of about 100°.

The engine examination on site was limited. It was later subjected to a detailed specialist examination.

Medical and pathological information

Post mortem examination found that the pilot had died of multiple injuries but disclosed no pre-existing medical condition which would have impaired his ability to operate the helicopter.

Toxicological investigation revealed traces of cannabis residue in the pilot's blood. The recency, amount and effect of cannabis use were not determined.

The observer suffered minor internal bruising, cuts and abrasions.

Fire

At some stage during the impact sequence, the fuel tank was ruptured. The estimated 40 litres of fuel was ignited by one of several possible sources. The fire burned and melted a high proportion of the helicopter, including most of each main rotor blade.

Survival aspects

The impact forces may have been survivable for the pilot, had the helicopter not impacted the ground on its left-hand side, where he was seated.

Neither the pilot nor the observer was wearing a helmet for this patrol but both were wearing four-point harnesses.

Tests and research

Expert metallurgical research was undertaken to establish the cause for the failed engine components. This indicated that the damage was a result of a connecting rod bearing failure, probably as a result of a combination oil starvation (due to the aircraft lying on its side) and high component loading at high crankshaft revolutions.

A number of environmental and situational factors, together with human peculiarities, can affect the performance of pilots and crew who operate near power lines. These can include visual acuity, depth perception, light intensity, background colours, and the amount of information being processed and alertness.

Organisational and management information

The operator held Civil Aviation Regulation 136 Air Service Operator and 136A Aerial Work Operator certificates, issued by the CAA. The pilot carried out the functions of Operations Manager, Chief Pilot and Maintenance Controller for the organisation.

The power company had selected this helicopter operator as its principal contractor because of the association with the power company's predecessor and the perceived experience offered by the pilot and his father. Whilst there was significant experience and knowledge on the part of the operator, with respect to transmission line technicalities, there was limited experience and training in operations associated with power lines.

The power company did not have any formal system, standards or requirements for selection of helicopter services nor did they have a formal system for selection and training of observers.

Additional information

The pilot was the subject of some pending legal proceedings. However, his father considered it unlikely these would have been distracting the pilot from his flying responsibilities and indicated that there had been no evidence of such distraction prior to the accident.

The operator's Operations Manual provided guidance to employees on a number of issues. One particular area dealt with intoxication and state of health. Section 1 item 1:13 of the manual stated:

No crew member while acting in his/her official capacity shall be in a state of intoxication or in a state of health in which his/her capacity so to act would be impaired by reason of his/her having consumed or used an intoxicant, sedative, narcotic or stimulant drug or preparation.

The responsibility for safety of the operation rested with the pilot. The Operations Manual stating that:

The pilot in Command is at all times responsible for the safety of the operation and must ensure that there is no danger to either the helicopter or to any person on the ground, and that no damage shall be caused to any property as a result of the operation.

For low level operations the manual stated:

No persons, other than those essential to the operation, shall be carried in the helicopter and the Pilot in Command shall ensure that all persons carried are properly briefed.

The briefings given for power line inspections did not refer to topographical maps, identifying where safety hazards, such as other power company transmission lines, may exist. Schematic diagrams of the power company network had been used previously, but these did not provide any information regarding the physical location of the power lines. Reference maps were not taken on the helicopter during the flight.

At some stage during the accident flight, the observer had asked the pilot how he looked out for the 110 kV transmission lines. The pilot said that because of the number of times he had flown the patrol he knew where they were. The pilot's father stated that sometimes jobs were arranged 'on the run' and there was a heavy reliance on power company observers to provide knowledge of hazards.

Five witnesses, from different locations, all heard the sound of the engine running after impact, stating that the noise continued after an explosion and after the power to their homes had gone off. One had noticed that one of the 110 kV conductors had sagged. The witnesses all described the sound of an engine revving at high speed and that the noise continued for some time. No one noticed the engine finally stop, as all witnesses were involved in getting themselves to the scene as soon as possible. By timing two of the witnesses during their re-enacted movements after the accident, it was estimated that the time the engine ran after impact with the ground was not less than 20 seconds and probably in excess of 40 seconds.

The pilot had previously flown along Jackson Road however this was rarely done.

The pilot's father indicated that the technique employed to avoid crossing lines was to initiate a climb was some two poles prior to the crossing line, with the corresponding descent once the line had been cleared. The pilot's father had experience in patrols of this nature and

the surrounding area power line system and they knew each other's work patterns.

The power company observer on the accident flight had not flown down Jackson Road before and was not familiar with the road and immediate area.

The 110 kV conductors were set against a background of scattered clouds and the support towers were out of the pilot's field of vision. The one to the south was obscured by a row of tall poplars and the one to the north was some 200 metres distant, on higher ground.

The operator's Operations Manual contained a brief section of a few pages, detailing training requirements for low level operations. The training syllabus required classroom training and covered general helicopter operation, the Operations Manual and regulatory requirements and meteorology. As a comparison, another section of the Operations Manual, relating to flying in a mountain environment, included 20 pages of information regarding high altitude and mountain operations.

Analysis

The flight briefing carried out by the pilot and the electricity company observer was not adequate for the purposes of identification of safety hazards. The electricity company did not have a formal procedure or policy for pre-flight task definition or pilot briefing, key tasks prior to any work undertaken within a wire environment. Prior to commencing patrols in helicopters, the electricity company had not briefed its observers regarding their role and responsibilities; other than to detect faults. It appears that the pilot did not carry out a safety briefing required by the operator's Operations Manual. The content of this briefing, as set down in the Operations Manual, did not require the pilot to make the observer aware of their responsibilities with respect to hazard avoidance, nor were any observer responsibilities stated in the manual.

The pilot is reported to have said that because of the number of times he had flown the patrol he knew where the power lines were located. Whilst the pilot may have felt comfortable with this method of identification, subsequent events proved that familiarity on its own may not be the most desirable means of obtaining environmental and situational awareness.

Neither occupant was wearing a helmet. In this case, the pilot's head injuries may have been reduced or prevented by wearing a helmet. However, it is unlikely that such protection would have saved his life. Whilst head protection may not, in all circumstances, prevent fatalities, every effort to obtain maximum protection should be taken.

The lack of use of an intercom for pilot/observer communication could not be shown to have contributed to this accident. In other circumstances it may have done so. The average time for initiation of meaningful avoiding action is about five seconds. It is therefore critical that a functional intercom system is used, so that easy instant communication is available between operational crews. This would allow maximum advance warning of approaching hazards and would encourage appropriate intercommunication between crewmembers.

As a result of the lack of briefings (from either his employer or the pilot) and the lack of training made available to him, the observer was not aware of the expectation, that the pilot may have had of him assisting in hazard avoidance. The observer was of the opinion that he was responsible for inspection only and it was up to the pilot to look for hazards. Whilst the operator's Operations Manual clearly identified the pilot as being responsible for safe

operations, given the environment that the operation was being flown in this was a heavy burden to place on one person.

The operator father and son team had a good understanding of what was expected of each other. However, this obviously did not flow over to third party observers.

The lack of a second observer, whose role would be to assist the pilot in hazard avoidance, probably contributed to this accident.

At the time of the accident, the helicopter was flying towards a setting sun, which would have reduced the pilot's visual acuity. The 110 kV line was set against a background of scattered clouds. Trees obscured one of the timber 110 kV support towers and the other support tower was some 200 metres distant, on higher ground. These were key visual indicators for situational and environmental awareness in providing the pilot with cues to look for other power lines. Observation the next day at the same time, in similar weather conditions, indicated that the 110 kV conductors were extremely difficult to see.

As the helicopter was being operated at a very low level, the scene in front of the pilot at close proximity was continuously changing and would have required continual refocussing.

He had been on duty in excess of the allowable duty time and as such may have been operating in a danger zone with respect to the effects of fatigue.

The pilot had undertaken the operator's required training. However, he had received little training in the nature, practices and hazards of operating within a low-level environment amongst power lines and other wires (a wire environment). He had reviewed another organisation's document, which detailed the procedures and requirements of helicopter operators involved in wire environment work. The pilot's initial training had provided a basis for development. Subsequent training had not provided the in-depth knowledge and understanding of the environmental and situational aspects of the low level wire environment. Pilot training for Commercial Licence, E Category Instructor Rating and Agricultural Rating (helicopter) covers some of the requirements for wire environment work. This information is by no means comprehensive and unless an individual undertakes all three levels of training (CPL, E Cat Instructor and Ag Rating) they will not obtain all the information currently available through formal training.

Examination of the wreckage and subsequent engine inspection, together with witness reports, indicated that there had been no mechanical failure of the helicopter prior to the main rotor blade impact with the 110 kV conductor.

The pathological and medical experts were not able to determine at what time the pilot had used cannabis, nor could they show what effect, in any, it had on the pilot's flying abilities.

It is likely that a combination of all of the above factors, together with the lack of adequate preparation (both training and briefings), prior to commencing the patrol, made it highly unlikely that the pilot would detect the crossing 110 kV transmission line. The observer was concentrating on the 11 kV lines, looking down and as a result was not looking for hazards.

Conclusions

The aircraft had a valid, non-terminating Certificate of Airworthiness and had been maintained in accordance with the Operator's Maintenance Manual.

The helicopter did not suffer any mechanical failure prior to impact with the 110 kV conductor.

There were a number of causal factors leading to the accident:

- The pilot was not adequately trained to perform the required duties in such a critical environment. There was a lack of substantive training available to him.
- The helicopter used, a Hughes 269C, was of a size such that a second observer could not be carried on the flight. This prevented a third pair of eyes being available for hazard detection and avoidance.
- The power company's briefing to their observer, with respect to his duties and responsibilities when carrying out fault isolation aerial surveys, was inadequate.
- The pre-flight briefing with respect to the charts and maps used and the resultant identification of hazards was inadequate. A high level reconnaissance had not been carried out to assist in the identification of hazards, nor was one required.
- The pilot did not perform an adequate pre-flight briefing. The observer was unaware that he was expected to look out for hazards, as the pilot had not briefed him to do so.
- The power company omitted to adopt a formal system of selection, direction and control of aerial services. Instead, they relied on the experience of the senior member of the operator's team and previous success of the operation to carry them through.

A number of environmental factors contributed to rendering the 110 kV transmission line difficult to detect:

- The 110 kV transmission line support towers were out of the field of vision of the pilot
- The approaching twilight hours and reducing light
- Scattered cloud together with varying changes and intensity of light
- Glare from the setting sun
- The height at which the pilot was looking from, ie, slightly below or at the level of the 110 kV conductors

- The complex array of continually changing circumstances, which happens at low level, where the surroundings are changing at a high rate, requiring constant refocussing of attention

The pilot had exceeded the operator's stated duty times. Whilst the effects of fatigue were not determined, fatigue may have played a contributory role.

The effect of cannabis use was not determined, but was in conflict with the intent of the operator's Operations Manual.

Safety Recommendations

A number of Safety Recommendations made as a result of this accident are being negotiated with interested parties.

Michael G Hunt
Assistant Director, Safety Investigation and Analysis

Date



View of the accident site, approximately along the direction of flight



View to the south-east, looking across Jackson Road, showing the relationship between the 11 kV (bottom) and 110 kV (top) lines after the 11 kV pole had been replaced. The helicopter approached left to right, striking the left-hand 110 kV conductor.



ZK-HHS during the photographic session on the morning of the accident.



View of the scene.