



AIRCRAFT ACCIDENT REPORT
OCCURRENCE NUMBER 01/451
WESTLAND WESSEX HC MK 5C
ZK-HVK
15KM SOUTH-WEST OF MOTUEKA
12 FEBRUARY 2001

Glossary of abbreviations used in this report:

CAA	Civil Aviation Authority
CAR	Civil Aviation Rule(s)
E	east
ft	foot or feet
HP	high-pressure
Lb	pounds
m	metre(s)
mm	millimetre(s)
NZDT	New Zealand Daylight Time
rpm	revolutions per minute
S	south
UTC	Coordinated Universal Time

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Aircraft type, serial number and registration:	Westland Wessex HC Mk 5C, WAL29, ZK-HVK
Number and type of engines:	2 Rolls-Royce Gnome
Year of manufacture:	1964
Date and time:	12 February 2001, 0740 hours* (approx)
Location:	15 km south-west of Moteuka Latitude: S 41° 11.35' Longitude: E 172° 50.59'
Type of flight:	Heli-logging
Persons on board:	Crew: 1
Injuries:	Crew: 1 fatal
Nature of damage:	Helicopter destroyed
Pilot-in-command's licence	Commercial Pilot Licence (Helicopter)
Pilot-in-command's age	39 years
Pilot-in-command's total flying experience:	2642 hours, 321 on type
Information sources:	Civil Aviation Authority field investigation
Investigator in Charge:	Mr A M Moselen

* Times are NZDT (UTC + 13 hours)

Synopsis

The Civil Aviation Authority was notified of the accident at 0930 hours on Monday 12 February 2001. The Transport Accident Investigation Commission was in turn notified shortly thereafter, but declined to investigate. A CAA site investigation was commenced the same day.

During heli-logging operations, the helicopter picked up a log and almost immediately placed it back on the ground. The helicopter then adopted a steep nose-down attitude and descended parallel to the terrain, colliding with the ground some 400 feet below the pickup site. The pilot was fatally injured and the helicopter destroyed by impact and fire.

1. Factual information

1.1 History of the flight

- 1.1.1 On 12 February 2001, the helicopter departed home base at about 0715 hours for the logging operational area, a short distance away. On arrival, the pilot landed at the skid site, the assembly point where the recovered logs were prepared for road transport.
- 1.1.2 The pilot vacated the helicopter briefly to converse with some of the other ground crew, after which two loggers boarded the helicopter and were delivered to their respective work sites.
- 1.1.3 A short time later, one of the loggers used his hand-held radio to advise the pilot that he had a log ready for pickup. On the first lift of the day, the helicopter approached the site and came to a hover to enable the logger to connect the lifting longline (attached to the helicopter's cargo hook) to the strop on the log. The logger's estimate of the weight of the log was one tonne.
- 1.1.4 The helicopter commenced lifting the log, but after the log had cleared the ground, the logger saw the helicopter lower it back onto the ground. Thinking that the pilot may have been expecting to lift an additional log due to the relatively light weight of the first log, the logger called the pilot to advise that he did not have another ready. There was no response from the pilot; at this stage the helicopter was still in a hover.
- 1.1.5 The logger was wondering why the pilot had put the log down, when he saw the helicopter nose down steeply and descend parallel to the terrain, which sloped down at approximately 70°.
- 1.1.6 The helicopter did not change attitude as it descended some 400 feet to the valley floor, where it struck the ground and burst into flames. Just prior to impact the logger observed the main rotor blades "bend up". His estimate of the elapsed time between the initial log pickup and impact was 15 seconds.
- 1.1.7 The accident occurred in daylight, at about 0745 hours, in steep forested terrain 15 km south-west of Motueka, at an elevation of approximately 500 feet. Grid reference 260-N27-968023, latitude S 41° 11.3' longitude E 172° 50.6'.

1.2 Injuries to persons

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

1.3 Damage to aircraft

1.3.1 The helicopter was destroyed.

1.4 Other damage

1.4.1 Nil.

1.5 Personnel information

1.5.1 The pilot, aged 39, held a Commercial Pilot Licence (Helicopter) and a Class 1 medical certificate valid to 16 August 2001.

1.5.2 The pilot was type-rated on the Wessex helicopter, and had completed 2642 hours total flight time, with 321 hours on type.

1.6 Aircraft information

1.6.1 Wessex HC Mk 5C, manufacturer's serial number WAL29 (military serial number XS509) was an ex-military, twin-engined, medium utility helicopter constructed in the United Kingdom in 1964 by Westland Helicopters Ltd. Two Rolls-Royce Gnome turbo-shaft engines, driving through a coupling gearbox and the respective transmissions powers a four-bladed main rotor and a four-bladed tail rotor.

1.6.2 The helicopter was first registered in New Zealand in December 1998. The CAA issued an Airworthiness Certificate in the Special category/Experimental sub-category for the purpose of operations under CAR Part 91.105 on 18 January 1999.

1.6.3 Up to the time of the accident, the helicopter had accrued 6598 hours total time in service. The last annual review of airworthiness had been completed on 30 May 2000. The release-to-service status could not be established because the certification was endorsed on the Technical Log carried on the aircraft. The Technical Log was destroyed in the post-impact fire.

1.6.4 After acquisition the helicopter weight had been reduced by the removal of a considerable amount of electronic and radio equipment. This design change had been approved in accordance with CAA requirements. The resulting aircraft empty weight was reduced to 9422 pounds. The normal maximum take-off weight

limit was 13,600 pounds. The operator had applied to the CAA for a reduction to 12,500 pounds but this had not been approved at the time of the accident.

- 1.6.5 The engines were each limited to a maximum torque of 3200 lb ft. For single-engine operations, either engine had an emergency rating of 1300shp (2700 lb ft torque), for a maximum of 2½ minutes.
- 1.6.6 Engine power management was achieved by computer-controlled fuel control systems, which scheduled engine fuel flow in response to power demand, at the same time equalising power output between the two engines, nominally 775 shp each.
- 1.6.7 The Flight Manual states that: *“failure of one engine at all up weights above about 11,700 pounds (air bleeds on) or 12,700 pounds (air bleeds off) usually renders the aircraft incapable of maintaining height at single-engine max contingency power at speeds below about 40 knots. Additionally, if the power automatically applied at the moment of failure is in excess of the single-engine max contingency, rotor rpm droop occurs if the collective lever is not lowered immediately. Whenever possible, make a running landing. If an engine fails in hover, it is advisable to land whether or not height can be maintained: an attempt to fly away from the hover should only be made if the surface is unsuitable for an immediate landing”*.
- 1.6.8 Cockpit instruments providing engine performance indications were:
 - Gas generator tachometer (each engine)
 - Power turbine inlet temperature gauge (each engine)
 - Fuel flow gauge (each engine)
 - Power turbines and rotor tachometer (single gauge with combined display)
 - Torquemeter
 - Oil pressure gauge (each engine)
 - Oil temperature gauge (each engine)
- 1.6.9 The Standard Warning System provided warnings of failures and abnormal status of certain aircraft systems. The Standard Warning Panel, located at the top centre of the instrument panel, comprised seven red (primary warning) captions and up to 15 amber (secondary warning) captions. In the event of a red caption illuminating, an audio warning (“firebell”) would sound in the pilot’s headset, and red “attention-getter” lights (located below each outer end of the instrument panel coaming) would flash.
- 1.6.10 The failure of an engine would result in the illumination of either the ENG P (port) or ENG S (starboard) red caption, warning of low oil pressure in the affected engine. There was no “engine failure” warning caption as such.

1.6.11 The normal command pilot position was the right seat, although the helicopter could be flown from either seat.

1.7 Meteorological information

1.7.1 The weather at the time of the accident was reportedly clear and calm.

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 Although the pilot was able to communicate with ground crews, the latter heard no transmission from the pilot during the accident sequence.

1.9.2 The investigation was unable to establish if the radio used by the pilot for communicating with the ground crew was independent of, or integrated with, the aircraft audio system through which the pilot would hear Standard Warning System aural warnings.

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 helicopter had struck the ground at speed, in a slight left bank and in a nose-down attitude of approximately 70°.

1.12.2 A non-uniform spray pattern on vegetation ahead of the wreckage in the direction of travel indicated that fuel had been ejected from the tanks at impact.

1.12.3 All of the wreckage was contained within the dimensions of the helicopter, but most had been consumed by an intense post-impact fire

1.12.4 The lifting long line had been jettisoned shortly before impact and was found lying approximately 30 feet from the main wreckage. There was no evidence of tree or ground impact on the log release mechanism, which would indicate snagging or jamming during descent.

1.12.5 No cockpit instrument indications or ancillary control settings were available because of impact and fire destruction. It was not possible to verify the pre-impact integrity of the flight controls or any other system.

1.12.6 The engines were buried beneath the burned wreckage and although substantially damaged by impact and heat, both were essentially complete. They were

retrieved from the site for later examination. Only the main gear wheel from the coupling gearbox was recovered.

- 1.12.7 Witness marks made by the main rotor blades on the rotor head were consistent with a high pitch angle on each blade at ground impact. The damage patterns on the blades indicated low rpm at impact, and all blades showed evidence of severe coning prior to impact.

1.13 Medical and pathological information

- 1.13.1 Because of severe incineration, a post-mortem examination of the pilot could not be conducted.
- 1.13.2 A review of the pilot's medical file disclosed no evidence of any condition that may have affected his ability to operate aircraft normally.

1.14 Fire

- 1.14.1 An intense post-crash fire destroyed much of the wreckage, severely limiting the extent of the investigation.
- 1.14.2 The fuel dispersal pattern adjacent to the wreckage suggested that there was a quantity of fuel on board at impact. As the fuel sprayed forwards in the direction of travel, some would have come into contact with an operative engine, a possible ignition source. The magnesium and aluminium alloys used in the helicopter structure, once ignited, would have burned with a very intense heat.
- 1.14.3 Although the engine bays were protected by fire extinguishers operated by an inertia switch, it could not be determined if these had operated on impact. In any case, their effectiveness would have been short-lived and confined to the engine area.

1.15 Survival aspects

- 1.15.1 The accident was not survivable, owing to the high decelerative forces involved, and the ensuing fire.

1.16 Tests and research

- 1.16.1 The engines and some accessories were submitted to the Defence Operational Technology Support Establishment (DOTSE), for examination. A Rolls-Royce technical specialist assisted in the inspection, and a number of components were subsequently forwarded to the Rolls-Royce Material Laboratory in England for further inspection and analysis.
- 1.16.2 The investigation identified that the damage sustained by the number 1 engine (left) was consistent with the engine striking the ground while operating at high rotational speed and producing power. The compressor showed no evidence of mechanical damage associated with a released blade or vane, or of pre-accident foreign object damage. The disc and blades of both turbine stages showed no evidence of mechanical failure, and laboratory examination of turbine blades from

both sections revealed a normal material structure with no evidence of exposure to abnormally high operating temperatures.

- 1.16.3 The number 1 engine accessories were unavailable for examination because of the extent of the post-crash fire damage.
- 1.16.4 The damage and witness marks exhibited by the number 2 (right) engine compressor section were consistent with low rotational speed at impact. There was no evidence of pre-accident mechanical distress. Severe distortion to the power turbine casing and markings in the front face of the turbine disc confirmed the power turbine was stationary during at least some part of the impact sequence. These indications were consistent with the engine not operating before impact.
- 1.16.5 Examination of a power turbine blade from the number 2 engine revealed bright indentations on the lower leading edge of the aerofoil and on the front of the root, which had not suffered any oxidation, indicating that there was very little heat within the engine at impact. The aerofoil was otherwise in good condition.
- 1.16.6 The main gear wheel from the coupling gearbox did not display any evidence of abnormal operation.

1.17 Organisational and management information

- 1.17.1 The operator did not hold an Air Operator certificate and consequently was not required to hold and maintain written operating procedures relating to its heli-logging activities. The work was being performed as a “private” operation.

1.18 Additional information

- 1.18.1 The helicopter fuel system comprised 13 fuel tanks, 11 of which are flexible fuel tanks under the cabin floor and two tanks situated above floor level. The tanks consisted of two groups; the aft group of seven, which, via a boost-pump, fed to the number 1 engine; and the forward group of six, similarly supplied the number 2 engine. There was provision for cross-feeding and fuel dumping. In normal operations the fuel cross-feed valve remains closed and would normally be opened only in the event of a fuel imbalance or for single-engine operation.
- 1.18.2 The helicopter operator indicated that the number 2 engine used more fuel and ran hotter than the number one engine possibly because of its higher time in service.
- 1.18.3 Fuel uplift records were not maintained for the helicopter operation. The aircraft was normally “hot” (engines running) refuelled at about 80-minute intervals during operations. At the completion of the day’s work, the aircraft was generally refuelled before leaving the site, however this investigation was unable to establish conclusively whether or not the helicopter had been refuelled at the end of the day prior to the accident.
- 1.18.4 The aircraft was maintained in accordance with an approved maintenance programme, namely the Westland Wessex HC Mk2 and HC Mk5 Master Maintenance Schedule AP 101C-0102-5A1.

- 1.18.5 During operations, daily inspections of the helicopter and normal day-to-day servicing (i.e. lubrication and replenishment) were performed by the pilot. Maintenance work on the aircraft was performed by a licensed aircraft maintenance engineer (LAME) with the requisite ratings, remote from the day-to-day operation. The pilot kept a diary listing maintenance items requiring further attention. Some of these entries related to defects that should have been reported (by the LAME or the pilot) to CAA in accordance with CAR Part 12. However, no corresponding defect occurrence reports appear on the CAA database.
- 1.18.6 A review of the aircraft logbooks held at the operator's base showed that a small number of the required minor checks had not been entered into the logbooks. The maintenance engineer indicated that these minor checks were carried out on site and had been entered onto the Technical Log held in the aircraft, and which was lost in the post-accident fire.
- 1.18.7 In addition to the engine failure indications referred to in 1.6.9 and 1.6.10, the pilot would, if monitoring cockpit instruments see a sudden decrease in gas generator rpm, power turbine inlet temperature, fuel flow, and power turbine speed. Depending on helicopter weight and airspeed, a decrease in rotor rpm may occur. At various combinations of high weight and low airspeed, the power output from the operating engine may be insufficient to maintain rotor rpm at a safe operating level. In this instance, the pilot must make a reduction in collective pitch to reduce rotor drag (and therefore power required), and if space permits, achieve forward flight. Forward flight results in translational lift, which further reduces rotor drag and facilitates rpm recovery.
- 1.18.8 If rotor speed decreases to a low level, it can become extremely difficult to restore it to a safe operating level, and indeed if left to decay below to a particular point recovery can be impossible. High blade pitch, with associated high drag, can quickly reduce rotor speed to this state. The rotor blades rely to an extent on centrifugal reaction to maintain their plane of rotation, and loss of rpm leads to the upward bending of the blades. This in turn reduces the area of the rotor disc, with a consequent further loss of rotor thrust.
- 1.18.9 External-load operations require the pilot to maintain intense focus on what is occurring outside of the helicopter. Flying from the left seat, the pilot is normally leaning well outside the cockpit for ground viewing during log lift and release. Consequently, cockpit indications may go unheeded during critical periods of operations.
- 1.18.10 Some helicopter types utilised on logging operations have had a modified cockpit "bubble" window fitted, with critical performance instruments and at least a master caution or warning light incorporated in the sill. These enable the pilot to monitor critical engine or transmission parameters without having to divert attention from the load lifting by leaning back into the cockpit at frequent intervals. In this case, the helicopter had no such modification, and the "attention-getter" light (see 1.6.9) on the instrument panel coaming would have been out of the pilot's field of view while he was leaning out of the cockpit.

- 1.18.11 On external load operations, ZK-HVK was flown from the left seat, as this afforded the pilot a better view of the under slung load than was obtainable from the right seat position. There was no flight manual limitation as to which seat a single pilot was to occupy.
- 1.18.12 Manufacturer's data for the Gnome engine indicated that a compressor "spool down" time of at least 40 seconds should be expected when an engine was shut down from its self-sustaining speed of 10,000 rpm.
- 1.18.13 As a result of a number of accidents, incidents and defect reports involving ex-military helicopters, the CAA initiated a review of the operation of these helicopters in mid-2001. At the time of writing of this report, the results of the review were not yet available.

1.19 Useful or effective investigation techniques

- 1.19.1 Nil.

2. Analysis

- 2.1 The scope of this investigation was severely limited by the fact that the helicopter had been largely destroyed by fire.
- 2.2 Examination of the engines, however, yielded conclusive evidence that at the time of the accident, the number 1 engine was operating at high rotational speed, and therefore developing significant power; and the number 2 engine was not developing power.
- 2.3 No systems examination was possible, thus no reason could be established for the number 2 engine's non-operational status.
- 2.4 Approximately 15 seconds elapsed from the initial log lift until the aircraft struck the ground. Spool-down time for the compressor to stop from 10,000 rpm is at least 40 seconds; from the normal operating speed in the region of 23,000 would take somewhat longer. Although the compressor speed at impact is unknown, there was sufficient inertia in the assembly that some rotational damage occurred; the fact that the power turbine was likely to have stopped by the time impact occurred suggests that the compressor rpm was low.
- 2.5 It is therefore likely that the number 2 engine stopped even before the pilot's attempt to lift the log. With his external focus, and the relatively light weight of the helicopter before the log was attached to the longline strop, the engine governing system could have compensated for the stoppage without the pilot's noticing. Any aural cues (such as the sound of the engine actually running down) could have been masked by the exhaust noise from number 1 engine; leaning out of the left side of the cockpit placed the pilot in close proximity to the exhaust outlet.

- 2.6 In this event, failure may have become evident as the weight of the log was taken up, to a point where a single engine could not maintain normal rotor rpm. The deliberate placement of the log back on the ground rather than an immediate jettison suggests that the pilot may have detected some abnormality, but considered the safety of ground personnel ahead of that of the helicopter.
- 2.7 The subsequent behaviour of the helicopter is consistent with the pilot's attempting to restore rotor rpm by achieving forward flight, in this case using the slope of the ground to commence a dive, which would result in rapid acceleration. The steep slope precluded any attempt at an immediate landing. The observed "coning" of the main rotor before impact could indicate that the rotor rpm continued to decay; or that the pilot raised the collective pitch lever in an attempt to avoid, or minimise the effect of ground contact.
- 2.8 The fuel dispersal pattern and the intensity of the post-impact fire indicate that there was fuel on board at the time of the accident, although the fire consumed any evidence that may have assisted in the determination of quantity and fuel system configuration. No reliable determination of the fuel status could be made because of the lack of fuel records and no conclusive evidence as to the last refuel; the possibility that the starboard engine ran out of fuel because of its reputed higher consumption rate could not be explored.
- 2.9 Diary entries made by the pilot noted several aircraft defects that fell within CAR Part 12 reporting criteria, but were not actually reported. Defect incident reporting enables CAA to perform an important part of its role in monitoring and making informed assessments of ongoing airworthiness matters. This monitoring role is particularly important when a manufacturer no longer supports an aircraft type, as was the case in this event. While there was no evidence that any of these defects may have contributed to the accident, the CAA was nevertheless deprived of information crucial to its monitoring function.
- 2.10 The review of maintenance documentation, including management systems showed that in the early stages of operation, considerable expertise was utilised by the operator to establish maintenance system and helicopter integrity. However, the control and monitoring processes utilised after the initial start of operations period relied heavily on one person and were not capable of detecting the omissions from the records, nor did they provide an independent review of the rather complex maintenance aspects of the operation. However, whilst a small number of the maintenance records for the aircraft did not have the required certification made, this is seen as an oversight and not a factor contributing to this accident.

3. Conclusions

- 3.1 The pilot was appropriately licensed and rated for the operation.
- 3.2 The aircraft had been modified to reduce the empty weight for the operation.

- 3.3 The complete status of the maintenance of the aircraft could not be determined as records entered on the Technical Log were destroyed in the accident.
- 3.4 The number 2 engine was probably not operating for some time prior to lifting the log from the ground.
- 3.5 No reason for the stoppage of the number 2 engine could be determined.
- 3.6 The pilot's attention was primarily focused on the external environment during the log lifting operation.
- 3.7 The pilot probably did not immediately detect that the number 2 engine was inoperative.
- 3.8 The helicopter performance was probably such that main rotor rpm could not be sustained on a single engine with the weight of the log beneath the helicopter.
- 3.9 The pilot lowered the nose of the helicopter and descended, probably in an attempt to recover lost main rotor rpm.
- 3.10 There was either insufficient space available to effect recovery, or the rotor rpm had decayed beyond the point where recovery was possible.
- 3.11 The accident was not survivable.

4. Safety actions

- 4.1 The CAA is revising the special category airworthiness certificate approval process for all ex-military helicopters, to ensure that maintenance programmes and modifications take into account the purposes for which they are to be used.
- 4.2 The CAA will advise/remind operators of special category aircraft of the requirement to comply with CAR Part 12 reporting to ensure that informed assessment of future airworthiness can be adequately performed.
- 4.3 The CAA has initiated action to require duplicate Technical Log information to be retained by the operator.

Authorised by

Alan Moselen
Investigator-in-Charge
6 June 2002

Richard White
Manager Safety Investigation
6 June 2002