Australian Government

Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY REPORT
Aviation Occurrence Investigation – AO-2009-017
Final

Wirestrike
Langkoop, Victoria
20 April 2009
VH-EZT
Robinson Helicopter
R44 Raven II

Australian Government

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CONTENTS

THE AUSTRALIAN TRANSPORT SAFETY BUREAU vi

TERMINOLOGY USED IN THIS REPORT vii

FACTUAL INFORMATION 9

History of the flight 9

Pilot information 11

Aircraft information 11

Spray equipment 12

Weight and balance information 13

Powerline information 14

Requirement to mark powerlines 15

Meteorological information 16

Communications 16

Wreckage and impact information 16

Medical and pathological information 18

Survival aspects 19

Pilot's seat 19

Organisational and management information 21

Additional information 22

Spraying procedures 22

Distraction 23

Visual cues 23

Pilot attention 24

ANALYSIS 25

The risk of unplanned application tasks 25

Availability of visual cues to assist with the detection of a wire hazard 25

Distractions during low-level operations 26

Operations in excess of the helicopter's maximum all-up weight 26

FINDINGS 29

Contributing safety factors 29

Other safety factors 29

SAFETY ACTION 31
Helicopter operator 31
Limited company oversight of operational procedures 31
APPENDIX A: MANUFACTURER'S SAFETY NOTICE SN-37 33
APPENDIX B: SOURCES AND SUBMISSIONS 35
Sources of Information 35
References 35
Submissions 35

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Figures 1 and 2: Google Earth
Appendix B: Robinson Helicopter Company

Abstract

On 20 April 2009, a Robinson Helicopter Company R44 (Raven II) helicopter, registered VH-EZT (EZT), was conducting aerial spraying operations near Langkoop, Victoria. Spraying commenced at 0800 Central Standard Time with a load of 300 L of foliar fertiliser. There were two helicopters spraying the pine paddocks that morning and the operating crews were to break for lunch at about 1300 at a pre-arranged meeting place. Just prior to lunch, the pilot of EZT was tasked with a number of unplanned spray runs and a cleanup run to complete the morning's spraying. When the helicopter did not arrive at the pre-arranged meeting place, the pilot of the second helicopter commenced searching and located the wreckage of EZT in a paddock, near a powerline. The pilot of EZT was fatally injured.

Helicopter EZT contacted a powerline that intersected the northern half of the final spray paddock before colliding with the ground. An examination of the wreckage of the helicopter did not find any mechanical abnormalities that might have contributed to the accident.

Recorded data from the helicopter's satellite navigation system showed that after completing the planned spray runs, the pilot did not conduct a reconnaissance of the unfamiliar area to the south of the plantation to identify any hazards. A reconnaissance flight may have alerted the pilot to the presence of the previously-identified powerline.

The investigation found that an additional hazard identification check prior to the conduct of a cleanup run was not routinely practiced by the pilots, or monitored by the operator. In response to that safety issue, the operator has advised that they will enhance the wire avoidance procedures in their operations manual and mandate that an additional hazard identification check shall be completed prior to any cleanup run.

In addition, the investigation determined that there were no fluid quantity markings on the helicopter's spray tank, and that the spray system included unapproved modifications that increased the risk of overweight operations.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The Bureau is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; fostering safety awareness, knowledge and action.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, relevant international agreements.

Purpose of safety investigations

The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated. The terms the ATSB uses to refer to key safety and risk concepts are set out in the next section: Terminology Used in this Report.

It is not a function of the ATSB to apportion blame or determine liability. At the same time, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

When safety recommendations are issued, they focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on a preferred method of corrective action. As with equivalent overseas organisations, the ATSB has no power to enforce the implementation of its recommendations. It is a matter for the body to which an ATSB recommendation is directed to assess the costs and benefits of any particular means of addressing a safety issue.

When the ATSB issues a safety recommendation to a person, organisation or agency, they must provide a written response within 90 days. That response must indicate whether they accept the recommendation, any reasons for not accepting part or all of the recommendation, and details of any proposed safety action to give effect to the recommendation.

The ATSB can also issue safety advisory notices suggesting that an organisation or an industry sector consider a safety issue and take action where it believes it appropriate. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

TERMINOLOGY USED IN THIS REPORT

Occurrence: accident or incident.

Safety factor: an event or condition that increases safety risk. In other words, it is something that, if it occurred in the future, would increase the likelihood of an occurrence, and/or the severity of the adverse consequences associated with an occurrence. Safety factors include the occurrence events (e.g. engine failure, signal passed at danger, grounding), individual actions (e.g. errors and violations), local conditions, current risk controls and organisational influences.

Contributing safety factor: a safety factor that, had it not occurred or existed at the time of an occurrence, then either: (a) the occurrence would probably not have occurred; or (b) the adverse consequences associated with the occurrence would probably not have occurred or have been as serious, or (c) another contributing safety factor would probably not have occurred or existed.

Other safety factor: a safety factor identified during an occurrence investigation which did not meet the definition of contributing safety factor but was still considered to be important to communicate in an investigation report in the interests of improved transport safety.

Other key finding: any finding, other than that associated with safety factors, considered important to include in an investigation report. Such findings may resolve ambiguity or controversy, describe possible scenarios or safety factors when firm safety factor findings were not able to be made, or note events or conditions which 'saved the day' or played an important role in reducing the risk associated with an occurrence.

Safety issue: a safety factor that (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operational environment at a specific point in time.

Risk level: The ATSB's assessment of the risk level associated with a safety issue is noted in the Findings section of the investigation report. It reflects the risk level as it existed at the time of the occurrence. That risk level may subsequently have been reduced as a result of safety actions taken by individuals or organisations during the course of an investigation.

Safety issues are broadly classified in terms of their level of risk as follows:

- **Critical** safety issue: associated with an intolerable level of risk and generally leading to the immediate issue of a safety recommendation unless corrective safety action has already been taken.
- **Significant** safety issue: associated with a risk level regarded as acceptable only if it is kept as low as reasonably practicable. The ATSB may issue a safety recommendation or a safety advisory notice if it assesses that further safety action may be practicable.
- **Minor** safety issue: associated with a broadly acceptable level of risk, although the ATSB may sometimes issue a safety advisory notice.

Safety action: the steps taken or proposed to be taken by a person, organisation or agency in response to a safety issue.

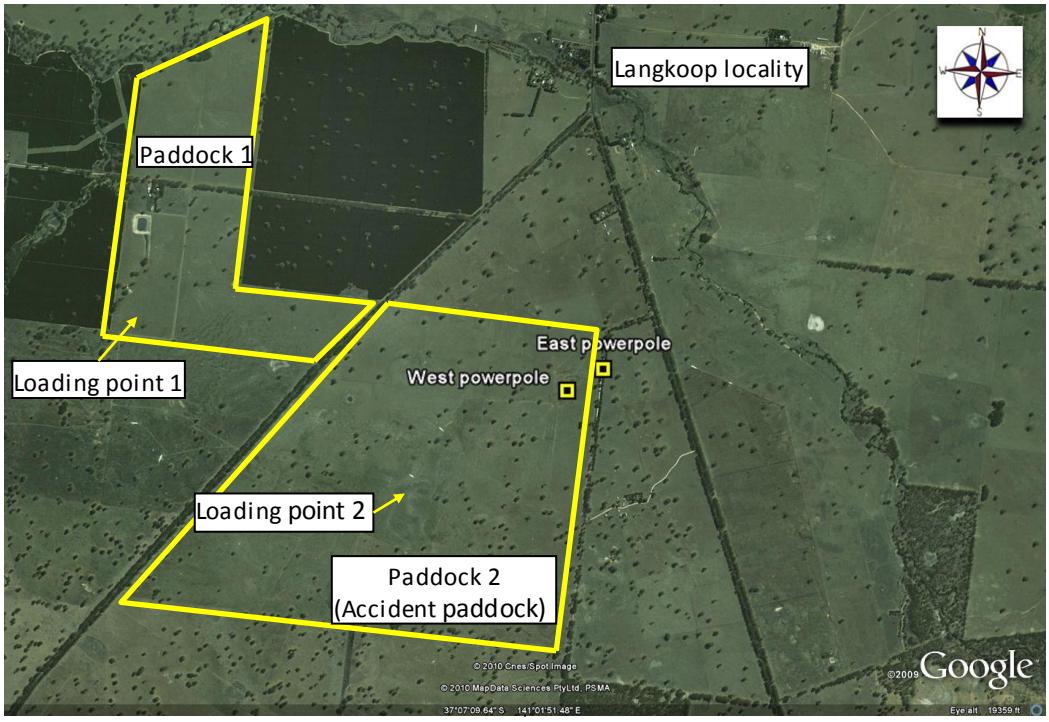
FACTUAL INFORMATION

History of the flight

On 20 April 2009 at about 0700 Central Standard Time[1], a Robinson Helicopter Company R44 Raven II helicopter (R44), registered VH-EZT (EZT), departed Naracoorte Aerodrome, South Australia to conduct aerial spraying operations near Langkoop, Victoria. A second R44 helicopter, registered VH-LOL (LOL), also departed Naracoorte Aerodrome to partake in the spraying operations and both helicopters arrived at the intended spray area at 0720.

Before commencing spraying, the forestry site manager, who was supervising spraying operations, briefed the helicopter operator's chief pilot about the spraying requirements, the layout of the two paddocks that were to be sprayed and the associated hazards (Figure 1). With the aid of a site topographic map, the chief pilot relayed that information to both pilots and discussed how the paddocks would be sprayed.

Figure 1: Overview of spray paddocks 1 and 2



Both helicopters were loaded with chemical at loading point 1 (Figure 1) and spraying was commenced in paddock 1 at about 0800. Spraying continued for 1 hour and 30 minutes, when the helicopters repositioned to meet a load vehicle in paddock 2. At 0936 the helicopters were shut down for 30 minutes awaiting a

[1] The 24-hour clock is used in this report to describe the local time of day, Central Standard Time (CST), as particular events occurred. Central Standard Time was Coordinated Universal Time (UTC) + 9.5 hours.

re-supply of water that was required for chemical mixing. It was reported that both pilots took a break during the wait for the re-supply and that a lunch break was planned after completing the spraying in paddock 2.

The pilots recommenced spraying at 1006. The pilot of EZT completed an additional 16 spray runs in paddock 1 before commencing operations in paddock 2.

The spray runs for paddock 2 were divided between the two helicopters, with the pilot of EZT allocated the northern half of the paddock. The planned spray runs had been programmed into EZT's Satloc[2] global positioning system (GPS) tracking device in preparation for the task and while operating in this area, the pilot successfully negotiated a number of hazards that included large trees, a disused windmill, a power pole and the powerline that was ultimately struck. That powerline partially intersected the northern half of paddock 2, and was aligned in a north-east to south-west direction (Figure 2).

The pilot had previously overflown the powerline eight times while conducting the planned spray runs in paddock 2. Subsequently, the pilot was tasked with two unplanned spray runs in the southern half of that paddock, followed by a cleanup run.

Immediately prior to the cleanup run, the pilot landed at loading point 2 and uplifted a total of 300 L of chemical. He then sprayed along the paddock's western boundary before applying the chemical along the eastern boundary in a northerly direction, toward the powerline (Figure 2).

A short time later the helicopter collided with and severed the powerline adjacent to the eastern boundary of the paddock before impacting the ground. The pilot was fatally injured.

Recorded information showed that the pilot last flew in the vicinity of the powerline about 18 minutes prior to the wirestrike. There was no evidence that the pilot conducted a hazard identification check before commencing the cleanup run.

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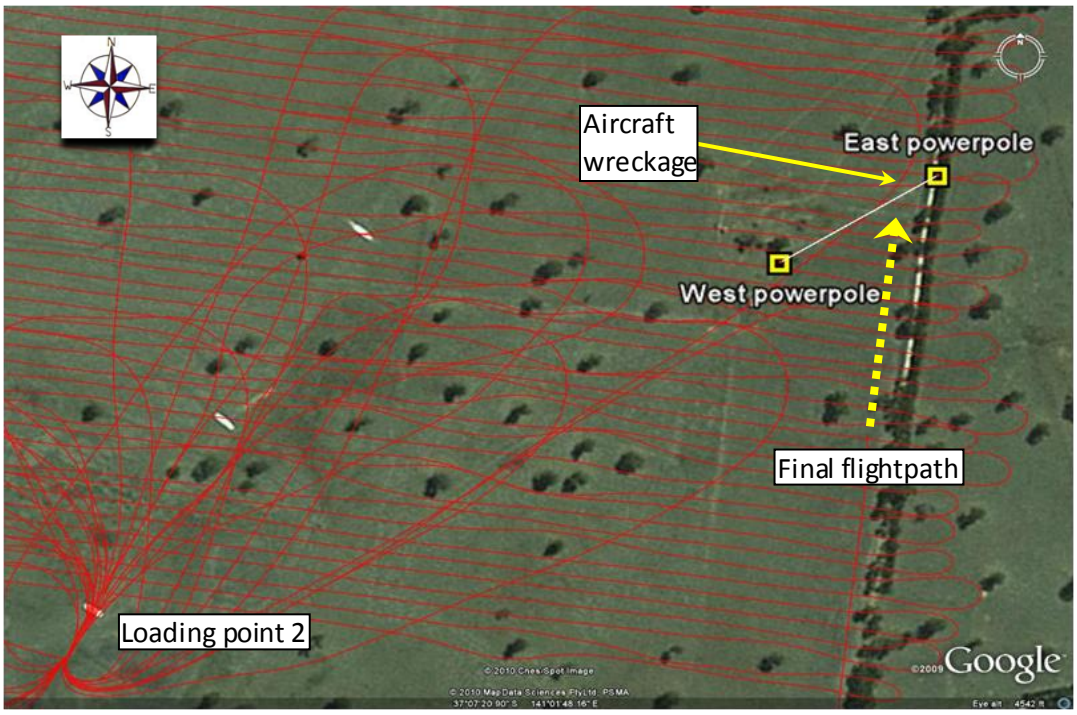
[2] The Satloc GPS guidance system is a visual guidance tool that allows pilots to spray precise patterns within a defined spray area.

Figure 2: EZT Satloc tracks and the position of the powerline in the northern half of paddock 2



Pilot information

The pilot held a Commercial Pilot (Helicopter) Licence (CPL(H)), was appropriately endorsed for the operation and held a valid Class 1 Aviation Medical Certificate with nil restrictions. He had accumulated a total aeronautical experience of about 750 flying hours, including about 260 hours on the R44. In the 3 months prior to 17 March 2009, the pilot accumulated about 67 aerial spraying flight hours.

The pilot held a Grade 2 Helicopter Agricultural Rating, an Aerial Agricultural Association of Australia (AAAA) Spraysafe Pilot Accreditation, and a Pest Management Technician Licence. The pilot successfully completed a helicopter flight review 1 month prior to the accident.

The pilot's duty times could not be determined as no current records were available.

Aircraft information

The Robinson R44 was a single-engine helicopter with a semi-rigid, two-bladed main rotor and seating for four people, including the pilot. The helicopter had skid-type landing gear and was fitted with a Helipod III spray system (Figure 3).

Figure 3: Operator's Helipod III spray system configuration

Manufacturer	Robinson Helicopter Company
Model	R44 Raven II
Serial Number	11443
Registration	VH-EZT
Year of manufacture	22 September 2006
Special certificate of airworthiness	SYDR/COA/371 - Restricted/ AG Ops.(Ref CAR 21.25 (1) (a) Issued 23 March 2007

Spray equipment

The Helipod III spray system included a single fibreglass belly tank that was attached to the helicopter's skid-type landing gear, a spray pump that was located on the front of the right skid, and a spray boom and nozzle arrangement that was located towards the front of the helicopter. The system had a total fluid capacity of 486 L and when fitted, the helicopter was to be operated in the restricted category only.[3]

[3] Had the effect of placing a number of restrictions on the operation of the helicopter during agricultural operations, including that no persons other than the minimum crew may be carried.

The aircraft flight manual supplement for the Helipod III system stated that the spray tank could be filled to a maximum capacity of 320 L or 320 kg. However, a placard on the helicopter's instrument panel stated that when the aircraft was fitted with the Helipod III spray system, the:

- helicopter's maximum all-up weight (MAUW)[4] must not be exceeded
- maximum fill load for the spray tank was to be 285 L or 285 kg
- tank was only to be loaded in a level attitude.

As part of the manufacturing process, the Helipod III spray tank was calibrated and fluid quantity levels were marked adjacent to two glass sight gauges. One sight gauge was located on each side of the spray tank to mitigate against inaccurate fluid quantity readings should the helicopter be inadvertently loaded on uneven ground.

In the case of EZT's spray tank, the sight gauges were transparent hoses that indicated the fluid quantity level of the spray tank. There were no fluid quantity markings on either the sight gauges or the tank that might assist a pilot or loader to accurately determine the quantity in the tank. The manufacturer of the Helipod III stated that the system that was fitted to this helicopter had a number of modifications incorporated that differed from the originally-certified spray unit design. The modifications made by the operator had not been certified.

The operator reported that the ground-based loading tank that was used to mix the chemical before loading the helicopter included fluid level graduations. That allowed the loader[5] to fill the helicopter's spray tank with the planned fluid quantities. The loader stated that relying on the markings on the loading tank mitigated the unreliability of the spray tank sight gauges as a consequence of any slope when filling that tank.

Weight and balance information

The loading crew reported that standard loads of 300 L of chemical were loaded during the day's flying. Of those loads, 100 L was a foliar fertilizer with trace elements of copper and zinc. The total fertilizer weight per load was 121kg.

The standard fuel load for the operation was 50 L, which was reportedly sourced from drum stock.

Examination of the fuel system identified a combined total of about 23 L of fuel remaining in the helicopter's two fuel tanks. That fuel was free of contaminants and both fuel caps were fastened. The loader reported that the helicopter was refuelled about 30 minutes before the last upload of chemical.

The flight manual supplement required that if a pilot's weight exceeded 100 kg, an appropriate amount of ballast was to be added to the front-left stowage compartment. That ensured that the aircraft remained within the design operating lateral centre of gravity (c.g) limits. The operator reported that ballast was not added to EZT for the flight despite the pilot weighing about 137 kg.

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4 Equivalent to the helicopter's maximum gross weight.

5 A ground-based assistant, who transports, mixes and loads the application product onto the aircraft.

Weight calculations based on known data indicated that the helicopter probably exceeded its MAUW by about 95 kg after the last upload of chemical.

The helicopter manufacturer highlighted the following risks when operating at weights above the helicopter's MAUW:

> Exceeding the gross weight in an R44 is primarily detrimental to component fatigue lives and helicopter performance and handling, and may also cause immediate structural damage to the aircraft depending on how the aircraft is handled.
>
> The component fatigue lives listed in the airworthiness limitations section of the maintenance manual are determined using fatigue stresses measured at a number of loading conditions at the aircraft's weight and centre of gravity limits. Exceeding the gross weight will increase fatigue loads beyond those used in the calculation of fatigue life and therefore may cause a significant reduction in fatigue life. This is also addressed in Safety Notice SN-37 [included at Appendix A to this investigation report].
>
> The certification requirements for helicopter performance and handling are only demonstrated up to aircraft weight and centre of gravity limits, and therefore operations beyond these limits have the potential for increased pilot workload and insufficient performance for certain operations.
>
> There are no margins built into the weight limits defined for an aircraft. Although it may appear to the pilot that the aircraft is capable of normal operations at weights above the maximum, fatigue damage will accumulate at a rate higher than that anticipated, and loss of control is possible when encountering flight conditions associated with high pilot workload and/or requiring maximum engine power.

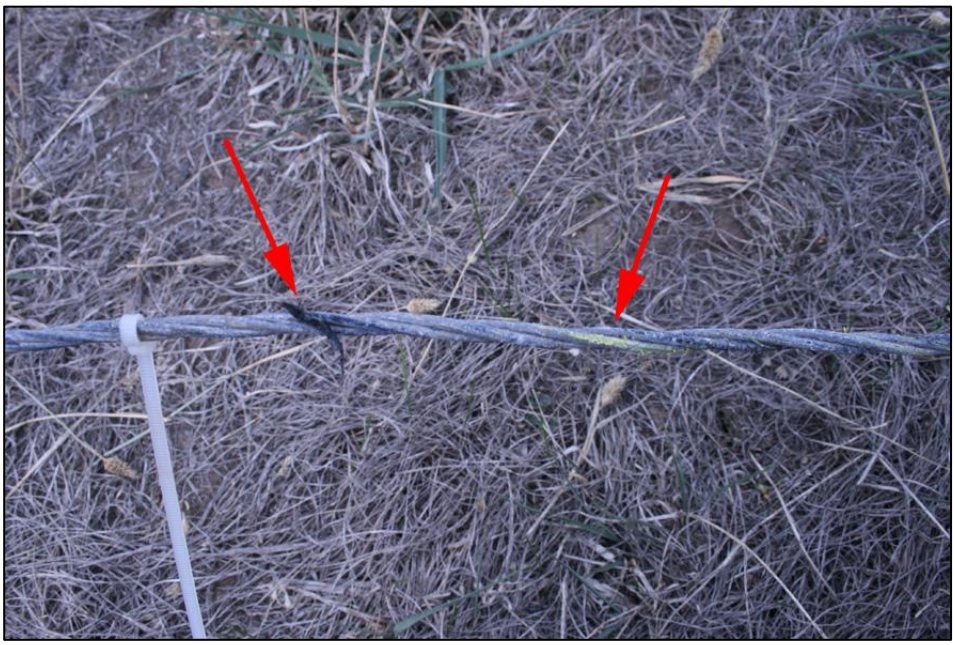
Powerline information

The powerline supplied a disused water pumping station toward the centre of paddock 2 and was reported to have been live at the time of the accident.

The 273 m span powerline included two conductors, each consisting of three strands of high tensile, interwoven steel supported by two power poles that were 9.1 m and 9.8 m in height. The helicopter struck the southernmost conductor at a point about 53 m south-west of the pole that was located beside the road adjacent to the paddock's eastern boundary (Figure 2). The height of the conductor at that point was estimated to be about 9 m above ground level (AGL).

Yellow and black transfer markings were evident on the conductor in the area adjacent to the fracture in the conductor (Figure 3). Those markings corresponded with score marks that were identified on the black plastic connector and yellow hose that formed part of the helicopter's spray unit assembly.

Figure 3: Black and yellow markings observed on the severed conductor, indicative of contact with the spray hoses and fittings



Requirement to mark powerlines

The relevant Australian standard[6] (AS 3891.1) stipulated that any section of cable which had a height in excess of 90 m and a continuous span greater than 50 m was required to be marked if it was above ground that did not contain a road, railway or navigable waterway.

In addition, AS 3891.2 highlighted that where regular low-level flying operations were carried out, visible ground or above ground markers should be considered to highlight the path of relevant powerlines. That included powerlines in areas where aerial spraying activities took place, if the powerlines were positioned near trees, or if the powerlines cut across the corner of a paddock that rendered them difficult to see.

Responsibility for the installation of markers rested with the person requesting the planned low-level flying operations. However, the pilot or pilot's delegate was required to be satisfied as to the need for, and the effectiveness of the markers prior to commencing spraying operations.

In this case, markers were not mandatory for the powerline that was struck by the helicopter.

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[6] Australian Standards AS 3891.1, 2008, Part 1, *Permanent marking of overhead cables and their supporting structures for other than planned low level flying*, and AS 3891.2, 2008, Part 2, *Marking of overhead cables for planned low level flying operations* addressed the requirements for marking overhead cables, including powerlines.

Meteorological information

The pilot of LOL and the loading crew reported that there was no cloud in the vicinity of the application area that day. The visibility was good and there was a light wind of about 5 kts from the east that later changed direction to the north.

The wreckage distribution, Satloc data and ground crew reports indicated that EZT was flying on a northerly heading of about 007° magnetic (M) and at a height of 9 m AGL. The sun's azimuth[7] at that time was 352° true (T) with a vertical angle[8] of about 41° above the horizon.[9] Therefore, the sun would have been about 25° to the left of the helicopter's direction of flight as it approached the powerline and the powerline would have been in full sun.

The pilot of LOL recalled turning to the north minutes before the accident, and although he was not directly affected by the sun during that turn, he commented that generally it was a glary day. The pilot of LOL reported regularly used his helmet's sun visor during spraying activities.

Communications

Spraying operations required both pilots to be in regular contact with each other and with the ground support crew and both helicopters were fitted with ultra high frequency (UHF) and very high frequency radios. It was reported that the UHF radio was used primarily to coordinate loading and to relay any requirements between operating crews.

A compact disc player with an auxiliary port for an external music device was also fitted to the aircraft that allowed pilots to listen to music as they conducted spraying operations. One pilot reported that music dulled the noise of the helicopter and prevented boredom, as spraying operations can sometimes be monotonous.

A personal music player was found in the wreckage trail and was identified as belonging to the pilot of EZT. When found, the unit was still turned ON and operating.

Wreckage and impact information

The helicopter's fuselage was predominantly intact and the tail boom had separated during the impact sequence (Figures 4 and 5). The spray tank that was normally mounted between the helicopter's skids had detached from its mounts and was resting against the aircraft. The spray boom and nozzle attachments had also detached during the accident sequence.

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[7] True azimuth is the clockwise horizontal angle from true north to the object being sighted. Magnetic variation for the accident site was 9.5°E.

[8] The Vertical angle is the angle measured in a vertical plane from the horizon to the required point.

[9] Determined from the Geoscience Australia web site www.ga.gov.au

Figure 4: Main wreckage, looking from the front of the helicopter

The majority of the damage was to the rear-left section of the helicopter (Figure 5). That damage and the separation of the tail boom were consistent with a compressive impact from the rear. The main fuselage and cabin area also sustained significant structural damage.

Figure 5: Rear fuselage compression

The wreckage distribution between the power poles was consistent with the wirestrike at that location. The wreckage was located close to the eastern edge of the plantation crop, and the wreckage trail extended for about 85 m north of the initial point of contact with the powerline.

An on-site examination of the spray gear and boom determined that the front-left corner of the tank had separated from the main tank structure. The separation was

relatively clean, and the angled scrape marks on the tank's blue plastic cap towards the front of the spray tank, and on the surface of the tank were consistent with a wirestrike. The spray boom also showed evidence of contact with the powerline.

Figure 6: Overview of the reassembled spray tank showing the damage caused by the powerline

An examination of the ground marks along the wreckage trail revealed a 20 cm rear section of the left landing gear skid tube embedded in the soil. That was likely to have been the point of initial ground impact, and was consistent with the damage to the rear-left of the helicopter. The middle and front segments of the left skid tube were found in close proximity to the embedded portion of the left skid tube.

A subsequent impact area further along the wreckage was consistent with the impact damage to the front-left of the helicopter. A ground depression and fragmented sections of the cockpit windscreen bubble were found at that location.

A number of damaged sections of the tail boom were found along the wreckage trail. Most indicated contact with the main rotor blades.

On-site examination revealed no evidence of any mechanical malfunction that might have contributed to the development of the accident. The engine was rotating at the time of the impact with the ground.

No defects were noted during the wreckage examination that might have affected the integrity of the pilot's restraint system. The seat belt and related assemblies were removed from the aircraft for technical examination.

Medical and pathological information

The pilot's post-mortem and toxicology reports were benign in respect of their possible contribution to the development of the accident.

Survival aspects

Pilot's seat

A general examination of the pilot's seat assembly showed gross deformation, tearing and downward buckling of the alloy sheet that comprised the under-seat structure. The crushing of the under-seat structure was consistent with its exposure to high vertical (downward) loading from the weight of the pilot.

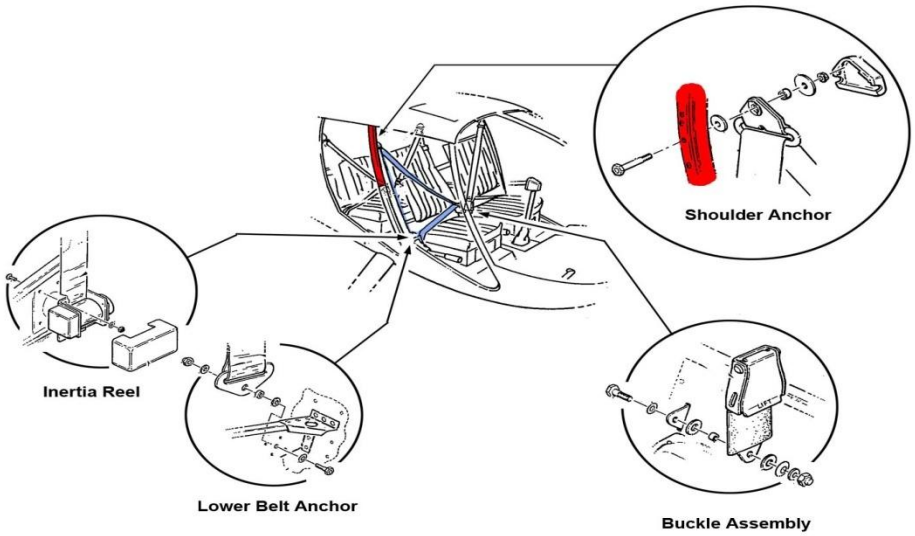
Prior to the accident, the backrest support crosstube had been bolted to lugs within the centre pillar. The crosstube would have normally provided support to the front seat occupant during flight; however, in this instance the tube had fractured from its left-side pillar attachment (passenger side) as a result of forces imposed on the structure during the accident.

Pilot's seat belt

The helicopter was fitted with a Type-2[10] restraint system. A Type-2 restraint is commonly referred to as a 'three-point' harness, where an adjustable shoulder harness and inertia reel restricts the movement of the chest and shoulder region, and a lap belt restrains the pelvis (Figure 7). The belt was attached to the aircraft in three locations; the lower right of the pilot's seat frame, the right-side centre pillar, and to the left of the pilot's seat frame.

Examination of the pilot's seat belt assembly showed that two out of the three attachment points had failed. The uppermost section of the right pillar that anchored the shoulder harness had fractured and had separated from the airframe.

Figure 7: Illustration of the R44 cabin showing the three-point seat belt assembly. The fractured pillar that anchored the shoulder harness is highlighted



[10] SAE Aerospace Standard AS8043B, *Restraint systems for civil aircraft*.

The buckle assembly was securely attached to the airframe and the seat belt harness was found latched in that assembly. The lower belt anchor bracket remained attached to a small section of the airframe, which had itself separated from the main structure (Figure 8).

Figure 8: View of the pilot's seat showing where the lower belt anchor bracket had been attached to the seat/airframe structure

Seat belt and related assemblies examination

The inertia reel was examined via radiographic testing. No evidence of any internal damage was observed to the inertia reel locking mechanism, and it exhibited features consistent with the passenger assembly that was not in use at the time of the accident. Additionally, the inertia reel mechanism was tested for functional integrity to determine if the inertia reel locking mechanism had failed. No fault was found with the inertia reel.

Manufacturer option for the installation of a four-point seat harness

The helicopter manufacturer provided for the optional installation in the R44 of a four-point harness in lieu of the standard three-point harness system that was fitted to EZT. When queried as to whether the fitment of the four-point harness might have improved the survivability of this accident, the manufacturer advised that:

> ...it was reasonably clear that the three point harness had a greater load supporting capacity than the four point harness...damage shown indicates that the loads were significantly beyond the emergency landing design criteria. It is unlikely that a four point harness would have provided improved survivability in this accident.

Organisational and management information

Requirements for the conduct of low-level agricultural operations

The *Day (VFR[11]) Syllabus – Helicopters* outlined the requirements for various helicopter pilot licences. That syllabus included the limited exposure of trainee pilots to low-level operations and their associated hazards.

Additional low-level training for the issue of an agricultural rating was contained in Civil Aviation Order (CAO) 40.6 and required a pilot to satisfactorily complete a period of ground training that was followed by initial and operational flight training. After a period of supervised flying, the pilot was able to exercise the privileges applicable to the agricultural rating unsupervised.

During the initial agricultural pilot training, pilots were to be familiar with low-level operations in the vicinity of powerlines. Pilots were required to explain various planning and risk control strategies for application in the identification of hazards, the effects of weather, the position of the sun and any implications for aerial application as a result of sun glare. Options to identify and then minimise the risks associated with the presence of powerlines included: conducting a preliminary inspection of the treatment area, being aware of the potential impact of in-flight distraction, and identifying visual cues associated with and maintaining awareness of previously-located powerlines.

There was no requirement for pilots to undergo formal training in wire awareness, or for helicopter pilots to conduct recurrent flight checks in agricultural operations.

Aerial inspection of the treatment area

As part of the requirement to hold an air operator's certificate, the operator was required to have an operations manual that provided pilots and staff with a description of the operator's policies and procedures. The manual also reinforced that flying operations were to be conducted in accordance with all Civil Aviation Safety Authority regulations.

The pilot had signed the operations manual about 6 months prior to the accident, which indicated that he had read, understood and agreed to apply the procedures outlined in the manual.

The operations manual required pilots to carry out an aerial inspection of the proposed treatment area in order to identify all hazards prior to commencing agricultural operations. That included an assessment of the:

- boundaries of the treatment area
- location of any powerlines in relation to the boundaries of the area to be treated; the height, position and distance between any supporting power poles; and the position of any guy wires[12]
- height and position of any other obstructions

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[11] Visual Flight Rules (VFR). The rules prescribed by the regulatory authority for visual flight.

[12] Used to secure anything liable to shift its position.

- locations of occupied buildings
- slope of the ground and effect of any contours and undulations
- availability of forced landing areas in the application area.

There was limited guidance in the operations manual on the planning and assessment of an application area; however, pilots were referred to the AAAA Aerial Application Pilot's Manual for more detailed information. It was reported that the AAAA manual was readily accessible to pilots and was located beside the company operations manual in the office.

The AAAA manual stressed the risk of pilots striking wires that had already been located but were subsequently forgotten. The manual highlighted that pilots should consider an additional hazards check before carrying out any cleanup runs, and advised pilots to concentrate on minimising their mental load during application flights and to avoid distractive influences. In contrast, the chief pilot believed that there was no need for an additional hazards check before a cleanup run as pilots were aware of what was in a treatment paddock.

Additional information

Forestry manager briefing

Prior to commencing the aerial spraying operations, the forestry site manager completed a site assessment of the intended spray area. That assessment identified residential developments, environmentally sensitive areas, roads, powerlines and other hazards that might affect the application. The layout of the spray area was charted on a topographical map.

The forestry site manager discussed his initial site assessment with the operator's chief pilot, who then passed that information on to the pilots. To ensure all items were briefed appropriately, and that the area to be sprayed was correctly identified, a site map that highlighted the spray paddocks was provided to both pilots. In addition, a ForestrySA (South Australia) pre-start checklist, which noted the hazards affecting the intended operation was used to ensure the completeness of the discussion. Pilots were able to highlight the relevant features and hazards on their maps, and to discuss any operational issues.

An examination of the site map that was used by the pilot of EZT showed the area to be sprayed and the positions at which the pilot planned to commence the spray runs. The hazards that existed in that section of the paddock were not highlighted.

It was reported by the loader and pilot of LOL that during the 0936 re-supply and break, both pilots discussed the powerline in the north-east corner of paddock 2. The difficulty of seeing the powerline as a consequence of it terminating part way into the paddock was also considered.

Spraying procedures

The agreed spray procedure for use in paddock 2 was to divide it into two halves, each requiring 40 spray runs. The pilot of EZT elected to conduct the 40 spray runs in the northern half of paddock 2 in an east-to-west direction, working from the middle of the paddock towards the northern boundary. The completion of each

spray run required the pilot to conduct a 180° turn prior to commencing the next run.

In order to achieve consistent chemical application rates and to ensure even spray coverage, aerial application pilots fly at set target speeds and altitudes. On the day, the target speed was about 65 kts, and the target altitude was 8 to10 m AGL.

It was determined by the operator that each load of 300 L would be applied to 10 hectares.

Distraction

Distraction refers to drawing away or diverting attention, or to an action that divides attention. Broadly, distraction becomes a risk when multiple stimuli or tasks make simultaneous demands for attention. Generally, distraction results from one of these competing stimuli or tasks interfering with or diverting attention from an individual's original task or focus.

The Australian Transport Safety Bureau research report titled *Dangerous distraction: An examination of accidents and incidents involving pilot distraction in Australia between 1997 and 2004* classified distractions as being:[13]

- visual - where the focus of attention moves to some aspect of the surrounding environment, such as nearby trees or on a road
- auditory - where the affected person may be listening to some stimulus like music, or to a mobile phone
- cognitive - when one's thoughts are not focused on a task, or the affected person is 'lost in thought'.

There is no doubt that pilots are routinely exposed to the risk of distraction. The sources of pilot distraction are diverse, can emanate from a range of tasks and can result in errors in the performance of complex tasks. Similarly, routine operations can be susceptible to the effects of distraction or preoccupation, as highlighted by Reason in 1990:[14]

> A necessary condition for the occurrence of a slip of action is the presence of attentional 'capture' associated with either distraction or preoccupation. This means that wherever else the limited attentional resource is being directed at that moment, it will not be focused on the routine task in hand.

Visual cues

The ability of pilots to detect powerlines depends on the physical aspects of the conductor (wire), such as the spacing of power poles, the orientation of the wire, and the effect of weather (especially visibility).

Under certain environmental conditions, powerlines will be contrasted against the surrounding environment and it may be possible to recognise this contrast as a wire. However the wire itself will often be beyond the resolving power of the eye,

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[13] Available for download at http://www.atsb.gov.au/media/36244/distraction_report.pdf

[14] Reason, J. (1990). Human error. Cambridge, UK: Cambridge University Press, pp 56

wherein the size of the wire and limitations of the eye can mean that it is actually impossible to see the wire. As such, pilots are taught to use additional cues to identify powerlines, such as the associated clearings or easements in trees or fields, or the power poles and/or buildings to which the powerlines connect.

The ability of a human to identify a power pole located in the periphery of the retina is limited as the eye's capability is more about detecting movement than the detail of an object.

During agricultural operations, pilots must retain the position of a powerline in their memory, and may rely on other visual indications of the presence of a wire (such as a group of trees near a power pole or similar). If a pilot then approaches the area from a different direction, such as during a cleanup run, the cues they relied on previously may no longer be noticeable or relevant to the re-identification of the hazard.

Pilot attention

The amount of time spent on a task can affect the ability of a person to remain attentive and vigilant, and the speed and accuracy of detection of stimuli decreases significantly over the first 20 to 35 minutes after commencing a task. It is possible to maintain a person's attention by:[15]

> ...making visual cues more obvious, providing better work-rest schedules, altering a task being performed, and to maintain noise and temperature at optimal levels.

The attempt to increase vigilance levels with the use of irrelevant sound stimulus such as music could affect information stored within a person's short-term memory.[16]

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[15] Saunders, M. S. & McCormick, E. J. (1993). *Human factors in engineering and design (Seventh edition).* NY: McGraw-Hill.

[16] Banbury, S. P., Macken, W. J., Tremblay, S., & Jones, D. M. (2001). Auditory distraction and short-term memory: Phenomena and practical implications. *Human Factors, 43,* 12-29

ANALYSIS

The aerial application of chemical and other substances, like any other low-level operation, elevates the risk of a wirestrike. Extensive investment has been, and continues to be made by regulatory and other authorities, industry participants and safety agencies in an effort to minimise that risk.

There was no evidence to suggest that the performance of the helicopter or its systems, or that the relatively benign weather, might have contributed to this wirestrike with a powerline over which the pilot had flown a number of times prior to the accident. This analysis will examine the contributory and other operational factors in the development of the accident and reinforce a number of strategies to reduce the risk of a wirestrike in such circumstances.

The risk of unplanned application tasks

The practice within the aerial agricultural industry to extensively pre-plan an application task is a valid risk management approach that takes into consideration the hazards affecting an application. Any deviation from previously-planned application runs, including an unplanned cleanup run, has the potential to affect a pilot's awareness of the relative position of previously-known powerlines and other hazards. Similarly, a pilot's ability to visually detect a hazard due to its changed aspect and visual cues can be reduced.

For this reason, the practice adopted by many aerial applicators and recommended by the Aerial Agricultural Association of Australia that an additional hazard check should be undertaken prior to a cleanup run has merit. Had the pilot carried out an additional hazard check prior to commencing the cleanup run, he would have been able to observe the powerline from a safe height and from the direction he intended to conduct the run. That would have allowed him to locate the powerline, to understand the difficulty of locating the power poles once at low level, and potentially to identify a number of features that would alert him of the approaching powerline during the subsequent cleanup run.

Availability of visual cues to assist with the detection of a wire hazard

During low-level operations, it can be difficult for pilots to see a powerline that can often be 'lost' in the visual background environment. In that case, the importance of visual cues to assist in the location of powerlines and other hazards, such as buildings, power poles, and easements should not be underestimated.

The final leg of the cleanup run required the pilot to fly between two large trees that were about 340 m south of the powerline. The tree on the pilot's left would have prevented him from visually identifying the south-west power pole until the helicopter had cleared the trees, and the north-east power pole was totally obscured by trees. In addition, the pilot would have had limited time to identify the southern pole before it moved into his peripheral vision, where the ability for the eye to detect a distant object is greatly reduced. As a result, there was increased reliance on the pilot being able to detect the conductor itself.

The ability of the pilot to detect the conductor was diminished as a result of the reported glary conditions in which the predominantly grey conductor was likely to blend in with the dark-coloured surrounding trees and horizon.

There was evidence that the visual cues available to alert the pilot to the relative position of the wire were significantly reduced. The investigation determined that when viewed from the direction of travel, the north-east power pole was totally obscured by large trees. The south-west pole terminated midway into the northern half of the paddock and was camouflaged by a cluster of large trees. A hazard identification check immediately prior to the cleanup run may have alerted the pilot to the limited visibility of the powerline when approached from the south.

The extent to which the use of powerline markings would have improved the pilot's ability to detect the wire could not be quantified.

Distractions during low-level operations

Divided attention can be a routine part of flying, especially during low-level operations such as agricultural spraying. Any stimulus in that environment that captures a pilot's focus for longer than normal, such as thinking of the pending lunch break, or that distracts the pilot increases the risk of low-level hazards, such as powerlines, not being identified by the pilot.

It was possible that the pilot was listening to music during the cleanup run. If that was so, the music could have divided the pilot's attention and further distracted the pilot from the cleanup run. As a distraction, it had the potential to affect the pilot's awareness/memory of the powerline in the north-east corner of the paddock.

The investigation could not discount that a combination of the pilot's preoccupation with completing the task before lunch, auditory distraction (listening to the music), and divided attention due to the pending lunch break combined to distract the pilot from identifying and avoiding the powerline. The time already spent on the application task may have diminished the pilot's vigilance and attention to the cleanup task.

Operations in excess of the helicopter's maximum all-up weight

As a result of the operator's unapproved spray system modifications and the helicopter's take-off weight being in excess of the helicopter's maximum all-up weight (MAUW), the helicopter's centre of gravity could not be determined.

Although the helicopter's MAUW at the time of the wirestrike was probably within limits, the weight of the helicopter would have been in excess of that limit earlier in the flight. As highlighted by the helicopter manufacturer, there is no guarantee that the helicopter's components will not fail as a result of overweight operations. Similarly, there can be no guarantee that an overweight helicopter will be able to manoeuvre as certified. Any increased inertia as a result of overweight operations, or changed control response can increase the risk that a pilot might not be able to avoid a late-notice hazard – such as a powerline. The manoeuvring associated with low-level aerial application is, by nature, likely to place additional loads on the aircraft and its controls.

The operator's modifications to the helicopter's spray tank would have limited the pilot's ability to accurately determine the fluid quantity in the tank. That increased the importance of the fluid quantity markings on the load truck's tank when loading the helicopter. Even so, the helicopter's spray tank would have had to have been empty each refill to allow for an accurate total load volume of 300 L. It could not be determined if the spray tank was empty before each refill, or the extent that the reliance on the truck tank markings may have contributed to the overweight operation.

FINDINGS

From the evidence available, the following findings are made with respect to the wirestrike near Langkoop, Victoria on 20 April 2009 involving Robinson Helicopter Company R44 Raven II aircraft, registered VH-EZT. They should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing safety factors

- The pilot did not conduct a hazard identification check prior to the cleanup run, which limited his awareness of, and ability to visually detect the powerline.
- Both power poles were obscured by large trees, depriving the pilot of critical visual cues as to the presence of the powerline.
- The helicopter sustained a wirestrike while conducting low-level aerial spraying operations.

Other safety factors

- The Aerial Agricultural Association of Australia suggestion that an additional hazard identification check be carried out prior to a cleanup run was not routinely practiced by the pilots, or monitored by the operator. *[Minor safety issue]*
- A combination of cognitive, visual and auditory distractions prevented the pilot's full attention being given to the cleanup run.
- The helicopter was loaded outside the parameters specified in the manufacturers' aircraft flight manual.
- The removal of fluid quantity markings from, and unapproved modifications to the helicopter's spray tank by the operator increased the risk of overweight operations. *[Minor safety issue]*

SAFETY ACTION

The safety issues identified during this investigation are listed in the Findings and Safety Actions sections of this report. The Australian Transport Safety Bureau (ATSB) expects that all safety issues identified by the investigation should be addressed by the relevant organisation(s). In addressing those issues, the ATSB prefers to encourage relevant organisation(s) to proactively initiate safety action, rather than to issue formal safety recommendations or safety advisory notices.

All of the responsible organisations for the safety issues identified during this investigation were given a draft report and invited to provide submissions. As part of that process, each organisation was asked to communicate what safety actions, if any, they had carried out or were planning to carry out in relation to each safety issue relevant to their organisation.

Helicopter operator

Limited company oversight of operational procedures

Minor Safety issue

The Aerial Agricultural Association of Australia suggestion that an additional hazard identification check be carried out prior to a cleanup run was not routinely practiced by the pilots, or monitored by the operator.

Action taken by the helicopter operator

As a result of this accident, the operator has advised that more comprehensive wire avoidance procedures will be included in the operator's operations manual, and that pilots will be required to conduct an additional hazard identification check prior to any cleanup run.

ATSB assessment of response/action

The ATSB is satisfied that the action by the helicopter operator will, when incorporated in the operator's operations manual, and applied to the operator's spraying activities, adequately address this safety issue.

APPENDIX A: MANUFACTURER'S SAFETY NOTICE SN-37

ROBINSON
HELICOPTER COMPANY

Safety Notice SN-37

Issued: Dec 01

EXCEEDING APPROVED LIMITATIONS CAN BE FATAL

Many pilots do not understand metal fatigue. Each time a metal component is loaded to a stress level above its fatigue limit, hidden damage occurs within the metal. There is no inspection method which can detect this invisible fatigue damage. The first indication will be a tiny microscopic crack in the metal, often hidden from view. The crack will grow with each repetition of the critical stress until the part suddenly breaks. Crack growth will occur quite rapidly in drive system parts from the high frequency torsional loads. It will also occur rapidly in rotor system components due to the high centrifugal force on the blades and hub. Damaging fatigue cycles occur with every revolution of an overloaded drive shaft or rotor blade.

If a pilot exceeds the power or airspeed limits on a few occasions without failure, he may be misled into believing he can safely operate at those high loads. Not true. Every second the limitations are exceeded, more stress cycles occur and additional fatigue damage can accumulate within the metal. Eventually, a fatigue crack will begin and grow until a sudden failure occurs. If the pilot is lucky, the part will have reached its approved service life and be replaced before failure. If not, there will likely be a serious or fatal accident.

WARNING

1) Always operate the aircraft well below its approved Vne (never exceed speed), especially in turbulent wind conditions.

2) Do not operate the engine above its placarded manifold pressure limits.

3) Do not load the aircraft above its approved gross weight limit.

4) **The most damaging conditions occur when flying or maneuvering at high airspeeds combined with high power settings.**

APPENDIX B: SOURCES AND SUBMISSIONS

Sources of Information

The main sources of information during the investigation included the:

- pilot of VH-LOL (LOL) and loaders
- operator of VH-EZT (EZT)
- South Australian Forestry Corporation (ForestrySA)
- helicopter and spray equipment manufacturers
- electricity provider.

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Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003* (the Act), the Australian Transport Safety Bureau (ATSB) may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to the operator of EZT, the pilot of LOL, ForestrySA, the helicopter manufacturer, the manufacturer of the spray equipment, the maintenance company that maintained the helicopter, the electricity provider and the Civil Aviation Safety Authority.

Submissions were received from the pilot of LOL, ForestrySA and the manufacturer of the spray equipment. The submissions were reviewed and, where considered appropriate, the text of the report was amended accordingly.

Wirestrike, Langkoop, Victoria
20 April 2009
VH-EZT, Robinson Helicopter Company R44 Raven II