Australian Government
Australian Transport Safety Bureau

Rescue hoist cable failure involving AS 350 B3, VH-UAH

1 km south-west of Bulga New South Wales, 5 February 2020

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Addendum

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Safety summary

What happened

On 4 February 2020, an Airbus Helicopters AS 350 B3 was being operated in support of New South Wales National Parks and Wildlife Service activities. Winching of personnel and equipment was being conducted when the operating crewman detected a technical issue with the load cable of the hoist system fitted to the helicopter. The outer strands of the cable toward its termination into the hook assembly had loosened in respect of the inner core.

During a subsequent hoist operation to restore the cable integrity, the cable fractured at the hook assembly while under load, releasing the weight bag and hook assembly to the ground. There was no damage to the helicopter or injuries to personnel.

What the ATSB found

The ATSB found that variations in the operator's stowage practices over an extended period of winching operations led to inadequate compression of the hook assembly and subsequent wear to the load cable. The wear damage was due to vibration and movement of the hook assembly during periods of helicopter operation. This led to a significant reduction in the cross-sectional area of the cable, fatigue and fracture of the strands and an associated reduction in cable strength.

It is likely that specific post-flight inspection requirements for the Breeze Eastern rescue hoist required in the Civil Aviation Safety Authority (CASA) Airworthiness Directive AD/SUPP/10 were not being adequately completed by the operator. The inspections were targeted at minimising wear damage to the load cable by ensuring correct stowage of the hook assembly at the end of each flight.

Finally, the operator's method of cycle counting during operation of the rescue hoist led to an accumulation of cycles that significantly exceeded the helicopter manufacturer's recommended life-limit. That exceedance probably compounded the level of wear damage sustained to the load cable.

What has been done as a result

The New South Wales National Parks and Wildlife Service (ParkAir) implemented a range of pro-active safety actions since the occurrence, including:

- In July 2020, ParkAir provided Breeze-Eastern Flight Line maintenance training for all staff including pilots, maintainers and rescue hoist crewman.
- A measurement gauge is now used by crewman to determine whether the hoist has adequate compression in accordance with the pre- and post-flight requirements listed within CASA Airworthiness Directive AD/SUPP/10.
- In January 2021, a revision of the ParkAir Flight Manual Supplement was accomplished to ensure cable inspection procedures requirements are now completed in accordance with CASA Airworthiness Directive AD/SUPP/10.
- ParkAir have adopted the more conservative Airbus Helicopters method for hoist cycle counting and all hoist cables now have a 500 cycle life-limit.

Additionally, as a direct result of this occurrence and the release of ATSB's Safety Advisory Notice SAN-2020-013-001, the following pro-active safety advice was released by organisations responsible for the design, manufacture, and regulation of helicopter rescue hoist systems:

- Breeze-Eastern Service Information Letter (SIL 14 Maintenance) *Breeze-Eastern Rescue Hoist Maintenance & Flight Line Inspections for BL-29700 Series*, release date 6 April 2020

- CASA Airworthiness Bulletin (AWB) 25-034 *Helicopter Rescue Hoist Wire Rope – Wear, Fatigue and Failure*, release date 22 April 2020
- Airbus Helicopters Safety Information Notice (SIN) 3507-S-25 *Fatigue failure of a BREEZE 450 Lbs hoist cable*, release date 4 June 2020
- European Aviation Safety Agency (EASA) Safety Information Bulletin (SIB) 2020-11 *Helicopter Rescue Hoist Cable Failure*, release date 11 June 2020.

Safety message

The ATSB advises all helicopter operators and flight crew involved in rescue hoist operations to review their current operational practices to ensure hoist operation and hook stowage are in accordance with the manufacturers' published procedures.

In addition, it is recommended that the pre- and post-flight inspection requirements of the hook and cable assembly, along with any recurring scheduled maintenance of the hoist system are closely reviewed, to ensure that they are completed in accordance with the manufacturers' instructions. Improper stowage of the hoist hook assembly can lead to excessive movement and accelerated wear of the cable, which if undetected, could have a fatal outcome.

Should any load cable exhibit an increased frequency of outer strand loosening requiring a condition operation, operators should be particularly mindful to check for narrowing or 'necking' of the cable at the ball end within the swivel hook assembly. This can signify that the cable has become damaged due to extreme wear and may no longer be safe to use.

Contents

The occurrence

An Airbus Helicopters AS 350 B3, registered VH-UAH, was being operated by the New South Wales (NSW) National Parks and Wildlife Service (NPWS) Flight Operations Unit (ParkAir) in support of bushfire operations during the 2019/20 summer period. The helicopter had been repositioned from the ParkAir aviation base at Bankstown Airport to a NPWS depot at Bulga, NSW to provide aerial support to fire crews at the Springvalley fire-grounds, within the Blue Mountains National Park. During that period, the helicopter was operated by a single pilot and a crewman operated the rescue hoist.

On 2 February 2020, the crewman assigned to VH-UAH was exchanged with another ParkAir crewman who had mobilised to Bulga. At duty handover, the departing crewman identified that the rescue hoist was operating without issue, however the load cable was starting to exhibit loose wires and would need monitoring. Over the next two days of operation about 30 winches of personnel and equipment was conducted. During that period the replacement crewman identified that the condition of the load cable from the hoist was continuing to deteriorate.

The outer wire strands of the load cable toward its termination into the swivel hook had loosened in relation to the inner core. Such loosening can develop during repeated short-length cable deployment and retrieval cycles. The crewman reported that, in an attempt to rectify the looseness, the outer wires of the cable were massaged and manipulated as it was reeled in and wound onto the hoist drum during operation. Despite that, the looseness was unable to be rectified.

On 4 February 2020, at the conclusion of the daily operations and on return to the Bulga depot, the crewman recommended to the ParkAir senior pilot that a conditioning operation be accomplished. Cable conditioning was a specific procedure intended to tension the cable and realign the wires to restore the cable integrity. It was agreed that it would be completed the following day prior to the conduct of any further winching sorties.

On the morning of 5 February 2020, following a pre-flight inspection of the rescue hoist, the crewman and senior pilot commenced the conditioning operation. A 160 kg weighted bag was attached to the swivel hook and the helicopter was lifted into a low hover and flown to an open field adjacent the NPWS Bulga depot. The bag was suspended about 5 m above the ground and the helicopter lifted into a vertical climb at an equivalent rate as the cable was reeled out from the rescue hoist. This continued until the maximum reel out extension limits of the hoist system were reached, after which the cable was reeled in. At the conclusion of that first conditioning run the crewman identified that the cable had further degraded.

The conduct of an additional conditioning operation was agreed and during that operation while under tension and close to maximum reel out, the cable failed, releasing the weighted bag and swivel hook to the ground.

The crewman advised the pilot that the cable had failed and that the hook and bag had fallen. The pilot's only reported perception of an anomaly was a slight tilt of the helicopter from the centre-of-gravity redistribution when the bag fell. Both crew members returned to the depot and recovered the bag and swivel hook for subsequent examination. There were no injuries to personnel or additional damage to the helicopter. A portion of the fractured cable and the general fitment of the rescue hoist to the AS350 helicopter is shown at Figure 1.

ParkAir immediate actions

Following the cable failure, the Chief Pilot and Senior Pilot distributed an internal notification to ParkAir staff advising of the occurrence. As an immediate measure, ParkAir contacted the hoist manufacturer and arranged for it to be examined. All further ParkAir winching operations were suspended until each system was inspected and had their cables replaced (with the exception of a single hoist that remained in service due to the recent fitment of a new load cable).

Figure 1: A NPWS ParkAir AS350 helicopter (left) displaying general fitment of the rescue hoist, and a close-up of the fractured cable (right)

The fractured cable was found protruding from the swivel hook assembly.
Source: National Parks and Wildlife Service

Context

Operational overview

The New South Wales (NSW) National Parks and Wildlife Service (NPWS) Flight Operations Unit (ParkAir) utilised a fleet of four AS350 B3 helicopters to support field operations that included fire management, personnel insertion duties, feral animal and pest species control. Each ParkAir helicopter could be equipped with an electric-powered recue hoist. A fifth hoist, also operated by ParkAir, was used as back-up in case of an unserviceability. The hoists were used for aerial winching of personnel and equipment into confined areas.

Aircraft information

VH-UAH was an Airbus Helicopters AS350-B3 light utility helicopter manufactured in 2014. It was powered by a single turbine engine and depending on its internal cabin configuration, could transport up to six people. The helicopter had been fitted with a hoist that was attached to an externally-mounted mechanical arm on the left side of the helicopter, adjacent to the rear cabin (Figure 1). The arm pivoted outward during use and also allowed the hoist to be stowed against the fuselage during forward flight.

Hoist information

Manufactured by Breeze-Eastern, the rescue hoist was a model HS-29700 and provided a means for the lowering and raising of a single person or equipment to and from the helicopter (Figure 2). The hoist was remotely operated by the crewmember using a controller and the pilot was also able to control the system if necessary.

The hoist was an approved modification for the helicopter. The instructions for continued airworthiness for the hoist were contained in the:

- Breeze-Eastern Flight Line and Operations Manual[1]
- Airbus Helicopters AS350B3 Master Servicing Manual.[2]

The HS-29700 hoist has an allowable lifting limit of 204 kg and contains a rotating drum onto which is spooled 50 m of useable wire cable that terminates with a swivel hook and bumper assembly. The cable speed can be varied[3] during operation and limit switches within the system automatically trigger to slow the hoist speed as the cable approaches the full-out, or full-in position. The bumper assembly near the swivel hook consists of a crushable rubber block and conical spring that is intended to compress as the cable is reeled in and the full-in limit switch is activated, stopping the hoist. Compression of the spring and bumper assembly is a design feature by the hoist manufacturer to ensure that the swivel hook is adequately homed after being reeled in.

The Breeze-Eastern maintenance manual contained the hoist operating instructions and guidance for continued airworthiness. The manual advised that when reeling in, the cable should be guided by hand, at full pendant thumbwheel deflection to the full in position. The manual provided the following cautionary statement:

> WARNING: WHEN NOT IN USE, THE HOOK MUST BE HOMED COMPLETELY IN THE FULL IN POSITION TO AVOID FATIGUE OF THE CABLE NEAR THE BALL END DUE TO VIBRATION.

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1 Breeze-Eastern TD-01-002, *Flight Line Operation and Maintenance Manual HS-29700 Series Rescue Hoist System*

2 Airbus Helicopters *Master Servicing Manual* AS350 B3

3 Line speed for the HS-29700 winch could be varied by the air crewman from 0 to 210 feet per minute by adjustment of the thumbwheel on the remote pendant.

Hoist cable

The load cable was specified to be manufactured from 0.156 inch diameter corrosion-resistant stainless steel into a 19-strand by 7-wire configured arrangement comprising an inner core and outer layer (Figure 2). To resist rotation during use, the outer strands were woven in the opposite direction to the inner core. A stainless-steel fitting with a spherical ball-end was swaged onto the termination of the cable to enable secure fitment of the swivel hook and bump stop assembly.

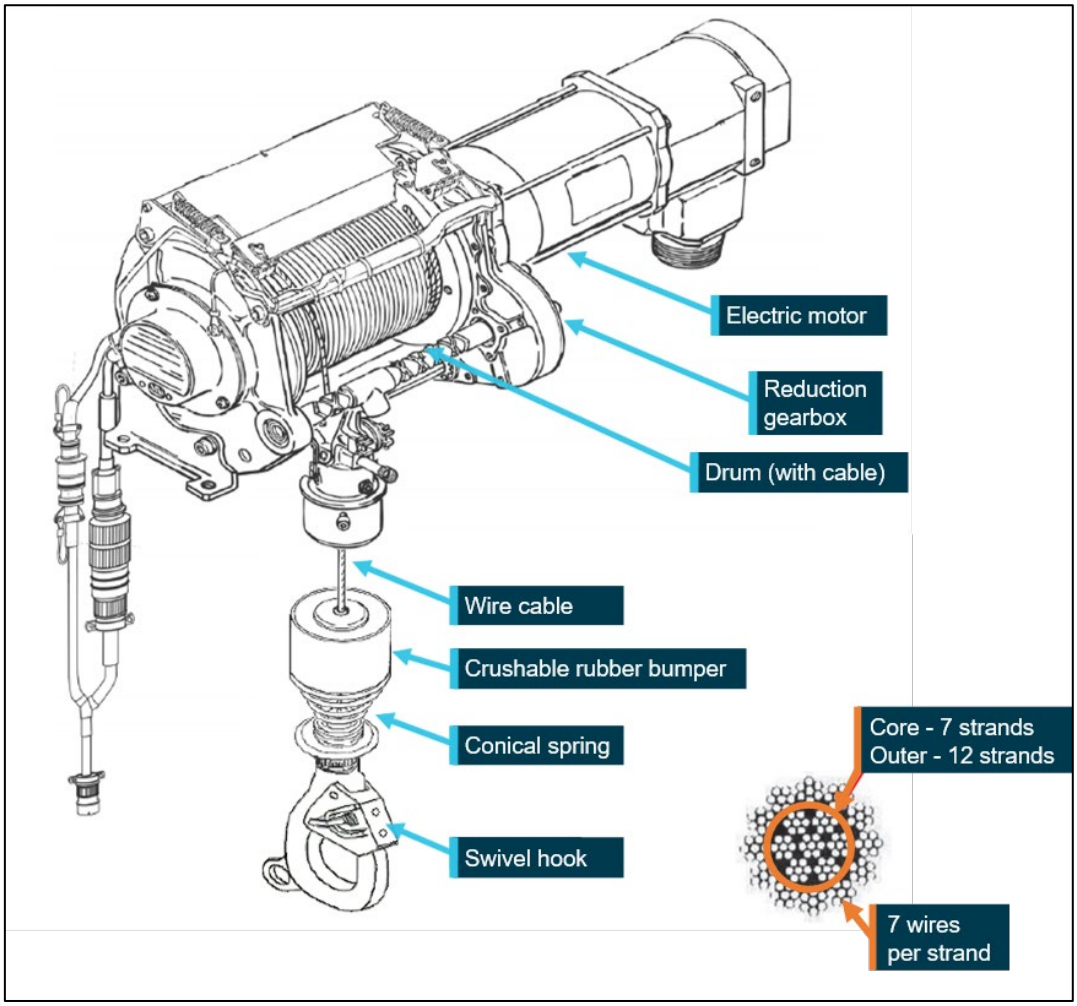
Cycle counting

The Breeze-Eastern hoist was designed with a mechanical counter that recorded each revolution of the drum. The number on the counter was required to be recorded in the hoist logbooks and a calculation provided the total number of hoist cycles accrued during each recurring maintenance period.

Breeze-Eastern used a method whereby the difference on the cycle counter between successive maintenance periods was divided by 264. One complete hoist cycle was equivalent to a full reel-out and then a full reel-in of the cable. This was equivalent to 264 revolutions of the drum being logged by the counter. The method was specific to Breeze-Eastern and did not consider the actual number of winch operations that had been completed. Breeze-Eastern recommended a 1,500-cycle life-limit for their hoist cables. The following cautionary note was contained within the Breeze-Eastern hoist manual:

> 1500 hoist cycle recommended replacement criteria is under ideal laboratory conditions, and may not be representative of actual operating conditions, or usage.

Figure 2: Breeze-Eastern HS-29700 rescue hoist and cross-section of the load cable showing its 19 strand x 7 wire configuration



Source: Breeze-Eastern, annotated by ATSB

Recent maintenance

All significant inspections, including recurring maintenance, were conducted by ParkAir's maintenance provider for the hoist. Records showed that the occurrence rescue hoist (serial number 203) was bought and first introduced into service by ParkAir in December 2011. Over the subsequent 9 years of operation, the hoist was installed onto various AS350 helicopters within the ParkAir fleet until being rotated onto VH-UAH in July 2019 where it remained in service. The hoist logbook contained cycle counter entries confirming that ParkAir had been using the Breeze-Eastern method for recording usage of their rescue hoists.

The last recorded maintenance activity contained in the hoist logbooks was on 3 December 2019 at approximately 600 hoist cycles and indicated the accomplishment of a 3-month and 6-month repetitive inspection in accordance with the Breeze-Eastern HS-29700 maintenance manual. Along with various checks of the system for functionality, an inspection of the swivel hook assembly was indicated as complete with no recorded defects. The load cable had accrued 617 hoist cycles at the time of the cable failure.

Technical examination

Hoist cable from ParkAir AS350 B3 helicopter, VH-UAH

The rescue hoist and the fractured load cable were sent to the ATSB technical facilities in Canberra for further analysis, with senior personnel from ParkAir in attendance during the preliminary examination.

The construction of the cable confirmed it to be of the configuration and type specified by Breeze-Eastern for the BL-29700 hoist. Measurements confirmed the cable to be of the correct diameter with a 19-strand by 7-wire arrangement. The specifications[4] required the load cable to be manufactured from an austenitic stainless steel with a minimum breaking strength of 980 kg.

The load cable fractured approximately 10 mm from the swaged ball end fitting that terminated into the swivel hook assembly (Figure 3). The diameter of the remnant cable stub had drawn down with 'necking' of the cable cross-section evident. Measurements also identified that the inner core had retracted between 50 to 60 mm from the outer layer. Those outer strands had splayed which was typical of an overload cable failure, while the inner core remained tightly gathered. A faint serial number was etched on the shank of the swaged fitting that was confirmed by Breeze-Eastern to match their own records for the hoist and that the cable had been an original fitment from 2011.

Close visual examination of the cable at the point of fracture in the 'necked' region identified that many of the wires were grooved and scalloped (Figure 4). There was no evidence of foreign debris, external abrasion, corrosion, kinking or nicks that might otherwise explain the failure. Remnant lubricant was identified between the wires and on the swaged ball end fitting.

A scanning electron microscope (SEM) was utilised to further analyse the failed cable at much higher magnifications. The SEM examination confirmed that the severe scalloping was due to a wear mechanism of the cable near the point of fracture. The wear had progressed to an extreme level with many of the wires having lost almost the entirety of their cross-section.

A mixed fracture mode was also identified with evidence that some wires had sustained fatigue cracking prior to failure (Figure 5). The general shape of the fatigue cracking was indicative that the cable had been exposed to cyclic bending loads. A portion of the wires had also failed in ductile overstress and these were likely what provided the remnant cable strength during the final conditioning operation.

Hoist cable from ParkAir AS350 B3 helicopter, VH-ZHG

An additional hoist cable was also supplied by ParkAir for comparative examination. That cable had been removed from another Breeze-Eastern BL-29700 rescue hoist as an immediate organisational response to the failure. The secondary hoist cable had accrued 535 hoist cycles. External inspection before destructive sectioning of that cable showed local 'necking' had also occurred in the same area as the failed cable approximately 10 mm from the swaged ball end fitting.

The 'necking' provided an indicator of the onset toward a serious defect, such as worn or broken internal wires and strands. The subtle changes in diameter associated with the 'necking' could also be felt when handling the cable during physical inspection. Magnified examination of the 'necked' region identified that wear grooves and scallops had occurred to the wires comprising the cable. The damage was similar in appearance to that from the failed cable off VH-UAH, though all strands remained intact. Figures 6 and 7 provide further detail on the severity of wear damage associated with 'necking' of the intact hoist cable.

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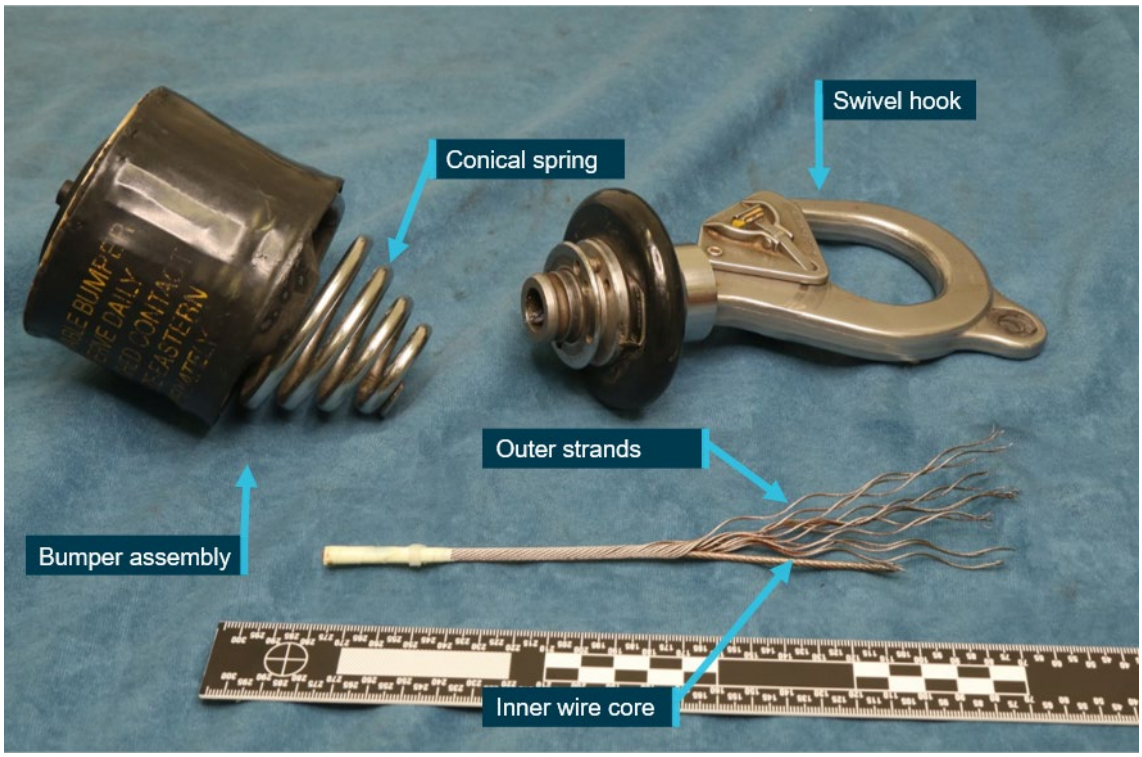
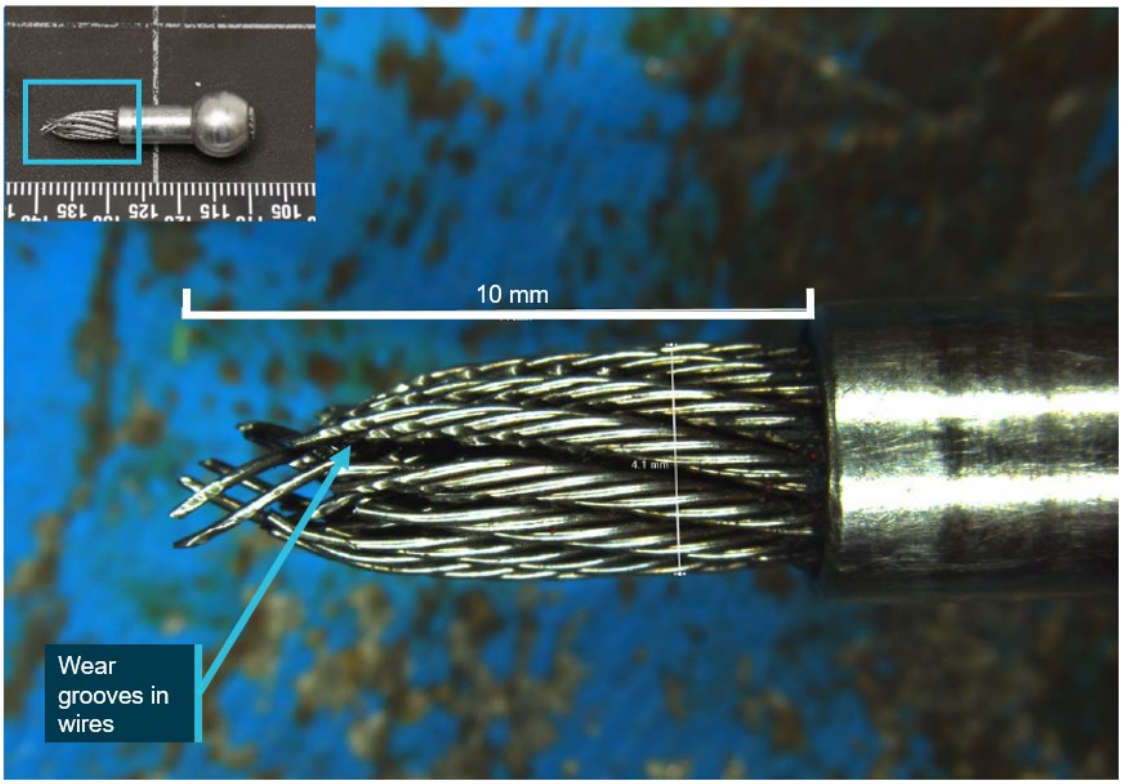
[4] US Department of Defence, MIL-DTL-83140A, 'WIRE ROPE: STEEL, (STAINLESS STEEL) PREFORMED, NONROTATING, FOR AIRCRAFT RESCUE HOIST AND CARGO HANDLING (WINCHING)', 9 July 2004

Figure 3: Swivel hook and bumper assembly



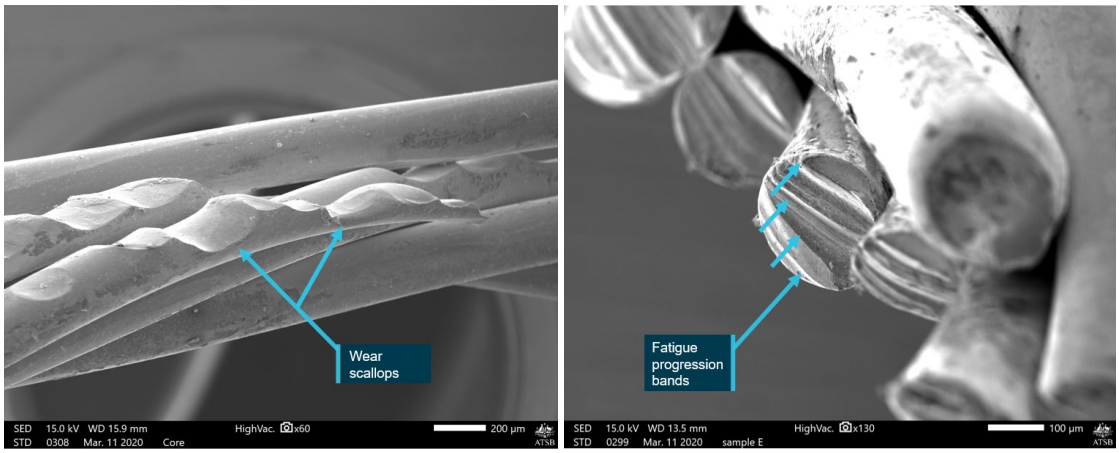
The wire strands comprising the inner core of the cable had retracted approximately 50 mm to 60 mm from the outer strands.
Source: ATSB

Figure 4: Close-up of the remnant cable portion near the swaged ball end fitting showed narrowing or 'necking' and grooves in many of the wires from severe wear damage



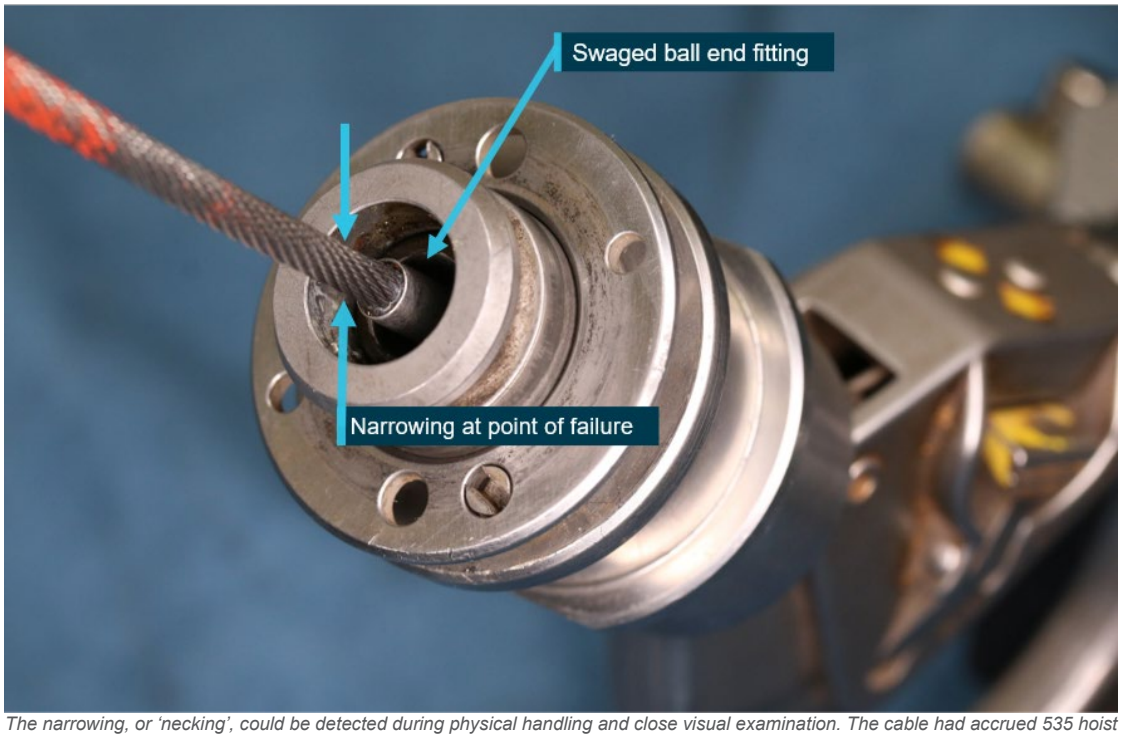
Source: ATSB

Figure 5: SEM images of the fractured cable identified severely worn wires (left) and fatigue crack progression bands from bending fatigue (right)



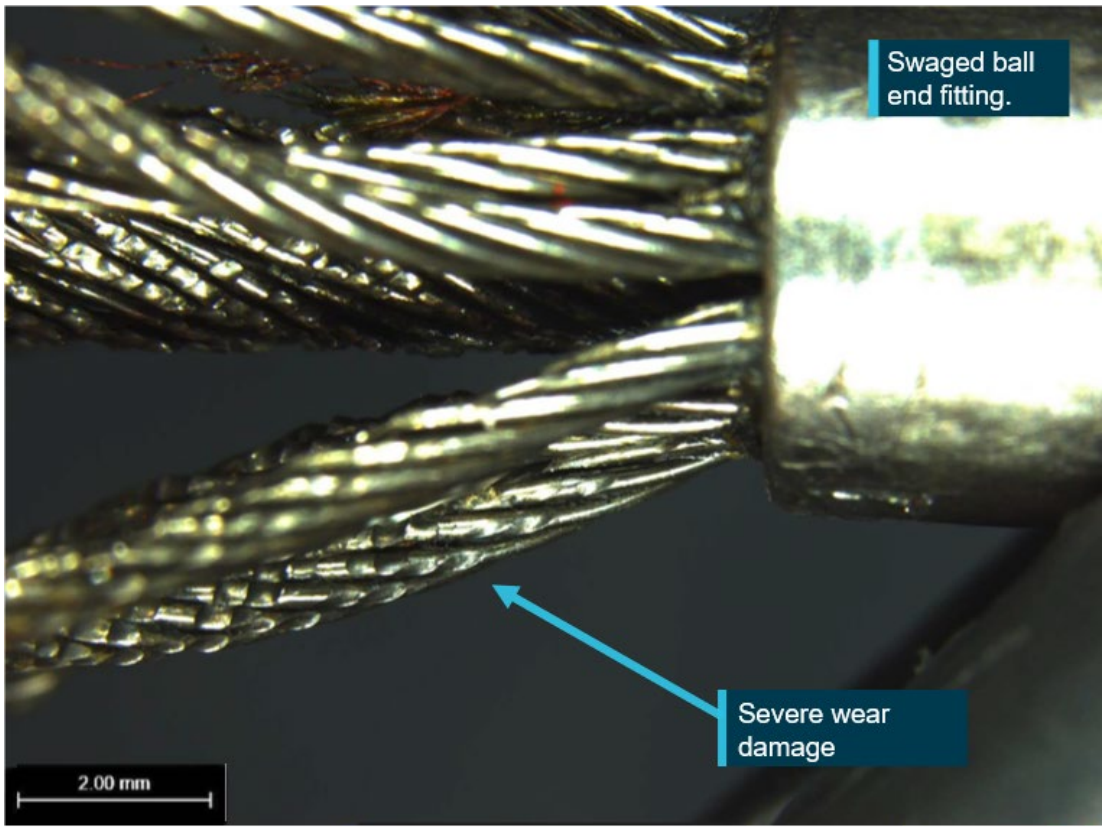
Source: ATSB

Figure 6: Another ParkAir rescue hoist removed from service after the occurrence displayed narrowing of the cable at the ball end fitting.



The narrowing, or 'necking', could be detected during physical handling and close visual examination. The cable had accrued 535 hoist cycles throughout its service life.
Source: ATSB

Figure 7: Severe wear to the wires was evident from the intact cable at the point of narrowing near the swaged fitting



The cable strands in the 'necked' region were spread apart in order to identify the extent of wear damage.
Source: ATSB

Hoist cable inspection requirements

Airworthiness Directive AD/SUPP/10 Breeze-Eastern hoists

Australian operators of Breeze-Eastern hoists were required to comply with Civil Aviation Safety Authority (CASA) Airworthiness Directive AD/SUPP/10.[5] The AD noted that damage can occur to a particular area of the load cable that may evade detection during normal inspection, resulting in a serious compromise of cable integrity. The AD referenced Breeze-Eastern document CAB-100-30[6] that introduced inspections intended to *significantly improve the operational safety of the rescue hoist system*. Specifically, operators of Breeze-Eastern hoists were required to conduct:

1. A one time and recurring inspection of the of the hoist's load cable in a specific area.
2. A pre-flight and post-flight inspection of the hook and bumper assembly during stowage.

During the one-time and recurring inspections, CAB-100-30 required maintenance personnel to partially disassemble the hook assembly to allow a close visual inspection of the cable at the ball end for evidence of necking down, loose or broken wires, and other damage. The hoist logbook indicated no defects were identified from that specific cable inspection, which had last been completed in December 2019 (at approximately 600 hoist cycles).

Pre- and post-flight inspections required from CAB-100-30 were intended to ensure proper stowage of the hook assembly - firmly seated against the bump stop at the conclusion of the homing procedure. CAB-100-30 noted that assurance of adequate hook homing could be

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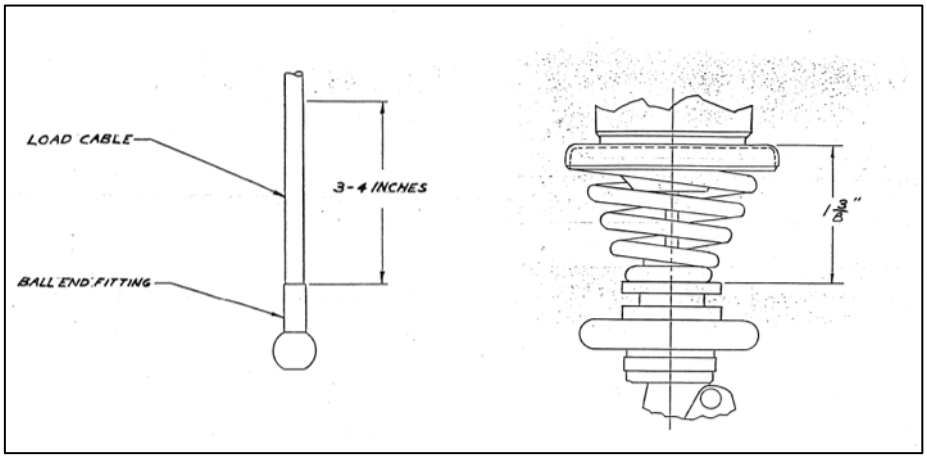
5 Civil Aviation Safety Authority Airworthiness Directive AD/SUPP/10 *Breeze-Eastern Hoists*, November 1998.

6 Breeze-Eastern Customer Advisory Bulletin CAB-100-30, *RESCUE HOIST LOAD CABLE AND HOOK / BUMPER STOWAGE INSPECTION,* 8 December 1987.

achieved by grasping it and rocking it fore and aft. Importantly, the advice from Breeze-Eastern within CAB-100-30 also indicated that during the post-flight inspection of the swivel hook, the degree of spring compression was required to be measured to verify proper homing of the hook, as identified in Figure 8.

Figure 8: Extract from Breeze-Eastern CAB 100-30 describing the inspection requirements 1) the load cable and 2) the hook and bumper spring compression measurement



Source: Breeze-Eastern

Organisation

ParkAir rescue hoist operation

While the rescue hoists within their operator's fleet were primarily used for winching of personnel and equipment in response to operational requirements, another significant aspect of hoist usage involved hoist training/familiarisation exercises. The familiarisation training was mostly conducted at low heights with about 5 m of cable reeled out, leading to the accrual of hundreds of short-haul winches per year.

Hook homing

The Breeze-Eastern procedures for reeling up the load cable and homing of the hook assembly were defined in the hoist operations manual.[7] At the conclusion of a winching operation, and while positioning the hook to the upper limit stop, Breeze-Eastern indicated that it was important to ensure that completion of that action was uninterrupted and provided the following advice:

> Always guide the hook by hand as the cable is reeled in, at full pendant thumbwheel deflection, to the full in position. Ensure the spring in the bumper is compressed sufficiently to prevent the hook from moving when the helicopter is in flight.

ParkAir advised the ATSB that minor variations to the prescribed Breeze-Eastern hook homing procedure had probably developed over the years without correction. It was indicated that in certain instances intermittent control of the cable speed and gentle homing had been conducted to avoid damaging the rubber bumper attached to the hook assembly.

The operator advised that it was uncertain how this deviation in practise arose, however it may have been influenced by a lack of recent Breeze-Eastern Flight Line maintenance training on the hoist system. Such training had last been conducted by ParkAir staff approximately 7 years prior. ParkAir had expanded in that time and staff turnover may have led to the factory-instructed lessons being diluted.

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[7] Breeze-Eastern Flight Line Operation and Maintenance Manual, HS-29700 Series Rescue Hoist System, 2008, p10.

AD/SUPP/10 hoist inspections pre- and post-flight

The ATSB identified that there was no reference within the operator's supplementary documentation to ensure the pre- and post-flight verification that the hook assembly was correctly homed. The safety concerns and corresponding checks raised by CASA within AD/SUPP/10 regarding adequate compression of the hook assembly were not mentioned within the documentation. The operator indicated that, although homing of the hook assembly was physically checked by the crewman at the end of each winching operation, a verification measurement for hook assembly compression, as per AD/SUPP/10 was not accomplished.

Airbus Helicopters hoist specific maintenance

Airbus Helicopters provided technical guidance in their *Master Servicing Manual*[8] that specified the maintenance operations to be performed by the helicopter operator. Within section *25-63 Equipment and Furnishings* of the manual, Airbus Helicopters defined a hard life-limit of 500 hoist cycles on the load cable for the Breeze-Eastern BL-29700 hoist. Airbus Helicopters defined a hoist cycle as:

> Hoisting cycles: HC (Hoist Cycle)
>
> 1 HC =
>
> - In flight, one downward movement + one upward movement, whatever the length of cable and load involved.
> - On the ground, one downward movement of 5 meters or more and one equivalent upward movement, whatever the load involved.

Both the Airbus Helicopters definition of a hoist cycle, and their definition of load cable life-limit were notably different to the definition and limits specified by Breeze-Eastern. Airbus Helicopters indicated that the reason for the discrepancy was to align the hoist cycle definition to other hoists within the Airbus Helicopters fleet. It was also indicated that although the Airbus Helicopters life-limit is significantly more restrictive than that defined by Breeze-Eastern, their limits were intended to provide a greater safety margin during operation.

Regulatory guidance on maintenance

During the course of the investigation, CASA advised the ATSB that regulatory information was available to operators regarding which publication should be consulted if there are two sources of conflicting information for maintaining continued airworthiness, such as that issued by Breeze-Eastern and that issued by Airbus Helicopters. Civil Aviation Regulation (CAR) 50E *Inconsistent requirements – resolution of inconsistencies,* stated the order of priorities under these circumstances:

> (4) The order of priority of requirements is as follows (starting with those of highest priority):
>
> (a) requirements in these Regulations (except those requirements mentioned in the remaining provisions of this subregulation);
>
> (b) requirements in instruments made under these Regulations;
>
> (c) requirements in documents (including designs) approved by CASA or authorised persons under these Regulations;
>
> (d) requirements in instructions issued by designers of modifications of aircraft;
>
> (e) requirements in instructions issued by designers of modifications of aircraft components;
>
> (f) requirements in instructions issued by aircraft manufacturers;
>
> (g) requirements in instructions issued by aircraft component manufacturers;

[8] Airbus Helicopters Master Servicing Manual AS350 B3

(h) requirements in instructions issued by aircraft material manufacturers;

(j) requirements in documents that are approved maintenance data because of paragraph 2A(2)(e).

Using the above list of priority requirements, the hoist had been fitted to the helicopter under a separate engineering instruction 4(d), however that instruction advised that the Airbus Helicopters 4(f) and Breeze-Eastern 4(g) maintenance instructions should be followed. CASA indicated that in this instance, the life-limits listed in the Airbus Helicopters master servicing manual would take precedence and were therefore to be followed.

Other occurrences

A search of the Australian defect reporting system, managed by CASA, identified no specific examples of cable failure similar to the occurrence involving VH-UAH.

However, a similar report of cable 'necking' was identified on a rescue hoist fitted to an Agusta Westland AW139 helicopter. The necking was identified at the swaged terminal within the hook assembly of a Breeze-Eastern hoist by that operator in May 2020. The defect report indicated that the necking had been found after release of CASA AWB 25-034 *Helicopter Rescue Hoist Wire Rope – Wear, Fatigue and Failure* (released in response to the occurrence involving VH-UAH). The cable had accrued 114 cycles and after identifying the necking it was replaced. Also mentioned in the defect report was an indication that the 'necking' was associated with many short hoist cycles accrued in training.

Safety analysis

Introduction

The following analysis discusses the factors surrounding the cable failure from a Breeze-Eastern rescue hoist fitted to an Airbus Helicopters AS 350 B3 helicopter, registered VH-UAH, which occurred near Bulga, New South Wales. The failure occurred while the helicopter crew were conducting a conditioning maintenance operation of the rescue hoist system to restore the integrity of the cable. Although no personnel were injured in this occurrence, the helicopter had previously been conducting live winching.

Wear damage and cable failure

The ATSB's technical examination identified that severe wear damage had developed within the wire strands of the load cable. Additionally, the cable internal core had retracted from the externally wound strands indicating that the inner portion had probably fractured prior to the commencement of the conditioning operation. The failure occurred when the cable was loaded with a 160 kg weighted bag which was significantly less than the ultimate tensile load limit of the cable. In normal circumstances the cable should have withstood the imposed load. There was no evidence of corrosion, kinking, shock loading or any other such damage on the cable that might have otherwise contributed to the failure. Remnant lubricant was identified between the wire strands.

The identified wear led to a significant reduction in cross-sectional area and eventual overstress of the load cable. Some of the worn wires also showed indicators of progressive fracture consistent with the development of fatigue cracking, with the remainder displaying ductile overstress fracture.

Stowage practices and Airworthiness Directive AD/SUPP/10

Breeze-Eastern provided clear advice in the operating instructions for the rescue hoist that when homing the hook, it was important to ensure that the homing action was not interrupted, using full deflection of the controller. This ensured adequate compression of the bump spring and prevented the hook from moving during flight.

The operator commented to the ATSB that in certain instances, intermittent control of the cable speed and gentle homing of the hook had been conducted to avoid damaging the rubber bumper attached to the hook assembly. Although that stowage practice was intended to prevent component damage, it probably led to inadequate compression of the hook assembly that resulted in winch cable damage as the hook assembly vibrated and moved during helicopter operation. The observed wear in the failed cable and the cable off another ParkAir rescue hoist, found to be the result of vibratory movement, supported that conclusion.

In addition to variations in the homing practices, it is likely that specific post-flight inspection requirements for the Breeze Eastern rescue hoist listed in Airworthiness Directive AD/SUPP/10 were not being adequately completed by the operator. The inspections were targeted at verifying correct stowage of the hook assembly at the beginning and end of each flight.

Although the hook assemblies were physically checked for security at the end of each winching sortie, a specific instruction contained within AD/SUPP/10 identified the requirement to measure the degree of spring compression that in turn verified proper hook stowage. The operator's inspection requirements for the rescue hoist did not contain any reference for a compression measurement to be accomplished.

Cycle counting

A significant difference was identified between the method that Breeze-Eastern and Airbus Helicopters used to define hoist cycles and life-limits for load cables. Breeze-Eastern

recommended a 1,500-cycle life-limit while Airbus recommended a 500-cycle life-limit. Breeze-Eastern utilised a mechanical counter within the mechanism of the winch to determine a full winch cycle, while Airbus identified a hoist cycle as a downward and upward movement of the cable in flight.

The winch had been installed onto the helicopter using an engineering instruction that deferred to both the Breeze-Eastern and Airbus Helicopters technical documentation for maintaining continuing airworthiness. In the event of conflicting sources of information, Civil Aviation Regulation (CAR) 50E *Inconsistent requirements – resolution of inconsistencies* provided the means to prioritise the relevant instruction. Under these circumstances, given the hierarchy of inspection orders contained within the regulations, the Airbus Helicopters maintenance instructions should have been followed. ParkAir's use of the Breeze-Eastern method for cycle counting during operation led to an accumulation of load cycles that significantly exceeded the 500-cycle life-limit recommended by Airbus Helicopters.

The wear that occurred to the wires probably occurred over an extended period of in-service movement of the hook assembly, further compounded by the overall extended age and accumulated load cycles of the cable. The hoist cable had accrued 617 hoist cycles and was 9 years old. Based on the number of short-haul winches accrued each year, it is very likely the cable had been exposed to thousands of load cycles. Had the Airbus Helicopters cycle life-limit been followed, the cable would have been removed from service prior to failure.

Findings

ATSB investigation report findings focus on safety factors (that is, events and conditions that increase risk). Safety factors include 'contributing factors' and 'other factors that increased risk' (that is, factors that did not meet the definition of a contributing factor for this occurrence but were still considered important to include in the report for the purpose of increasing awareness and enhancing safety). In addition 'other findings' may be included to provide important information about topics other than safety factors.

Safety issues are highlighted in bold to emphasise their importance. A safety issue is 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 operating environment at a specific point in time.

These findings should not be read as apportioning blame or liability to any particular organisation or individual.

From the evidence available, the following findings are made with respect to the rescue hoist cable failure from an AS350 B3 helicopter that occurred on 5 February 2020.

Contributing factors

- While the helicopter crew were conducting a conditioning maintenance operation of the hoist system, the hoist cable fractured, which allowed the suspended load to fall to the ground.
- Wear damage from in-service movement of the hook assembly led to a significant reduction in cross-sectional area, fatigue and overstress fracture of the strands and an associated reduction in cable strength. The wear was probably compounded by the extended age of the cable and accumulated load cycles.
- Variations in hook stowage practices following winching operations led to inadequate compression of the hook assembly. This probably led to the winch cable becoming damaged due to wear as the hook assembly vibrated and moved during helicopter operation.
- **It is likely that specific post-flight inspection requirements for the Breeze-Eastern rescue hoist listed in Airworthiness Directive AD/SUPP/10 were not adequately completed by the operator. The inspections were targeted at ensuring correct stowage of the hook assembly at the end of each flight. (Safety issue)**
- The operator's method for cycle counting during operation of the rescue hoist led to an accumulation of cable load cycles that exceeded the 500-cycle life-limit recommended by Airbus Helicopters.

Safety issues and actions

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues. The ATSB expects relevant organisations will address all safety issues an investigation identifies.

Depending on the level of risk of a safety issue, the extent of corrective action taken by the relevant organisation(s), or the desirability of directing a broad safety message to the aviation, industry, the ATSB may issue a formal safety recommendation or safety advisory notice as part of the final report.

All of the directly involved parties were provided with 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.

The initial public version of these safety issues and actions are provided separately on the ATSB website, to facilitate monitoring by interested parties. Where relevant, the safety issues and actions will be updated on the ATSB website as further information about safety action comes to hand.

Safety action not associated with an identified safety issue

Industry awareness of the rescue hoist cable failure

After being notified of the cable failure and on completing the technical examination of the hoist components, the ATSB advised the Civil Aviation Safety (CASA), Breeze-Eastern, the European Aviation Safety Agency (EASA), and Airbus Helicopters. Those organisations, along with the ATSB, released the following advisories to provide an alert to the broader helicopter industry.

Breeze-Eastern released Service Information Letter (SIL 14 Maintenance) *Breeze-Eastern Rescue Hoist Maintenance & Flight Line Inspections for BL-29700 Series,* on 6 April 2020. The SIL reminded operators, hoist maintainers and personnel of the critical importance of all listed inspections, including pre-and post-flight, contained in the BL-29700 hoist maintenance manual. The SIL reiterated the requirement to ensure proper compression of the spring from the bumper assembly, and the need for careful inspection of the cable in the immediate area of the swaged ball end fitting.

> Proper hook homing inspections post flight must be done according to the flight line maintenance manual and other appropriate technical documents. Failure to complete these checks and verify that the hook is homed correctly post flight could cause a loosely stowed hook to vibrate during flight, creating stress on the wire rope cable.
>
> The continual vibration of a helicopter and a loosely "homed" hook can result in a fatigue failure of the cable immediately above the ball end fitting.

CASA released Airworthiness Bulletin (AWB) 25-034 *Helicopter Rescue Hoist Wire Rope – Wear, Fatigue and Failure,* on 22 April 2020 to emphasise the care, attention and proficiency required to safely operate and maintain winch systems that lifted and lowered personnel and loads. Within the AWB CASA discussed the cable failure and recommended operators to:

> Ensure inspections are completed methodically and thoroughly.
>
> Always ensure the hook has been homed securely, as per approved data. This will prevent the hook causing premature cable fatigue.
>
> Hoist system cycle counters cannot be used to replace physical and visual system inspections. These cycles are based on fatigue life determined in laboratories. Many hoist operations consist of much shorter deploy and retrieve cycles, than a counter may show. Additional inspections may be warranted.

ATSB released a Safety Advisory Notice (SAN) AO-2020-013-SAN-001 on 23 April 2020 that provided a preliminary summary of the cable failure. The SAN was distributed to all Australian operators permitted to conduct aerial work and conduct helicopter winching operations. The SAN advised:

> For all helicopter operators and flight crew involved in rescue hoist operations to review their current operational practices to ensure hoist operation and hook stowage are in accordance with the hoist manufacturers' published procedures.
>
> For operators, flight crew and maintainers to closely review the pre- and post-flight inspection requirements of the hook and cable assembly, along with any recurring scheduled maintenance of the hoist system, to ensure that they are completed in accordance with the manufacturers' instructions.

Airbus Helicopters released a Safety Information Notice (SIN) 3507-S-25 *Fatigue failure of a BREEZE 450 Lbs hoist cable,* on 4 June 2020 to all operators of AS350 and AS355 civilian helicopters fitted with the Breeze-Eastern BL-29700 winch. The notice provided a reminder that:

> … after a hoisting mission, the hoist operator must position the hoist hook to the upper stop, while holding the control handle in the upward direction without interrupting the automatic stop of the hoist so that the compression phase of the hook assembly is not interrupted.

The notice also advised operators that maintenance of the hoist was to be completed using the Airbus Helicopters definition of a hoist cycle, whereby:

> 1 Hoist cycle (HC) =
>
> In flight, one downward movement + one upward movement, whatever the length of the cable and load involved
>
> On the ground, one downward movement of 5 meters or more and one equivalent upward movement, whatever the load involved.

EASA released Safety Information Bulletin (SIB) 2020-11 *Helicopter Rescue Hoist Cable Failure* on 11 June 2020 that informed European operators of the Breeze-Eastern 450 lb BL-29700 series rescue hoist of the Australian occurrence. EASA recommended the following to all AS350 and AS355 helicopter operators:

> …maintenance personnel should use the applicable Airbus Helicopters definition of a hoist cycle
>
> …maintenance personnel and pilot(s), as applicable, should perform the pre-flight and post-flight inspection(s) as per applicable B-E CMM instructions
>
> …pilots and on-board hoist operators should ensure a proper hoist stowing at the end of each hoist operation, by fully reeling it in to compress the hook bumper. Failure to follow this procedure could result in damage (due to wear and fatigue through vibration and aerodynamic loading) to the cable.

Compliance with AD SUPP 10

Safety issue description

It is likely that specific post-flight inspection requirements for the Breeze Eastern rescue hoist listed in Airworthiness Directive AD/SUPP/10 were not adequately completed by the operator. The inspections were targeted at ensuring correct stowage of the hook assembly at the end of each flight.

Issue number:	AO-2020-013-SI-01
Issue owner:	New South Wales National Parks and Wildlife Service (ParkAir)
Transport function:	Aviation: Other
Current issue status:	Closed – Adequately addressed
Issue status justification:	The ATSB considers that the safety action undertaken by the New South Wales National Parks and Wildlife Service (ParkAir) adequately addresses the safety issue. The operator's compliance with Airworthiness Directive AD/SUPP /10 provides confirmation to personnel involved in winching operations that the hook

	assembly has been adequately stowed, and further limits the potential for the load cable to become damaged during helicopter operations.

Proactive safety action taken by New South Wales National Parks and Wildlife Service (ParkAir)

Action number:	AO-2020-013-PSA-04
Action organisation:	New South Wales National Parks and Wildlife Service (ParkAir)
Action status:	Closed

Following this occurrence New South Wales National Parks and Wildlife Service (ParkAir) advised the following safety actions had been completed:

- Throughout February 2020 winching operations were suspended and the load cables replaced within their fleet of Breeze-Eastern rescue hoists.
- In July 2020, ParkAir were provided Breeze-Eastern Flight Line maintenance training for all staff including pilots, maintainers and rescue hoist crewman.
- A measurement gauge is now used by crewman to determine whether the hoist has adequate compression in accordance with the pre- and post-flight requirements listed within CASA Airworthiness Directive AD/SUPP/10.
- In January 2021, a revision of the ParkAir Flight Manual Supplement was accomplished to ensure cable inspection procedures requirements are now completed in accordance with CASA AD/SUPP/10.
- ParkAir are also now conducting a full-out and then full-in during daily cable conditioning operations in accordance with the Breeze-Eastern flight operations and maintenance manual.
- ParkAir have adopted the Airbus Helicopters method for hoist cycle counting and all hoist cables have a 500 cycle life-limit.

General details

Occurrence details

Date and time:	5 February 2020	
Occurrence category:	Incident	
Primary occurrence type:	Aircraft component failure	
Location:	1 km south-west of Bulga, New South Wales	
	Latitude: 12º 34.567' S	Longitude: 123º 4.567' E

Aircraft details

Manufacturer and model:	Airbus Helicopters AS 350 B3	
Registration:	VH-UAH	
Operator:	Aviation Utilities Pty Ltd	
Serial number:	7861	
Type of operation:	Aerial work	
Activity:	Helicopter winching	
Departure:	Bulga, New South Wales	
Destination:	Bulga, New South Wales	
Persons on board:	Crew – 2	Passengers – 0
Injuries:	Crew – 0	Passengers – 0
Aircraft damage:	None	

Glossary

AD	Airworthiness Directive
ATSB	Australian Transport Safety Bureau
AWB	Airworthiness Bulletin
CAR	Civil Aviation Regulation
CASA	Civil Aviation Safety Authority
CMM	Component maintenance manual
EASA	European Aviation Safety Agency
HC	Hoist cycle
NPWS	National Parks and Wildlife Service
NSW	New South Wales
SAN	Safety Advisory Notice
SEM	Scanning electron microscope
SIB	Safety Information Bulletin
SIL	Service Information Letter
SIN	Safety Information Notice

Sources and submissions

Sources of information

The sources of information during the investigation included:

- New South Wales National Parks and Wildlife Service Flight Operations Unit (ParkAir)
- Civil Aviation Safety Authority
- Breeze-Eastern
- Airbus Helicopters

Additional references

Breeze-Eastern Customer Advisory Bulletin CAB 100-51, Use and Maintenance of Wire Rope on Airborne Personnel Hoists, October 1994

Civil Aviation Safety Authority, Helicopter Personnel Winching, Airworthiness Article AAC 1-103 September 1998

Civil Aviation Safety Authority, Airworthiness Bulletin 25-003 Issue 1, Helicopter Personnel Winching - Human External Cargo (HEC) Operations, 25 April 2015

Helicopter Rescue Techniques, Civilian Public Safety and Military Helicopter Rescue Operations, United States Department of the Interior National Park Service, National SAR Academy (NSARA), First edition October 2013

Information on Helicopter Hoist Wire Rope, Failure Modes, and Rejection Criteria, Zephyr International IIc 2013

James Paul WALLIS, The importance of cable care, AirMed & Rescue Magazine, 4 June 2019

Kasim TURGAT et. al. Falls from height: a retrospective analysis, World Journal of Emergency Medicine, 2018 pp46-50

US Department of Defence, Wire Rope – Steel - Nonrotating for Aircraft Rescue Hoist, Military Specification MIL-W-83140 April 1969. Washington, DC

Submissions

Under section 26 of the *Transport Safety Investigation Act 2003*, the ATSB may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. That section 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 following directly involved parties:

- New South Wales National Parks and Wildlife Service Flight Operations Unit (ParkAir)
- Civil Aviation Safety Authority
- European Aviation Safety Association
- United States National Transportation Safety Board
- Breeze-Eastern
- Airbus Helicopters
- Bureau d'Enquêtes et d'Analyses of France
- the helicopter owner
- the rescue hoist maintainer

Submissions were received from:

- Breeze-Eastern
- Civil Aviation Safety Authority

The submissions were reviewed and, where considered appropriate, the text of the report was amended accordingly.

Australian Transport Safety Bureau

About the ATSB

The ATSB is an independent Commonwealth Government statutory agency. It is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers.

The ATSB's purpose is to improve the safety of, and public confidence in, aviation, rail and marine transport through:

- 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, as well as participating in overseas investigations involving Australian-registered aircraft and ships. It prioritises investigations that have the potential to deliver the greatest public benefit through improvements to transport safety.

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

Purpose of safety investigations

The objective of a safety investigation is to enhance transport safety. This is done through:

- identifying safety issues and facilitating safety action to address those issues
- providing information about occurrences and their associated safety factors to facilitate learning within the transport industry.

It is not a function of the ATSB to apportion blame or provide a means for determining 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. The ATSB does not investigate for the purpose of taking administrative, regulatory or criminal action.

Terminology

An explanation of terminology used in ATSB investigation reports is available on the ATSB website. This includes terms such as occurrence, contributing factor, other factor that increased risk, and safety issue.