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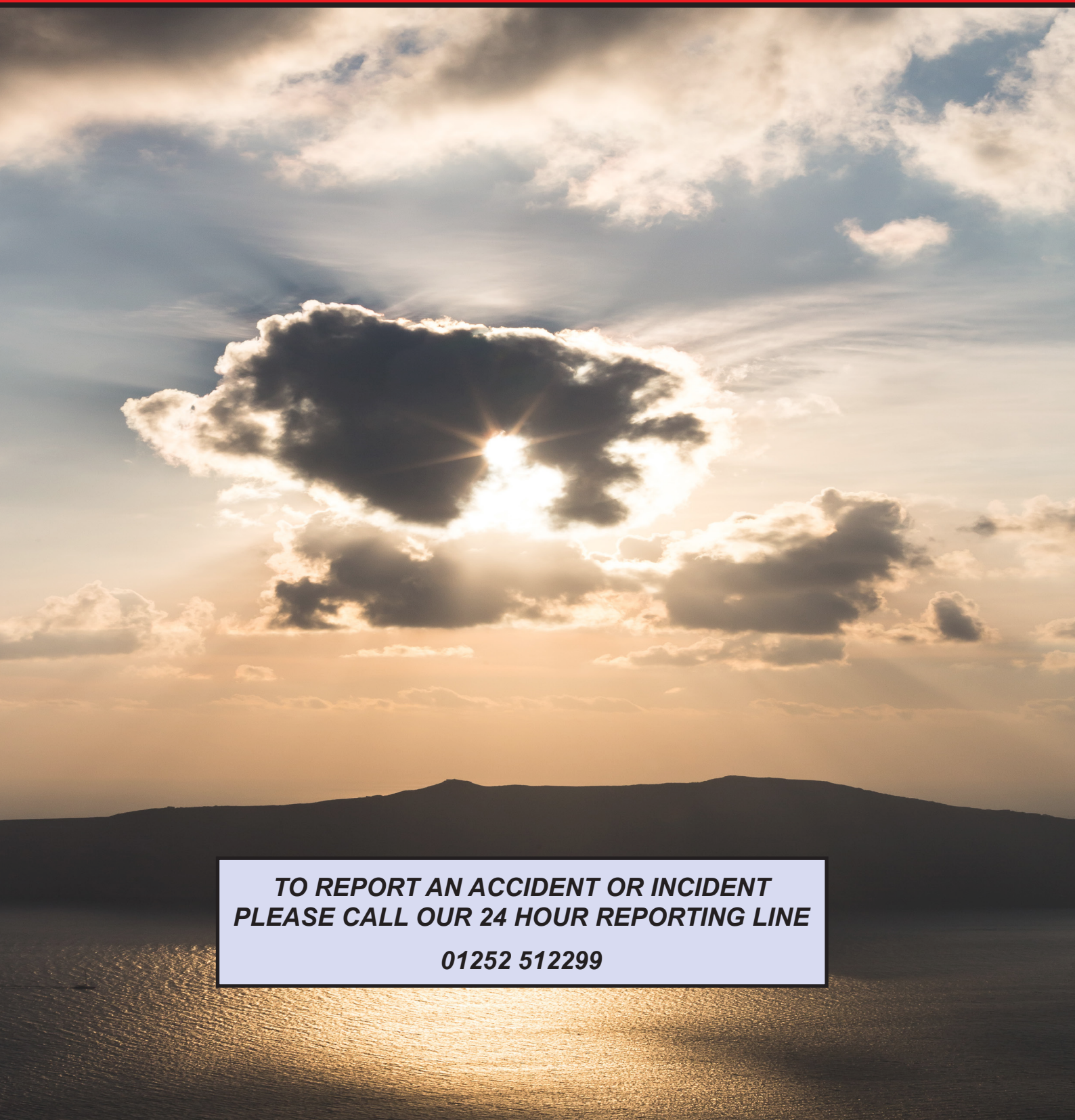
Air Accidents Investigation Branch

AAIB Bulletin 2/2016



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Published 11 February 2016

Cover picture courtesy of Stephen R Lynn
(www.srlynnphotography.co.uk)

ISSN 0309-4278

Published by the Air Accidents Investigation Branch, Department for Transport
Printed in the UK on paper containing at least 75% recycled fibre

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AAIB Special Bulletins and Interim Reports

This section contains Special Bulletins and Interim Reports that have been published since the last AAIB monthly bulletin.

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AAIB Bulletin S4/2015 *SPECIAL*

ACCIDENT

Aircraft Type and Registration:	Hawker Hunter T7, G-BXFI	
No & Type of Engines:	1 Rolls-Royce Avon Mk 122 turbojet engine	
Year of Manufacture:	1959 (Serial no: 41H-670815)	
Location:	Near Shoreham Airport, West Sussex	
Date & Time (UTC):	22 August 2015 at 1222 hrs	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - 1 (Serious)	Passengers - N/A Others - 11 (Fatal)
Nature of Damage:	Aircraft destroyed	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	51 years	
Commander's Flying Experience:	14,249 hours (of which 40 were on type) Last 90 days - 115 hours Last 28 days - 53 hours	
Information Source:	AAIB Field Investigation	

Introduction

The aircraft was taking part in an air display at Shoreham Airport during which it conducted a manoeuvre with both a vertical and rolling component, at the apex of which it was inverted. Following the subsequent descent, the aircraft did not achieve level flight before it struck the westbound carriageway of the A27.

Special Bulletin S3/2015 was published on 4 September 2015 to provide preliminary information about the accident gathered from ground inspection, radar data, recorded images and other sources.

This Special Bulletin is published to highlight findings of the AAIB investigation regarding ejection seat safety and the maintenance of ex-military jet aircraft, and to assist the Civil Aviation Authority in its 'Review of UK Civil Air Displays' announced on 9 September 2015. A final report will be published in due course.

Seven Safety Recommendations are made.

Safety of first responders

Some ex-military jet aircraft are fitted with aircrew escape systems, including ejection seats and canopy jettison systems that contain pyrotechnic cartridges.

Following the accident to G-BXFI, and a separate accident to a Folland Gnat[1] during an air display at Oulton Park on 1 August 2015, the ejection seats fitted to both aircraft were found in a damaged condition. Some of the pyrotechnic cartridges were still live but had been subject to impact forces and post-crash fire. This posed a significant hazard to the first responders and to other personnel on the accident site. Accident response and investigation work in the vicinity of the seats was delayed until competent persons were brought to the site by the AAIB to make the seats safe. In both cases, the respective air display organisers did not have access to relevant aircraft hazard information or emergency contact details for organisations which could render the seats safe. Ex-military aircraft may be equipped with other devices, such as miniature detonation cords (MDC) or other pyrotechnic charges, which can also represent a hazard to first responders and accident site personnel. The following Safety Recommendation is therefore made:

Safety Recommendation 2015-041

It is recommended that the Civil Aviation Authority require operators of ex-military aircraft fitted with ejection seats or other pyrotechnic devices operating in the United Kingdom, to ensure that hazard information is readily available which includes contact details of a competent organisation or person able to make the devices safe following an accident.

Maintenance of ejection seats

The ejection seats and the canopy jettison system in the Hawker Hunter T Mk 7 rely on a number of pyrotechnic cartridges to provide the propellant for the ejection sequence. The ejection seat manufacturer recommends that the installed life of the cartridges does not exceed 2 years and that the total life does not exceed 6 years from the date of cartridge manufacture.

Footnote:

[1] The accident involving Folland Gnat G-TIMM is the subject of a separate AAIB investigation.

Ex-military aircraft on the UK civil register must operate in accordance with Civil Aviation Publication (CAP) 632 '*Operation of Permit-to-Fly ex-military aircraft on the UK register.*' This document requires that all swept-wing ex-military aircraft equipped with ejection seats are operated with 'live' ejection seats. Paragraphs 5.8 and 5.9 state:

> *'5.8 Where ejection seats are an integral part of the aircrew escape system, as specified in the relevant Pilots Notes, Flight or Aircrew Manuals, it is recommended that they be fully serviceable for all flights. Approval should be sought from the CAA (Application and Approvals) at the earliest opportunity if it is intended to operate with inert ejection seats (or other escape systems). It is unlikely that the CAA will allow swept-wing aircraft fitted with ejection seats to be flown unless the equipment is fully operational.*
>
> *5.9 Ejection seat cartridge lives are typically 2 years installed, within a 6 year shelf life. To be fully serviceable the cartridges installed must be within their appropriate lives.'*

In addition, each aircraft in this category is issued with a unique Airworthiness Approval Note (AAN) by the CAA, which forms the basis of its airworthiness approval. AAN No 26172 was issued by the CAA in 1998 for G-BXFI, when it was accepted onto the civil aircraft register, and states:

> *'Cartridges for the Aircrew Assisted Escape System have a 6 (six) year overall/ shelf life and 2 (two) year installed life…..'*

The CAA commented that an AAN is a 'snapshot' of the aircraft status at the time it was placed on the civil register and that any change to a specified component life would need to be approved by the CAA. Any proposed extension would require technical justification.

Chapter 5 of CAP 733 - '*Permit to Fly Aircraft*' describes maintenance of ex-military aircraft. Paragraph 5.4 of that chapter states:

> *'5.4 Ex-military aircraft may have specific life limits for the aircraft structure or critical components defined by the manufacturer, these limits must not be exceeded. Where the manufacturer permits further operation for a period dependent upon the embodiment of additional modifications by more comprehensive and in-depth maintenance checks, these must be carried out before an extension to the operating life will be agreed. There will be no extension of aircraft life limits beyond those that are defined and supported by the manufacturer.'*

The foregoing indicates that the cartridge life specified in ANN No 26172 was a requirement, not guidance or a recommendation.

The ejection seat and canopy jettison cartridges fitted to G-BXFI were manufactured in June and July 2008, and were installed in November 2012, shortly after the maintenance

organisation assumed responsibility for the aircraft. The technical records were updated to correctly indicate the cartridge expiry dates as June and July 2014.

In January 2014, the maintenance organisation placed an order for new ejection seat cartridges and was advised by the supplier that they would be delivered in approximately 52 weeks. During the aircraft's annual maintenance inspection in February 2014 the maintenance organisation decided to leave the cartridges installed until the next scheduled annual inspection and updated the technical records to indicate that the cartridge installation had been extended until February 2015.

During the next annual inspection in February 2015, the maintenance organisation again decided to leave the cartridges installed, as the new cartridges had not yet been delivered. The technical records were updated indicating that cartridge replacement was due in February 2016. The new cartridges were delivered in June 2015, but were not fitted to the aircraft.

The maintenance organisation stated to the AAIB that it operates a 'six-year installed life' policy for ejection seat cartridges. This is not consistent with the manufacturer's recommendations, the guidance in CAP 632, or the requirements of AAN No 26172. The technical records indicate that the maintenance organisation was aware of the cartridge expiry dates at the time they were first installed and stated to the AAIB that the extension of the cartridge lives had been discussed with the CAA, but it did not seek formal approval for this. The maintenance organisation's Maintenance Exposition document stated:

> *'The Chief Engineer will approve the variation if he is satisfied that airworthiness will not be affected. If it is outside his power to approve the variation then he will refer the matter, in writing to the local CAA supervising Surveyor for consideration. Any variation agreed will be entered in the serialised variation file held in Technical Records, and in the aircraft's log books.*
>
> *Variations to scheduled maintenance check periods and component lives may be granted within the limits laid down by the schedule, subject to mandatory requirements or ultimate lives not being exceeded in the extension period.'*

The maintenance organisation informed the AAIB that it considered the decision to extend the cartridge lives was taken within the privileges of its maintenance approvals and therefore it did not consider it necessary to seek formal approval from the CAA to extend the cartridge lives. The CAA stated that any extension of ejection seat cartridge lives would require written approval, and would be based on a technical justification and proof that new cartridges had been ordered.

Neither the maintenence organisation nor the CAA have provided evidence of a written approval or technical justification. Therefore, the ejection seats installed in G-BXFI did not meet the definition of '*fully serviceable*' in CAP 632 paragraph 5.9, nor the requirements of ANN No 26172, and had not done so since June 2014, because they were fitted with time-expired cartridges.

The AAIB understands that other civil-operated ex-military aircraft have been operated with time-expired ejection seat cartridges installed.

The ejection seat manufacturer advised the AAIB that using time-expired cartridges could increase the risk of an un-commanded ejection; or, when ejection is commanded, could result in increased discharge time of cartridges affecting the ejection sequence, or uncontrolled explosion of the cartridges.

In February 2015 the ejection seat manufacturer ceased to provide technical support or replacement parts for ejection seats fitted to aircraft which no longer operate in their original military role. Ejection seats installed in civil-operated ex-military aircraft fall into this category and replacement cartridges manufactured by the original manufacturer are no longer available. As a result, the ejection seat manufacturer considers that such ejection seats should be deactivated to prevent the risk of inadvertent operation. This is contrary to the current CAP 632 requirement for ejection seats in swept-wing aircraft to be operated in a fully operational and armed condition.

The service and maintenance of ejection seats is a specialist task. Civilian organisations which operate or maintain ex-military jet aircraft in the UK often rely on individuals or organisations with specialist skills and prior military experience in ejection seat maintenance to accomplish these tasks. The CAA does not currently issue specific Maintenance Approvals for specialised tasks such as ejection seat maintenance, and these tasks are instead performed under the Maintenance Approval of the designated maintenance organisation.

Ex-military aircraft are accepted onto the UK civil register on the basis of a satisfactory military safety record. Where the presence of aircrew escape systems, such as ejection seats, contributed to that safety record, the CAA expects that the aircraft will continue to operate with these systems in a serviceable condition. The CAA has approved the disarming of ejection seats in some straight-wing ex-military aircraft, where it considers the aircraft has a landing speed low enough to allow a pilot to make a forced landing. However, based on the higher operating speeds of swept-wing ex-military jet aircraft, the CAA requires these aircraft to operate with serviceable ejection seats to provide a means of aircrew escape. Charged systems such as ejection seats carry an inherent safety risk to operational and maintenance personnel and to first responders in the event of an accident. It is acknowledged that, in requiring civilian-operated ex-military aircraft to be equipped with live ejection seats, the CAA must consider the benefits of having a means of aircrew escape against the inherent risks presented by such systems.

The following Safety Recommendation is made:

Safety Recommendation 2015-042

It is recommended that the Civil Aviation Authority review the guidance in CAP 632 with respect to ejection seats and the means by which operators of ex-military aircraft equipped with them comply with this guidance. This review should include:

- The benefits and hazards of aircrew escape systems in civilian operated aircraft
- The use of time-expired components
- The availability of approved spares
- The seat manufacturer's guidance on deactivating its historic products
- Adoption of a dedicated Maintenance Approval for persons or organisations competent to perform ejection seat maintenance

Aircraft maintenance

Training

Aircraft like the Hawker Hunter were built for military service and it was intended that they would be maintained by organisations with comprehensive facilities and personnel who had undergone extensive training. The aircraft's operation, in military service, was also supported by the Original Equipment Manufacturer (OEM) who provided type-specific training, maintenance planning documentation, aircraft and component manuals, a publication amendment service and specialist technical support.

The OEM was also able to share the experience of the worldwide fleet among operators and other relevant organisations. When the aircraft type was retired from military service the support provided by the OEM ceased, limiting the ability of individual civilian organisations operating the type to benefit from worldwide experience.

The technical publications for these ex-military jet aircraft were written in the 1950s and 1960s and assumed a certain level of training and skill. For example, they did not always include comprehensive instructions for component removal and installation. The investigation has found that civil organisations maintaining ex-military aircraft may rely on a core of personnel with prior military aircraft maintenance experience, and who may be familiar with the aircraft type and its manuals.

The lack of OEM support, and the limited number of aircraft of these types on the civil register, means that there are no training courses available for civilian maintenance personnel to maintain ex-military jet aircraft. Informal type-specific training may be undertaken in-house, using ex-military personnel to pass on their knowledge and experience of the aircraft, but this process relies on individual experience and recollection and may therefore vary from organisation to organisation.

Given the limited scope for the dissemination of relevant information from global fleet experience to individual maintenance organisations, and the variability in maintenance training, the following Safety Recommendation is made:

Safety Recommendation 2015-043

It is recommended that the Civil Aviation Authority promote a process for the effective dissemination of ex-military jet aircraft experience and type-specific knowledge between individual maintenance organisations.

Publications

For an ex-military aircraft to be accepted onto the civil register it must comply with the requirements of CAP 733 *'Permit to Fly Aircraft'* Section 5. The CAA issues an Airworthiness Approval Note (AAN) for the aircraft which, among other items, details the documents required to operate and maintain it. These documents are no longer subject to routine amendment and the AAN does not usually specify the required document amendment standard. One manual supplied by the Royal Air Force, to assist the AAIB, was found to contain 20 amendments which were not included in the equivalent manual for G-BXFI. The maintenance organisation confirmed that, in order to try to determine if a more recent revision of the manual was available, it had contacted other maintenance organisations and museums. The AAIB has not established the effect of the variations in manual amendment standard but the lack of a defined minimum amendment standard for technical publications may lead to variations in the maintenance of aircraft of the same type. Therefore the following Safety Recommendation is made:

Safety Recommendation 2015-044

It is recommended that the Civil Aviation Authority establish a minimum amendment standard for the technical publications for each ex-military jet aircraft operated on the United Kingdom civil register.

Maintenance programmes

Discussion with the CAA and maintenance organisations revealed that the maintenance programme for a specific aircraft, whilst based on the OEM's planned maintenance schedule, is developed by the respective maintenance organisation and approved by the CAA. When responsibility for the aircraft's maintenance is transferred to another organisation, the maintenance programme remains the property of the originating organisation and therefore might not be given to the new organisation. The new maintenance organisation must then develop its own maintenance programme, possibly with a limited understanding of the previous maintenance regime, and submit it to the CAA for approval. Therefore the following Safety Recommendation is made:

Safety Recommendation 2015-045

It is recommended that the Civil Aviation Authority require that the maintenance programme relating to an ex-military jet aircraft is transferred with the aircraft when it moves to another maintenance organisation to ensure continuity of the aircraft's maintenance.

Permit to Fly

Ex-military aircraft do not qualify for a Certificate of Airworthiness and are operated under a National Permit to Fly[1] issued under the provisions of Article 21 of the UK Air Navigation Order (ANO). The aircraft is also issued with a Certificate of Validity (C of V) on an annual basis which confirms that the aircraft continues to meet the requirements of its Permit to Fly[2]. Article 22 of the ANO states that a Permit to Fly ceases to be in force if the CAA has issued a directive that requires an inspection, until that inspection has been satisfactorily completed.

Maintenance approval

An approved maintenance organisation that holds the privilege to recommend the issue of a C of V, but does not hold the privilege to issue a C of V, will make a recommendation to the CAA for the revalidation of the aircraft's Permit to Fly. This includes a statement that the aircraft complies with the relevant requirements for British Civil Airworthiness Requirements (BCAR) Section A, which includes the applicable Mandatory Permit Directives (MPD) and life-limited components. On receipt of the recommendation the CAA checks the information submitted with the statement before issuing a new C of V.

The CAA may grant an approved maintenance organisation the privilege to issue its own C of V in respect of a particular category of aircraft. In these circumstances, there is no requirement for the CAA to verify the validity of the statements made as part of the C of V renewal process or to inspect the aircraft or its records. The organisation responsible for the maintenance of G-BXFI had been granted this privilege.

Mandatory Permit Directive (MPD) 2001-001

The aircraft was fitted with a Rolls-Royce Avon 122 engine. The CAA issued MPD 2001-001, applicable to the Rolls-Royce Avon 1, 100 and 200 series engines in response to AAIB Safety Recommendation 99-27, made after a fatal accident to a Hawker Hunter in 1998. This introduced a maximum engine calendar life of 15 years between overhauls, however, recognising that the condition of the engine could be monitored by routine inspection and tests, the CAA allowed operators, and maintenance organisations, to propose an Alternative Means of Compliance (AMOC) for the MPD. If approved, the operator could, through the application of the AMOC, continue to operate the engine beyond the 15-year life stated in the MPD. AMOCs vary from aircraft to aircraft due to a number of factors including aircraft utilisation. The CAA has confirmed that a number of AMOCs to MPD 2001-001 have been in place for several years. However, since their approval, techniques for inspection and monitoring have improved and new methods may be available.

As a result of the accident to G-BXFI, the CAA published Safety Directive SD-2015/003 on 25 August 2015 which required all operators of Hawker Hunter aircraft on the UK civil register to cease all flying operations. At the date of publication of this Special Bulletin CAA Safety Directive SD-2015/003 remains in effect.

Footnote:

[1] Granted under BCAR A3-7.
[2] CAP 733 Section 1.

The CAA has stated that, prior to any return-to-service of Hawker Hunter aircraft, it will require a comprehensive airworthiness review which will include the effectiveness of relevant MPDs.

In order to ensure that all of the currently approved AMOCs for MPD 2001-001 continue to provide adequate monitoring of engine condition and take account of developments in inspection and monitoring methods, the following Safety Recommendation is made:

Safety Recommendation 2015-046

It is recommended that the Civil Aviation Authority review the effectiveness of all approved Alternative Means of Compliance to Mandatory Permit Directive 2001 001.

A review of the records for G-BXFI confirmed that when the maintenance of the aircraft transferred to the current maintenance organisation in August 2012, the previous maintenance organisation had an approved AMOC in place for MPD 2001-001 which consisted of a series of inspections carried out every two years. As part of the maintenance performed after the aircraft's transfer, the CAA permitted the use of the existing AMOC to verify the engine's serviceability until December 2014, to allow the current maintenance organisation time to submit its own AMOC for approval. At the end of this maintenance input the CAA issued a new C of V, valid from 5 December 2012 to 4 December 2013.

The maintenance organisation subsequently issued a new C of V at the end of November 2013 covering the period from 28 November 2013 to 4 December 2014. It then completed an online form which included a compliance statement to confirm the aircraft's airworthiness status.

In mid-January 2014 the maintenance organisation contacted the CAA with its proposal for an AMOC to MPD 2001-001. Email correspondence, provided to the investigation by the CAA, confirmed that the CAA responded at the end of January 2014. This response identified a list of additional information which should be included in any formal submission for an AMOC. The maintenance organisation had no recollection or record of the CAA response and no formal proposal for an AMOC to MPD 2001-001 was made to the CAA.

During annual maintenance between January and March 2014 the maintenance organisation removed the engine from the aircraft and completed the tasks outlined in its proposed AMOC to MPD 2001-001. The aircraft records were annotated stating compliance with MPD 2001-001. In April 2014, the maintenance organisation contacted the CAA for an update on the progress of its AMOC proposal for MPD 2001-001. The investigation has not been able to identify any response from the CAA to this enquiry.

Between December 2014 and March 2015 the aircraft underwent another period of scheduled maintenance where no significant tasks relating to MPD 2001-001 were carried out. In March 2015 the maintenance organisation issued a new C of V covering the period from 11 March 2015 to 10 March 2016.

The work completed by the current maintenance organisation in 2012, using the previous maintenance organisation's approved AMOC, allowed the aircraft's engine to remain in operation until December 2014.

The maintenance organisation was required, under its CAA maintenance approvals, to ensure that systems and procedures were in place to ensure any aircraft under its care met the UK airworthiness requirements. The maintenance organisation believed that the package of work it carried out in March 2014 met the requirements of an AMOC for MPD 2001-001.

In a formal representation to the AAIB, in relation to this Special Bulletin, the CAA reported that it was unclear whether a legally valid AMOC to MPD 2001-001 was in place for G-BXFI at the time of the accident. On this basis it could not determine if the aircraft met the requirements of its Permit to Fly from December 2014 onwards. The CAA indicated that it was trying to clarify the postion. In order to provide certainty of the airworthiness status of ex-military jet aircraft in future, the following Safety Recommendation is made:

Safety Recommendation 2015-047

It is recommended that the Civil Aviation Authority review its procedures to ensure that a *'Permit to Fly-Certificate of Validity'* is valid when it is issued.

Further investigation

The AAIB continues to examine the aircraft and its maintenance records to determine its condition before the accident. It will also explore the operation of the aircraft, the organisation of the event with regard to public safety, and associated regulatory issues.

The AAIB will report any significant developments as the investigation progresses.

Published 21 December 2015

AAIB Field Investigation Reports

A field investigation is an independent investigation in which AAIB investigators collect, record and analyse evidence.

The process may include, attending the scene of the accident or serious incident; interviewing witnesses; reviewing documents, procedures and practices; examining aircraft wreckage or components; and analysing recorded data.

The investigation, which can take a number of months to complete, will conclude with a published report.

SERIOUS INCIDENT

Aircraft Type and Registration:	Airbus A320-232, G-EUYE
No & Type of Engines:	2 International Aero Engine V2527-A5 turbofan engines
Year of Manufacture:	2009 (Serial no: 3912)
Date & Time (UTC):	27 July 2015 at 2110 hrs UTC
Location:	90 nm south-east of London Heathrow Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 6 Passengers - 157
Injuries:	Crew - None Passengers - None
Nature of Damage:	Worn avionic blower fan bearing
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	41 years
Commander's Flying Experience:	10,250 hours (of which 4,700 were on type) Last 90 days - 255 hours Last 28 days - 93 hours
Information Source:	AAIB Field Investigation

Synopsis

Whilst in the cruise at FL240, the flight crew became aware of an unusual noise and an electrical burning smell. The noise quickly developed into a high pitched squeal, with some associated vibration and the smell became stronger, although there was no visible smoke. After donning their oxygen masks the flight crew actioned the appropriate emergency checklist, after which the noise ceased. The aircraft landed safely at its planned destination.

Investigation revealed the cause of the event to be worn bearings in the avionics blower fan. This is a known problem, and both the fan and aircraft manufacturers have taken safety actions to prevent similar incidents in future.

History of the flight

The incident occurred during a scheduled passenger flight between Paris Charles de Gaulle Airport and London Heathrow Airport. Whilst cruising at FL240 and approaching the descent point for London, the flight crew became aware of an unusual noise and an electrical burning smell. The noise quickly developed into a high pitched squeal with some associated vibration and the smell became stronger, although there was no visible smoke.

The flight crew donned their full-face oxygen masks and selected a 100% oxygen supply to protect against the fumes. At the time, the co-pilot was the handling pilot. The commander transmitted a MAYDAY call and received clearance from London ATC for an expeditious descent. He then initiated the drill for smoke/fumes/avionics smoke using the Quick Reference Handbook (the first step, donning the oxygen masks, having already been completed).

The next step of the checklist required that the 'blower' fan in the avionics ventilation system be set to override, following which the noise immediately ceased. The commander completed the checklist, and the crew thought it most likely that the blower fan had been the source of the problem, although they had no means of confirming it.

The commander contacted the senior cabin crew member and briefed her on the situation. She was unaware of the problem and reported that the cabin was unaffected. There was a brief report later of a similar burning smell in part of the cabin, but this did not persist.

There were no unusual flight deck indications before the onset of the problem. After the checklist was actioned, the ECAM[1] alerted the crew to a ventilation system BLOWER FAULT. Later, as the aircraft neared Heathrow, the ECAM generated a further caution, EXTRACT FAULT. The crew noted the cautions, which did not necessitate any further crew action.

As the approach progressed, the flight crew considered that the situation had probably been successfully contained. However, as a precaution, they elected to remain on 100% oxygen until after landing. The approach and landing were uneventful. After the aircraft had vacated the runway, the commander brought it to a stop to allow an external inspection by the airport fire service. As there were no abnormal indications, the aircraft then continued taxiing to its parking stand.

The flight crew later commented that the service provided by London ATC in response to their emergency had greatly assisted them in achieving an expeditious descent and landing. In particular, direct routings and minimal frequency changes had helped to keep their workload at a reasonable level.

Flight crew training

The use of the flight crew oxygen masks is practised during simulator training and checking details. The crew considered that their simulator training had been effective in allowing them to don the masks quickly, to communicate through them and to continue to deal with the situation effectively. After the incident the commander remarked that, because simulator masks are used regularly for training, they do not include the protective clear film cover over the visor which is in place on the actual aircraft masks. Consequently, it is easy to forget that the cover is present, particularly as a situation requiring mask use will inevitably be a stressful one. This happened in this case, although omitting to remove the protective cover did not cause the crew any difficulties with vision.

Footnote:

[1] Electronic Centralised Aircraft Monitor.

Engineering investigation

The avionics blower fan is part of the equipment cooling system and is located in the forward avionics compartment. Visual examination of the fan from G-EUYE in situ revealed no anomalies, but when the fan was switched on a rumbling noise was heard and vibration was felt through the cabin floor. The symptoms were similar to previous fan failures caused by worn bearings, which typically results in a rumbling noise, followed by the smell of burning in the cabin. The fan was removed and when spun by hand it emitted a burning odour and the bearings were worn and noisy.

There are two types of avionics blower fan bearing in service: the original blower fan uses steel ball bearings and the improved fan has ceramic bearings. The fan removed from G-EUYE contained ceramic bearings.

The operator advised that, following a number of recent events, they were in the process of implementing a revised maintenance policy to overhaul fans with ceramic bearings every 12,000 flying hours. At the time of failure the fan from G-EUYE had accrued approximately 16,000 flying hours and was due to be removed for overhaul at the next scheduled maintenance ('C Check'), in September 2015.

Safety actions

In March 2005 the fan manufacturer issued a Vendor Service Bulletin, 3454-21-108, to replace the original steel ball bearings with an improved ceramic bearing. The aircraft manufacturer issued a corresponding Service Information Letter, SIL 21-141, to notify operators. SIL 21-141 was replaced by In Service Information (ISI) 21.26.00027, published in November 2013. The introduction of ceramic bearings has reduced the in-service arising rate, but the aircraft manufacturer reported that fan failure still causes between five and 10 aircraft diversions per year.

In August 2013 the fan manufacturer issued a Service Information Letter, 3454HC-21-250, to inform operators that a new overhaul task had been added to the fan Component Maintenance Manual. The task periodically replaces the bearings and other components subject to wear, with a recommended periodicity of 10,000 Flying Hours. However, the fan manufacturer acknowledged that operators may wish to set their own avionics blower fan maintenance plan and recommended that operators avoid exceeding 12,000 flying hours between fan overhauls.

The aircraft manufacturer advised that, in the longer term, fan vibration monitoring will be the subject of an in-service evaluation aimed at reducing similar events in the future.

ACCIDENT

Aircraft Type and Registration:	Raytheon 390, Premier I, G-OOMC
No & Type of Engines:	2 Williams International FJ44-2A turbofan engines
Year of Manufacture:	2005 (Serial no: RB-146)
Date & Time (UTC):	12 March 2015 at 1148 hrs
Location:	Blackpool Airport, Lancashire
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 2 Passengers - 2
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damaged beyond economic repair
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	34 years
Commander's Flying Experience:	3,455 hours (of which 408 were on type) Last 90 days - 85 hours Last 28 days - 29 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft suffered a hydraulic system problem shortly before commencing an approach to Blackpool Airport. The hydraulic pressure fluctuated initially and there was subsequently a total hydraulic system failure, which was not recognised by the crew. The loss of hydraulic pressure resulted in the speedbrake/lift dump system and power brakes being unavailable, but the emergency braking system remained operational.

The emergency brakes, although available, were not applied during the landing and the aircraft overran the runway at about 80 kt and was extensively damaged. The occupants, who were uninjured, evacuated without assistance.

The investigation determined that, irrespective of the omission to apply the emergency brakes, the Landing Distance Available (LDA) at Blackpool was insufficient for the aircraft to land with a hydraulic failure. A fatigue crack in the port cap[1] of the left hydraulic pump had caused a hydraulic leak which eventually resulted in the total loss of the hydraulic system.

Footnote

[1] Port Cap – Aluminium alloy (7075-T73) cover plate fitted to the pump piston casing containing the suction and pressure ports.

History of the flight

The aircraft planned to fly from Avignon Airport, France to Blackpool Airport, with two flight crew and two passengers. The co-pilot performed the external checks; this included checking the fluid level in the hydraulic reservoir, as stated in the '*Pilot Checklist*'. The aircraft was refuelled to 3,000 lb and, after the passengers boarded, it departed for Blackpool. The commander was the pilot flying (PF).

The takeoff and cruise to Blackpool were uneventful. Prior to the descent the crew noted ATIS Information 'Lima', which stated: Runway 10, wind from 150° at 18 kt, visibility 9 km, FEW clouds at 2,000 ft aal, temperature 11°C, dew point 8°C, QNH 1021 hPa, runway damp over its whole length. The commander planned and briefed for the NDB approach to Runway 10, which was to be flown with the autopilot engaged.

Whilst descending through FL120, the left, followed by the right, hydraulic low pressure cautions illuminated. Upon checking the hydraulic pressure gauge, situated to the left of the commander's control column, the pressure was noted to be '*cycling up and down*', but for the majority of the time it indicated about 2,800 psi (in the green arc). During this time the hydraulic low pressure cautions went on and off irregularly, with the left caution being on more often than the right. The co-pilot then actioned the '*HYDRAULIC SYSTEM - HYDRAULIC PUMP FAILURE'* checklist. It stated that if the hydraulic pressure was a minimum of 2,800 psi, the flight could be continued[2].

Just before the aircraft reached the Blackpool NDB, the commander commented "IT'S DROPPING", but he could not recall what he was referring to. This was followed by the ROLL FAIL and SPEED BRK [BRAKE] FAIL caution messages illuminating. The co-pilot then actioned the applicable checklists. These stated that the Landing Distances Required (LDR) would increase by approximately 65% and 21%, respectively. As the ROLL FAIL LDR increase was greater than that of the SPEED BRK FAIL, the crew used an LDR increase of 65% which the co-pilot equated to 5,950 ft. Runway 10 at Blackpool has an LDA of 6,131 ft, therefore they elected to continue to Blackpool.

The ROLL FAIL checklist stated that a '*FLAPS UP*' landing was required. The co-pilot then calculated the V_{REF}[3] of 132 kt, including a 20 kt increment, as stipulated by the '*FLAPS UP, 10, OR 20 APPROACH AND LANDING*' checklist. The commander then continued with the approach.

At about 4 nm on final approach the co-pilot lowered the landing gear, in response to the commander's request. About 8 seconds later the commander said "JUST LOST IT ALL"; referring to the general state of the aircraft. This was followed almost immediately by the landing gear unsafe aural warning, as the main landing gear was not indicating down and locked. Whilst descending through 1,000 ft, at just over 3 nm from the threshold, the commander asked the co-pilot to action the '*ALTERNATE GEAR EXTENSION'* checklist.

Footnote

[2] See *Operational procedures/checklists* below for the complete checklist procedure.

[3] V_{REF} is the speed to be flown on the final approach prior to landing.

The commander then discontinued the approach by selecting ALT HOLD, increased engine thrust and selected a 500 ft/min rate of climb on the autopilot. However, a few seconds later, before the co-pilot could action the checklist, the main gear indicated down and locked. The commander disconnected the autopilot and continued the approach. The crew did not consider reviewing the '*HYDRAULIC SYSTEM - HYDRAULIC PUMP FAILURE'* checklist as they had not recognised the symptoms of loss of hydraulic pressure.

When ATC issued the aircraft its landing clearance the wind was from 140° at 17 kt. This equated to a headwind component of about 10 kt and a crosswind of about 12 kt.

As the aircraft descended through 500 ft (the Minimum Descent Altitude (MDA) for the approach) at 1.5 nm from the threshold, the commander instructed the co-pilot to advise ATC that they had a hydraulic problem and to request the RFFS to be put on standby. There was a slight delay in transmitting this request, due to another aircraft on frequency, but the request was acknowledged by ATC.

The aircraft touched down about 1,500 ft from the start of the paved surface at an airspeed of 132 kt and a groundspeed of 124 kt. When the commander applied the toe (power) brakes he felt no significant retardation. During the landing roll no attempt was made to apply the emergency brakes, as required in the event of a power brake failure. The co-pilot asked if he should try to operate the lift dump, but it failed to function, due to the lack of hydraulic pressure. At some point, while the aircraft was on the runway, the co-pilot transmitted a MAYDAY call to ATC. When an overrun appeared likely, the commander shut down the engines. The aircraft subsequently overran the end of the runway at a groundspeed of about 80 kt. The commander later commented that he was in a "state of panic" during the landing roll and was unsure whether or not he had applied the emergency brake.

As the aircraft left the paved surface the commander steered the aircraft slightly right to avoid a shallow downslope to the left of runway's extended centreline. The aircraft continued across the rough, uneven ground, during which the nose gear collapsed and the wing to fuselage attachments were severely damaged (Figure 1). Once it had come to a stop, he shut down the remaining aircraft systems. The passengers and crew, who were uninjured, vacated the aircraft via the entry/exit door and moved upwind to a safe distance. The RRFS arrived shortly thereafter.

Figure 1
G-OOMC post-accident

Recorded data

The aircraft was equipped with a 30-minute duration CVR which was removed from the aircraft and successfully replayed by the AAIB. The recording commenced as the aircraft started its descent from FL250 at 1118 hrs, prior to the hydraulic system fault indication, and ended almost immediately as the aircraft overran the runway, at 1148 hrs. (The CVR is stopped automatically if an acceleration of 6g or greater is sensed by an inertia switch).

Radar information was available from three radar heads. The radar at St Annes, located less than 1 nm to the south-east of Blackpool Airport, provided a complete record of the approach and landing, with Mode S groundspeed and airspeed data available.

The salient recorded data for the approach and landing are presented in Figure 2.

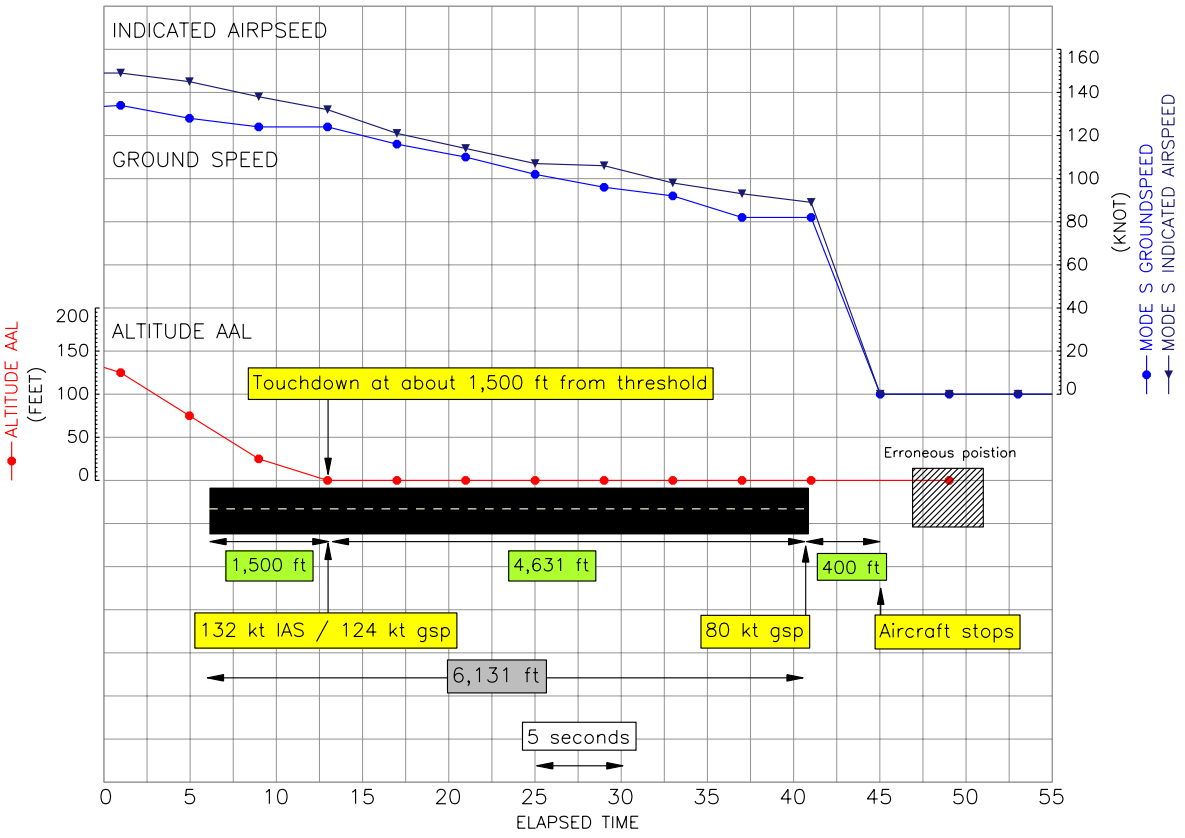

Figure 2

Salient final approach and landing data

Aircraft damage

Marks on the runway showed that the main landing gear (MLG) inboard doors remained extended throughout the landing, suffering edge abrasion damage as a result. The aircraft travelled approximately 123 m beyond the runway paved surface, during which the nose landing gear collapsed and the nosewheel detached.

Prior to coming to a halt, the left wingtip was driven into the ground, deflecting the aircraft from its path. The four wing-to-fuselage mounting forgings were damaged and, in three cases, had fractured. The wing was displaced to the right, indicated by extensive root fairing and inboard flap track damage.

Subsequent examination found evidence of a hydraulic fluid leak within the left engine nacelle, in the vicinity of the hydraulic pump. Hydraulic fluid had congealed and accumulated on the engine bleed air pipe, on surrounding pipes and surfaces, and at the bottom of the lower panel. The engine casing and components attached to the lower portion of the engine were covered in a thin film of hydraulic fluid (Figure 3). The hydraulic reservoir was empty, but a small amount of residual fluid was present in the filter housings and the bottom of the assembly. The filter blockage indicators had not 'popped' and the fluid and filters were found in a clean and uncontaminated condition.

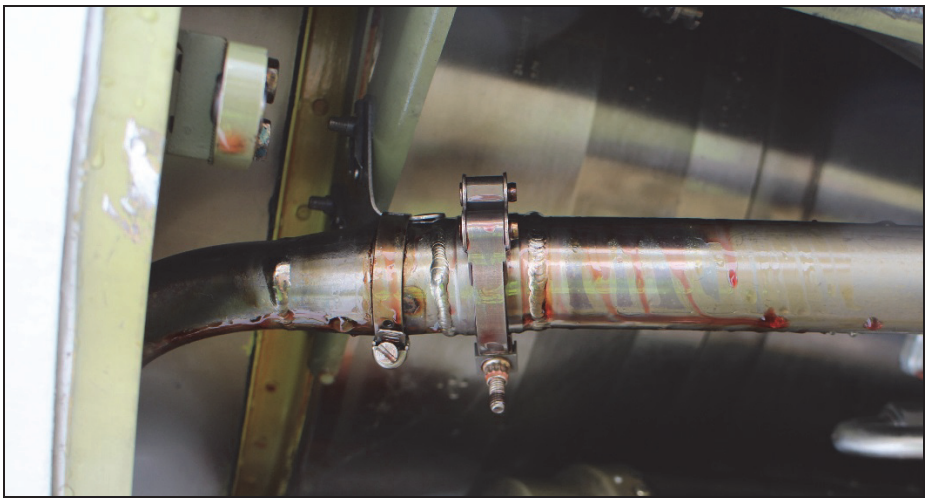

Figure 3

Hydraulic system leak spray dispersion within the left engine nacelle

Operational procedures/checklists

Premier I/IA Airplane flight Manual (AFM)

Section 3, *Emergency Procedures*, states:

> *'…Bold type indicates steps of a procedure requiring immediate action by the flight crew.'*

Premier I/IA Pilot Checklist

Page ii states:

> *'This document is an abbreviation of the checklists and procedures contained in…Section 3A (ABNORMAL PROCEDURES)…of the FAA-approved Airplane Flight Manual (AFM)…Since this is an Abbreviated Checklist, the intent of all applicable warnings has been included, most explanatory items, notes and cautions have been omitted for brevity. Consequently, users of this Abbreviated Checklist must be familiar with and operate the airplane in accordance with the official applicable AFM.'*

Page E-4 states:

> *'Certain component failures are capable of compromising multiple airplane systems. It is possible that the root failure may not be annunciated or otherwise apparent to the pilot. In these cases the pilot must respond directly to the annunciated, or otherwise identified, system failures and consult the AFM/Checklist for each corresponding individual abnormal or emergency procedure.*

Where different procedures result in conflicting aircraft configurations for safe recovery to landing, the most restrictive is to be used. ***Where different procedures identify landing distance factors to increase the required landing distance, the factors are additive*** [AAIB bold] *and are always applied to the applicable normal landing distance.'*

Page A-28 states:

'HYDRAULIC SYSTEM

HYDRAULIC PUMP FAILURE
(L OR R HYD PRESS LO ANNUNCIATOR ILLUMINATED)

1. Hydraulic Pressure ..... VERIFY 2800 PSI MINIMUM

2. Firewall Shutoff Valve Annunciators..... VERIFY ASSOCIATE WHITE L OR R H/V OPEN INDICATION

3. Flight ..... CONTINUE

…

If hydraulic pressure is below 2800 psi:[4]

9. Flaps..... UP

…

23.Landing Gear .....DN, USE ALTERNATE GEAR EXTENSION PROCEDURE

24. Flaps ..... VERIFY UP

25. Autopilot .....DISENGAGE

26. Airspeed..... VREF + 20 KIAS

27. Yaw Damp.....OFF

28. Emergency Brakes (After Touchdown) .....APPLY GRADUALLY

NOTE

Landing distance will increase approximately 133%.

Footnote

[4] The Hydraulic Pump Failure checklist, in the AFM, contains the following below this condition:
'NOTE:
The following hydraulically powered systems may not operate normally or may be inoperative: Landing Gear, Speed Brakes, Roll Spoilers, Lift Dump and Power Brakes'

Page A-24 states:

'ROLL SPOILER FAILURE
(ROLL FAIL ANNUNCIATOR ILLUMINATED)

1. *Flaps ..... UP*
2. *Airspeed (Above 15,000 ft.).....0.64 MACH (MAX)*
3. *Airspeed (Below 15,000 ft.) .....NO RESTRICTION*
4. *Speedbrakes.....WILL NOT EXTEND*
5. *Lift Dump ..... INBD PANELS ONLY OPERABLE*
6. *Land .....FLAPS UP*
7. *See FLAPS UP, 10, OR 20 APPROACH AND LANDING Procedure; Tab 3, page A-8.*

NOTE

Landing distance will increase approximately 65%.'

SPEEDBRAKE FAILURE
(SPEED BRK FAIL ANNUNCIATOR ILLUMINATED)

1. *Airspeed. .....NO LIMITS*
2. *Altitude .....NO LIMITS*
3. *Speedbrakes .....WILL NOT EXTEND*
4. *Lift Dump .....INBD PANELS ONLY*

NOTE

With SPEED BRK FAIL annunciator illuminated, avoid excessive control wheel movement with respect to roll control. Landing distance will increase approximately 21%.'

Page E-22 states:

'POWER BRAKE FAILURE

1. Emergency Brakes..... APPLY GRADUALLY

NOTE

Landing distance will increase approximately 48%.'

Aircraft performance

Aircraft details

The following weights were established from the aircraft's flight documentation:

Dry operating mass = 8,877 lb
ZFW = 9,450 lb
Fuel remaining at Blackpool ~1,000 lb
Landing weight = 10,450 lb

LDR calculations

The aircraft manufacturer calculated that, for the aforementioned landing weight and reported atmospheric conditions, the LDR on a dry runway[5], assuming no aircraft system failures, is 2,807 ft.

The co-pilot had calculated the LDR, with no failures, to be 3,000 ft. He then applied an LDR increment of 65%. This should have equated to 4,950 ft; however, he had calculated a figure of 5,950 ft. He could not recall how he had arrived at this.

The *Hydraulic Pump Failure* checklist states that the landing distance is increased by 133%. Applying this factor, the manufacturer calculated that the LDR for the conditions and aircraft weight at the time of the accident should have been 2,807 ft + 3,733 ft = 6,540 ft.

Airport information

Runway 10 at Blackpool Airport has a magnetic bearing of 097° and an LDA of 6,131 ft.

The nominated alternate airport for the flight was Liverpool Airport, 27 nm south-south-east, with a LDA of 6,893 ft on Runway 09. Other possible alternate airports in the locality were Warton Aerodrome, 6 nm east-south-east, with an LDA of 7,736 ft on Runway 07 and Manchester Airport, 37 nm south-east, with a LDA of 8,488 ft on Runway 05L.

Decision making

An operator's Operation Manual Part A (OMA) provides generic information and standard operating procedures (SOPs) applicable to all the aircraft types flown by an operator. Operation Manual Part B (OMB) provides information and SOPs specific to an aircraft type.

The operator's OMB for the Premier I/IA did not include any guidance for its pilots on decision making. However, the operator's OMBs for their other aircraft types did include such information. This guidance included a description of the five steps to take during the decision making process. The last step is titled '*Review*'. In this section it states:

Footnote

[5] A runway is considered damp when the surface is not dry, but when the water does not give it a shiny appearance. There are no performance corrections required for a damp runway, therefore dry performance figures can be used.

> *'…A rushed decision without due consideration of situation and options is almost always THE WRONG DECISION...'*

Decision making is covered in pilots' initial and recurrent crew resource management (CRM) training syllabus and is also assessed during a pilot's six-monthly recurrent checks (Licence Proficiency Check and Operator's Proficiency Checks).

The commander was a CRM instructor and was appointed a line trainer in January 2015. The co-pilot had received decision making training in December 2014, during his initial CRM training.

Aircraft and systems description

Landing gear

The tricycle landing gear consists of oleo struts which are operated hydraulically and can be lowered under gravity in an emergency.

Wheel brakes

The mainwheels are fitted with anti-lock multiple disc hydraulic brakes, operated by toe pedals. The parking and emergency braking system operates the brakes using hydraulic pressure supplied by an accumulator. The emergency accumulator is pre-charged to 800 psi and pressurised via a non-return valve to 3,000 psi when hydraulic system pressure builds after engine start. This pressure remains until the emergency or parking brakes are used. The emergency brakes are activated using the parking brake lever, and provide reduced retardation without anti-skid protection. The emergency accumulator is of sufficient volume to provide approximately 20 brake applications.

Flying controls

The flying control system uses conventional pushrods, cables and pulleys to operate the ailerons, rudder and elevators. Three hydraulically actuated spoiler panels are mounted on each wing and aid lateral control, act as speedbrakes and provide lift dumping on the ground. The wing flaps are electrically operated.

Hydraulic system

There is a 1.6 US gallon[6] (6.04 litres) reservoir and multiple filter assembly, known as the Hydraulic Package, located in the rear equipment bay. The reservoir is a non-separated type (air over fluid) and is pressurised by engine bleed air to about 20 psi. There is a sight glass fitted to the reservoir, but for pre-flight checks there is a test switch and light in the right rear equipment bay. If the light illuminates when the button is pressed, it indicates that the reservoir contains less than 1.2 gallons and should be replenished.

Footnote

[6] Gallons used throughout this report are US gallons which equate to 3.78 litres or 6.66 imperial pints.

The system is pressurised by two pumps, producing 3,000 ± 150 psi, driven by the left and right engine accessory gearboxes. The pump output pressure lines are fitted with pulse dampers to smooth out pump fluctuations and pressurised fluid is delivered to the system via the Hydraulic Package. Hydraulic system pressure is displayed on an analogue gauge on the left side of the instrument panel in the cockpit. The system is also fitted with left and right pump output monitoring pressure switches which illuminate either a L or R HYD PRES LO caption on the cockpit annunciator panel when the corresponding hydraulic pump output pressure drops below 2,400 ± 150 psi.

Engineering findings

The left hydraulic pump and associated pipework were tested at the system working pressure. During the test a constant leak was visible in the vicinity of the pressure compensator[7] assembly chamber plug on the port cap of the pump.

Further testing was performed by the manufacturer in the US, under the supervision of the NTSB Accredited Representative. Figure 4 shows the pump under test leaking hydraulic fluid.

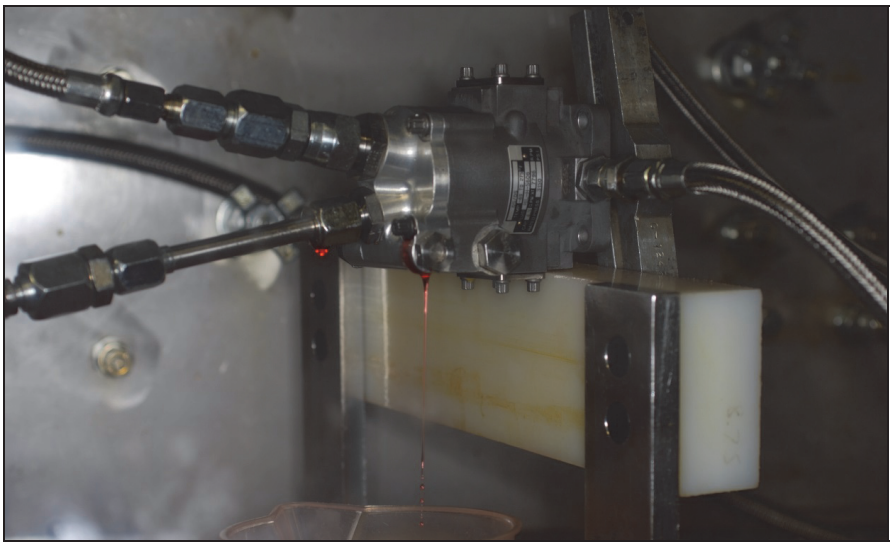

Figure 4

Hydraulic pump leaking under high pressure (3,000 psi) test
(Photo courtesy of the NTSB)

The leak was emanating from a crack surrounding a threaded hole for the compensator plug fitting in the port cap. A steady stream of hydraulic fluid leaked from the crack and 50 ml was collected over a two-minute period. The crack was enhanced by dye penetrant and is shown in Figure 5.

Footnote

[7] The compensator is a spring loaded valve device within the pump to limit pump outlet pressure to a predetermined level and adjust pump outlet flow to the level needed to maintain the set pressure.

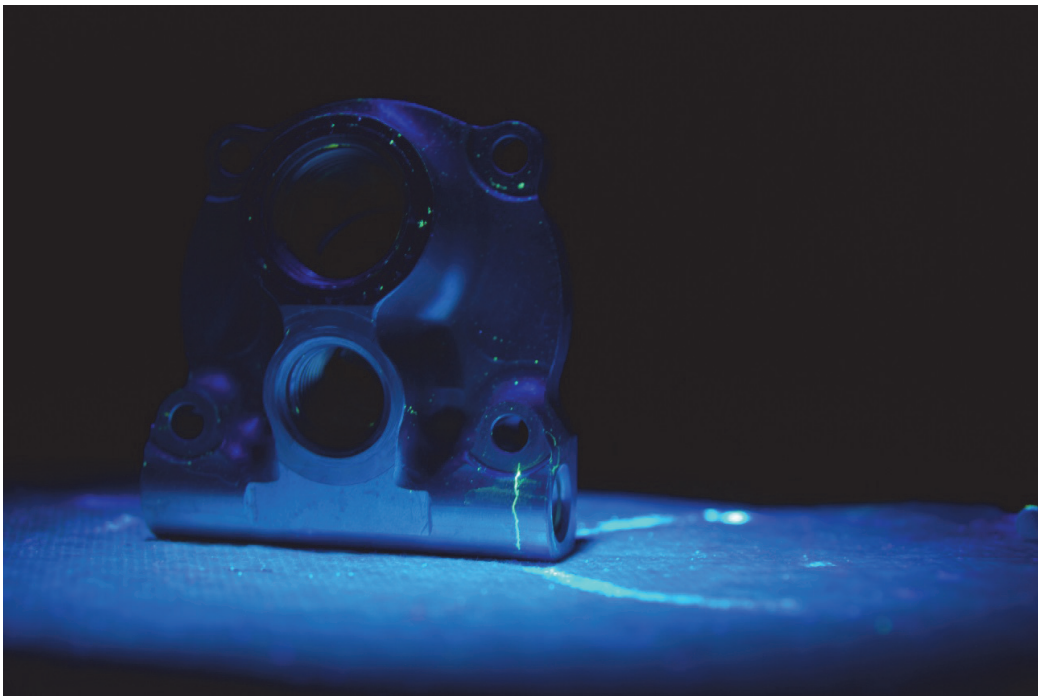

Figure 5

Crack in the port cap shown with dye penetrant under UV light
(Photo courtesy of the NTSB)

The left hydraulic pump, serial number K0365, was manufactured in May 2005 and fitted new to G-OOMC at aircraft build, in 2005. At the time of the accident it had accumulated 2,114 flying hours. On disassembly, with the exception of the crack in the port cap, the pump was found to be in good condition.

Detailed laboratory testing was carried out on the port cap structure and fracture. This showed that the port cap was of the correct material specification. Examination of the fracture area revealed multiple-origin fatigue cracking from a thread root inside the bore which had propagated to the outer surface of the port cap. The thread root, from which the crack originated, was mid-way down the bore and its trough radius was found to be 0.003 inch. There was also evidence of pitting on the thread root and adjacent surfaces.

Analysis

Conduct of the flight

Crew response

Prior to departure the co-pilot verified during the aircraft external checks that there was sufficient hydraulic fluid in the reservoir. During the descent to Blackpool the hydraulic pressure indication was observed to be fluctuating. The crew initially responded by actioning the hydraulic pump failure checklist. As the hydraulic pressure was indicating about 2,800 psi for the majority of the time, the crew elected to continue the flight, in accordance with Item 3 of the checklist.

Shortly thereafter the roll spoiler and speedbrake failure captions illuminated. The co-pilot actioned the relevant checklists, which required increments to be added to the LDR. He incorrectly calculated the LDR to be 5,950 ft, but could not recall exactly how he had arrived at this figure. Based on this figure, Blackpool appeared suitable to the crew in this situation.

The crew did not return to the hydraulic pump failure checklist because they were reportedly unaware that there had been a hydraulic system failure. The checklist items for hydraulic pressure below 2,800 psi contained the significant information that the emergency brakes would have to be applied after touchdown and the landing distance would have to be increased by approximately 133%. By not completing the hydraulic pump failure checklist, the crew were unaware of this increment and the need to use emergency brakes. If the correct increment of 133% had been applied to the crew's calculated LDR of 3,000 ft, this would have given an LDR of 6,990 ft and it would have been evident that the 6,131 ft runway at Blackpool was unsuitable.

After touchdown, the commander applied the toe brakes, but found them to be ineffective. He directed the co-pilot to deploy the lift dump system but this was inoperative due to the hydraulic failure. The emergency brake was not applied and the retardation of the aircraft was minimal, causing it to depart the runway at about 80 kt.

Crew decision making

The crew's decision to continue the flight to Blackpool was appropriate for the hydraulic indications with which they were initially presented.

Despite various indications of a serious hydraulic system malfunction as the flight progressed, the crew did not appear to fully recognise the situation and so did not return to the hydraulic pump failure checklist. Consequently, they constructed their mental model without the vital additional information contained in the rest of hydraulic pump failure checklist. This caused them to conclude, incorrectly, that Blackpool had sufficient LDA for the aircraft's condition, and they were unaware that application of the emergency brake was necessary on landing.

It is likely that, had the crew taken more time to thoroughly review the situation, they would have developed a more complete understanding of the implications of the hydraulic failure and reacted accordingly.

Engineering aspects

Loss of hydraulic pressure

The crew carried out the reservoir level check procedure in accordance with the checklist prior to the flight and found it to be correct, as indicated by the test light not illuminating. This meant that there was at least 1.2 gals (4.5 litres) of fluid within the reservoir. Evidence of hydraulic leakage was only visible within the left engine nacelle.

The crew reported fluctuating hydraulic pressure in the latter stages of the flight and intermittent L HYD PRESS LO then R HYD PRESS LO captions on the annunciator panel, the left more than the right. After they had selected the landing gear down the hydraulic pressure dropped completely. The pressure fluctuations suggest that the left pump in particular was struggling to maintain pressure due to cavitation and leakage. As the fluid in the system was gradually depleting, later shown by the fluid accumulation in the engine bay, the right hydraulic pump was also suffering cavitation, as indicated by the R HYD PRESS LO indications. When the MLG was lowered the fluid taken in by the retraction jacks, which is estimated to be at least 4 pints (2.27 litres), further reduced the volume of hydraulic fluid. This resulted in more severe pump cavitation such that the pumps were not able to produce or maintain useable hydraulic pressure. It is likely that the fluid quantity became unviable as the landing gear reached the full extent of its travel, manifesting itself in a delay in getting the gear down and locked indication and the inboard doors not being able to complete their sequence and remaining open.

The parking/emergency brake was not affected by the hydraulic system loss. Had a demand been made on the emergency brakes system during the landing it would have worked normally, albeit without anti-skid and a reduced retardation capability.

Pump port cap failure

The multiple-origin cracking found in the port cap by the laboratory testing had propagated from a thread root in the bore to the outer surface of the cap. It is not known how long the crack had been propagating for, but it is likely that the crack broke the surface of the cap relatively recently, allowing the leakage of fluid outwards under pressure from within the pump. The excessive pitting at the root of the thread is likely to have initiated the fatigue crack, with the thread root radius as a contributory factor. The load imparted into the thread by the compensator plug fitting places the thread under a constant tensile stress when the pump is operating, leading to the eventual fatigue failure.

AAIB observation

During the examination of the aircraft at the accident site items of personal property, and other items, were found beneath the cockpit flooring, having fallen through the rudder pedal recesses. The items found included a mobile phone, glasses case and a plastic mineral water bottle. These items had the potential to cause a rudder or steering control restriction.

Safety actions

A review identified two other instances of port cap failures due to a crack around the compensator plug. The records also show that the failed pump on G-OOMC (serial number K0365) was manufactured within a few weeks of the other two pumps, one of which was the next serial number (K0366).

The pump manufacturer is taking action to replace the port caps from the batch of port caps processed by the outside non-destructive testing (NDT) vendor which have excessive pitting. Service Bulletin 66179-29-486 is being issued to replace port caps with serial numbers 0057 to 0099 with port caps manufactured under the current process which do not have excessive pitting.

The AAIB highlighted the issue of loose articles beneath the cockpit floor to the aircraft manufacturer's Continued Operational Safety Department. Although they had not received any previous reports, the manufacturer has taken the safety action of adding the issue to the fleet safety monitoring list.

Since this accident, the operator of G-OOMC has removed the information on decision making from Operations Manual Part B and incorporated it into Part A of the Operations Manual.

AAIB Correspondence Reports

These are reports on accidents and incidents which were not subject to a Field Investigation.

They are wholly, or largely, based on information provided by the aircraft commander in an Aircraft Accident Report Form (AARF) and in some cases additional information from other sources.

The accuracy of the information provided cannot be assured.

ACCIDENT

Aircraft Type and Registration:	Aeronca C3, G-AEFT	
No & Type of Engines:	1 J.A.Prestwich J99 piston engine	
Year of Manufacture:	1936 (Serial no: A-610)	
Date & Time (UTC):	14 October 2015 at 1510 hrs	
Location:	Near Polzeath, Cornwall	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Propeller detached	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	46 years	
Commander's Flying Experience:	10,030 hours (of which 275 were on type) Last 90 days - 58 hours Last 28 days - 16 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot and additional enquiries by the AAIB	

Synopsis

The aircraft was flying at 2,500 ft when the propeller suddenly detached. The pilot was able to execute a forced landing with no further damage to the aircraft. The detachment had been caused by a fatigue crack which had developed in the tapered end of the crankshaft. This problem had been recognised in 1939 but had not resulted in any mandatory requirements. The Light Aircraft Association (LAA) have now mandated a repetitive visual and dye-penetrant inspection of the crankshaft for corrosion and cracking.

History of the flight

The aircraft was en-route from Bodmin to Roche at 2,500 ft. It was rolling out of a gentle left orbit when there was a loud bang and the pilot saw the propeller falling away to the left side. He completed the vital actions and turned towards a suitable pasture to the east for a forced landing. Having transmitted a distress call to Newquay Airport, he spotted the golf club at Roserrow and remembered that there was a landing strip nearby. He arrived there with plenty of height to spare, so was able to fly overhead to check for obstructions before performing a successful forced landing with no further damage. A nearby Cessna 152 was able to relay a message to Newquay that the aircraft had landed safely.

Engineering examination

The propeller was recovered from a building site near Polzeath, where it had landed without causing damage or injury. The pilot examined the assembly and could see that

it had detached because the tapered end of the crankshaft on which it was mounted, had fractured (Figure 1). He also recognised that the fracture was almost identical to one he had seen in an AAIB Bulletin concerning another JAP J99-engined aircraft in 2012 (G-EBJI, Bulletin 10/2012).

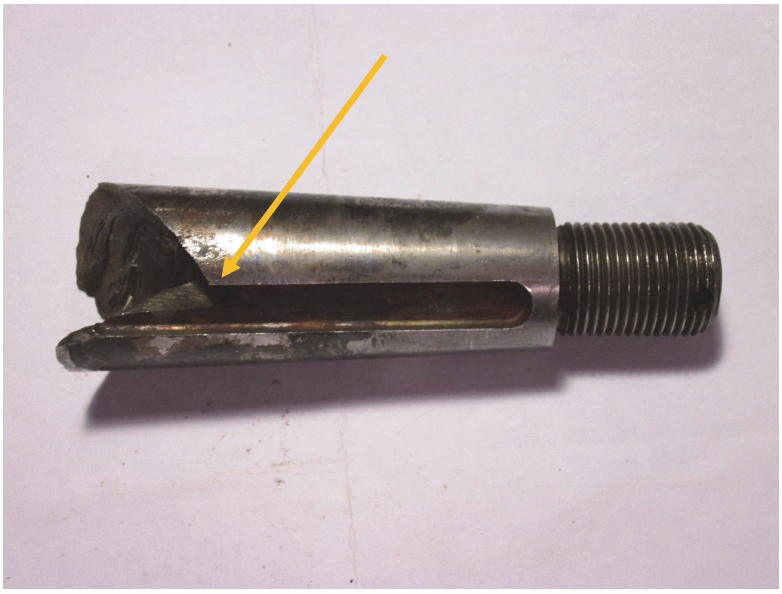

Figure 1

Failed crankshaft showing corrosion pitting in the area of the fatigue crack origin (arrowed).

The above report noted that the JAP J99 engine was essentially a licence-built version of the Aeronca E-113c engine with the addition of dual ignition, and that propeller attachment was the same. As long ago as 1939, Aeronca had experienced a number of instances of cracking from the aft end of the keyway slot and had issued Service Memorandum M-36 to advise operators to remove the propeller and visually inspect for cracks at 25 flying hour intervals. The Memorandum had not been given Airworthiness Directive status in the United States or subject to a Mandatory Permit Directive in the UK and was not, therefore, mandatory. The AAIB Bulletin noted that the LAA would

> *'alert owners of aircraft fitted with JAP J99 and Aeronca E113 series engines to the potential for crankshaft fatigue cracking and additionally will include a reference to Service memorandum M-36 for affected engines in the Type Acceptance Data Sheet (TADS) on the LAA website.'*

In addition, the LAA were also in the process of defining a suitable inspection interval and non-destructive test method for crack detection.

Comparison of the photographs from G-EBJI and G-AEFT showed remarkable similarity and both were clearly high-cycle fatigue failures. Both fatigue origins were towards the aft end of the keyway slot, although it could be seen that the origin on 'FT' also appeared to coincide with a degree of corrosion pitting.

The owner of G-AEFT has commented that he had removed the propeller in 2012 and given it a visual inspection upon learning of the incident involving G-EBJI. Although he did not see any cracks, he now suspects that a dye-penetrant inspection would have revealed cracks.

Subsequent safety actions

After the occurrence to G-AEFT, the LAA advised that details of the first occurrence and of the Aeronca bulletin had been widely promulgated through the LAA in-house magazine 'Safety Spot'. Due to the publicity already given to this incident through Safety Spot, the very small numbers of engines involved (nine known to the LAA), and the specialist nature of the engine it had not thought it necessary to issue written directives at this time.

However, as a result of this second occurrence, in which corrosion pitting may have contributed to the problem and a visual inspection had apparently been insufficient to detect the onset of cracking, the LAA have issued Airworthiness Information Leaflets (AIL) No. MOD/ENG/JAP/001 for the JAP engine, and MOD/ENG/AER/001 for the Aeronca version, effectively mandating the following for all engines before further flight:

- Removal of the propeller.
- Removal of the Woodruff key.
- Inspection, using a 10x magnifying glass, of the tapered end for corrosion or obvious cracking, particularly around the edges and corners of the keyway. If cracks or corrosion pits are found, the crankshaft must be scrapped.
- If the findings from the step above are negative, then the area around the keyway should be subjected to a Dye Penetrant inspection technique. If no cracks are found, then the propeller can be refitted and remain in service
- The above work and subsequent refitting of the propeller should be completed to the satisfaction of a suitably qualified LAA Inspector, who should then raise worksheets and sign the log book to confirm compliance with the AIL.

The inspection is to be repeated every 25 flying hours or 3 calendar years, whichever occurs first. A copy of Aeronca memorandum M-36 was attached to the AILs for information.

ACCIDENT

Aircraft Type and Registration:	Cessna 172S Skyhawk, G-MEGS	
No & Type of Engines:	1 Lycoming IO-360-L2A piston engine	
Year of Manufacture:	2008 (Serial no: 172S10723)	
Date & Time (UTC):	16 May 2015 at 1550 hrs	
Location:	Perranporth Airfield, Cornwall	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Propeller tips abraded, structural damage to fuselage frames and bulkheads, lower skin deformed	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	68 years	
Commander's Flying Experience:	112 hours (all of which were on type) Last 90 days - 7 hours Last 28 days - 5 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

Synopsis

The pilot was relatively inexperienced and operating into a cliff-top airfield, with the onshore surface wind at the maximum demonstrated crosswind for the aircraft. A damaging hard landing ensued, though this was not recognised until after the aircraft had returned to its home base.

History of the flight

The pilot, who had about 40 hours as pilot-in-command, hired the aircraft from a club at Cambridge Airport and flew to Perranporth Airfield, via Garston Farm Airstrip near Bath. He reported that he had flown into Perranporth twice before (both on the same day) about six months previously. On this occasion, he arrived overhead the airfield ten minutes before it was due to close. For unknown reasons, he was unable to contact Perranporth Radio. So, Newquay Airport ATC (located 9 nm to the NE) provided a relay, by telephone, to inform him that the runway in use was 05 and the surface wind was from 320° at 15 kt. The pilot reported feeling under some pressure due to the airfield closing time and, although he had considered asking for an alternative runway[1], commenced an approach to Runway 05, intending to land with full flap (Flap 30).

Footnote

[1] Perranporth's licensed runways are 27/09 and 23/05

In a frank report, the pilot described his speed being about 75 kt towards the end of the approach, 10 kt faster than intended. During the landing flare, the aircraft ballooned and he held the aircraft's attitude. It landed heavily and the pilot heard a bang, which he thought came from the landing gear.

On 20 May, four days later, the pilot flew the aircraft back to Cambridge Airport, having noticed no defects during his pre-flight inspection, when he focused his attention on the landing gear. On 21 May, a pre-flight inspection by another pilot noted damage to the tips of the propeller blades and the aircraft was withdrawn from service. The subsequent maintenance inspection revealed significant damage to the skin and frames, consistent with a heavy landing. The aircraft had not operated since its return from Perranporth.

Weather

Before departure, the pilot noted that the TAF for Newquay Airport, covering the period 0900 hrs to 1800 hrs, forecast: wind from 320° at 16 kt, greater than 10 km visibility and few cloud at 3,000 ft.

Pilot Operating Handbook

The C172S Pilot Operating Handbook states that the maximum crosswind demonstrated is 15kt. In *Normal Procedures,* it recommends that pilots use the minimum flap setting required for the field length when landing in a strong crosswind. It highlights that *'maximum allowable crosswind velocity is dependent upon pilot capability as well as airplane limitations'.*

CAA advice

The CAA's Safety Sense Leaflet 1, *Good Airmanship,* Section 28*,* states:

> *a. 'Know the maximum demonstrated cross-wind for the aircraft type you are flying and factor this for your experience and recency.*
>
> *b. Remember, that was obtained by a test pilot! If the wind approaches what you have decided is your own limit, be ready to divert. You may retain better control on landing by not using full flap.*
>
> *e. If another runway which is more into wind is available, use it….'*

Safety action

The flying club, from which the pilot hired G-MEGS, has introduced more constraining weather and currency requirements for pilots with less than 100 hrs pilot-in-command. In order to monitor flight planning, they have introduced a cross-country checklist, requiring pilots to complete details of their intended flight and obtain authorisation from an appropriate staff member.

Discussion

The weather forecast for Newquay, available before departure, suggested that the wind at Perranporth was likely to be at or close to the maximum demonstrated crosswind for the aircraft, whichever runway was in use. The conditions were, therefore, likely to be challenging for an inexperienced pilot operating into a coastal airfield, with the wind passing over sea cliffs, producing turbulence. Also, arriving at his destination shortly before the airfield closed did not seem to allow the pilot sufficient time to consider contingencies or alternate plans of action.

The pilot commented that, if faced with a similar situation in the future, he would divert to the into-wind runway at Newquay.

ACCIDENT

Aircraft Type and Registration:	Cirrus SR22, N124CP	
No & Type of Engines:	1 Continental Motors IO-550-N piston engine	
Year of Manufacture:	2008	
Date & Time (UTC):	5 September 2015 at 1200 hrs	
Location:	Great Massingham Airfield, Norfolk	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 2
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Landing gear, propeller, nose cowling and wing	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	64 years	
Commander's Flying Experience:	1,339 hours (of which 27 were on type) Last 90 days - 27 hours Last 28 days - 11 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot and enquiries by the AAIB	

The aircraft was approaching Great Massingham Airfield Runway 04 in good visibility with a wind of 340° at 15 kt. The pilot reported a stable approach at 80 kt but, during the flare, the aircraft was "hit by unstable air and windshear". This caused a wing to drop and subsequent flight control correction was insufficient to prevent the aircraft from "grounding" and led to a nose landing gear collapse. The aircraft departed the runway to the left into a ploughed field.

The pilot and passengers were wearing full harnesses and were uninjured. The pilot considered that unstable air at low level from localised terrain led to the loss of control. The pilot had landed at Great Massingham on Runway 22 in the past, but not Runway 04.

ACCIDENT

Aircraft Type and Registration:	Minicab (JB01 Standard), G-ATPV
No & Type of Engines:	1 Continental Motors Corp C90-8F piston engine
Year of Manufacture:	1959 (Serial no: JB-01)
Date & Time (UTC):	18 April 2015 at 1250 hrs
Location:	Fenland Airfield, Lincolnshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Serious) Passengers - N/A
Nature of Damage:	Propellor destroyed
Commander's Licence:	Light Aircraft Pilot's Licence
Commander's Age:	65 years
Commander's Flying Experience:	394 hours (of which 175 were on type) Last 90 days - 7 hours Last 28 days - 7 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and report by the airfield operator

Synopsis

The throttle was in the fully open position when the pilot attempted to start the engine by hand-swinging the propeller. The engine started at high power, the aircraft tipped forward and the pilot was struck by the propeller suffering a serious injury.

The accident

The aircraft was not fitted with a starter motor and the pilot was attempting to start the engine by hand-swinging the propeller from the front - the cockpit was unoccupied. He believed he had followed his normal procedure, which included applying the parking brake, chocking the aircraft and setting the throttle to the marked start position (about 1" open). However, when the engine fired, the pilot was immediately aware that the rpm was too high. He attempted to move round the aircraft, to the left side of the cockpit, to shut the engine down but, as he did so, the aircraft tipped forward and he was struck repeatedly on the forearm by the propeller. The aircraft continued to tip over and the propeller was shattered as it struck the ground. This also stopped the engine.

The accident was seen by airfield staff who provided extensive first aid, including improvising a tourniquet with a belt. Ambulance assistance was called promptly and arrived twenty-five minutes after the accident.

Other information

Photographs taken shortly after the accident (Figure 1) showed the throttle lever in the fully open position and the stick forward of the neutral position.

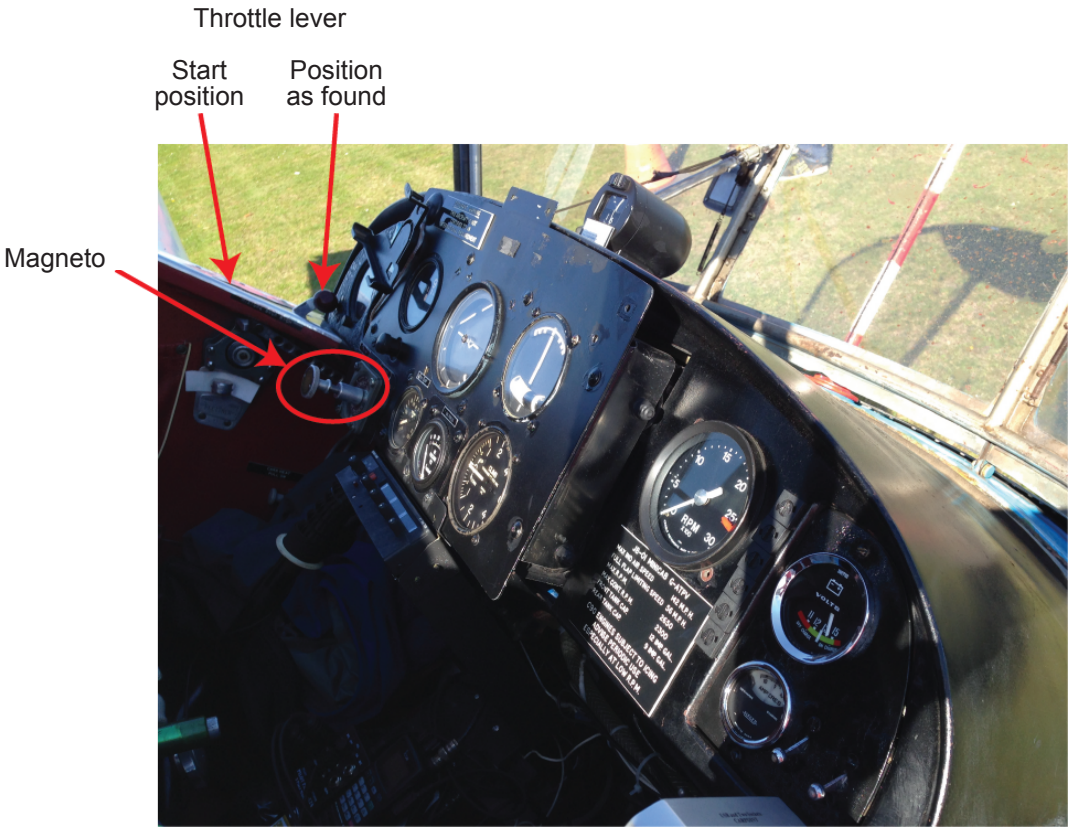

Figure 1

G-ATPV instrument panel (photograph taken by Fenland Aero Club)

As first aid was being conducted, other personnel, including an aircraft engineer, attempted to shut down the aircraft. However, they were hampered by the unconventional layout of the controls. Initially, the magnetos could not be identified and the master switch remained on.

Pilot's experience

The pilot reported that he had, almost exclusively, operated aircraft which required hand-starting. He estimated that he had conducted hundreds of hand-starts, mainly without any other person being present.

Engine starting procedure

The pilot reported that, in order to start the engine, it was necessary to use the acceleration jet of the carburettor. This required the throttle to be pumped, then left in the fully open position while the propeller was pulled through. The throttle would then be retarded to the start position, before the magnetos were selected ON and the propeller was hand-swung to start the engine.

He considered it most likely that, immediately before the accident, he had omitted to retard the throttle from the fully open position before attempting to swing the propeller.

In the CAA's Safety Sense Leaflet 1e, *Good Airmanship,* Section 19, it states:

> *'b) Never attempt to hand swing a propeller (or allow anyone else to swing your propeller) unless you know the proper, safe procedure for your aircraft and situation, and there is a suitably briefed person at the controls, the brakes are ON and/or the wheels are chocked. Check that the area behind the aircraft is clear.'*

Advice on propeller swinging has also been published by the LAA[1], in Pilot magazine[2] and by CASA.[3]

Pilot's risk assessment

The pilot later commented that he had previously considered the risk of this sort of error and had decided that he would not tie back the control stick. He reasoned that, in the event of a high RPM start, if the stick was back and the brakes did not hold, the aircraft would be more likely to run away and possibly become airborne. He considered that, if the aircraft was braked and chocked without the control stick being held back, it would be more likely to tip forward. Although that would hazard him, it would reduce the risk to others. He had also decided not to use a checklist, as he felt it would be a distraction from focussing on the aircraft.

Human factors

Reason[4] (1990) would define the pilot's mistake as a lapse; a step of his starting procedure was unintentionally omitted, resulting in the throttle not being retarded. Then, the pilot did not see the incorrectly positioned throttle, although he believed he had looked at it. Where a process is conducted routinely or frequently, there is risk of seeing what is expected rather than what is actually there.

Conclusions

The pilot considered it most likely that, immediately before the accident, he had omitted to retard the throttle from the fully open position before attempting to swing the propeller. In human factors terms, this was an unintentional lapse.

CAA Safety Sense Leaflet 1e advises that there is a suitably briefed person at the controls when attempting to hand swing a propeller.

Footnotes

1 http://www.lightaircraftassociation.co.uk/2014/Mag/Apr/Safety.pdf
2 http://www.pilotweb.aero/techniques-training/how_to_prop_swing_1_4043093
3 http://www.casa.gov.au/wcmswr/_assets/main/fsa/1998/jul/28.pdf
4 Human Error, James Reason, 1990

ACCIDENT

Aircraft Type and Registration:	Mooney M20K 231, G-BYEE	
No & Type of Engines:	1 Teledyne Continental TSIO-360-LB1 piston engine	
Year of Manufacture:	1980 (Serial no: 25-0282)	
Date & Time (UTC):	4 October 2015 at 1130 hrs	
Location:	Caernarfon Airport, Gwynedd	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 2
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Severe damage to left wing and minor damage to propeller	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	70 years	
Commander's Flying Experience:	896 hours (of which 449 were on type) Last 90 days - 11 hours Last 28 days - 4 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot and enquiries by the AAIB	

Synopsis

The aircraft bounced twice before landing to the left of the runway and colliding with a fence post. The pilot taxied the aircraft to the parking area and shut it down normally. The left wing was substantially damaged.

History of the flight

The aircraft was flown from Wellesbourne Airfield to Caernarfon Airport and joined the circuit for asphalt Runway 07. The pilot reported that, when he turned onto final approach, the weather conditions were good, with the wind from 180º at 6 kt. He stated that he flew a normal approach but flared too high and this led to a bounced landing. He briefly increased the power, in an effort to stabilise the aircraft, but it bounced a second time and deviated to the left of the runway. The pilot believes the crosswind might have caused the aircraft to drift left and that the left wheel touched the grass to the side of the runway, causing the aircraft to veer further left.

The aircraft, now with all three wheels on the grass, continued to deviate from the runway. The pilot saw a vehicle ahead of him, parked on a disused taxiway and this was the focus of his attention when the left wing struck a fence post, 46 m from the runway centreline, which he had not noticed. The collision caused the aircraft to turn abruptly, further to the left, and it continued its landing roll.

The pilot refrained from trying to brake the aircraft sharply, as it was travelling over an unknown surface. It crossed a disused, intersecting runway and he then regained full control, steering the aircraft back towards Runway 07, leaving the parked vehicle to his left. He did not appreciate the extent of the damage to the left wing until he had taxied the aircraft to the parking area and shut it down. There was also damage to one propeller blade, possibly caused by a loose stone during the landing.

Figure 1
G-BYEE showing the severely damaged left wing

ACCIDENT

Aircraft Type and Registration:	Piper PA-28-161 Cherokee Warrior II, G-MSFT
No & Type of Engines:	1 Lycoming O-320-D3G piston engine
Year of Manufacture:	1984 (Serial no: 28-8416093)
Date & Time (UTC):	22 November 2015 at 1430 hrs
Location:	Compton Abbas Airfield, Dorset
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Minor dent to right leading edge by wingtip of G-MSFT. Minor damage to trailing edge of left aileron of G-OONY
Commander's Licence:	Private Pilot's Licence
Commander's Age:	49 years
Commander's Flying Experience:	349 hours (of which 125 were on type) Last 90 days - 4 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft had landed and was taxiing towards its parking area at about 10 mph. As it entered an area bounded by a parked PA-28 aircraft, G-OONY, on the right, and a line of traffic cones on the left, the control tower radioed the pilot to advise him to watch out for the cones. He instinctively looked to the left and believes he must then unwittingly have applied some right steering input because the right wingtip of his aircraft struck the trailing edge of the left aileron of G-OONY.

The pilot stated that he was aware of both obstructions and would have cleared them but was distracted by the "unfortunately-timed" radio call.

ACCIDENT

Aircraft Type and Registration:	Piper PA-28-161 Cherokee Warrior III, G-COVB
No & Type of Engines:	1 Lycoming O-320-D3G piston engine
Year of Manufacture:	2005 (Serial no: 2842234)
Date & Time (UTC):	23 February 2015 at 1140 hrs
Location:	Shotteswell Airfield, Warwickshire
Type of Flight:	Private
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - 1 (Serious) Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	78 years
Commander's Flying Experience:	5,500 hours (of which 1,350 were on type) Last 90 days - 15 hours Last 28 days - 8 hours
Information Source:	Aircraft Accident Report submitted by the pilot and photographs of the accident site

Synopsis

The aircraft was flying a practice forced landing to a grass airstrip with the intention of performing a go-around. At about 500 ft, the aircraft encountered severe turbulence in a strong crosswind. The handling pilot was unable to arrest a rapid descent and the aircraft struck the ground adjacent to the airstrip.

History of the flight

The purpose of the flight was to conduct a Licence Proficiency Check for the renewal of a Private Pilot's Licence. On board were a Flight Examiner and a pilot under check whose licence had expired. The pilot under check acted as handling pilot throughout.

The aircraft departed Coventry Airport at 1055 hrs. Runway 23 was in use, with a surface wind from 230° at 17 kt. There was good visibility and scattered cloud at 2,000 ft. The temperature was 6°C and the dew point was 2°C.

After takeoff, the aircraft climbed to the south to an altitude of about 3,000 ft for a period of general handling, after which the handling pilot was presented with a simulated engine failure. As the aircraft descended, he identified the grass airstrip at Shotteswell Airfield, near Banbury, and declared his intention to plan an approach there. It had previously been briefed that a go-around would be flown from any practice forced landing, from not lower than 300 ft agl.

The airstrip itself was 700 m long and orientated 15/33. The handling pilot elected to use Runway 33 and flew a left hand circuit to reach a final approach position at about 500 ft. At this point, the aircraft encountered severe turbulence in the strong crosswind and the pilot was unable to prevent the aircraft descending rapidly towards the airstrip.

The aircraft's right wing touched the ground and the aircraft cartwheeled, with the nose and port wing striking the ground in turn. Photographs of the accident site showed the first ground markings about 30 m to the left of Runway 33, between the runway and trees flanking a minor road. The aircraft was tracking across the runway, so that when it came to rest it was lying inverted at the runway edge.

Both occupants remained conscious throughout the accident sequence and were able to leave the badly damaged aircraft through a gap in the structure in the right windscreen area.

Meteorological information

The wind reports at Coventry Airport, 16 nm north of the accident site, showed that the wind there increased for a time after the aircraft's departure. The 1050 hrs report (the last obtained by the crew) showed a wind from 230° at 17 kt. Thirty minutes later, the wind was reported at 20 kt and at 1150 hrs (soon after the estimated time of the accident) it was 19 kt with gusts to 30 kt and with variations in direction. Although the mean wind started to reduce from mid-afternoon, the gusts were reported into early evening.

The forecast for the day, issued by the Met Office at 0802 hrs and valid between 0900 hrs and 1800 hrs, gave a surface wind of 12 kt from 230°. However, it also included a 30% probability of the wind increasing to 15 kt and gusting to 25 kt, associated with showers of rain and snow.

Conclusion

The aircraft encountered adverse weather conditions while flying a practice forced landing profile. The conditions created a situation which was beyond the crew's ability to deal with effectively, resulting in a loss of control at a critical stage of the flight.

ACCIDENT

Aircraft Type and Registration:	Piper PA-38-112 Tomahawk, G-BWNU	
No & Type of Engines:	1 Lycoming O-235-L2C piston engine	
Year of Manufacture:	1978 (Serial no: 38-78A0334)	
Date & Time (UTC):	29 August 2015 at 1330 hrs	
Location:	Cotswold Airport, Gloucestershire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Damage to the left flap	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	68 years	
Commander's Flying Experience:	298 hours (of which 53 were on type) Last 90 days - 2 hours Last 28 days - 1 hour	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

The pilot was carrying out touch-and-go circuits to Runway 26, which has an asphalt surface and runway lighting. The weather was good, with a light wind varying between 250° and 270° at about 4 kt. Visibility was in excess of 10 km and there were scattered clouds at 4,000 ft. The pilot had flown two normal powered circuits, touching down on the runway threshold markings and, on the third circuit, decided to carry out a glide approach to the same touchdown point. At the end of the downwind leg, at a height of about 1,000 ft, he closed the throttle, established the glide and selected the first stage of flap. The airspeed was reduced to 70 kt and the second stage of flap was selected while a continuous turn approach was flown. When the pilot was satisfied he would achieve his aiming point, he selected the third and final stage of flap. The sink rate increased and he applied power but during the touchdown the left landing gear wheel struck a threshold runway light. After landing, the pilot found the left flap damaged by glass debris. He considered that an earlier application of power would have prevented the incident.

ACCIDENT

Aircraft Type and Registration:	Reims Cessna F152, G-BLZH	
No & Type of Engines:	1 Lycoming O-235-L2C piston engine	
Year of Manufacture:	1985 (Serial no: 1965)	
Date & Time (UTC):	16 August 2015 at 0928 hrs	
Location:	Wolverhampton Halfpenny Green Airport, West Midlands	
Type of Flight:	Training	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Moderate damage to propeller and nose cowl, wingtips, fusleage and tail surfaces	
Commander's Licence:	Student pilot	
Commander's Age:	32 years	
Commander's Flying Experience:	30 hours (of which 3 were on type) Last 90 days - 11 hours Last 28 days - 4 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

The student pilot completed a dual instructional flight of 30 minutes before being briefed by his instructor to repeat the exercise solo. Runway 34 was in use, the weather was generally fine and there was a variable surface wind of 2 kt. The instructor cautioned the student about the lack of headwind for landing and told him to modify his circuit to allow for the possibility of a light tailwind on finals.

The student took off at 0855 hrs and completed the first part of the exercise. On final approach to land, the aircraft floated above the runway without touching down, so the student flew a go-around. On the second approach the aircraft again floated but the student felt there was adequate runway remaining to continue with the landing. However, when the aircraft touched down, it did so heavily and bounced. The student applied full power to go-around, but was unable to maintain directional control and the aircraft veered to the left. It came to rest inverted on the grass to the left of the runway.

The aircraft cabin structure remained intact and the student, who was uninjured, was able to extricate himself from the aircraft using a main door.

ACCIDENT

Aircraft Type and Registration:	RL7A XP Sherwood Ranger, G-CHHD
No & Type of Engines:	1 Jabiru 2200A piston engine
Year of Manufacture:	2012 (Serial no: LAA 237A-15054)
Date & Time (UTC):	16 August 2015 at 1605 hrs
Location:	Druridge Bay Airfield, Northumberland
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Damage to propeller, engine cowlings and wings; engine shock-loaded
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	70 years
Commander's Flying Experience:	855 hours (of which 16 were on type) Last 90 days - 12 hours Last 28 days - 12 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Summary

During a takeoff run, the right main wheel failed and the aircraft nosed over. The failure was probably the result of insufficient torque being applied to the wheel's attachment nuts during original assembly.

History of the flight

Following an uneventful flight into Druridge Bay Airfield earlier in the day, the pilot was taking off from the grass runway for the return flight to his home base at Eshott. Approximately 8 seconds into the takeoff run, just as the aircraft was about to become airborne, the right main wheel suddenly failed, with the broken remains of the wheel digging into the ground and causing the aircraft to nose over. The aircraft came to rest in an inverted attitude, at an angle to the runway heading. With some difficulty, the pilot managed to release his harness and he dropped onto the ground; he was then able to escape from the aircraft having sustained minor injuries.

The investigation

The right wheel was constructed from two aluminium halves which were bolted together. It was found that the outer half had failed circumferentially, which had allowed the outer rim to separate.

This aircraft was administered by the Light Aircraft Association (who published an article on this accident in the October 2015 edition of their '*Light Aviation Magazine*') and the components were sent to them for examination. Figures 1 and 2 show the wheel in the as-received condition.

Photo: LAA

Figure 1

G-CHHD right main wheel

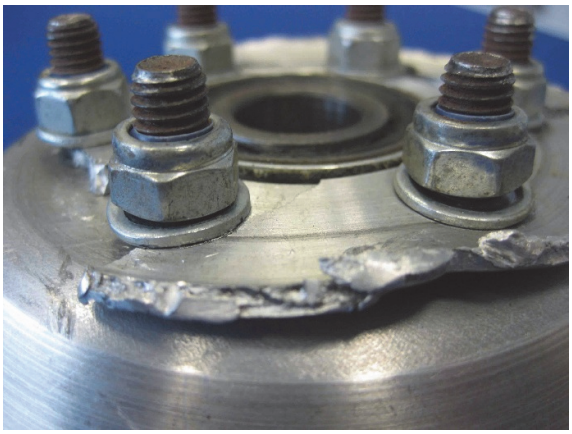

Photo: LAA

Figure 2

G-CHHD right main wheel - detail

The LAA's examination revealed that two of the six attachment bolts were not fully tightened down, which left a gap of around 1.5 mm (see Figure 2), with another bolt noted as being loose. Corrosion products were observed near one of the loose bolts (see Figure 3), with evidence pointing to fretting that occurred as a result of relative movement between the two halves in service.

Photo: LAA

Figure 3

Showing corrosion products and radial crack

A radial crack is visible in Figure 3, which would have occurred during the circumferential progression of what was determined to be a low-cycle fatigue crack. The remainder of the failure was attributed to overload. It was concluded that the failure probably resulted from insufficient torque being applied to the attachment nuts during the initial assembly. (Note: this aircraft was constructed by a previous owner).

The LAA commented that as far as they were aware, this was the first failure of this nature over many years of use of this aircraft type. G-CHHD was in fact a Group 'A' aircraft as it was the heaviest of the Sherwood Ranger variants. However, the LAA stated that adequate strength had been demonstrated by conducting drop tests at the highest aircraft weight.

Of some concern in this accident was that the pilot risked more serious injury by releasing his harness whilst inverted, such that he dropped head-first onto the ground. Many people were on the airfield at the time; however, rather than await rescue, the pilot reported that he could smell escaping fuel, which prompted him to take immediate action.

ACCIDENT

Aircraft Type and Registration:	Robinson R22 Beta, G-DEFY	
No & Type of Engines:	1 Lycoming O-360-J2A piston engine	
Year of Manufacture:	2004 (Serial no: 3633)	
Date & Time (UTC):	25 September 2015 at 1416 hrs	
Location:	Elstree Aerodrome, Hertfordshire	
Type of Flight:	Training	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - 1 (Minor)	Passengers - N/A
Nature of Damage:	Substantial	
Commander's Licence:	Student pilot	
Commander's Age:	44 years	
Commander's Flying Experience:	55 hours (of which 53 were on type) Last 90 days - 10 hours Last 28 days - 4 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

Synopsis

The helicopter rolled to the right during the student pilot's first solo takeoff attempt. It suffered extensive damage and the pilot sustained a minor injury.

History of the flight

Following a satisfactory dual detail, the student pilot was briefed by his instructor to carry out a solo takeoff, hover and landing; it was to be the student's first solo flight. The instructor vacated the helicopter and moved a safe distance away before giving his student the signal to proceed. The student pilot completed his pre-takeoff checks and started to lift gently into a hover from the grass surface. Before the helicopter stabilised in the hover, it rolled to the right and onto its side, suffering extensive damage. The student pilot, who suffered a minor injury, vacated the helicopter through the cabin door. He reported that the helicopter had been subject to dynamic rollover.

AAIB note

Dynamic rollover may occur when one skid or wheel is in contact with the ground and the helicopter rolls to one side. As it rolls, the horizontal component of the total rotor thrust in the same direction produces a rolling moment about the point of ground contact. The rolling moment is initially opposed by the weight of the aircraft acting vertically downwards but, if the roll angle reaches a critical value and the skid or wheel remains in contact with the surface, the helicopter will roll over.

ACCIDENT

Aircraft Type and Registration:	Robinson R22 Beta, G-TIMH	
No & Type of Engines:	1 Lycoming O-360-J2A piston engine	
Year of Manufacture:	2007 (Serial no: 4108)	
Date & Time (UTC):	13 September 2015 at 1330 hrs	
Location:	Nottingham Heliport	
Type of Flight:	Training	
Persons on Board:	Crew - 2	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Damage to the tailcone, cabin floor and engine firewall	
Commander's Licence:	Commercial Pilot's License	
Commander's Age:	45 years	
Commander's Flying Experience:	1,366 hours (of which 841 were on type) Last 90 days - 138 hours Last 28 days - 61 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

Synopsis

The helicopter suffered a heavy landing during a training exercise. An initial inspection did not reveal any damage but later, under different light conditions, damage in the aft fuselage area was noticed.

History of the flight

The instructor and student were carrying out an exercise to practise engine failures in the hover. The first few practices were completed to successful landings. The final attempt resulted in a turn to the left, through 100°, and a heavy landing, both skids touching down together. No unusual vibrations or noises were heard and the instructor lifted the helicopter into a hover, to check for normal operation. No faults were observed and the training detail was continued.

On completion, the helicopter returned to the apron area and the instructor carried out a post-flight inspection. This included a check of the top of the cooling fan for any evidence of contact from the tail rotor mechanism and a check of the lower cross tube for signs of damage or bowing. No damage was observed.

The helicopter was then used on another training flight. After it had returned and shut down, the instructor noticed an "odd" refection of sunlight from the forward part of the tailcone. Further inspections revealed damage to the engine firewall and the cabin floor.

Conclusions

It was considered that the damage must have occurred during the earlier heavy landing. The helicopter has a black colour scheme, which may have made the damage more difficult to see on the first inspection.

The instructor considered that he had not reacted quickly enough to an incorrect yaw pedal input by the student.

ACCIDENT

Aircraft Type and Registration:	Robinson R66, G-LROK
No & Type of Engines:	1 Rolls-Royce 250-C300/A1 turboshaft engine
Year of Manufacture:	2015 (Serial no: 581)
Date & Time (UTC):	12 September 2015 at 0956 hrs
Location:	Denham Airfield, Buckinghamshire
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Damage to the main rotor blades, drive train, transmission bay, tail boom and windshield
Commander's Licence:	Student
Commander's Age:	49 years
Commander's Flying Experience:	70 hours (of which 18 were on type) Last 90 days - 10 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and subsequent AAIB enquiries.

The student pilot had commenced training for his PPL(H) on the R44, in which he had flown solo, before changing to the R66 some 18 flying hours before the accident flight.

On the day, he completed five dual circuits with his instructor. They then landed and the instructor exited the helicopter, to allow the student to conduct his first solo flight on the R66. As the student lifted into the hover, the helicopter rolled right and the rotors struck the ground. The helicopter came to rest on its side and the student, who sustained minor injuries, was able to vacate the cabin. The instructor, who was standing 50 yards away, commented that it appeared a dynamic rollover had occurred.

In 1982 the Robinson Helicopter Company issued Safety Notice *SN-9,* concerning dynamic rollover[1]. It states:

> *'A dynamic rollover can occur whenever the landing gear contacts a fixed object, forcing the aircraft to pivot about the object instead of about its own center of gravity…Once started, dynamic rollover cannot be stopped by application of opposite cyclic alone…Quickly applying down collective is the most effective way to stop dynamic rollover.'*

Footnote

[1] http://www.robinsonheli.com/service_library/safety_notices/rhc_sn09.pdf

ACCIDENT

Aircraft Type and Registration:	Spitfire Mk 26 (80% scale replica), G-CENI
No & Type of Engines:	1 Jabiru 5100A piston engine
Year of Manufacture:	2007 (Serial no: PFA 324-14102)
Date & Time (UTC):	18 July 2015 at 1207 hrs
Location:	Peterborough Sibson Airport, Cambridgeshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Propeller broken, engine shock-loaded, firewall distorted, damage to flaps and fuselage underside
Commander's Licence:	Private Pilot's Licence
Commander's Age:	47 years
Commander's Flying Experience:	388 hours (of which 26 were on type) Last 90 days - 8 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Summary

While preparing for landing, the pilot was unable to extend the left landing gear. After a number of attempts to rectify the situation, the pilot made a successful 'wheels-up' landing. Investigation indicated that the difficulty in extending the gear had been due to a combination of a stuck microswitch and a slightly bent gear leg.

Circumstances of the accident

Following a flight from Sibson to Peterborough Connington earlier in the day, the aircraft departed for the return flight. After takeoff the landing gear was retracted, with all indications appearing normal. On joining downwind in the Sibson circuit the aircraft was slowed to within the gear deployment arc on the airspeed indicator and the pilot switched the cockpit panel switches (one for each main gear) to the DOWN position. He noticed a green light on the left gear indicator (indicating DOWN), although the mechanical indicator on the left wing showed the gear was still in the UP position. The pilot then operated both gear levers to deploy the landing gear in the normal way. The right indicator light turned red, indicating the gear was travelling, and the left remained green. On completing the cycle, a check of the wing indicators showed that the right gear was now down but the left gear had remained up. The pilot called Sibson tower, requesting a go-around and a visual check of the landing gear; the tower confirmed that the right gear was down but the

left was still retracted. The pilot then retracted the right gear and departed to the south of the airfield, where numerous recycling attempts, using positive 'g', were made to try to assist the gear to deploy, but to no avail. A second pass by the Sibson tower confirmed that there was no change.

During the second climb-out, the pilot observed that the engine oil temperature was high, most probably due to prolonged operation at a relatively low airspeed. He dealt with this by increasing the power and departing to the south once again to bring the oil temperature down. He also informed Sibson of his intention to deploy the emergency gear release system. Accordingly, he pulled the emergency release cable for the left gear but the leg failed to deploy, with the wing indicator still showing the UP position.

The pilot considered his options for an emergency landing and decided to return to Sibson, where, after further gear recycling attempts and another flypast, he confirmed that nothing had changed. He circled the aircraft in the vicinity of the airfield, burning off fuel, while he awaited for the emergency services to get into position. During this time he formulated his approach and landing plan, opting for the use of power and flaps, which he considered were appropriate for the thermal and gusty conditions on Runway 24L. Following one more low level go-around to select a landing spot and assess the condition of the grass runway, the pilot retracted the cockpit canopy and made his approach at around 55 kt, reducing to 45 kt. The aircraft touched down on the stall and stopped after a ground-slide of around 10 m. The pilot, who was uninjured, turned off the fuel and battery master switch before exiting the aircraft.

Aircraft description

The Spitfire Mk 26 is a conventionally configured low-wing monoplane which is an 80% scale replica of the wartime fighter. The aircraft is manufactured in kit form in Australia for construction by amateurs and is administered in the UK by the Light Aircraft Association (LAA).

The two main landing gear legs are independently raised and lowered by means of electrically powered rams and are locked up and down by locking pins operated by Teleflex-type cables. Emergency lowering is by means of a pull-cable that withdraws a securing pin, which, when removed, allows the spring-loaded operating 'ram to gear leg' connecting pin to be ejected; after this ejection, gear extension occurs by a combination of gravity and spring assistance.

Electrical control of each left and right system is achieved by a panel-mounted, three-position switch: UP, DOWN and neutral. UP and DOWN microswitches control the current direction to the motors. Thus an UP selection is made by moving the switches to the UP position, which arms the system; these are independent systems and, while it is usual to operate the landing gears simultaneously, they can be operated separately if desired. Two levers (again, one for each system) on the left side of the cockpit are then moved rearward, which, via the Teleflex cables, disengage a locking pin on each side, which in turn allow a microswitch to complete a circuit to enable the motor to retract the gear. When the leg reaches its retracted position, the other microswitch stops the motor. The lever can then be moved forward to

re-engage the lock pin, and the gear switches would be returned to the neutral position. The gear is lowered by a similar process: each switch is moved to the DOWN position and the lock levers moved forward which, via the UP microswitches, allow the motors to extend the gears until electrical power is removed by activation of the DOWN microswitches.

The investigation

The subsequent investigation discovered that the left landing gear DOWN microswitch had become stuck so that it could not complete the electrical circuit (when the lock lever was moved) to enable the motor to extend the gear.

Examination of the left landing gear system revealed that there was a degree of residual tension such that, after removing the connecting pin by pulling the emergency handle, the gear did not move under gravitational and spring forces. One turn on a rod end was enough to relieve the tension and enable the emergency system to operate as designed. Whilst it was originally thought that this condition was the result of incorrect rigging, it was subsequently found that the leg was slightly bent, possibly as a result of a previous heavy landing or excessive side load. This had caused the wheel to press against the underside of the wing skin, thus generating the tension in the system.

The LAA have asked all owners of this aircraft type to conduct drop tests of the emergency landing gear system with the aircraft supported on jacks. The LAA also commented that the main gear legs supplied with later Mk 26 aircraft kits are more robust than those of earlier examples. In fact the Mk 26 kit is no longer available, having been replaced by a 90% scale version, the Mk 26B.

The September issue of the LAA's magazine '*Light Aviation*' carried an illustrated article on this accident.

ACCIDENT

Aircraft Type and Registration:	Tipsy Nipper T.66 Series 2, G-NIPS
No & Type of Engines:	1 Revmaster 2100D piston engine
Year of Manufacture:	1960 (Serial no: 36)
Date & Time (UTC):	14 July 2015 at 1336 hrs
Location:	West Tisted, Hampshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Serious) Passengers - N/A
Nature of Damage:	Damage to landing gear and fuselage
Commander's Licence:	Private Pilot's Licence
Commander's Age:	69 years
Commander's Flying Experience:	2,500 hours (of which 20 were on type) Last 90 days - 27 hours Last 28 days - 14 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot was flying at 1,000 ft when he noticed an unusual rattling noise from the engine. He began a diversion to West Tisted Airstrip but, when he was approximately one mile away, there was a loud bang and the engine stopped.

The pilot found the area did not contain a good choice of fields for a forced landing and he selected what appeared to be a ploughed field as the least-worst option. Having recognised that the aircraft might invert on landing, he arranged his approach so that the aircraft passed close to a farm tractor, in the hope of alerting the driver to his presence. The field contained a brown coloured standing crop and, as the aircraft touched down, it inverted immediately. The pilot sustained spinal injuries and was trapped in the aircraft. However, he was rescued by farm staff righting the aircraft before the emergency services arrived. There was no fire.

The pilot reported that the engine was significantly damaged internally, making it difficult to determine which component initiated the failure. However, it appeared to have been caused by a broken valve fouling a piston, which then failed.

ACCIDENT

Aircraft Type and Registration:	Vans RV-9A, G-XSAM	
No & Type of Engines:	1 Wilksch WAM-120 piston engine	
Year of Manufacture:	2008 (Serial no: PFA 320-13797)	
Date & Time (UTC):	18 September 2015 at 1830 hrs	
Location:	Old Sarum Airfield, Wiltshire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 1
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Damage to propeller, nose and nose landing gear	
Commander's Licence:	Commercial Pilot's Licence	
Commander's Age:	35 years	
Commander's Flying Experience:	3,046 hours (of which 2 were on type) Last 90 days - 78 hours Last 28 days - 23 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

Synopsis

During the ground roll after landing, the nose landing gear folded backwards and the nose and propeller struck the ground. The damage to the nose gear was consistent with overload forces, but the pilot was unable to say how such loads had been generated.

History of the flight

The aircraft was landing on grass Runway 24 at Old Sarum at about 1830 hrs UTC. The pilot reported that the touchdown and first part of the ground roll were normal but, as the aircraft slowed, the nose landing gear collapsed and the nose and propeller struck the ground before it came to a halt.

Discussion

The pilot stated that he was unsure as to why the collapse had occurred. He considered that his technique had been no different from the previous three landings he had performed earlier in the day and two he had observed the owner of the aircraft conducting. He believed he had applied "suitable" back pressure on the control column during the landing roll. He said that the runway was quite bumpy but he had not felt any major bumps.

Examination of the aircraft showed that the nose landing gear leg had folded backwards and there was distortion of the nosewheel fork relative to the leg. Previous experience of collapses on this type of nose gear suggests that this kind of damage is typical when the

nose landing gear is subjected to high loads which can cause the nosewheel fork to bend and dig into the ground – the resulting drag on grass runways then typically causes the leg itself to collapse backwards in bending near its mounts (Figure 1).

Figure 1

Nose landing gear of G-XSAM showing distortion of nosewheel fork and tubular leg

The Light Aircraft Association (LAA) Type Acceptance Data Sheet for the Vans RV-9 and -9A contains the following paragraph:

> *'Problems have been experienced with the RV-9A noseleg, especially when operating off grass, with instances of the nosewheel bending back and the strut digging into the ground, causing a rapid stop and further damage. In order to avoid this risk, it is important to maintain the correct nosewheel tyre pressure, and to trim the spat to ensure generous clearance between the tyre and the wheel aperture in the spat (circa half an inch). It is also important to maintain suitable preload on the nosewheel axle bearings, torquing up the axle nut gently as required in the absence of a conventional spacer between the bearings. It is also important to land the aircraft on the mainwheels first and hold the nosewheel off the ground during the initial part of the landing roll, rather than landing on all three wheels together which encourages wheelbarrowing and overloading the nosewheel.'*

This advice is also reflected in various manufacturers' communications including a Vans Service Letter dated 9 November 2007, which advocated keeping '*the stick fully back when taxiing, especially after touchdown*'.

It is noted that the landing occurred nearly 15 minutes after official sunset. It is not known whether this had any bearing on the accident.

ACCIDENT

Aircraft Type and Registration:	Jabiru UL, G-RYAL	
No & Type of Engines:	1 Jabiru 2200A piston engine	
Year of Manufacture:	2000 (Serial no: PFA 274A-13365)	
Date & Time (UTC):	31 October 2015 at 1200 hrs	
Location:	Sandtoft Airfield, North Lincolnshire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 1
Injuries:	Crew - 1 (Serious)	Passengers - 1 (Serious)
Nature of Damage:	Aircraft destroyed	
Commander's Licence:	National Private Pilot's Licence	
Commander's Age:	85 years	
Commander's Flying Experience:	440 hours (of which 9 were on type) Last 90 days - 10 hours Last 28 days - 4 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

Synopsis

The aircraft struck a lamp post on short final to Runway 23. This caused the aircraft to pitch nose-down and hit a road. The pilot had been aiming to land at the beginning of the paved surface instead of the runway threshold, which was displaced by 190 m.

History of the flight

The pilot had been flying for about 30 years on, primarily, Piper PA-28, PA-38, Cessna 150, 152 and TB10 aircraft. He had recently bought the home-built Jabiru UL (G-RYAL), had carried out a 1.2 hour flight with the previous owner and had logged 8 hours as pilot-in-command since then. He had not undertaken any flights in the aircraft with an instructor.

He had experienced difficulties landing the aircraft at his local farm strip of Coal Aston so he had flown to Sandtoft. Two weeks later he decided to carry out some circuits at Sandtoft. The wind was from 230° and he estimated the overcast cloud base to be at 700 ft. He took a passenger and briefed him to call out his airspeed on final approach so that he, the pilot, could concentrate on touching down as early as possible. He had experienced a lot of 'float' during landing and wanted to have the full runway length available.

The pilot commenced his approach to Runway 23 and was targeting an approach speed of 57 kt with full flap. Runway 23 has a 190 m displaced threshold but he was aiming to land at the beginning of the paved surface (Figure 1). He "got a bit low" during the approach and

at one point added power to climb, then he heard his passenger saying "there's a lighting column", or words to that effect, and a second later he felt an impact. CCTV captured the moment when the aircraft's tailplane struck a lamp post (Figure 2). The aircraft then pitched nose-down, hit a road and slid about 35 m before coming to rest against the airfield perimeter fence. Both the pilot and his passenger were seriously injured and were assisted by emergency services.

Figure 1

Sandtoft Runway 23. Location of the lamp post struck by the aircraft marked with an 'x' (Image courtesy Google Earth)

Figure 2

CCTV snapshot of the moment after the aircraft's tailplane hit the lamp post

Pilot comments

The pilot had been unaware of the lamp post and was unaware that the surface before a displaced threshold was not part of the landing surface. He was also unaware that displaced thresholds were often in place to ensure sufficient clearance from obstacles on the approach path.

ACCIDENT

Aircraft Type and Registration:	Mainair Blade, G-MZLC
No & Type of Engines:	1 Rotax 582 piston engine
Year of Manufacture:	1998 (Serial no: 1146-0298-7-W949)
Date & Time (UTC):	22 August 2015 at 1315 hrs
Location:	Culbokie Airfield, Ross and Cromarty
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Damage to wing, propeller, monopole, pod and wheel fairings
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	72 years
Commander's Flying Experience:	70 hours (of which 69 were on type) Last 90 days - 6 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft bounced on landing and then veered to the left. After the second touchdown the aircraft departed the runway and overturned in a ploughed field.

History of the flight

After a local flight the pilot returned overhead Culbokie Airfield. From the windsock he estimated the wind to be about 10 to 12 mph from 110° to 130°. He flew a high approach to Runway 09 (grass), which was 190 m long and 12 m wide, because he had experienced turbulence on approach to 09 before. Crossing the runway threshold he pulled the bar back to lose height and reduced power – the airspeed was 50 mph. He then flared late and the aircraft touched down on all three wheels and bounced into the air.

A video camera attached to the right wing captured the landing and showed the aircraft veer left after the bounce. When the aircraft touched down again it was heading towards the left side of the runway. One second later the nosewheel and left wheel entered tall grass and struck a metal post which resulted in the post flipping into the air. The nosewheel then lifted off but the left wheel hit a furrow in a ploughed field which caused the aircraft to pitch down. At this point, the post, which was still spinning, may have struck the propeller. The nosewheel dug into the field and the aircraft rolled onto its right side, where it came to rest. The pilot reported applying full power and pushing the bar forwards

after the second touchdown but it was too late to prevent the runway excursion. The pilot suffered two broken finger tips, and after some initial difficulties, was able to extricate himself from the aircraft.

ACCIDENT

Aircraft Type and Registration:	Pegasus Quik, G-XJJM
No & Type of Engines:	1 Rotax 912ULS piston engine
Year of Manufacture:	2007 (Serial no: 8306)
Date & Time (UTC):	23 July 2015 at 1747 hrs
Location:	Hall Lane Farm, Burtonwood, Cheshire
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Serious) Passengers - N/A
Nature of Damage	Aircraft damaged beyond economic repair
Commander's Licence:	Student
Commander's Age:	27 years
Commander's Flying Experience:	45 hours (all of which were on type) Last 90 days - 4 hours Last 28 days - 3 hours
Information Source:	Enquires by the AAIB

Synopsis

The flex-wing aircraft, while being flown at low level by a student, struck an electrical transmission cable and crashed into a field to the east of Hall Lane Farm, Burtonwood, Cheshire. The student reported that due to "post-traumatic amnesia" he had no recollection of the accident flight or the events preceding it.

History of the flight

The student was undergoing flex-wing training at Manchester (Barton) Aerodrome for his National Private Pilot's Licence (NPPL). At the time of the accident he had accumulated 39 hours dual and six hours solo flying. His instructor stated that he had completed the BMAA NPPL Microlight Training Syllabus and had passed his Human Performance and Air Law ground exams.

On the day of the accident the student flew with his instructor for 15 minutes who then authorised him to fly solo for one hour during which he was to practise basic handling including climbing and descending turns. The student was briefed to remain within the normal training area, which was bounded by the M6 to the west, the M62 to the south and the M61 to the north. He was also briefed to fly between 800 ft and 1,800 ft at all times, except when he was west of the 'River Glaze' (Glaze Brook), located 4 miles to the west of the airfield, when he was not to fly above 1,200 ft. All the flying was to be carried out within visual range of the airfield.

The instructor reported that the student returned to the airfield after approximately one hour and following a break was authorised to repeat the exercise. The instructor reported that the wind was light and the visibility excellent. It was during this second solo flight that the aircraft collided with electrical transmission cables.

The student damaged his spine and sustained a broken ankle, hip, sternum and eye socket, and was taken to hospital by air ambulance.

GPS Data

The aircraft was equipped with a Garmin 296 GPS, which contained a track file for the accident flight. The accident flight lasted approximately 36 minutes. On departing the airfield, the aircraft flew 10 miles to the west of the airfield, beyond the M6 and the 'River Glaze', climbing to a height of 5,000 ft agl. During the transit the aircraft few into the Manchester TMA. After approximately five minutes, the aircraft descended to a height of approximately 50 ft agl. For the remaining 13 minutes the aircraft was flown between 100 and 650 ft agl during which it entered Class D airspace. During this period, it completed numerous turning manoeuvres while flying between the southern edge of Newton-le-Willows and the M62. The final part of the flight was flown south along Sankey Brook at an average height of 100 ft agl.

Witness account

A witness who lived in the southern part of Newton-le-Willows saw the aircraft manoeuvring close to the houses. He said that many people had come out of their homes to watch the microlight, which he captured on video as it flew south along the route of the canal, which the AAIB estimated was approximately 75 m (260 ft) from where the video was taken. A still from the video is shown at Figure 1. The witness noted that the engine noise was heard to change as the aircraft manoeuvred and the aircraft crashed shortly after the video was recorded. The AAIB estimated that the accident site was approximately 440 m south of where the video was taken and from GPS data it was established that the aircraft would have taken 10 seconds to fly this distance.

Figure 1

Still taken from the video clip provided by a witness

Aircraft history

The aircraft was destroyed in the accident and was not examined by the AAIB. However, the last Permit Renewal had been carried out on 11 December 2014. A new engine had been fitted in early 2015 and at the time of the accident had operated from new for 135 hrs. The last engine servicing had been carried out approximately eight hours previously. The pilot made no mention to his instructor, after he landed after the first flight, of any problems with the aircraft or its engine.

Comment

The aircraft was observed by a number of witnesses flying at low level before it collided with the 132 KV electrical transmission cable before it struck the ground.

The engineers who inspected the cable reported that the aircraft initially struck the top phase conductor, which was measured as being 25 m (80 ft) above the ground and then passed between the top phase and earth conductor, measured as being 30 m (100 ft) above the ground. The aircraft struck the cable at a position midway between the supporting pylons. While the outer copper conductor on the cable had been damaged, the inner steel core remained intact.

Miscellaneous

This section contains Addenda, Corrections and a list of the ten most recent Aircraft Accident ('Formal') Reports published by the AAIB.

The complete reports can be downloaded from the AAIB website (www.aaib.gov.uk).

BULLETIN CORRECTION

Aircraft Type and Registration:	Pegasus Quantum 15, G-MZJH
Date & Time (UTC):	19 September 2015 at 1330hrs
Location:	Private strip, near Slipton, Northamptonshire
Information Source:	Aircraft Accident Report Form

AAIB Bulletin No 12/2015, page 59 refers

The pilot declared incorrect details against hours on type when he submitted the AARF.

Commander's Flying Experience states:

- 208 hours (of which 3 were on type)

Commander's Flying Experience should state:

- 208 hours (of which **92** were on type)

The online version of this report was amended on 16 December 2015.

TEN MOST RECENTLY PUBLISHED FORMAL REPORTS ISSUED BY THE AIR ACCIDENTS INVESTIGATION BRANCH

7/2010 Aerospatiale (Eurocopter) AS 332L Super Puma, G-PUMI at Aberdeen Airport, Scotland on 13 October 2006.

Published November 2010.

8/2010 Cessna 402C, G-EYES and Rand KR-2, G-BOLZ near Coventry Airport on 17 August 2008.

Published December 2010.

1/2011 Eurocopter EC225 LP Super Puma, G-REDU near the Eastern Trough Area Project Central Production Facility Platform in the North Sea on 18 February 2009.

Published September 2011.

2/2011 Aerospatiale (Eurocopter) AS332 L2 Super Puma, G-REDL 11 nm NE of Peterhead, Scotland on 1 April 2009.

Published November 2011.

1/2014 Airbus A330-343, G-VSXY at London Gatwick Airport on 16 April 2012.

Published February 2014.

2/2014 Eurocopter EC225 LP Super Puma G-REDW, 34 nm east of Aberdeen, Scotland on 10 May 2012 and G-CHCN, 32 nm south-west of Sumburgh, Shetland Islands on 22 October 2012.

Published June 2014.

3/2014 Agusta A109E, G-CRST Near Vauxhall Bridge, Central London on 16 January 2013.

Published September 2014.

1/2015 Airbus A319-131, G-EUOE London Heathrow Airport on 24 May 2013.

Published July 2015.

2/2015 Boeing B787-8, ET-AOP London Heathrow Airport on 12 July 2013.

Published August 2015.

3/2015 Eurocopter (Deutschland) EC135 T2+, G-SPAO Glasgow City Centre, Scotland on 29 November 2013.

Published October 2015.

Unabridged versions of all AAIB Formal Reports, published back to and including 1971, are available in full on the AAIB Website

http://www.aaib.gov.uk

GLOSSARY OF ABBREVIATIONS

aal	above airfield level
ACAS	Airborne Collision Avoidance System
ACARS	Automatic Communications And Reporting System
ADF	Automatic Direction Finding equipment
AFIS(O)	Aerodrome Flight Information Service (Officer)
agl	above ground level
AIC	Aeronautical Information Circular
amsl	above mean sea level
AOM	Aerodrome Operating Minima
APU	Auxiliary Power Unit
ASI	airspeed indicator
ATC(C)(O)	Air Traffic Control (Centre)(Officer)
ATIS	Automatic Terminal Information System
ATPL	Airline Transport Pilot's Licence
BMAA	British Microlight Aircraft Association
BGA	British Gliding Association
BBAC	British Balloon and Airship Club
BHPA	British Hang Gliding & Paragliding Association
CAA	Civil Aviation Authority
CAVOK	Ceiling And Visibility OK (for VFR flight)
CAS	calibrated airspeed
cc	cubic centimetres
CG	Centre of Gravity
cm	centimetre(s)
CPL	Commercial Pilot's Licence
°C,F,M,T	Celsius, Fahrenheit, magnetic, true
CVR	Cockpit Voice Recorder
DFDR	Digital Flight Data Recorder
DME	Distance Measuring Equipment
EAS	equivalent airspeed
EASA	European Aviation Safety Agency
ECAM	Electronic Centralised Aircraft Monitoring
EGPWS	Enhanced GPWS
EGT	Exhaust Gas Temperature
EICAS	Engine Indication and Crew Alerting System
EPR	Engine Pressure Ratio
ETA	Estimated Time of Arrival
ETD	Estimated Time of Departure
FAA	Federal Aviation Administration (USA)
FIR	Flight Information Region
FL	Flight Level
ft	feet
ft/min	feet per minute
g	acceleration due to Earth's gravity
GPS	Global Positioning System
GPWS	Ground Proximity Warning System
hrs	hours (clock time as in 1200 hrs)
HP	high pressure
hPa	hectopascal (equivalent unit to mb)
IAS	indicated airspeed
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
IP	Intermediate Pressure
IR	Instrument Rating
ISA	International Standard Atmosphere
kg	kilogram(s)
KCAS	knots calibrated airspeed
KIAS	knots indicated airspeed
KTAS	knots true airspeed
km	kilometre(s)
kt	knot(s)
lb	pound(s)
LP	low pressure
LAA	Light Aircraft Association
LDA	Landing Distance Available
LPC	Licence Proficiency Check
m	metre(s)
mb	millibar(s)
MDA	Minimum Descent Altitude
METAR	a timed aerodrome meteorological report
min	minutes
mm	millimetre(s)
mph	miles per hour
MTWA	Maximum Total Weight Authorised
N	Newtons
N_R	Main rotor rotation speed (rotorcraft)
N_g	Gas generator rotation speed (rotorcraft)
N_1	engine fan or LP compressor speed
NDB	Non-Directional radio Beacon
nm	nautical mile(s)
NOTAM	Notice to Airmen
OAT	Outside Air Temperature
OPC	Operator Proficiency Check
PAPI	Precision Approach Path Indicator
PF	Pilot Flying
PIC	Pilot in Command
PNF	Pilot Not Flying
POH	Pilot's Operating Handbook
PPL	Private Pilot's Licence
psi	pounds per square inch
QFE	altimeter pressure setting to indicate height above aerodrome
QNH	altimeter pressure setting to indicate elevation amsl
RA	Resolution Advisory
RFFS	Rescue and Fire Fighting Service
rpm	revolutions per minute
RTF	radiotelephony
RVR	Runway Visual Range
SAR	Search and Rescue
SB	Service Bulletin
SSR	Secondary Surveillance Radar
TA	Traffic Advisory
TAF	Terminal Aerodrome Forecast
TAS	true airspeed
TAWS	Terrain Awareness and Warning System
TCAS	Traffic Collision Avoidance System
TGT	Turbine Gas Temperature
TODA	Takeoff Distance Available
UHF	Ultra High Frequency
USG	US gallons
UTC	Co-ordinated Universal Time (GMT)
V	Volt(s)
V_1	Takeoff decision speed
V_2	Takeoff safety speed
V_R	Rotation speed
V_{REF}	Reference airspeed (approach)
V_{NE}	Never Exceed airspeed
VASI	Visual Approach Slope Indicator
VFR	Visual Flight Rules
VHF	Very High Frequency
VMC	Visual Meteorological Conditions
VOR	VHF Omnidirectional radio Range

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