AAIB
Air Accidents Investigation Branch

Annual Safety Review 2022

Published 27 April 2023.

Enquiries regarding the content of this publication should be addressed to:

Air Accidents Investigation Branch
Farnborough House
Berkshire Copse Road
Aldershot
Hampshire
GU11 2HH.

This document is also available in electronic (pdf) format at www.aaib.gov.uk

Foreword

2022 marked 100 years of air accident investigation regulations in the UK. There is an article in this review which explains the origins of the regulations and their evolution since then. The regulations (and the aviation industry) have progressed a great deal in this time. However, it is noteworthy that the fundamental principle established in 1922 - to investigate accidents to *learn* from them to improve safety and prevent further accidents - has endured to this day and has become an international standard.

It is remarkable how much aviation safety has improved over the last 100 years through incremental changes to the way that aircraft are designed, manufactured, maintained and operated. Almost everywhere one looks across the aviation ecosystem there are physical systems and standard practices that have been introduced to improve safety as a direct result of learning from previous accidents and incidents. This has been underpinned by an open reporting culture, and a clear focus on improving safety without attribution of blame.

That important work continues with increased emphasis on learning from serious incidents. In-depth investigation of these occurrences provides an opportunity to identify safety issues, and make recommendations to address weaknesses, before they become manifest in an accident. This has helped to make aviation one of the safest forms of transport and is an approach that is now emulated across other transport modes and other domains such as healthcare.

2022 saw a welcome lifting of COVID restrictions and a return to relatively normal flying operations, albeit with global flight traffic stabilising at around 90% of pre-pandemic levels. The AAIB received 778 occurrence notifications (compared to 826 in 2019) and opened 2 formal and 27 field investigations. A further 78 investigations were opened by correspondence and details recorded on another 189 occurrences. In addition, the AAIB appointed an accredited representative to 61 overseas investigations.

There were 9 fatal accidents in the UK involving 11 deaths. All but one involved General Aviation (3 light aircraft, 2 microlights, 2 gliders and 1 helicopter). The recurring themes continued to be loss of control in flight during aerobatics, following partial power loss or flight into clouds by unqualified pilots. Sadly, there was also a third-party fatality due to the effects of downwash from a search and rescue helicopter landing at a hospital landing site.

The dominant recurring themes in the accidents and serious incidents involving commercial air transport aircraft were mishandling of the aircraft during landing or go-around, complex electrical failures leading to system degradation, and failures to achieve takeoff performance.

A historic moment in 2022 was the agreement at the 41st ICAO Assembly of the long-term aspirational goal for international aviation of net-zero carbon emissions by 2050. There is huge impetus for innovation in the development of sustainable aviation fuels and low emission power-plant. Development activities are not without risk and the AAIB completed its investigation into an accident involving a hydrogen fuel cell powered development aircraft. Several recommendations were made to improve the management and oversight of flights under experimental conditions.

The AAIB sometimes needs to commission flight test activities to explore specific characteristics of an aircraft type that has been involved in an accident. There is an article in this Review which explains when and how the AAIB uses test flights with qualified test pilots to assist with an investigation.

In 2022 the AAIB published 2 special bulletins, 27 field investigation reports and 85 correspondence investigation reports. As always, the sole purpose of these investigations was to improve aviation safety and they generated 19 safety recommendations of which two were designated as safety recommendations of global concern. In this Review there are full details of each recommendation, together with the response received and updates of the progress of the action taken. In addition, there are details of 101 significant actions taken proactively by the industry in 2022 to enhance safety as a direct result of AAIB investigations but without the need for a specific recommendation.

In this way the 2022 Annual Safety Review brings together in one place a wealth of safety information which I trust you will find interesting and useful.

Crispin Orr
Chief Inspector of Air Accidents

Contents

Follow us on Twitter:

@aaibgovuk

1922 to 2022
100 years of accident investigation regulations

Introduction

On 28 June 1922 the first regulations were issued in the UK to formalise the investigation of aircraft accidents. They set in place a framework by which to investigate aircraft accidents to learn from them, improve safety and ultimately prevent further accidents. This article sets out the history and evolution of those regulations over the last 100 years.

The first regulations

The first fatality from an aircraft accident involved Charles Rolls, of Roll-Royce, when his modified Wright Flyer suffered a failure of the modified tail-booms due to overstress during a pitch demand. This was in 1910 when aviation was starting to take hold. There followed a spate of accidents involving the new flying machines, with nine fatalities in 1911 alone, a sobering figure considering at that time there were only 110 pilots with Aero Club certificates.

A group of individuals, including a Mr Cockburn, were concerned about these accidents so they set up the Public Safety and Accidents Investigation Committee of the Royal Aero Club. They undertook to investigate and prepare reports into the causes of all aircraft accidents with a view to provide lessons to prevent recurrence. The first such report by the committee was published in 1912 into an accident to a Flanders F3 Monoplane. Between 1912 and 1914 the committee investigated 26 fatal injuries. In 1915 the designation of an Inspector of Accidents within the Aeronautical Inspection Department of the Royal Flying Corps was given to Captain George Cockburn (Figure 1) and was the start of the work of the AAIB.

The Great War put a stop to civil aviation, so most of the work of the Inspector of Accidents was into military aircraft accidents involving the Royal Flying Corps. At the end of the War civil aviation resumed and the Government appointed the Civil Aerial Transport Committee to report to the Air Board on the development and regulation for commercial civil aviation. Mr Cockburn was a member of the committee and there were submissions providing information on the need to investigate accidents and to learn valuable lessons to discover and eliminate their causes including minor mishaps. The committee report recommended that official investigations into all accidents of a serious nature to aircraft carrying passengers for hire should be carried out by expert investigators and that power be conferred to compel for such investigation and regulate the manner in which it would be undertaken. This recommendation laid the foundation for the first regulations into aircraft accident investigation.

Figure 1
Inspector of Accidents
Captain George Cockburn RFC

The Paris Convention Relating to the Regulation of Aerial Navigation was agreed in 1919 and set the first common international air law principles. An Air Navigation Bill was produced in 1920 and included the provision for regulations on the investigation of aircraft accidents. This was debated in the house and indeed Mr Churchill who was Secretary of State for Air when asked about the cost of investigating accidents commented that "the cost of £2,500 was a moderate amount to keep an official record and to make uniform study of those accidents".

The subsequent Air Navigation Act 1920 provided for regulations on the investigation of any accident occurring in or over the UK or its territorial waters or elsewhere to UK registered aircraft. On 28 June 1922 the first "The Air Navigation (Investigation of Accidents) Regulations" were made to formalise the investigation of aircraft accidents.

The regulation

The regulations conferred the formal designation of "Inspector of Accidents" a designation used today only that "air" is now inserted to avoid confusion with the other accident investigation branches that came about later. The first formal Inspector of Air Accidents was Major Cooper who had recently taken over the previous informal position from Captain Cockburn.

The principles of accident investigation were laid down clearly and provided a foundation that has endured to this day. The most identifiable is the notification of accidents; the regulation provides the need to notify an accident to the Air Ministry and local Police. At this time the Accidents Investigation Branch was now established as part of the Air Ministry. A notification had to contain specific information, this list endures today and indeed is standard across the world.

The definition of an accident at the time was one involving death or personal injury to persons in the aircraft, serious structural damage to the aircraft or grounds to believe there has been a failure in the air of any part of the aircraft. Over the years this definition has been further refined but is still based around either fatal or serious injury or damage to the aircraft (with some exceptions on minor damage).

Aircraft were to remain undisturbed until the Inspector is able to examine the aircraft. This need to preserve the site and any evidence remains a very important aspect for inspectors to work out what happened. Latterly, this preservation includes locating and securing the crash protected data recorders or 'black boxes'.

Various powers were conveyed on Inspectors, including the ability to summons witnesses and require them to provide necessary documentation and full unhampered access to the aircraft. Obstruction of an Inspector was an offence, as it is today.

There were two types of investigation in the regulations, one was a preliminary investigation which although it resulted in a report would not be published unless the Secretary of State ordered it. The second type was a formal investigation, a term still in use today, which is more akin to a court inquiry. Importantly a court of inquiry could make recommendations for the avoidance of similar accidents in the future. A formal investigation, again, was only published if the Secretary of State so ordered.

A contravention of the regulations could result in a “fine of £50 or three months imprisonment with or without hard labour.”!

Inter-war years

The first report to be produced under the 1922 regulations was an accident to a Vickers Vulcan G-EBBL (Figure 2). The aircraft was flying in poor weather and the engine failed and carried out a forced landing. Fortunately there were no injuries. The cause was fuel starvation due to issues with the fuel gauge markings with a recommendation to have a “danger” low fuel marking. It was not published though.

On 21 July 1930 a flight from France to Croydon ended in disaster as the aircraft suffered an inflight breakup whilst in cloud with turbulent conditions over Meopham, Kent. There were six fatalities on the Junkers F13Ge, G-AAZK (Figure 3), and the passengers were of high standing which led to a lot of debate in the House over private and public investigations. There was also pressure from the relatives of those killed to be given the opportunity to ask questions and be made aware of the findings. Eventually the Secretary of State ordered the publication of the report; this was the first report to be formally published under the regulations.

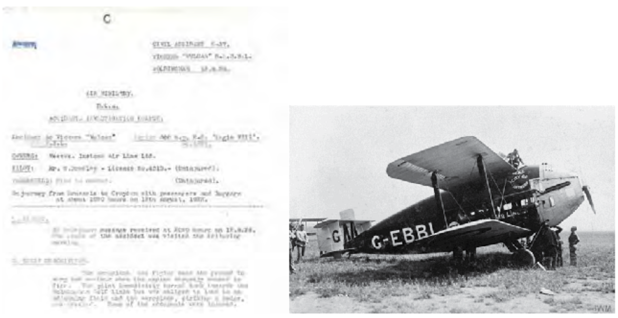


Figure 2
Accident report to G-EBBL

Figure 3
Published accident report to G-AAZK

Post WWII and Annex 13

After WWII, the Provisional International Civil Aviation Organisation (ICAO) was set up. This was tasked with setting the standards and recommended practices, one of which was accident investigation (AIG). The technical division was chaired by Air Commodore Vernon Brown – the then Chief Inspector of Air Accidents at the AIB. It is probably for this reason that the resulting Annex 13 to the Convention on International Civil Aviation, Aircraft Accident and Incident Investigation was similar to the regulations in the UK. (Figure 4)

Figure 4
ICAO Annex 13 and Technical Division Committee

Shelmerdine, Newton and Cairns

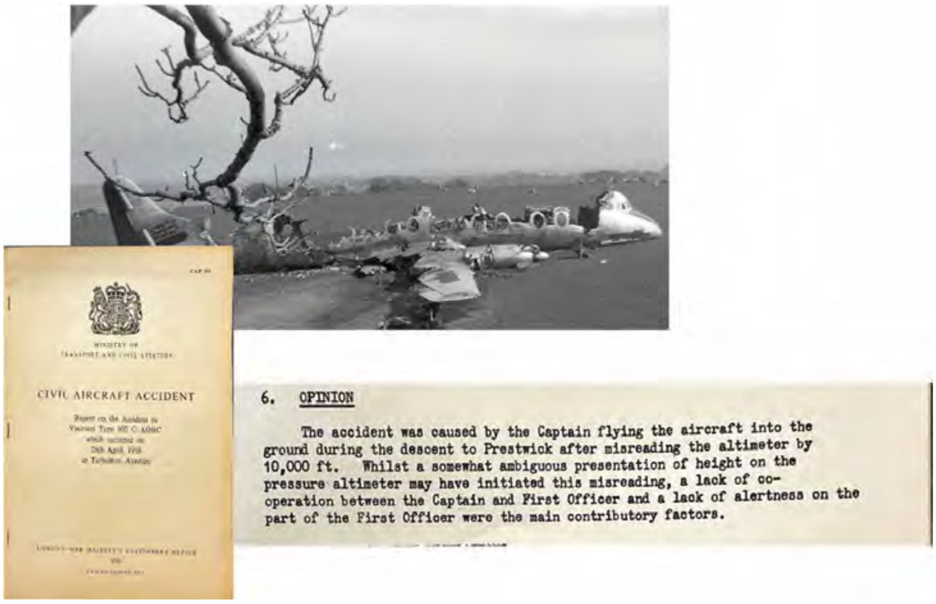
In 1948 a committee, chaired by C M Newton, was tasked to inquire into the procedure for investigation of air accidents. This had followed shortly after a committee chaired by Lt. Col. Sir Francis C. Shelmerdine had recommended standard reporting and sharing of safety information. Newton's report contained criticism that too many investigations were in private and that since 1922 there had only been two court investigations, one public inquiry and three informal public inquires. This led to an acceptance that from 1948 until 1972 all large public transport air accidents would result in a public inquiry.

The regulations were updated again in 1951 to align with the newly issued Annex 13 and took onboard the issues raised in the committee recommendations.

On 28 April 1958 a Viscount, G-AORC, crashed on approach to Prestwick, the report conclusion was "the accident was caused by the captain flying into the ground during the decent to Prestwick after misreading the altimeter by 10,000 ft" (Figure 5). The captain of the aircraft survived and was quite aggrieved by the investigation process in that he felt he did not have enough opportunity to provide representations on the report.

Given the heated debates in the House another committee chaired by David Cairns was tasked with reviewing the law and practice of the investigation of accidents and licencing. The lengthy report, published in 1960, explored many issues, in particular about private and public reporting and the ability for those whose reputation is affected to provide representation.

There were several recommendations including the provision for an independent review board to be instituted at the request of someone who objects to a finding against them from an investigation.



6. OPINION

The accident was caused by the Captain flying the aircraft into the ground during the descent to Prestwick after misreading the altimeter by 10,000 ft. Whilst a somewhat ambiguous presentation of height on the pressure altimeter may have initiated this misreading, a lack of co-operation between the Captain and First Officer and a lack of alertness on the part of the First Officer were the main contributory factors.

Figure 5
G-AORC accident report

No-blame and public reporting

Quite a bit of time passed between the issue of the Cairns report and change to the regulations. However, in 1969 the regulations were significantly overhauled and took on board some of the recommendations.

For the first time the purpose of the investigation was clearly explained and that it was not to ascribe blame or liability. The foundation of the no-blame accident investigations we know today.

It also introduced the need for anyone whose reputation was to be affected to be able provide representation within 28 days and allowed for review boards.

Significantly all reports were finally to be made public, so from 1970 the AIB has published them either in a monthly bulletin or as a standalone "formal" report.

As reports were now routinely published, after the public inquiry into the tragic accident to the Trident, G-ARPI, in Staines in 1972, (Figure 6) it was deemed that the AIB provided suitable reports that addressed the issues in a more efficient manner than any public inquiry and so there has not been another such inquiry into an aircraft accident since. In 1996 the regulations were updated to remove any reference to public inquires and review boards. This further strengthened the ability for open, just and no-blame investigation.

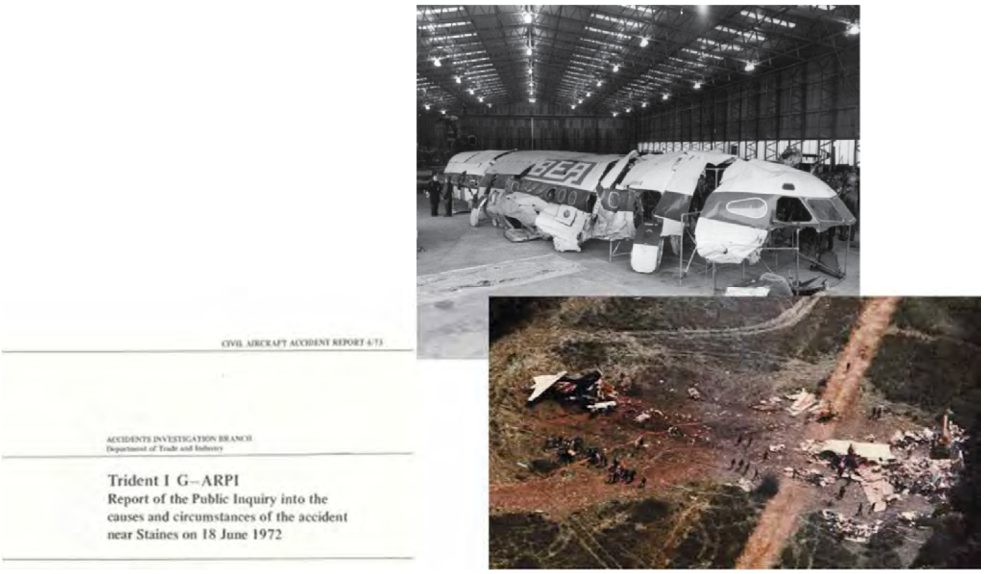


Figure 6

G-ARPI the last aircraft accident public inquiry

Records and disclosure

Up to 1996 all investigations were done in private, which meant information provided to Inspectors was confidential. However, there was always the possibility that information could be disclosed on request, particularly if there was a review board or public inquiry. With the development of flight data recorders and cockpit voice recorders there was a recognition that there needed to be protection of sensitive records so they would not be used inappropriately. Annex 13 introduced protections of relevant records in 1976 and has been further expanded over the years to encompass cockpit audio and image recordings. The protections have meant investigators are able to obtain open and frank information from persons involved, who would otherwise not do so for fear of it being used against them. The protection of such records was put into UK law in 1996.

Europe

Civil aircraft accident investigation worldwide is governed by Annex 13 which is then brought into national law. In the European Union each member state had their own laws including the UK. In 1994 a Directive was issued to establish some fundamental principles on investigation of accidents. This eventually led to a regulation EU 996/2010 which standardised the investigation of civil aviation accidents in the European Union. It remains today and is now a retained law in the UK and runs alongside the 2018 iteration of the UK regulations.

Legacy and future

The legacy of aircraft accident investigation is seen whenever you travel; from the aircraft design and manufacturing to the seating, passenger briefings and safety equipment around you. The principle first initiated by Mr Cockburn and others in the Public Safety and Accidents Investigation Committee, of finding out what happened purely to prevent recurrence without apportioning blame or liability, endures today worldwide. It has led to aviation being one of the safest forms of transport. In 2021 there were only five fatal accidents in the UK, resulting in seven deaths across all aviation and none involving commercial air transport.

The principles used by the AAIB have been adopted across other modes of transport with a Marine Accident Investigation Branch established in 1989 following the public inquiry into the 1987 capsizing of the cross-channel ferry Herald of Free Enterprise in which 193 people died. Then a Rail Accident Investigation Branch was set up in 2005 following Lord Cullen's inquiry report on the Ladbroke Grove rail accident in 1999.

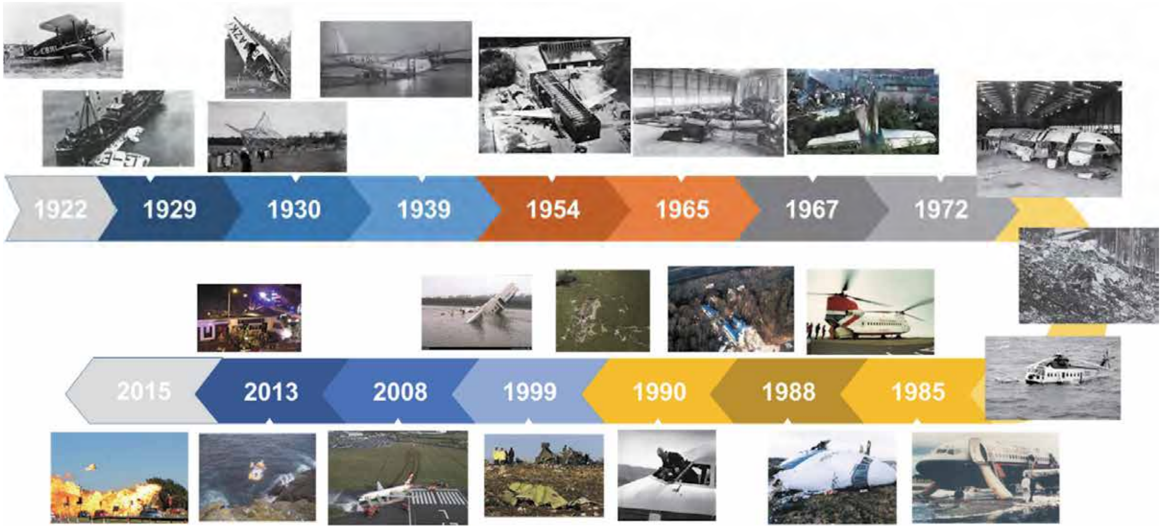
The approach has been expanded - into healthcare with the Healthcare Safety Investigation Branch, and the recently announced creation of a Road Safety Investigation Branch, all based on the regulations established for civil aviation over the last 100 years.

With the increase in unmanned aircraft, the AAIB has had to adapt quickly to new technology. The regulations were well suited to allow the investigation of these aircraft which meant there was not much adjustment needed. These established investigation principles have allowed the AAIB to provide valuable learning that has fed into the development of new technologies such as those in urban air mobility, autonomous aircraft and new fuel technologies.

What of the future? In 2021 the AAIB was given the additional role as the UK's Spaceflight Accident Investigation Authority – and whilst the AAIB name has not changed, it does expand our remit and the regulatory basis is already well established.

N739PA
Lockerbie, Dumfries and Galloway on 21 December 1988
Wreckage reconstruction at AAIB facilities in Farnborough

Significant and influential investigations under the Regulations since 1922



- **1922 – Vickers Vulcan, G-EBLL**
  The aircraft was flying in poor weather when the engine failed leading to a forced landing. This was the first investigation under the 1922 Regulations.

- **1929 – Handley Page W10 biplane, G-EBMT**
  Over the English Channel. One of its two engines failed and the aircraft was unable to maintain height and eventually ditched. This led to a requirement that all passenger aircraft should be capable of maintaining height with one engine failed.

- **1930 – R101 airship**
  France. A gas leak led to a loss of control. This was the first Public Inquiry under 1922 Regulations.

- **1930 – Junkers F13Ge, G-AAZK**
  Kent. Inflight structural failure and break up during turbulent weather. This was the first report into an aircraft accident in the UK under the Regulations to be made public.

- **1939 – Short Empire flying boat *Cavalier*, G-ADUU**
  Near Bermuda, ditching due to engine failure. This led to the introduction of life jackets, proper passenger briefing and the use of seat belts during takeoff and landing.

- **1954 – Comet disasters**
  The investigation found evidence of fatigue leading to a fuller understanding of the effects of pressurisation on fuselages. Following these accidents flight data recorders were mandated in UK in 1965.

AAIB 24-hour Reporting - Telephone number
+44 (0)1252 512299
www.aaib.gov.uk
@aaibgovuk

- **1965 – Vickers Vanguard, G-APEE**
  Heathrow. Loss of control during a low visibility approach which led to developments in approach aids and autoland capability.

- **1967 – Canadair C-4 Argonaut, G-ALHG**
  Crashed in Stockport with a high loss of life. The cause was fuel starvation. A contributory factor was crew fatigue. Several died because they could not escape due to seat design.

- **1972 – Hawker Siddeley Trident, G-ARPI**
  Staines. The droops (leading edge lift enhancement devices) were not extended, leading to a deep stall on takeoff. This led to cockpit voice recorder (CVR) fitment in the UK and Crew Resource Management (CRM) processes.

- **1973 – Vickers Vanguard, G-AXOP**
  Switzerland, the AAIB assisted the Swiss investigation. Controlled flight into terrain (CFIT) in poor visibility. This accident led to the mandatory carriage of CVR worldwide.

- **1983 – Sikorsky S61, G-BEON**
  Off the Scilly Isles. Unintentional descent into the sea. This accident led to the precursor of Terrain Avoidance Warning Systems (TAWS) and de-lethalisation of helicopters (removal of sharp edges to avoid puncturing life rafts).

- **1985 – Boeing 737, G-BGJL**
  Manchester Airport. Uncontained engine failure. This led to the improvement of cabin fire safety and evacuation rules including the size of emergency exits.

- **1987 – Boeing Vertol CH47 Chinook, G-BWFC**
  2.5 miles east of the Shetland Isles. Front rotor transmission failure. This led to the introduction of Health Usage Monitoring Systems (HUMs).

- **1988 – Lockerbie**
  Unlawful interference with an aircraft which led to the security improvements.

- **1989 – Boeing 737, G-OBME**
  Kegworth. Engine failure handling. This led to improvements in cockpit displays and survivability.

- **1990 – BAC 1-11, G-BJRT**
  Over Didcot, Oxfordshire. Cockpit window failure caused by incorrect bolt fitment due to engineering Human Factors (HF). This led to changes to vital point and duplicate inspections and regular refresher training for engineers.

- **1995 – Emb-110 Bandeirante, G-OEAA**
  Near Leeds Bradford Airport. This fatal accident led to the introduction of Flight Data Monitoring.

- **1999** – **Boeing 747-2B5F, HL7451**
  Near Stansted shortly after takeoff. Attitude director indicator (ADI) failure and lack of CRM.

- **2001** – **Shorts SD360, G-BNMT**
  Near Edinburgh. This accident was caused by icing in an engine intake and led to improvements to crew in-flight anti icing procedures.

- **2008** – **Boeing 777, G-YMMM**
  At Heathrow. Ice blockage within the fuel oil heat exchanger. This accident led to fuel system ice tolerance design improvements.

- **2013 – AS332 L2 Super Puma, G-WNSB**
  Sumburgh. Loss of flight parameter awareness on approach. This accident led to developments in rebreathers, evacuation procedures and equipment.

- **2013** – **EC135, G-SPAO**
  Clutha Vaults Pub central Glasgow. Fuel starvation resulting in both engines flame out. This accident led to the introduction of cockpit image recorders on all aircraft operated on behalf of the state.

- **2015** – **Hawker Hunter, G-BXFI**
  Shoreham. CFIT onto a main road during an airshow. This accident led to airshow public safety improvements.

G-YMMM
London Heathrow Airport, UK on 17 January 2008
Overview of accident site

The use of test flights for aircraft accident and incident investigation

Introduction

The AAIB carries out aircraft accident investigations independently and with impartiality, but not in isolation. This article looks at when and how the AAIB uses test flights with qualified test pilots to assist with an investigation.

When is this required?

An AAIB investigation is carried out to establish the causal and contributory factors leading to an accident or serious incident and to encourage safety action to improve aviation safety and to prevent recurrence. AAIB Inspectors, whilst they have significant and varied aviation experience and expertise, are generalist and sometimes require specialist support to provide an additional test and research capability.

The AAIB often investigates accidents to aircraft where the original records of the flight characteristics or flight envelope may lack precise detail, or where test data no longer exists. Pilots' notes and aircraft handbooks will usually list the various limitations, such as maximum and minimum speeds, and provide information on weight and balance, handling and performance. They also include warnings, cautions and notes on the particular traits of an aircraft. However, they tend not to include detail on how an aircraft would react or respond when outside of any prescribed limitations.

Investigators may also have to consider how the aircraft was being flown in the lead up to an accident, and what cues or physical indications a pilot would have felt or sensed at the time. They may also need to consider the effect that normal or abnormal pilot inputs might have had on the aircraft.

AAIB inspectors will spend time researching archives, speaking to the original manufacturer, if they still exist, and talking to various flying organisations who may have knowledge of the aircraft or similar types. If by this stage questions remain unanswered, the AAIB will consider commissioning a test flight or an observation flight to obtain information and numerical data.

Test flying

A qualified test pilot is trained to fly an aircraft accurately, following prescribed procedures and plans, to make detailed observations and assessments whilst exploring an aircraft envelope. They are also able to identify the onset of adverse characteristics and take rapid action to maintain safe flight if required. Notwithstanding their advanced flying skills, they are also able to analyse how pilots of varying degrees of training and skills might react in a certain situation. This aspect is often particularly useful in AAIB investigations.

Examples which specifically require a qualified test pilot are such things as operating with equipment deactivated or in a degraded state, or to explore the characteristics of an aircraft under unusual circumstances within its flight envelope. Examples may also include flights with specialist test equipment attached to the exterior of the aircraft or interfacing with the aircraft's existing structure or systems.

AAIB decision process

Test flights are potentially costly and by their nature are not without risk. Therefore, the following specific considerations are taken into account.

- What information or data is being sought from a test flight?
- Is this the only way to obtain the information needed?
- Can the test be done using a simulator?
- Is a representative aircraft available and what is the cost?
- How will the data be gathered and recorded?
- Does the benefit of obtaining the information outweigh the hazards and costs of doing so?
- Can all the risks be identified and adequate mitigations put in place?

Historic aircraft case

The AAIB investigated an accident involving a historic aircraft in 2021 and the report was published in 2022. The aircraft was a Stampe SV4C, G-AWEF; a single engine biplane built in 1947. Test flying was an important part of this investigation and illustrates the process.

Background

The aircraft was taking part in a formation display practice with three other similar aircraft (Figure 1)

Figure 1

The four Stampe SV4C aircraft photographed during the accident flight
(G-AWEF is the red and yellow aircraft at the top of the picture)
(used with permission)

Whilst practising a manoeuvre involving a synchronised line abreast stall turn, shown in Figure 2, one of the aircraft was seen to enter a spin. The aircraft did not fully recover from the spin before striking the ground and fatally injuring the pilot. No evidence was found of any pre-existing fault or damage to the aircraft which could have caused the spin or prevented the aircraft from recovering from the spin.

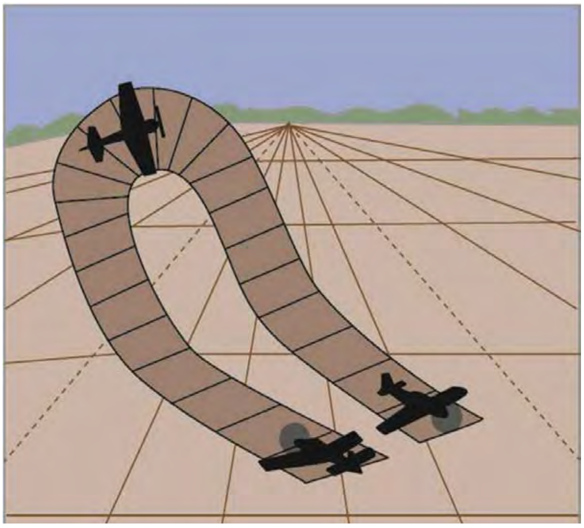


Figure 2
Stall turn manoeuvre schematic

The investigation team had been able to analyse witness and CCTV evidence which showed how the other aircraft had carried out the manoeuvre at the same time but had not departed from the planned flight path. A number of theories were offered but none were able to provide an explanation of why this manoeuvre had gone wrong.

The method by which the manoeuvre should be flown was clearly understood and the exact points where and when rudder, aileron and elevator inputs should be made were known. However, it was not known what the effect of making these control inputs out of sequence or incorrectly were. It was known that the aircraft had entered a spin, but it was not known how the aircraft could enter a spin from the stall turn manoeuvre. None of the historical information about the aircraft showed the minimum altitude required to successfully recover from a spin. Accordingly, the following specific requirements of a test flight were set out.

- To determine how the aircraft could enter a spin from the modified stall turn.
- To assess the aircraft's spin characteristics to determine the height lost during a spin and during the recovery.
- To assess the aircraft's longitudinal and lateral stability to determine if a pilot could move the elevator or rudder to an unintended position without any obvious tactile cues.

Aircraft selection

A suitable aircraft needs to be found that matches the accident aircraft as much as possible. It is often the case, especially with historic aircraft, that subtle changes and modifications have been made throughout its history, so finding a suitable aircraft can be challenging. The weight and balance of the aircraft also needs to be as close as possible for any comparison to be valid.

In this case another Stampe SV4C aircraft was available, although there was a minor difference in an engine ancillary component. However, this did not affect the handling or flying characteristics. The weight and balance of the accident aircraft could also be matched.

Test pilot selection and briefing

The UK has several fully qualified freelance test pilots available with fixed and rotary wing experience. Following a selection process against criteria for contracting the work, a suitable test pilot is engaged under agreed terms and conditions and fully briefed. This involves looking at the details surrounding the accident and what the test flights are aiming to achieve. At the same time the test pilot must enter into a confidentiality agreement to comply with the accident investigation regulations.

Location

The selection of a suitable location to carry out the test flying depends on the requirements of the test flight. The location must afford minimal risks to the test aircraft and third parties. Considerations include the avoidance of other aircraft, having enough height to recover from upsets and staying clear of any ground hazards. This usually means conducting the tests in Class G airspace with 10,000 feet or unlimited upper air clearance and over a sparsely populated area.

Conditions

Depending on the data required from the test flight it may be necessary to replicate the environmental conditions at the time of the accident. This may mean finding a day with the same visibility, atmospheric pressure, wind speed and direction. Test flights are usually carried out in day visual meteorological conditions.

Risk mitigation

Great care is taken in the preparation for a test flight as we do not want a repeat of the accident! At each stage, risks and hazards are identified and mitigations are put in place. The table excerpt below shows an example of how this is done (Figure 3).

Hazard description	Risk Description	Initial rating			Mitigation Measures	Final rating			Remarks (if applicable)
		L	S	Risk Decision U = Unacceptable R = Review A = Acceptable		L	S	Risk Decision U = Unacceptable R = Review A = Acceptable	
Intentional fully developed spin and recovery to determine height loss.	Following stall/spin test item, failure to recover from spin resulting in fatal injuries.	4	5	U	1. For deliberate spin tests pilot(s) to wear parachute/helmet. 2. CG to be confirmed within limits. 3. Pilot(s) to be current in spin entry/recovery procedures. 4. For dual flights pilots to brief handover/ takeover of control with and without serviceable intercom. 5. Minimum entry height for deliberate spinning to be 5200 ft agl based on four turns at 300 ft/turn and dive recovery altitude loss (1000 ft) to ensure recovery can be completed above 3000 ft agl. 6. Clear of cloud with clear horizon.	1	5	R	

Figure 3
Risk assessment and mitigation table excerpt

Gathering the data

There are a variety of means by which to gather the data. The simplest form might be the test pilot noting various indications from the aircraft instruments. However, the AAIB usually uses small audio video recording devices, GPS tracking devices and data loggers in addition to the notes made by the test pilot. In the example case, simple gauges were used to establish the position and tactile forces applied and felt in the controls.

Conduct of the flight

A precise test flight plan is developed and agreed before the flight and gives instructions by which to carry out the data gathering during the flight. This is set out for the test pilot in the form of a test card, an example is shown below (Figure 4).

Stall Turns to the right

Carry out each test in the matrix – start the pullup on a downwind heading and record test conditions and whether autorotation was induced	
Test Conditions	
Loading	DUAL/SOLO
Wind Speed (kt)	
Entry Height (ft)	
Entry Speed (kt)	95 / 85 / 75
Entry Attitude (deg)	70 / 90
Rudder input speed (kt)	50 / 40
Throttle at 90° point	OPEN / CLOSED
Exit Attitude (deg)	70 / 90
Exit Height (ft)	
Autorotation	YES/NO
Ease of identifying direction of spin	
Remarks	
Did prop stop?	YES/NO

Figure 4
Flight test card

The test flight(s) are carried out with inter-flight debriefs as required. However, if at any stage during the test flying unforeseen or abnormal characteristics become apparent, the flight will be stopped and reviewed. At no stage will the test pilot or aircraft be put under unmitigated risk.

Results

In the example case, the flight tests showed that the most likely reason the aircraft entered a spin was that either too much aft stick was applied before the yawing turn was complete or that the rudder was not centralised when the pull-out was commenced. It was also found that the average height loss per turn started at 140 ft for the first full turn, 170 ft for the second and 200 ft for subsequent turns, and that the average height required to pull-out once the spin had stopped was about 450 ft. Therefore, the height loss from the initial departure through to the recovery to a positive climb would be in the region of 590 ft for a 1-turn spin, 760 ft for a 2-turn spin, 960 ft for a 3-turn spin and 1,160 ft for a 4-turn spin.

The figures presented show the accuracy achievable when the test flight is carried out and this was very important to the investigation.

Conclusion

The AAIB strives to investigate aircraft accidents and serious incidents thoroughly. Test flying is one of the many tools the AAIB use to achieve this. By their nature test flights carry an increased risk and the AAIB decision to conduct a test flight is not taken lightly. In all cases where test flying take place, the benefits to an investigation must outweigh the risk and cost. They are another way in which the AAIB works to improve aviation safety.

Accident timeline

The timeline illustrated here shows the various steps taken by the AAIB from the initiation of an investigation to the publication of a report. It shows a typical accident where the AAIB deploy a team to investigate the causes and contributory factors in a commercial air transport or general aviation accident or serious incident.

1 Notification

The AAIB are notified of an incident to an aircraft or unmanned air system (UAS). The notification is usually by telephone call or electronic media. Notifications are immediately acted upon; 24 hours a day 7 days a week.

2 Assessment

An AAIB Principal Inspector in the role of Duty Coordinator will assess the information received and if necessary, seek further clarification. A response decision is taken which can range from no further action to initiating a major deployment of an AAIB team.

Most accidents require a small team of three or four Inspectors. There are two teams available at any one time.

A team will prepare and depart to the scene of the accident as soon as possible. In the UK this is usually by road but further afield, such as Northern Ireland or Scotland, the team may use commercial flights

3 Evidence Gathering

On arrival the Inspectors commence the investigation and gather evidence.

Depending on the nature of the accident, small aircraft wreckage will be recovered to the AAIB headquarters. Large commercial aircraft may require local hangarage or, if they are relatively undamaged, will be formally handed back to the owner or operator.

On average the work at the accident site takes three or four days.

4 Investigation

On return to the AAIB HQ, the evidence and initial findings are presented to the Chief Inspector of Aircraft Accidents (CIAA) and all the AAIB staff. A decision is then made on the scope of the investigation with agreed resources and timelines where possible.

Work continues using the evidence to establish the causal and contributory factors of the accident. This may require testing and research and additional witness interviews, data analysis as well as forensic examination of the aircraft and its components.

This work often takes several weeks if not months to complete. The AAIB aim to publish a report within a year of the event, if that is not possible an anniversary statement is published.

Should safety information need to be provided promptly or safety action taken, the AAIB will publish a Special Bulletin.

5 Report Review and Preparation

The investigation team prepares the report as the investigation progresses. The facts and evidence are analysed, with regular analysis reviews and in some cases with peer reviews too. During this analysis the casual and contributory factors, and safety issues are identified that may require a safety recommendation. These safety issues are discussed with the responsible authority and where action is being taken this will be reflected in the report. If a Safety Recommendation is proposed this is assessed under a specific peer review.

The time necessary to review and prepare the draft report is dependent on the complexity of the accident and the report can go through several iterations.

Accident Timeline cont

6 Consultation Period

A confidential draft report is prepared and provided to those States and authorities that have been involved in the investigation and to anyone whose reputation is likely to be affected. The consultation is carried out under the relevant regulations with a response, containing any substantive representations, required within 28 days, which can be extended on request.

7 Response Review

When all the responses have been received from those that have been consulted the IIC will consider each response along with the investigation team and decide on whether there is a need to amend the report. It is also possible that new evidence may be presented by consultees that requires further investigative work and may result in a further consultation.

8 Approval for publication

The draft report is submitted by the IIC to the CIAA for final approval for publication, after which it is passed to the publications team for preparation for publication – including proof reading.

9 Pre-Publication

Prior to publication, the final report is provided to those involved in the accident and the relatives of the victims. The report is also provided to the other States involved in the investigation, the relevant authorities and advisers, so that they are fully aware of the contents of the report and can prepare for any public or media enquiries. The pre-publication report is a protected document and cannot be disclosed until it is published.

10 Publication

The report is published either online as soon as it is ready for field and formal investigations or in the monthly bulletin for others. All reports are publicly available on the AAIB website. Letters are sent to the addressees of the safety recommendations in the report asking for their response within 90 days on the action they are likely to take or if no action is being taken as to the reason why.

11 Post-Publication

Following publication, for fatal accidents, the investigation team provide Statements to the Coroner or Procurator Fiscal and may subsequently appear in the Coroner's Inquest or Fatal Accident Inquiry.

Where a safety recommendation has been made, the AAIB will assess the responses and track the action taken.

The investigation could be "reopened" if in the opinion of the Chief Inspector there is new and significant evidence which will require a return to Step 4.

2022 AAIB operational statistics

An overview of AAIB activity during 2022

2022 Statistics

An overview of our involvement during 2022

This graphic shows the AAIB activity statistics for 2022. Of interest is that 2022 saw 778 notifications of an event or occurrence to the AAIB. In 2021 this figure was 746 which reflected the return to a relative aviation normality in commercial, general and UAS aviation after the upheavals of 2020. However, the 2022 figure is only 4.3% higher than the notifications received in 2021.

778
Number of Notifications received by the AAIB

Investigations Opened

2	Formal
27	Field
78	Correspondence (AARF)
189	Record-only (RO)

Number of Notifications Year-on-Year Difference

2022 vs 2021	2022 vs 2020	2022 vs 2019
+4.3%	+40.7%	-5.8%

UK Fatal Accidents and Number of Deaths

		2022 vs 2021
9	Number of UK Fatal Accidents	+80.0%
11	Number of Deaths	+57.1%

AAIB Activity Overseas

19	UK Registered Aircraft Overseas
42	Foreign Registered Aircraft Overseas

External Involvement

3	Military (AAIB assistance)
36	Sporting Associations informed

338
No Further AAIB Action

2022 Statistics

An overview of our involvement during 2022

Activity Associated with UAS

138
Of the 778 Notifications received by the AAIB involved UAS
18%

81
Of the 267 Correspondence (AARF) Investigations (incl RO) opened involved UAS

Safety Recommendations and Safety Actions

19
Number of Safety Recommendations made

21%
Of those Safety Recommendations involved UAS

Action Status for Recommendations made in 2022

53% | 26% | 21%

Action Status for Recommendations made in 2021

57% | 3% | 8% | 22% | 5% | 5%

- Adequate - Planned Action Completed - Closed
- Adequate - Planned Action Ongoing Update Due - Open
- Partially Adequate - Planned Action Completed - Closed
- Partially Adequate - Planned Action Ongoing Update Due - Open
- Not Adequate - Not Enough Information - Open
- Not Adequate - Planned Action Completed - Closed
- Awaiting Response

101
Number of Safety Actions noted

7%
Of those Safety Actions involved UAS

Publications

9 Number of UAS Correspondence Investigation Reports published

85 Number of Correspondence Investigation Reports published (incl UAS)
Average time to publication: 6.38 months

211 Record Only Reports published
Average time to publication: 2.72 months

27 Field Reports published

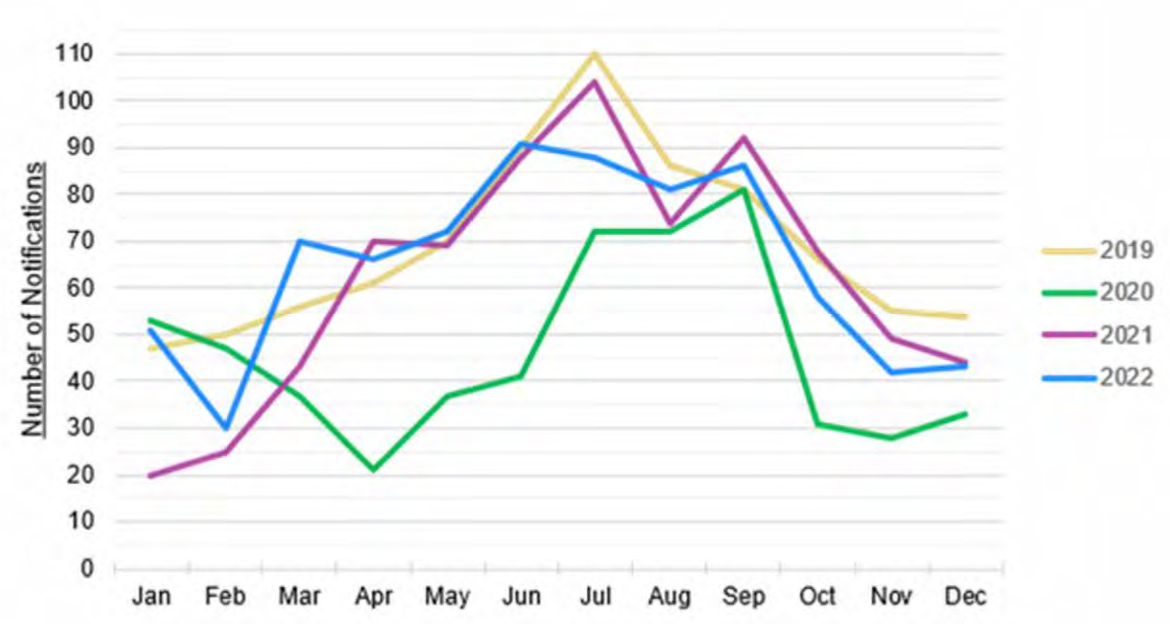
1 Of those Field Reports published involved UAS

Average time to publication: 11.7 months

2 Special Bulletins published

Notification statistics year on year

Notifications to the AAIB are calls and communications received which give information on an aviation related occurrence which usually result in a case being raised. Information is received from a variety of sources and are assessed by AAIB staff to determine a response. The following graphs show month by month notification statistics for the years 2019 to 2022.



CICTT factors

Every occurrence in the UK is recorded and coded using the occurrence taxonomy defined by the CAST/ICAO Common Taxonomy Team (CICTT). This is a worldwide standard taxonomy to permit analysis of data in support of safety initiatives. It should be noted that an investigation may find multiple causal or contributary factors, for example turbulence (TURB) leading to abnormal runway contact (ARC).

The top five predominant causal factors apparent in the various categories of AAIB investigations carried out during 2022 are shown in the following set of graphics:

- All Investigations
- Field Investigations
- Correspondence (AARF) Investigations
- Record Only Investigations
- UAS Investigations

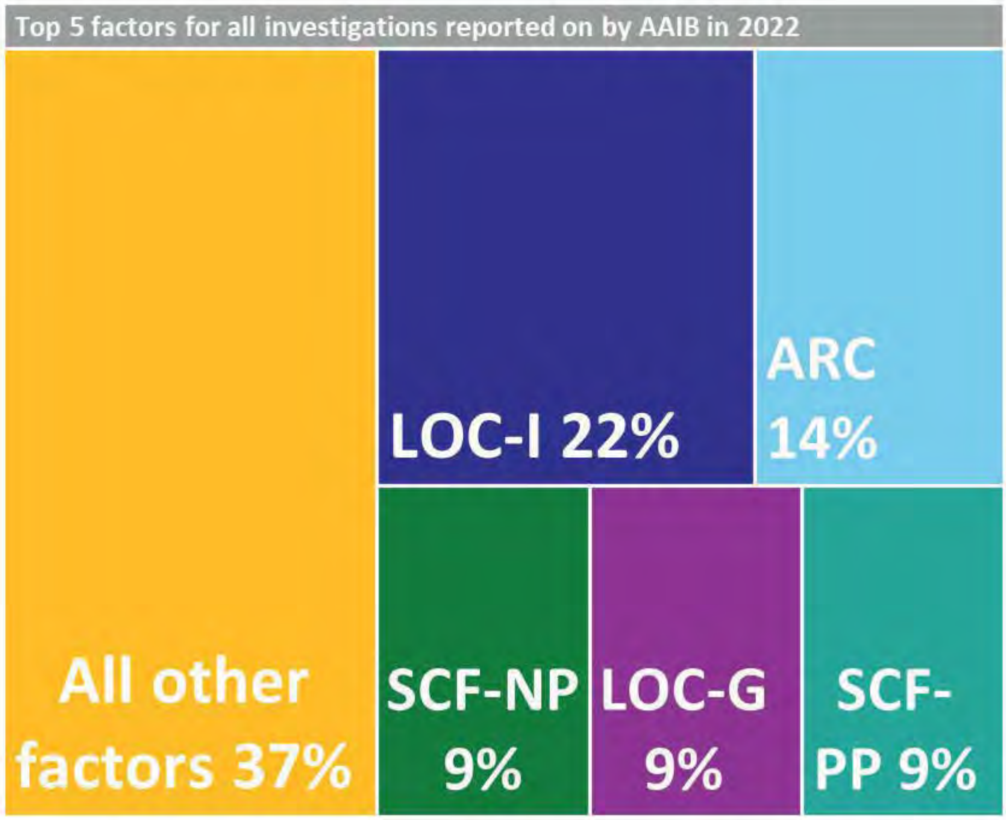
Note - There are causal and contributory factors within the statistics, but these feature as low percentages, between 1% and 6%. For completeness they are shown added together as 'all other factors' in each graphic.

The last two graphics show the causal factor distribution in all:

- Field investigations into fatal accidents and
- Commercial Air Transport (CAT) field investigations.

(The taxonomy abbreviations used in the graphics can be found in the list at Appendix 1. A quick reference list has been included below each graphic)

All investigations

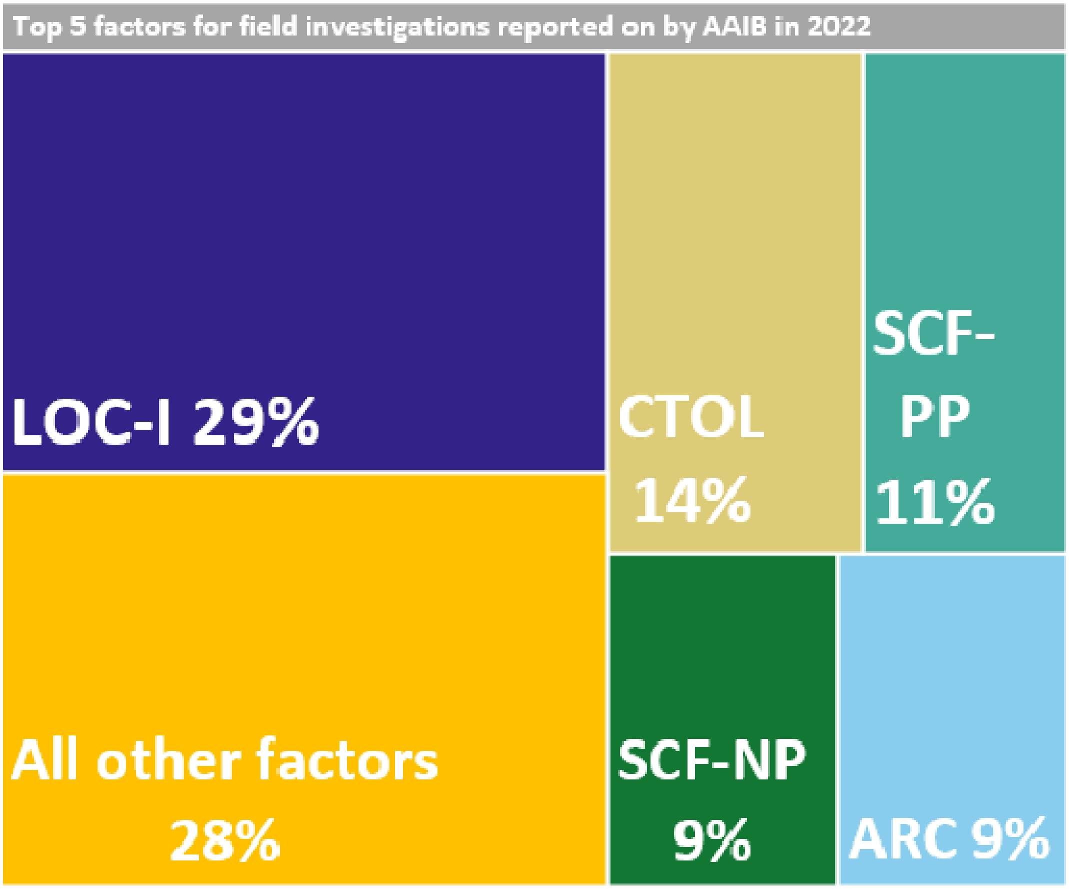


As in previous years, the overall predominant factor in aircraft accidents and serious incidents is loss of control in flight (LOC-I).

Quick reference key

LOC-I loss of control in flight
ARC abnormal runway contact
LOC-G loss of control on the ground
SCF-PP system or component failure power plant
SCF-NP system or component failure non power plant

Field investigations

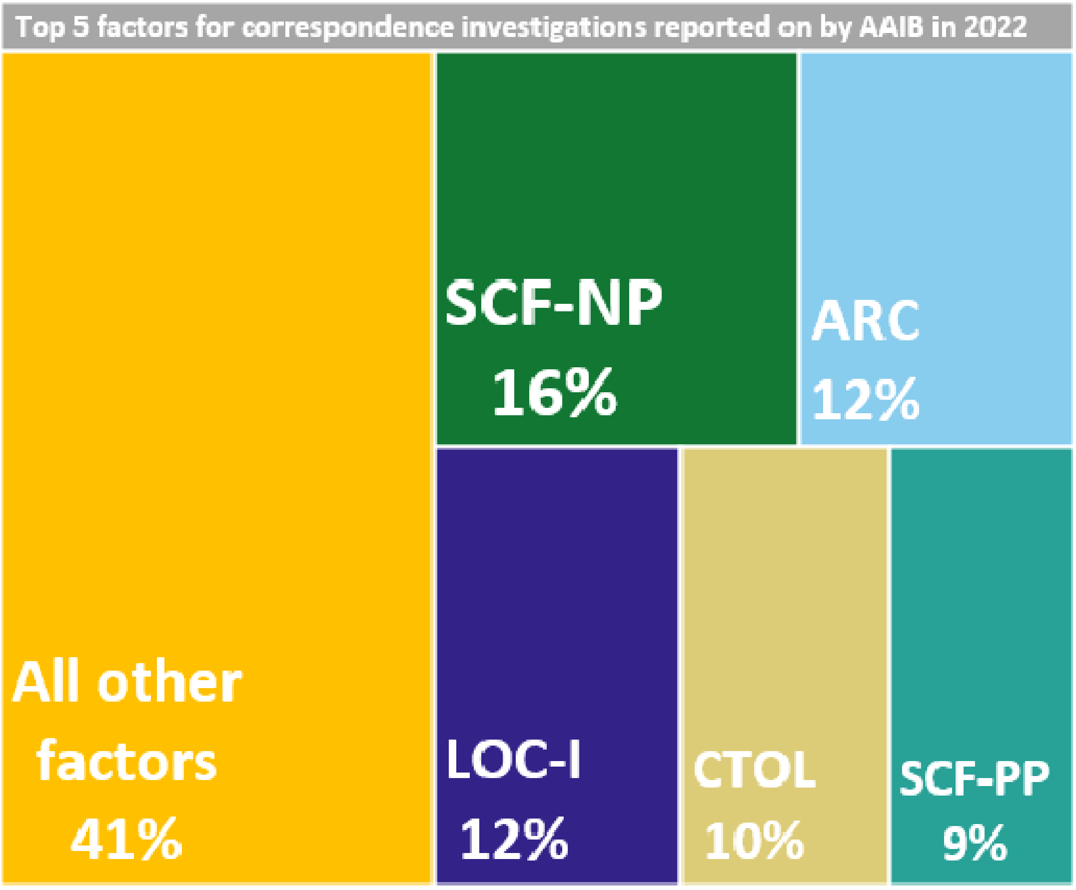


In 2022 the AAIB published 27 field investigation reports, of which 9 were investigations into fatal GA accidents. There were 18 field investigations into non-fatal accidents or serious incidents to both GA and CAT aircraft. LOC-I and collision with obstacle during takeoff and landing (CTOL) were the predominant factors.

Quick reference key

LOC-I loss of control in flight
CTOL collision with obstacle during takeoff and landing
SCF-PP system or component failure power plant
ARC abnormal runway contact
SCF-NP system or component failure non power plant

Correspondence investigations

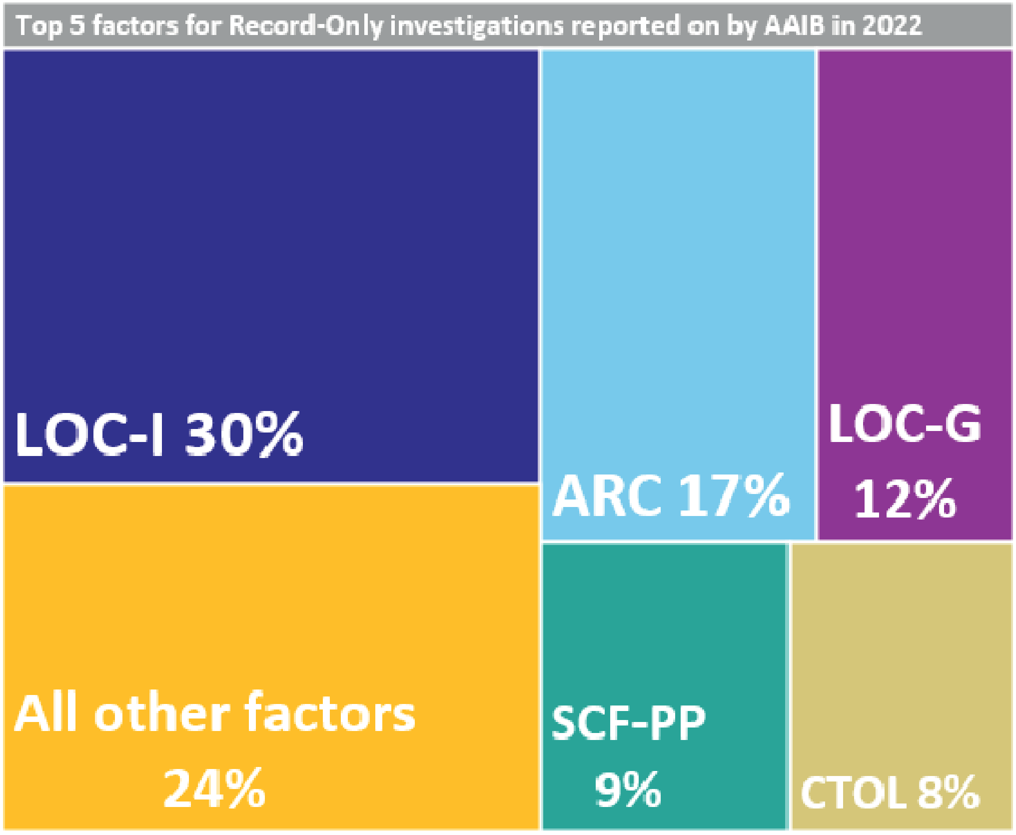


Correspondence investigations are usually conducted into non-fatal accidents and serious incidents on GA and CAT aircraft that do not warrant deployment of an AAIB team. They use the information provided by the pilot with follow up enquiries by AAIB Inspectors. During 2022 the overall trend was the same as 2021 with SCF-NP being the predominant factor. Abnormal runway contact (ARC) was a significant feature during 2022 and was often the result handling or aerodynamic factors during landing.

Quick reference key

SCF-NP system or component failure non power plant
ARC abnormal runway contact
LOC-I loss of control in flight
CTOL collision with obstacle during takeoff and landing
SCF-PP system or component failure power plant

Record only (RO) investigations

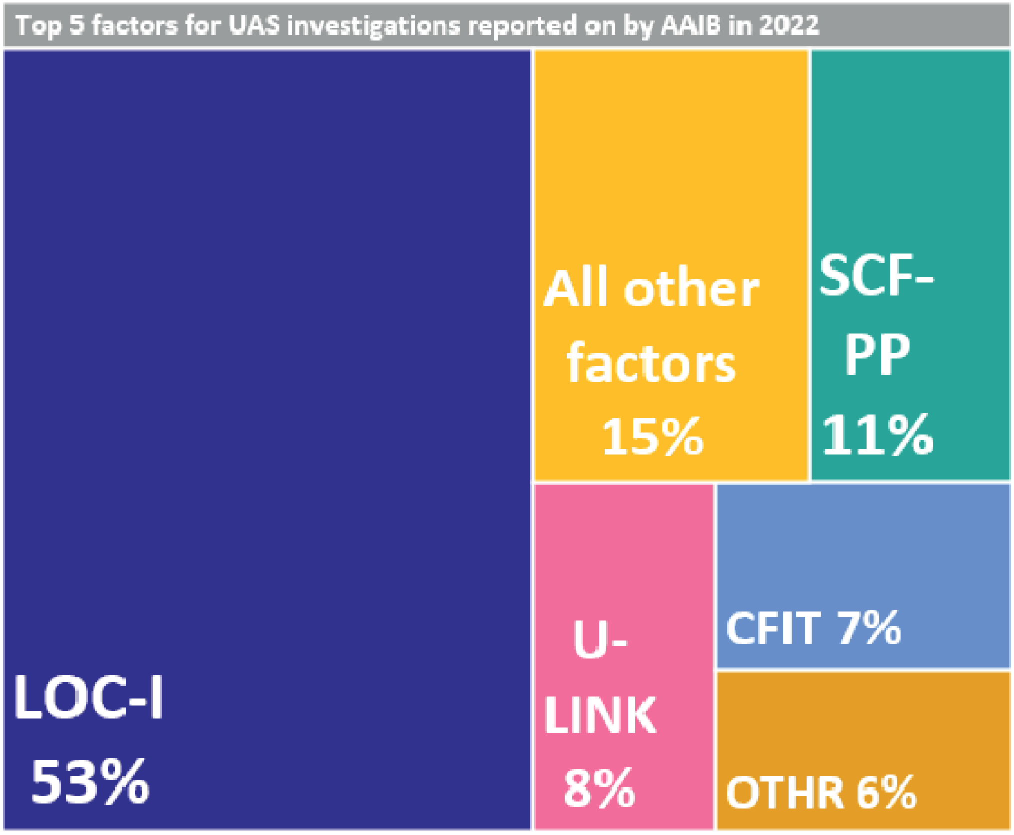


Record only (RO) investigations are those in which there are minor or no injuries, that if investigated fully have little likelihood of identifying new safety lessons that will advance aviation safety. Most RO cases are GA and reflect the overall trend in field and correspondence investigations, and so LOC-I and ARC are also the predominant factor in incidents which fall into the RO category.

Quick reference key

LOC-I loss of control in flight
ARC abnormal runway contact
LOC-G loss of control on the ground
SCF-PP system or component failure power plant
CTOL collision with obstacle during takeoff and landing

UAS investigations



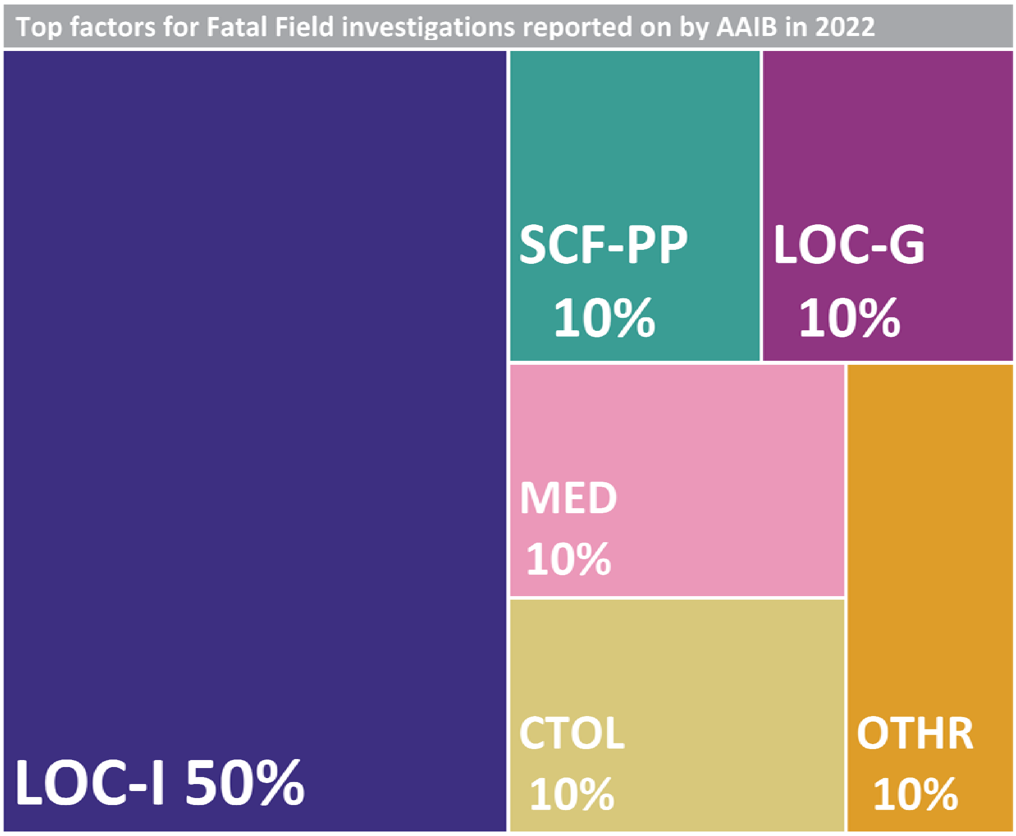
The predominant cause of UAS accidents, was LOC-I usually resulting from the UAS becoming unresponsive to control inputs or displaying erratic or uncommanded responses.

Quick reference key

LOC-I loss of control in flight
SCF-PP system or component failure power plant
U-LINK UAS loss of link
CFIT controlled flight into or toward terrain
OTHR other

Field investigations into fatal accidents

(All GA accidents, there were no fatal CAT accidents in 2022.)

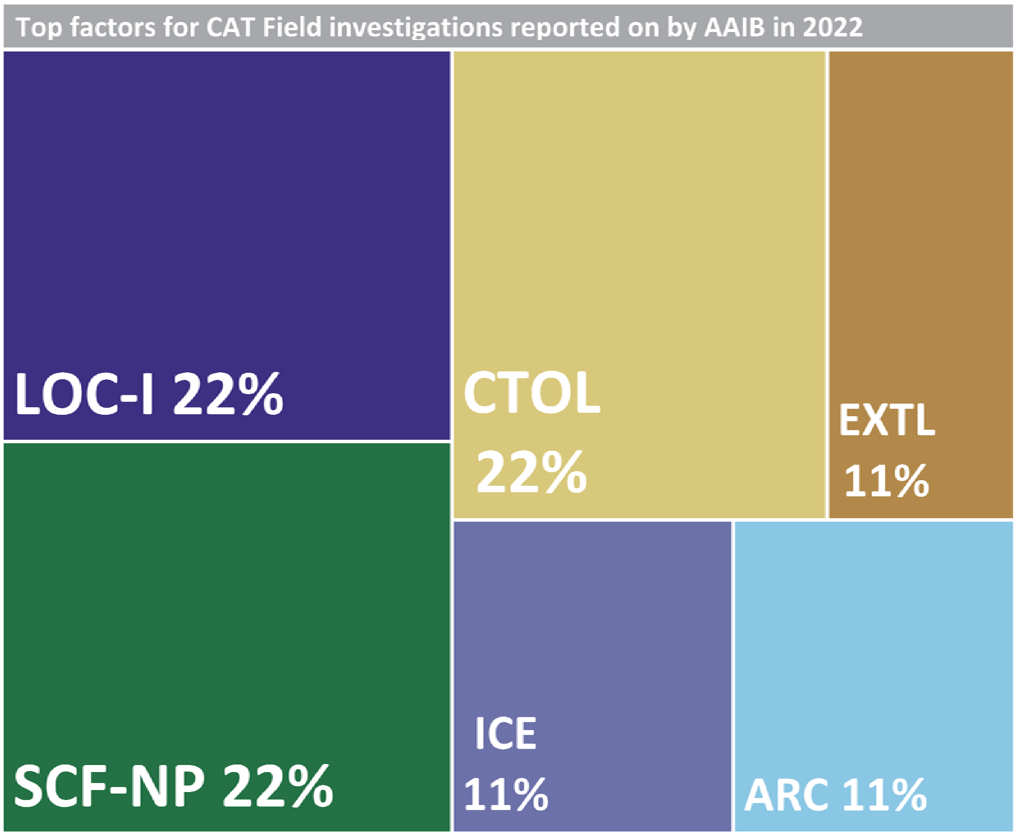


The predominant factor in fatal accidents was LOC-I. This usually resulted from low speed near to the ground and the aircraft stalling with an incipient or fully developed spin.

Quick reference key

LOC-I loss of control in flight
CTOL collision with obstacle during takeoff and landing
LOC-G loss of control on the ground
MED medical
SCF-PP system or component failure power plant
OTHR other

CAT field investigations



(LOC-1, SCF-NP and CTOL figures are 22.2%, ICE, ARC and EXTL figures are 11.13% and have been rounded down for chart purposes.)

Like GA accidents, LOC-I continues to be a significant factor in CAT accidents and serious incidents. The system or component failure – non power plant (SCF-NP) rate has decreased since 2021 but CAT CTOL, for example tail strike events, have increased during 2022.

Quick reference key

LOC-I loss of control in flight
SCF-NP system or component failure non power plant
CTOL collision with obstacle during takeoff and landing
EXTL external load related occurrences
ICE icing
ARC abnormal runway contact

Safety Recommendations

Introduction

The AAIB will make Safety Recommendations based on the findings of an investigation and the need for action to be taken to maintain and improve aviation safety. Each Safety Recommendation made by the AAIB is given a unique reference number based on the year issued. For example, 2022-001 and so on.

The AAIB is responsible for assessing the responses to Safety Recommendations and monitoring the action subsequently taken. The AAIB carries out this function for the UK, its Overseas Territories and Crown Dependencies.

The AAIB monitors the progress of actions taken in response to a Safety Recommendation but does not undertake the role of the regulator nor provide opinion on the efficacy of the action. The AAIB reports regularly to the Board of Accident Investigation Branches (BAIB) and the State Safety Board (SSB) on progress toward completion. It is for the SSB to decide on whether there is a need for any additional intervention.

This monitoring of actions is not only for Safety Recommendations issued by the AAIB but also those that have been issued to addresses in the UK from other Accident Investigation Authorities.

Response assessment

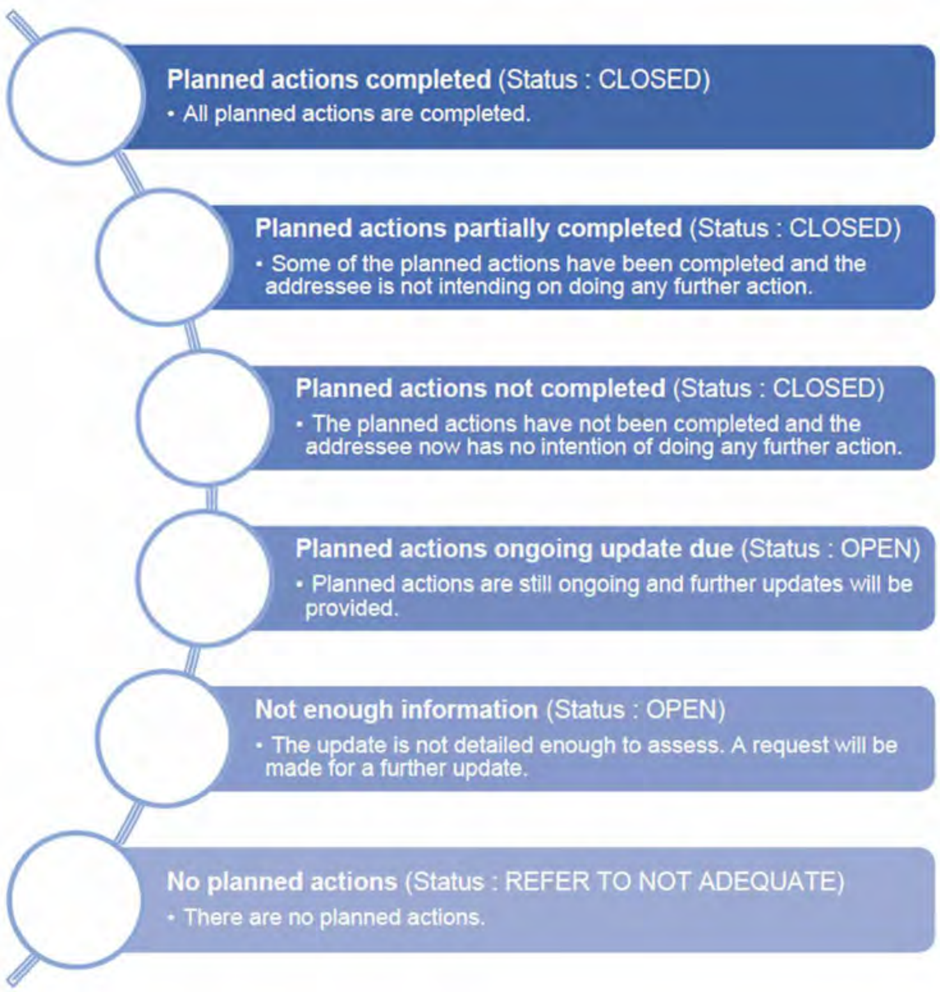
When the AAIB receives a response to a recommendation from the addressee it is assessed as to its adequacy under the requirements of Article 18 of retained Regulation (EU) 996/2010. The AAIB applies the following assessment criteria to the Safety Recommendation responses.

- **Adequate** means that the response fully meets the intent of the Safety Recommendation and the action is expected to address the safety issue.
- **Partially Adequate** means the response goes someway to meeting the intent of the Safety Recommendation and the action will address the safety issue to a certain extent, but further action would be required to fully address the issue identified.
- **Not Adequate** means that the response does not address the intent of the Safety Recommendation, nor does it address the safety issue concerned. The AAIB will apply an open or closed status depending on the expectation of whether the addressee will reassess their response.
    - **Not Adequate - OPEN** The status of 'open' implies that AAIB still has concerns regarding the identified safety deficiency and that there is an expectation that the addressee will provide further responses.

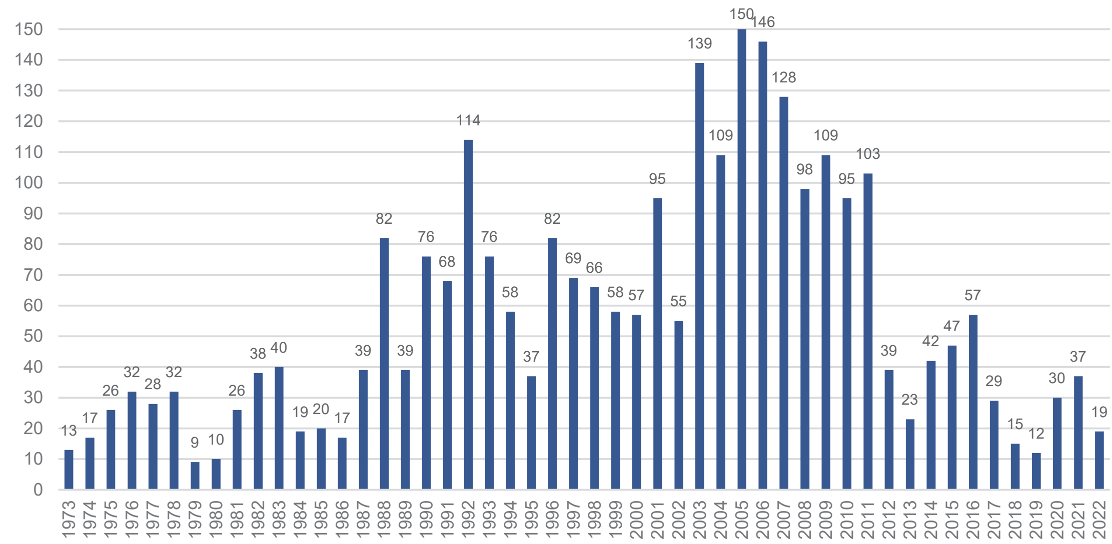
- **Not Adequate - CLOSED** The status 'closed' implies that there is a low likelihood that the addressee will act on the recommendation or provide any further responses.

- **Superseded** means the Safety Recommendation has been 'Superseded' either by a 'newer' and more comprehensive Safety Recommendation or actions have subsequently been taken by the addressee that have superseded the recommendation.

In reporting on the monitoring of the actions taken to a Safety Recommendation they are reported as meeting one of the following:



Number of Safety Recommendations made per year



Of the 19 Safety Recommendations issued in 2022, as of 26 January 2023, responses have been received for 15 Safety Recommendations. The AAIB response assessment has classified those responses as follows:

- Ten are **Adequate**, with planned actions ongoing and remain **Open**.
- Five are **Partially Adequate**, with planned actions ongoing and remain **Open**.
- Four are **Awaiting Response**.

Safety Recommendations of Global Concern (SRGC)

A Safety Recommendation assessed to be a SRGC is defined as:

> A safety recommendation regarding a systemic deficiency having a probability of recurrence, with significant consequences at a global level, and requiring timely action to improve safety.

SRGC provided to ICAO can be found on their website:

https://www.icao.int/safety/airnavigation/AIG/Pages/Safety-Recommendations-of-Global-Concern-(SRGC).aspx

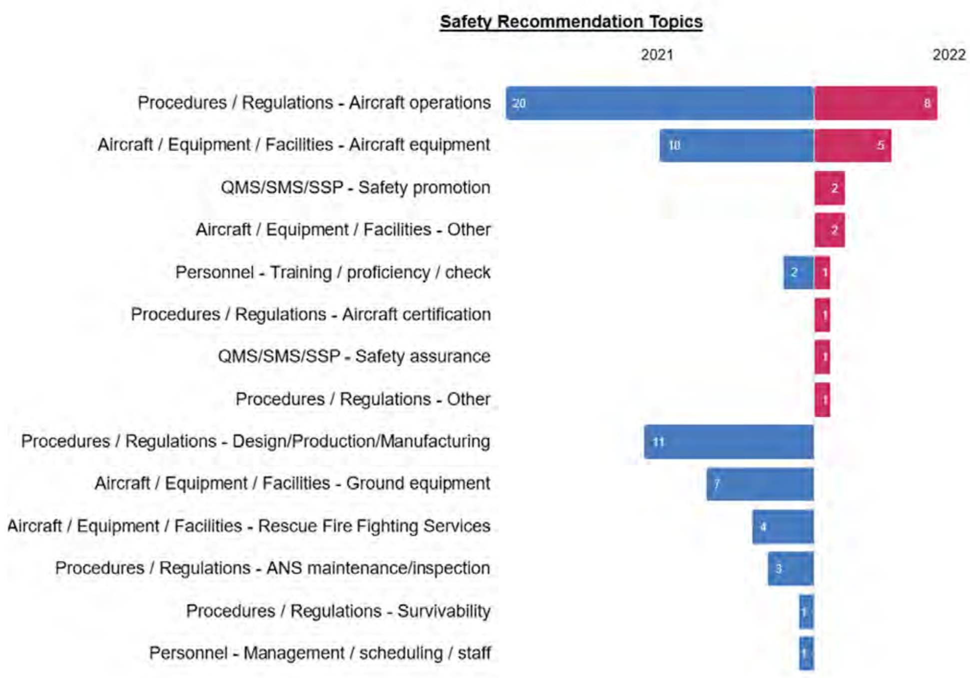
Of the nineteen Safety Recommendations issued by the AAIB in 2022, two were designated SRGC.

Note - The regulations and a link to ICAO Annex 13 can be found on the AAIB website:

https://www.gov.uk/government/collections/aaib-regulations-and-mous

Summary table

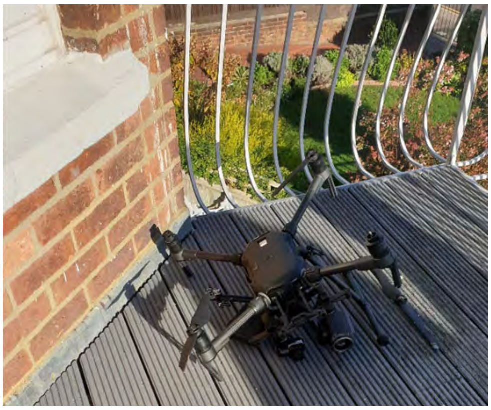
Number	Response Assessment	Action Status	Status
2022-001	Awaiting Response		Open
2022-002	Awaiting Response		Open
2022-003	Awaiting Response		Open
2022-004	Partially Adequate	Planned Action Ongoing	Open
2022-005	Partially Adequate	Planned Action Ongoing	Open
2022-006	Partially Adequate	Planned Action Ongoing	Open
2022-007	Partially Adequate	Planned Action Ongoing	Open
2022-008	Adequate	Planned Action Ongoing	Open
2022-009	Adequate	Planned Action Ongoing	Open
2022-010	Adequate	Planned Action Ongoing	Open
2022-011	Adequate	Planned Action Ongoing	Open
2022-012	Adequate	Planned Action Ongoing	Open
2022-013	Adequate	Planned Action Ongoing	Open
2022-014	Adequate	Planned Action Ongoing	Open
2022-015	Adequate	Planned Action Ongoing	Open
2022-016	Awaiting Response		Open
2022-017	Partially Adequate	Planned Action Ongoing	Open
2022-018	Adequate	Planned Action Ongoing	Open
2022-019	Adequate	Planned Action Ongoing	Open



Safety Recommendations issued during 2022

UAS DJI Matrice M210
19 November 2020 at Poole, Dorset

Investigation Synopsis



Damage to UA

The quadcopter unmanned aircraft (UA) was being flown over the city of Poole during a police operation when the wind at 400 ft exceeded the forecast wind, the manufacturer's wind limit and the maximum restricted speed of the UA. The UA drifted beyond visual line of sight and then communication with it was lost. When the battery level was low it entered an auto-land mode but collided with the wall of a house, damaging its propeller blades before coming to rest on a balcony. The investigation revealed that shortly after takeoff one of the UA's two batteries had disconnected which resulted in its maximum speed being restricted, but this restriction is not referenced in the user manual and neither the remote pilot nor operator were aware of it. When the UA detected that the manufacturer's wind limit had been exceeded, the message triggered on the pilot's controller display was 'Fly with caution, strong wind' instead of advising the pilot that the limit had been exceeded and that the UA should be landed as soon as possible. Three Safety Recommendations were made to the UAS manufacturer and one to the CAA on Visual Line of Sight guidance.

Safety Recommendation 2022-001

Justification

The manufacturer appears to have used the same message for both a level 1 and a level 2 wind warning, causing confusion to the remote pilot on the action to take. The manufacturer had set a wind limit of 27 mph, and therefore the level 2 wind warning should have advised the pilot to land as soon as possible.

Therefore, the following Safety Recommendation was made:

> **Safety Recommendation 2022-001**
>
> It is recommended that DJI amend the DJI Pilot and DJI GO4 apps to warn the remote pilot when the wind limit has been exceeded and that the UA should be landed as soon as possible.

Date Safety Recommendation made: 5 April 2022

Latest Response received: Awaiting Response

AAIB Assessment:

Action Status:

Safety Recommendation Status: **Open**

Safety Recommendation 2022-002

Justification

The pilot is required to maintain visual line of sight with the UA and therefore could miss an alert message on the controller screen if they are concentrating on manoeuvring the UA visually. If messages related to safety of flight had an associated aural warning the pilot's attention could be drawn to them.

Therefore, the following Safety Recommendation was made:

> **Safety Recommendation 2022-002**
>
> It is recommended that DJI amend the DJI Pilot and DJI GO4 apps so that an aural alert is triggered when alert messages relating to safety of flight appear.

Date Safety Recommendation made: 5 April 2022

Latest response received: **Awaiting Response**

AAIB Assessment:

Action Status:

Safety Recommendation Status: **Open**

Safety Recommendation 2022-003

Justification

At low battery voltages the DJI Matrice 200 series activates a pitch limiting system which reduces the maximum speed of the UA and the wind limits it can operate in. The manufacturer's user manual for the Matrice 200 series does not provide details of the operation of the pitch limiting system.

Therefore, the following Safety Recommendation was made:

Safety Recommendation 2022-003

It is recommended that DJI amend the Matrice 200 series user manual to provide information on the pitch attitude limiting system, including the new maximum speed which results from the limit, and the battery level at which it triggers; and communicate this change widely to pilots and operators.

Date Safety Recommendation made: 5 April 2022

Latest Response received: Awaiting Response

AAIB Assessment:

Action Status:

Safety Recommendation Status: **Open**

Safety Recommendation 2022-004

Justification

The operator had adopted a distance of 500 m for their VLOS operations in part because of the CAA's guidance in CAP 722. At this distance the Matrice has an apparent size of just 0.4 by 0.3 mm on a piece of paper held at normal reading distance and its orientation cannot be determined. It is not clear from the regulation or CAP 722 whether this is acceptable.

Therefore, the following Safety Recommendation was made:

Safety Recommendation 2022-004

It is recommended that the Civil Aviation Authority review the Visual Line of Sight distance figures in CAP 722 and amend the guidance to make it clear that just being able to see an unmanned aircraft is not sufficient for Visual Line of Sight operations and that pilots need to be able to demonstrate that at the distance they are flying, they can manoeuvre it rapidly to avoid a collision and can also land the unmanned aircraft safely following a loss of position-holding without reference to video or telemetry.

Date Safety Recommendation made: 5 April 2022

Latest response received: 5 January 2023

Thank you for the recommendation, which we [the CAA] have reviewed, and concluded that we should add some further GM to the Acceptable Means of Compliance and Guidance Material (AMC and GM) document. There are two aspects to this recommendation:

a) The manoeuvring of a UA, at distances they are operating at following a failure; and

b) The landing of a UA, at distances they are operating at following a failure.

On the first part (a) of the recommendation, we believe that the current guidance contained, in relation to being able to safely manoeuvre the aircraft at any distance within VLOS, is sufficient.

On the second part (b) of this recommendation, we have now added guidance that will focus on the importance of maintaining situational awareness, in regard to potential landing sites, should one be required following an emergency or other such event. We now advise Remote Pilots to make use of available sensors to scan the immediate ground below the aircraft to check for uninvolved persons and potential landing sites, so that a suitable site may be quickly located should it be needed.

The finalised text has now been published as GM in the Annex of UK Regulation (EU) 2019/947, under 'Emergency Landing' and can be found at GM1 UAS.OPEN.060(2)(b) Responsibilities of the Remote Pilot (caa.co.uk). It is also included below for ease of reference:

> *'Planning is a crucial stage of a mission's success and Remote Pilots (RPs) must consider all 'in-flight' emergency scenarios, particularly when operating at a range where a systems failure or external influence may remove the RTH option and potentially result in an unplanned landing outside of the VLOS criteria. RPs should continually identify and update suitable Emergency Landing Sites (ELS) as part of their desk top analysis, when conducting on-site reconnaissance and throughout the flight phase.*
>
> *If an UA Observer is not employed and an aircraft experiences a critical system failure, or is subject to unexpected external influences, precluding the aircraft from safely returning to the home point it may be necessary to conduct an unassisted emergency landing away from the RP. RPs are required to maintain good situational awareness throughout all flights and must therefore adequately divide their attention between scanning the airspace for conflicting aircraft and achieving the mission. This should also involve exploiting the aircraft's sensor to scan the ground below for uninvolved persons infringing the safety minima and to identify suitable emergency landing sites (ELSs) should an emergency landing be required. RPs should proactively scan and plan for new ELSs as the aircraft tracks away from the previous one. In such circumstances, whilst it is accepted that an RP may have little or no control*

over the aircraft's safe descent, they must make every effort to mitigate the risk to uninvolved persons.'

We believe this satisfies the intent of SR 2022-004.

AAIB Assessment:	**Partially Adequate**
Action Status:	**Planned Action Ongoing** **Update Due 05 July 2023**
Safety Recommendation Status:	**Open**

Feedback rationale

The AAIB recognises the changes to the guidance material and CAP 722 however the current revision of CAP 722 does not make it clear that remote pilots must maintain sufficient visual line of sight of the UA to manoeuvre it without the use of video or telemetry. An update is requested before 5 July 2023.

Grumman AA-5, G-BBSA

25 September 2021 at Teesside International Airport

Investigation Synopsis

The aircraft suffered a partial loss of engine power very shortly after takeoff from Runway 23 at Teesside International Airport. The pilot, believing the aircraft was outside the airport boundary, attempted a turnback to the airport to land. The aircraft stalled during the turn and struck the ground west of the runway near the Runway 05 threshold. The three occupants all sustained serious injuries.

Accident site, looking south with the Runway 05 threshold behind

Three Safety Recommendations were made with respect to pilot training for partial engine power loss events.

Safety Recommendation 2022-005

Justification

A partial power loss event, in particular immediately after takeoff, presents the pilot with challenging, unfamiliar decisions in an environment where aircraft handling is demanding and the timeframe is short. Although addressed during Australian PPL training, the issue is not covered in the UK PPL syllabus, and current CAA Safety information only addresses the issue through reference to other documents. It is therefore not straightforward for pilots to prepare themselves appropriately to deal with such malfunctions. There are opportunities, both during ab initio training and, subsequently, during revalidation flights with an instructor/examiner, to cover this issue.

Therefore, the following Safety Recommendations were made:

> **Safety Recommendation 2022-005**
>
> It is recommended that the UK Civil Aviation Authority require ab initio pilots to undergo training in the management of partial power loss situations in single-engine fixed-wing aeroplanes.

Date Safety Recommendation made: 9 June 2022

Latest response received: 11 August 2022

The CAA accepts this Safety Recommendation.

The CAA will launch a project to understand the root causes of partial power loss mishandling in single-engine, fixed-wing aeroplanes. The CAA will be guided by the project findings to develop and implement proportionate solutions for ab initio pilot training in the management of partial power loss situations.

The CAA will provide an update on the action taken to address the three safety recommendations by the end of Q1 2023.

AAIB Assessment	**Partially Adequate**
Action Status:	**Planned Action Ongoing** **Update Due 31 March 2023**
Safety Recommendation Status:	**Open**

Feedback rationale

The AAIB acknowledges the steps being taken by the CAA and will await a further update on the action taken by 31 March 2023

Safety Recommendation 2022-006

It is recommended that the UK Civil Aviation Authority provide detailed guidance on techniques for managing partial power loss situations and to promote their use by instructors and examiners when conducting training for a rating revalidation in single-engine fixed-wing aeroplanes.

Date Safety Recommendation made: 9 June 2022

Latest Response received: 11 August 2022

The CAA accepts this Safety Recommendation.

The CAA will develop detailed guidance and techniques for managing partial power loss situations in single-engine fixed-wing aeroplanes based on the solutions developed by the CAA project team. The CAA will promote their use by instructors and examiners when conducting training for a rating revalidation.

The CAA will provide an update on the action taken to address the three safety recommendations by the end of Q1 2023.

AAIB Assessment:	**Partially Adequate**
Action Status:	**Planned Action Ongoing** **Update Due 31 March 2023**
Safety Recommendation Status:	**Open**

Feedback rationale

The AAIB acknowledges the steps being taken by the CAA and will await a further update on the action taken by 31 March 2023.

Safety Recommendation 2022-007

It is recommended that the UK Civil Aviation Authority updates its General Aviation safety promotions to include information for pilots regarding techniques for managing partial power loss situations in single-engine fixed-wing aeroplanes.

Date Safety Recommendation made: 9 June 2022

Latest response received: 11 August 2022

The CAA accepts this Safety Recommendation.

The CAA will devise and promulgate safety promotion material for managing partial power loss situations, which will be informed by the findings of the aforementioned CAA project.

The CAA will provide an update on the action taken to address the three safety recommendations by the end of Q1 2023.

AAIB Assessment: **Partially Adequate**

Action Status: **Planned Action Ongoing**
Update Due 31 March 2023

Safety Recommendation Status: **Open**

Feedback rationale

The AAIB acknowledges the steps being taken by the CAA and will await a further update on the action taken by 31 March 2023.

Piper PA-46-350P (Modified), G-HYZA
29 April 2021, 1 mile north of Cranfield Airport

Investigation Synopsis


G-HYZA accident site

The electrically powered aircraft was undertaking experimental flight tests, under E Conditions, when power to the electrical motors was lost. A forced landing was carried out close to Cranfield airfield during which the aircraft was severely damaged.

The loss of power occurred during an interruption of the power supply when, as part of the test procedure, the battery was selected off with the intention of leaving the electrical motors solely powered by the hydrogen fuel cell. During this interruption the windmilling propeller generated a voltage high enough to operate the inverter protection system, which locked out the power to the motors. The pilot and observer were unable to reset the system and restore electrical power.

Five Safety Recommendations were made regarding Civil Aviation Publication (CAP) 1220, 'Operation of experimental aircraft under E Conditions'. The operator has also taken Safety Action to address a number of findings from this accident.

Safety Recommendation 2022-008

Justification

While CAP1220 does not require aircraft to conform with the airworthiness requirements of a Permit to Fly or Certificate of Airworthiness, there are safety benefits in following existing design guidelines, where possible, to ensure that the operational risk is kept as low as reasonably practicable and tolerable.

Therefore, the following Safety Recommendation was made:

> **Safety Recommendation 2022-008**
>
> It is recommended that the Civil Aviation Authority develops guidance in CAP1220, Operation of Aircraft Under E Conditions, regarding the use of existing guidance on the design and positioning of controls and displays used in the operation of the aircraft.

Date Safety Recommendation made: 20 July 2022

Safety Recommednations Overview

Latest response received: 20 September 2022

The CAA accepts this Safety Recommendation.

We will enhance the existing guidance in Part B of the CAP1220 dossier as per the Safety Recommendation.

We will aim to issue revised guidance within CAP1220 by the end of December 2023.

AAIB Assessment: **Adequate**

Action Status: **Planned Action Ongoing**
Update Due 31 December 2023

Safety Recommendation Status: **Open**

Feedback rationale

The AAIB acknowledges the CAA response and asks the CAA to provide an update on the proposed changes to CAP 1220 by the end of December 2023.

Safety Recommendation 2022-009

Justification

The reduction in the burden of regulation makes E Conditions attractive to a wide range of parties who wish to test a proof of concept ranging from relatively simple designs to high-profile, leading-edge technology. The scope of CAP1220 allows for a wide range of experimental projects some of which may be beyond the original intent of the authors in 2015 and beyond the experience and resources of some parties. Complex and commercially dynamic projects, or those involving multi-crew aircraft operation, may require additional provisions to ensure that they can be safely managed.

Therefore, the following Safety Recommendation was made:

Safety Recommendation 2022-009

It is recommended that the Civil Aviation Authority clarify the scope of projects considered suitable to be carried out under CAP1220, Operation of Aircraft Under E Conditions, and any additional provisions that might be required for more complex projects.

Date Safety Recommendation made: **20 July 2022**

Latest response received: **20 September 2022**

The CAA accepts this Safety Recommendation.

We will clarify the scope of projects within CAP1220 and also any additional provisions that might be required for more complex projects. This may mean limiting the complexity of projects within the boundaries of E Conditions and directing more complex projects to the usual certification routes in Part 21 and BCAR Section A. An element of this work will be to define what we mean by complex and non-complex projects.

We will aim to issue revised guidance within CAP1220 by the end of December 2023.

AAIB Assessment: **Adequate**

Action Status: **Planned Action Ongoing**
Update Due 31 December 2023

Safety Recommendation Status: **Open**

Feedback rationale

The AAIB acknowledges the CAA response and asks the CAA to provide an update on the proposed changes to CAP 1220 by the end of December 2023.

Safety Recommendation 2022-010

Justification

Apart from the basic details submitted on the declaration, there is no independent review of the suitability of a project for E Conditions or if all the required conditions have been fully addressed in the Dossier. That judgement is delegated to the competent person who may be supported in this decision by the operator and the experimenting team where one exists. There is an option for the CAA to review the Dossier, but it is unclear what would trigger this additional scrutiny. It was not triggered for G-HYZA, which at the time of the accident was one of the more complex projects conducted under E Conditions.

Therefore, the following Safety Recommendation was made:

Safety Recommendation 2022-010

It is recommended that the Civil Aviation Authority require an independent review of the Dossier for aircraft operating under the provisions of CAP1220, Operation of Aircraft Under E Conditions, to ensure the project meets the intent of the guidance and can be safely managed by a competent person.

Date Safety Recommendation made: 20 July 2022

Latest response received: 20 September 2022

The CAA accepts this Safety Recommendation.

We will work to establish a process of independent review of the dossier required under CAP1220 to ensure the project meets the intent of the guidance and can be safely managed by the competent person. It is our intent to ensure the CAA is not the person that performs this review so as to maintain the overall current objective of delegation and proportionality of E Conditions in a deregulated environment.

We will aim to issue revised guidance within CAP1220 by the end of December 2023.

AAIB Assessment: **Adequate**

Action Status: **Planned Action Ongoing**
Update Due 31 December 2023

Safety Recommendation Status: **Open**

Feedback rationale

The AAIB acknowledges the CAA response and asks the CAA to provide an update on the proposed changes to CAP 1220 by the end of December 2023.

Safety Recommendation 2022-011

Justification

Currently, there is no assessment required to ensure the competent person is able to fulfil their responsibilities, considering factors such as organisational relationships, conflicting interests, availability, skills and knowledge. A closer assessment could identify if the individual is suitable, or if additional measures are required, to assist the competent person manage the project.

Therefore, the following Safety Recommendation was made:

Safety Recommendation 2022-011

It is recommended that the Civil Aviation Authority requires that the individual nominated as a competent person under CAP1220, Operation of Aircraft Under E Conditions, has the knowledge, skills, experience, and capacity to manage and oversee the experimental test programme registered on the Declaration.

Date Safety Recommendation made: 20 July 2022

Latest response received: 20 September 2022

The CAA accepts this Safety Recommendation.

We shall review the current guidance in Chapter 6 of CAP1220 to determine any additional contents that may be necessary to fully assess all expected areas of competence as mentioned in the Safety Recommendation.

We will aim to issue revised guidance within CAP1220 by the end of December 2023.

AAIB Assessment: **Adequate**

Action Status: **Planned Action Ongoing**
Update Due 31 December 2023

Safety Recommendation Status: **Open**

Feedback rationale

The AAIB acknowledges the CAA response and asks the CAA to provide an update on the proposed changes to CAP 1220 by the end of December 2023.

Safety Recommendation 2022-012

Justification

CAP1220 provides limited guidance on how to organise a complex experimental flight test programme, nor does it address the management of human, organisational and cultural factors that were seen in the accident involving G-HYZA. The safety of operating under E Conditions could be strengthened through additional guidance and training to help the competent person anticipate and manage factors that may be prevalent. The principal test pilot also has a key role in the safety of the programme, as well as the management and organisation of the flight, and would also benefit from this training and guidance.

Therefore, the following Safety Recommendation was made:

> **Safety Recommendation 2022-012**
>
> It is recommended that the Civil Aviation Authority enhance the guidance for the competent person and principal test pilot in the organisation, management, and conduct of the flight of an experimental aircraft project operating under CAP1220, Operation of Aircraft Under E Conditions.

Date Safety Recommendation made: 20 July 2022

Latest response received: 20 September 2022

The CAA accepts this Safety Recommendation.

We will review and enhance the guidance for the competent person and principal test pilot as per the intent of the Safety Recommendation.

We will aim to issue revised guidance within CAP1220 by the end of December 2023.

AAIB Assessment: **Adequate**

Action Status: **Planned Action Ongoing**
Update Due 31 December 2023

Safety Recommendation Status: **Open**

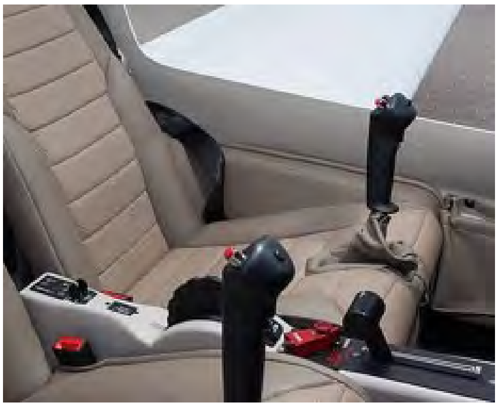
Feedback rationale

The AAIB acknowledges the CAA response and asks the CAA to provide an update on the proposed changes to CAP 1220 by the end of December 2023.

[DA 40 NG, G-CTSB]
12 December 2020, Cranfield Airport abeam Taxiway C1

Investigation Synopsis

The pilot was seriously injured when the aircraft stalled and then struck the ground shortly after takeoff from a height of about 100-200 ft. It had been loaded with five containers of de-icing fluid, contrary to the approved training organisation's prohibition on the carriage of cargo and dangerous goods. One container, loaded in the front right footwell close to the flying controls, limited the control stick's available forward movement.



Flight control stick DA 40 NG

The aircraft was near its maximum permitted takeoff weight and aft centre of gravity limit when it departed. This, together with the limited control authority available, caused the accident.

The investigation found that aspects of the management of the Approved Training Organisation may have contributed to the accident. The de-icing fluid was probably incorrectly classified by the manufacturer as a non-dangerous good, with incorrect safety information supplied.

One Safety Recommendation was made regarding the use of recording facilities on digital flight instrument systems.

Safety Recommendation 2022-013

Justification

When a memory card is installed, the Garmin G1000 instrumentation system can record flight and engine data parameters beneficial to safety investigation. This Safety Recommendation is made to ensure this capability is more widely known and understood.

Therefore, the following safety recommendation was made:

> **Safety Recommendation 2022-013**
>
> It is recommended that the Civil Aviation Authority promote the use of the recording facility on Garmin 1000 instrument systems and its potential benefits.

Date Safety Recommendation made: 15 July 2022

Latest response received: 6 October 2022

The CAA accepts this Safety Recommendation.

The CAA will devise a safety promotion plan to promote the use of the recording facility on Garmin 1000 instrument systems and similar devices, highlighting their potential benefits to pilots and operators.

The CAA will aim to deliver the safety promotion activity by the end of 2023.

AAIB Assessment: **Adequate**

Action Status: **Planned Action Ongoing**
Update Due 17 April 2023

Safety Recommendation Status: **Open**

Feedback rationale

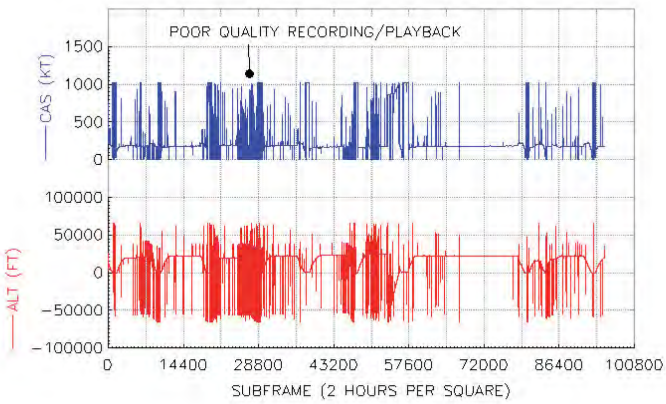
The AAIB acknowledges the CAA's response and requests an update on progress by 17 April 2023.

BAe ATP, SE-LPS

9 April 2021, Isle of Man / Ronaldsway Airport

Investigation Synopsis

SE-LPS was on approach to Ronaldsway Airport, Isle of Man with the co-pilot as PF. As the aircraft approached the minimum descent altitude, the co-pilot attempted to disengage the autopilot. There was no audio tone to indicate the disengagement and the co-pilot felt there was resistance in the flying controls. Both pilots checked the cockpit indications which seemed to show that the autopilot had disengaged. The commander took control and also felt resistance in the flying controls. He pressed and held the synchronisation (syn) button on the control column which he felt released the controls and was able to land the aircraft normally.



Example parameters illustrating quality issues of magnetic tape
FDR recording from SE-LPS

A definite cause could not be found for the autopilot not disengaging as designed. The manufacturer responsible for the design of the autopilot identified a possible scenario where the autopilot servomotors could remain engaged after the autopilot disengaged. This would result in higher-than-normal forces at the cockpit controls.

On 2 December 2021, another autopilot occurrence on an ATP, registration SE-MAJ, was reported to the AAIB. The results of this investigation are included in this report.

Safety action was taken by the CAA to include additional testing of the autopilot system as part of the continued airworthiness programme of the ATP. The operator took safety action to reconfigure their fleet so that either pilot could override either autopilot via the syn button on their respective control wheel. The operator also initiated remedial action to try and prevent water ingress into the cockpit.

Two Safety Recommendations were made to the CAA regarding the use of magnetic tape recorders.

Safety Recommendation 2022-014

Justification

Magnetic tape recorders are still being used on aircraft beyond the date that EASA believed they would no longer be in service and a number of them have been involved in AAIB investigations. The extent to which magnetic tape flight recorders are used by UK Air Operator Certificate holders is not known.

Therefore the following Safety Recommendation was made:

> **Safety Recommendation 2022-014**
>
> It is recommended that the Civil Aviation Authority review the use of magnetic tape flight data recorders used in aircraft operated by UK Air Operator Certificate holders and establish if there is a practical way to comply with the ICAO requirement to cease their use.

Date Safety Recommendation made: 19 August 2022

Latest response received: 20 October 2022

[CAA] Airworthiness have carried out a survey of prominent UK operators and none of the responses received indicate use of magnetic tape flight data recorders.

We will review the existing regulation CAT.IDE. A.190 & CAT.IDE. H.190 (Compliant with EUROCAE ED-112) for flight data recorders and consider if a change to the existing regulations are required to align with Cockpit Voice Recorders.

AAIB Assessment: **Adequate**

Action Status: **Planned Action Ongoing**
Update Due 30 April 2023

Safety Recommendation Status: **Open**

Feedback rationale

The AAIB acknowledges the CAA response and asks the CAA to provide an update by 30 April 2023.

Safety Recommendation 2022-015

Justification

The quality of magnetic tape recordings can vary significantly throughout the recording, and currently only a quality check of a sample of the recording is required.

Therefore, the following Safety Recommendation was made:

> **Safety Recommendation 2022-015**
>
> It is recommended that the Civil Aviation Authority require that magnetic tape flight data recorders, used in aircraft operated by UK Air Operator Certificate holders, comply with the Civil Aviation Authority Specification No 10, regarding the error rate requirements, by checking the complete recording rather than by undertaking a sample check.

Date Safety Recommendation made: 19 August 2022

Latest response received: 20 October 2022

The CAA have agreed to review CAP 731 which details the UK requirements for maintenance of Flight data recorders in order to capture the appropriate error rate requirements of the complete recording.

This is a substantial technical document and will take some time to review and update in order to capture the requirements in recommendation 2022-015 and latest standards for digital as well as magnetic tape flight data recorders.

The CAA would like to propose that the next update to these AAIB recommendations shall be provided by the end of April 2023.

AAIB Assessment: **Adequate**

Action Status: **Planned Action Ongoing**
Update Due 30 April 2023

Safety Recommendation Status: **Open**

Feedback rationale

The AAIB acknowledges the CAA response and asks the CAA to provide an update by 30 April 2023.

BN2B-26 Islander, J8-VBI

29 September 2021, John A. Osborne Airport, Montserrat

Investigation Synopsis

On landing at John A Osborne Airport, Montserrat, the pilot was unable to maintain directional control of the aircraft, later reporting the left brake felt "spongy". The aircraft veered off the right side of the runway and came to rest in an adjacent drainage ditch.

Still image captured from a video showing the aircraft's departure point from Runway 10 and final resting place

An inspection of the aircraft's braking system revealed a slight brake fluid leak from one of the pistons in the left outboard brake calliper. This would have prevented full brake pressure being achieved on the left brakes, resulting in an asymmetric braking effect. Difficulty in maintaining directional control was compounded by the use of an incorrect braking technique on landing.

The investigation identified shortcomings with the operator's manuals, procedures and regulatory oversight.

Safety Recommendation 2022-016

Justification

To ensure proper compliance of appropriate Operating standards the following safety recommendation was made:

> **Safety Recommendation 2022-016**
>
> It is recommended that the Eastern Caribbean Civil Aviation Authority (ECCAA) should ensure SVG Air Operations Manual complies with Saint Vincent and the Grenadines Civil Aviation (Amendment) Regulations, 2014 and ECCAA Part 9 Implementing Standards for Air Operator Certification and Administration.

Date Safety Recommendation made: 15 September 2022

Latest response received: Awaiting Response

AAIB Assessment **Awaiting Response:**

Action Status:

Safety Recommendation Status: **Open**

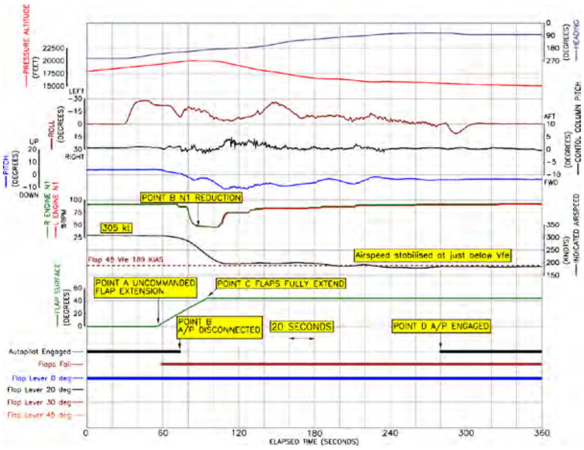
Bombardier CL-600-2B16 (604), D-AAAY

10 August 2022, In the climb after departing Farnborough Airport, Hampshire

Investigation Synopsis (Special Bulletin S2/2022)

A Bombardier Challenger 604, registration D-AAAY, had an uncommanded flap extension, above the maximum flaps-extended speed while the aircraft was in the climb after departing Farnborough Airport. The aircraft returned to Farnborough where it landed without further incident.

One Safety Recommendation was made in Special Bulletin S2/2022 and four Safety Actions have been taken by the regulator and aircraft manufacturer. The investigation continues.



FDR data of uncommanded flap extension

Safety Recommendation 2022-017

Justification

On this occasion the crew, who were actively monitoring the aircraft during climb, quickly noticed the uncommanded flap extension and were able to respond appropriately to control the aircraft and reduce its speed to below the flap limit speed. Even so, the flap overspeed reached up to about 103 kt and the speed was not reduced below the flaps 45 limit speed for some 170 seconds.

Had the aircraft been in the cruise, the crew may not have been able to recognise the uncommanded flap extension so promptly and take corrective action within the time required for the flaps to fully extend.

To ensure that operators are aware of the actions to take in the event of an uncommanded flap operation, which may occur without warning, the following Safety Recommendation was made:

> **Safety Recommendation 2022-017**
>
> It is recommended that Bombardier inform operators of the Challenger 600 series of aircraft of the actions to take in the event of uncommanded flap operation in flight.

Date Safety Recommendation made: 16 September 2022

Latest response received: 14 December 2022

Bombardier is still evaluating the flight crew actions which could be taken in the event of uncommanded unarrested flap operation, and what those actions might be. A final decision will be taken on January 27th, 2023.

AAIB Assessment: **Adequate**

Action Status: **Planned Action Ongoing**
Update Due 17 February 2023

Safety Recommendation Status: **Open**

Feedback rationale

The AAIB acknowledges the response from Bombardier Aviation and asks for an update to be provided by 17 February 2023.

Boeing 737-800, G-JZHL

1 December 2021, Kuusamo Airport, Finland

Investigation Synopsis

During takeoff from Kuusamo Airport in Finland the flight crew inadvertently left the thrust set at the 70% engine run-up setting rather than the 89% required for takeoff. The aircraft became airborne with 400 m of runway remaining and climbed away slowly. At 250 ft agl the flight crew realised they had insufficient thrust and applied the correct power. The flight continued without further incident.

PFD prior to starting the takeoff (image captured in a simulator)

The thrust was not set correctly because the TOGA button was not pressed. It was not pressed because the co-pilot was startled by the aircraft starting to move when he set 70% power against the brakes. The aircraft started to move because the co-pilot applied insufficient brake pressure. The commander was distracted by a radio call and neither he, nor the co-pilot, checked the thrust was correctly set.

The AAIB has investigated several takeoff performance incidents across the industry. This incident is further evidence that the current barriers designed to prevent these events are not fully effective, and improved reliability is likely only through the introduction of a technical barrier. A Safety Recommendation was made to develop technical specifications and, ultimately, certification standards for a technical solution.

A Safety Recommendation was also made to improve the detection of takeoffs with compromised performance, to support the prompt reporting of occurrences.

Safety Recommendation 2022-018

Justification

The AAIB and other SIAs have investigated many takeoff performance incidents which have resulted in aircraft taking off with insufficient thrust. The circumstances of each incident differ but the outcome is the same. The human checks currently in place do not always stop these incidents occurring. Whilst they are effective in many cases, such checks are occasionally omitted or fail to detect errors because there is a limit to the reliability that can be achieved with any human task. Higher levels of reliability are likely to require technological intervention to detect abnormally low acceleration during takeoff in time to enable crews to safely reject the takeoff. SR 2018-014, made to EASA, addressed this issue when the UK was part of the EU. SR 2022-018 addresses the same issue but is made to the UK CAA.

Therefore, the following Safety Recommendation was made:

Safety Recommendation 2022-018

It is recommended that the UK Civil Aviation Authority, in conjunction with other regulatory authorities, develop a set of technical specifications and, subsequently, develop certification standards for an on-board system that will alert the crew of an aircraft to abnormally low acceleration during takeoff.

Date Safety Recommendation made: 29 September 2022

Latest response received: 2 December 2022

The UK CAA accepts this Safety Recommendation.

In order to ensure any UK position is coordinated with other key aviation regulatory bodies, we have started engagement to determine what, if any, parallel workstreams are already in process. We have also started engagement with Organisations developing standards for Aviation Equipment to understand if they have already been approached to work towards an agreed Minimum Operational Performance Standard (MOPS) for any design solution. Any future mandate that is associated with agreed technical specifications will require further consultation – ideally with a coordinated regulatory action.

A workshop with key UK airlines is planned for Q1 2023 to start the initial scope of a technical solution. This will be followed by OEM meetings and further regulator outreach to try and maintain common collective position. The consequences and viability of a UK only approach will have to be considered in due course if a more global consensus is not possible.

The Civil Aviation Authority would like to propose that our next update to AAIB recommendation 2022-018 shall be provided by the end of June 2023.

AAIB Assessment: **Adequate**

Action Status: **Planned Action Ongoing**
Update Due 30 June 2023

Safety Recommendation Status: **Open**

Feedback rationale

The AAIB looks forward to an update by the end of June 2023.

Safety Recommendation 2022-019

Justification

Flight Data Monitoring (FDM) can be used to monitor the frequency of occurrences of takeoff performance events and to ensure they are reported appropriately. EASA has published guidance material on the subject and has recommended that operators implement in their FDM programmes specific algorithms to detect precursors relevant to the monitoring of takeoff performance. SR 2022-019 aims to encourage operators to use FDM in this way.

Therefore, the following Safety Recommendation was made:

> **Safety Recommendation 2022-019**
>
> It is recommended that the UK Civil Aviation Authority encourage all UK Air Operator Certificate holders to implement into their flight data monitoring programme algorithms to detect the precursors relevant to the monitoring of takeoff performance detailed in the European Operators Flight Data Monitoring Document, Guidance for the implementation of flight data monitoring precursors.

Date Safety Recommendation made: 29 September 2022

Latest response received: 2 December 2022

The UK CAA accepts this Safety Recommendation.

The UK CAA recognises that the identification of the correct threat line, which could lead to a runway excursion event, is an important part of any safety risk mitigation strategies for the Take-off Performance errors.

The UK CAA will seek to maximise the safety benefit of the Flight Data Monitoring (FDM) programmes by

- Identifying FDM events that can be easily linked to take-off performance errors as 'precursors' to the undesired outcome (runway excursion).
- Agree on common trigger values that could be used to produce a wider data set to identify sector risks to share with all operators, subject to confidential protocols being agreed and accepted.

We plan to do this by working with large Air Operator Certificate (AOC) organisations through dedicated workshops and publish FDM 'best practice considerations' by the end of 2023.

The Civil Aviation Authority would like to propose that our next update to AAIB recommendation 2022-019 shall be provided by the end of June 2023.

AAIB Assessment:	**Adequate**
Action Status:	**Planned Action Ongoing** **Update Due 30 June 2023**
Safety Recommendation Status:	**Open**

Feedback Rationale

The AAIB looks forward to an update by the end of June 2023.

Safety Actions from investigations reported on in 2022

Early in an investigation the AAIB will engage with authorities and organisations which are directly involved and can act upon any identified safety issues. The intention is to prevent recurrence and to that end to encourage proactive action whilst the investigation is ongoing and not for those involved to wait for the issue of official Safety Recommendations.

When safety action is taken, it means there is usually no need to raise a Safety Recommendation as the safety issue has been addressed. The published report details the safety issues and the safety action that has taken place. (By convention Safety Issues are published in the reports with a green highlight box).

Note: If the issue remains then a Safety Recommendation may be raised accordingly and this will then require a formal response by the addressee.

In 2022, 101 safety actions directly resulted from AAIB investigations. These arose from one Special Bulletin, 17 Field Investigations and 14 Correspondence Investigations.

Index of Safety Actions Recorded in Field and Correspondence Investigations

(Listed by aircraft weight, manufacturer and type)

Special Bulletin - S2/2022

Bombardier CL-600-2B16 (604 variant), D-AAAY
10 August 2022, In the climb after departing from Farnborough Airport, Hampshire

Synopsis

A Bombardier Challenger 604, registration D-AAAY, had an uncommanded flap extension, above the maximum flaps-extended speed while the aircraft was in the climb after departing Farnborough Airport. The aircraft returned to Farnborough where it landed without further incident.

Special Bulletin S2/2022 contained preliminary information from the investigation. One Safety Recommendation was made and four Safety Actions acknowledged that had been taken by the regulator and aircraft manufacturer.

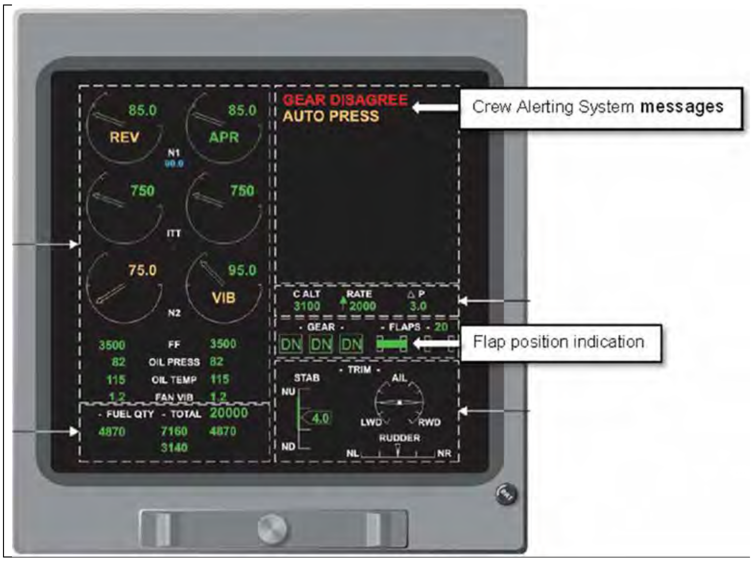


Illustration of EICAS primary page information

Safety actions

- The Transport Canada have advised that they and Bombardier are reviewing the safety case for the flap operating system of the Challenger 600 series of aircraft to ensure that the safety risk probability of an uncommanded flap movement is correct.

- By 20 October 2022, the manufacturer will advise operators of the Challenger 600 series of aircraft, through an Advisory Wire, of the circumstances of the occurrence to D-AAAY.

- By 20 October 2022, the manufacturer Bombardier will advise operators, through an Advisory Wire, of the existing maintenance tasks that will identify if the flaps are operating at half speed.

- Transport Canada have advised that Bombardier and Transport Canada will determine any appropriate actions to ensure that the protection system on the Challenger 600 series of aircraft will stop an uncommanded flap extension and the system operates as intended. Transport Canada will mandate such actions as necessary for the continued safe operation of the aircraft.

Commercial Air transport (Fixed Wing)

Airbus A320-232, G-EUUO (in date order of occurrence)
Airbus A320-251N, G-TTNH
Boeing 777-236, G-YMMR
Airbus A330-343, G-VKSS
Boeing 787-9, G-ZBKJ
Boeing 777-336ER, G-STBJ
Boeing 787-8, G-ZBJF
Airbus A319-131, G-DBCG
Between 9 June 2021 and 19 July 2021, London Heathrow Airport, UK

Synopsis

Between 9 June 2021 and 19 July 2021, several aircraft suffered from abnormal pitot/static system events, two of which resulted in rejected takeoffs. The AAIB investigation identified the cause to be the nesting activity of certain species of wasps and bees within pitot probes. The investigation report addressed the likely reasons as to why there was a concentration of such events over a relatively short period of time.

G-YMMR blocked pitot tube

Although Heathrow Airport and the surrounding area was the focus for these occurrences, detailed information on the environmental factors was provided for the operators of airfields at other locations to take into consideration. Safety action has been taken by the Civil Aviation Authority (CAA) and those airline operators affected to reduce the risk of reoccurrence by introducing additional inspections and changes to the use of pitot covers. In addition, the airport operator is updating its environmental hazard management plan to take into account the findings of this investigation.

Safety actions

Action taken by the CAA:

- On 12 June 2021, the CAA published Safety Notice SN-2021/014 – Pitot blockage events to raise awareness of a possible 'insect infestation' issue amongst operators, maintenance, and continuing airworthiness management organisations. Flight crews were also to be reminded of the importance of speed checks during the takeoff roll and the actions to be taken in the event of a discrepancy.

- In addition, by remaining engaged with action being taken by the airport operator, the CAA will facilitate the communication more widely of any best practice identified.

Action taken by affected airline operators:

- As the investigation evolved, the affected operators introduced enhanced use of pitot covers for aircraft on the ground and one operator introduced a regime of detailed visual inspections as part of the pre-departure checks. These measures were put in place whilst it was determined that insect activity remained at an elevated level.

Action being taken by the airport operator:

- The airport operator is updating its management of airport environmental hazards to include a layered surveillance and alerting plan to provide information to airline operators on when the risks posed by insects increase. This will enable the operators to put in place, when necessary, additional control measures in mitigation, such as enhanced use of pitot covers or additional pre-flight inspections.

Boeing 787-8, G-ZBJB
18 June 2021, London Heathrow Airport Stand 583

Synopsis

The aircraft was on stand being prepared for a cargo flight from London Heathrow to Frankfurt. A ground maintenance team was working to address three fault messages associated with the Nose Landing Gear (NLG) doors while the flight crew prepared the aircraft for the flight. The Dispatch Deviation Guide confirmed that rectification of the defects could be deferred to a later date providing the landing gear was recycled to confirm the NLG doors functioned correctly. To prevent the landing gear from retracting when UP was selected, the landing gear downlock pins were fitted. However, when the lead engineer selected the landing gear lever to UP, the NLG retracted. The aircraft's nose struck the ground causing significant damage to the lower front section of the aircraft and inflicting minor injuries on the co-pilot and one of the cargo loading team.

View of the right side of the aircraft following NLG retraction

The NLG downlock pin had inadvertently been inserted in the downlock link assembly apex pin bore instead of the downlock pin hole. The design of the aircraft nose landing gear downlock assembly created an opportunity for error when inserting the NLG locking pin, with two holes located so close together that the pin could be inadvertently inserted in the incorrect location. A Service Bulletin (SB) and Airworthiness Directive (AD) was available that would have prevented the accident, but this had not yet been completed on G-ZBJB.

The operator and the airport have introduced a number of Safety Actions which cover the adoption of corrective modifications to the aircraft, changes to maintenance and incident response procedures.

Safety actions

As a result of the accident the aircraft operator has taken the following safety actions:

- The AD and SB has been fully installed on all the operator's applicable Boeing 787 aircraft.
- The operator has reviewed their processes to assess SBs and ADs and has developed appropriate organisational structures to identify and manage health and safety risks more effectively in the Technical Document Review process.
- The adoption of an SMS within the Operator's maintenance organisation is already underway following the CAA's rulemaking announcement for the introduction of an SMS into the Part 21 and Part 145 with the aim of Government approval by the end of 2022.

- The operator has provided ramp maintenance personnel with access to manufacturers' technical data, documents and manuals via their issued iPads.
- The operator has introduced a new software application for tech news that has an improved interface including filtering and prioritisation functions and requires each page of every article to be displayed before it can be signed.
- The operator has begun a review of their Incident Response Manual.

The airport operator has also taken the following safety actions:

- The airport Emergency Orders (EO) Action Cards for each stakeholder will be amended to include a requirement for each Business Unit to make an individual assessment of the incident categorisation and communicate that to the RFFS Commander.
- The airport EO Action Card for the RFFS Commander will be amended to include a consideration of a change in categorisation in liaison with other stakeholders.
- The airport EOs will include a cordon requirement in all categories for the Campus Security Manager.

[Airbus A320-232, 9H-LOZ](#)
28 May 2021, London Stansted Airport, Essex

Synopsis

On a routine short flight, during final approach to land, the No 2 engine reduced to idle and would not respond to any control inputs. The flight crew performed a missed approach and, following the relevant checklist procedure, elected to shut down the engine. They then performed an uneventful single-engine approach and landed safely. The engineering investigation determined that the cause of the engine problem was most likely an inadvertent activation of the overspeed protection valve in the fuel control system. The problem has occurred previously on other V2500 engines and is being addressed through safety actions by the engine and aircraft manufacturers.

Post-flight report

Safety actions

- It has been reported that the engine manufacturer has conducted investigations at component and system level to understand the cause of the inadvertent overspeed protection valve activations. Definitive identification of the root cause has not been possible, but several factors have been identified as possible contributors. These will be addressed as product improvement changes to the Fuel Metereing Unit (FMU) and are targeted to be available in Q3 2022. The aircraft manufacturer reported that progress on these issues is regularly communicated to operators of the engine during customer meetings, in which both the aircraft and engine manufacturers participate.
- At the request of the operator of 9H-LOZ, the aircraft manufacturer also agreed to review the wording of the Flight Crew Operating Manual (FCOM) procedure for an 'ENG 1/2 FADEC FAULT' warning, to advise crews that the parameters will not always revert to 'XX' in the event of a problem occurring and may appear as frozen or abnormal values.

Safety Actions Overview

[Boeing 737-800, G-JZHL](#)
1 December 2021, Kuusamo Airport, Finland

Synopsis

During takeoff from Kuusamo Airport in Finland the flight crew inadvertently left the thrust set at the 70% engine run-up setting rather than the 89% required for takeoff. The aircraft became airborne with 400 m of runway remaining and climbed away slowly. At 250 ft agl the flight crew realised they had insufficient thrust and applied the correct power. The flight continued without further incident.

PFD Speed Tape trend arrow (left image with 89% N_1, right image with 70% N_1) (Images captured on a simulator)

The thrust was not set correctly because the TOGA button was not pressed. It was not pressed because the co-pilot was startled by the aircraft starting to move when he set 70% power against the brakes. The aircraft started to move because the co-pilot applied insufficient brake pressure. The commander was distracted by a radio call and neither he, nor the co-pilot, checked the thrust was correctly set.

The AAIB has investigated several takeoff performance incidents across the industry. This incident is further evidence that the current barriers designed to prevent these events are not fully effective, and improved reliability is likely only through the introduction of a technical barrier. A Safety Recommendation was made to develop technical specifications and, ultimately, certification standards for a technical solution.

A Safety Recommendation was also made to improve the detection of takeoffs with compromised performance, to support the prompt reporting of occurrences.

Safety actions

The operator:

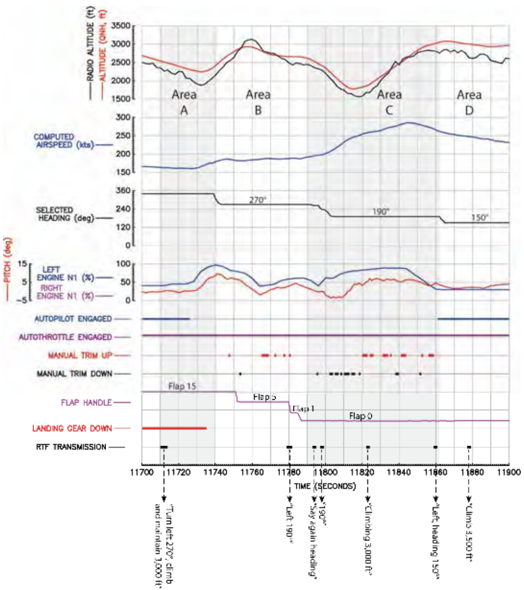
- Issued a flight crew general notice highlighting the importance of applying sufficient brake pressure during a pre-takeoff engine run-up.
- Began to monitor Flight Data monitoring (FDM) data to detect any further issues with brake pressure during pre-takeoff engine run-up.
- Included a pre-takeoff engine run-up and distraction during the takeoff roll in an line oriented evaluation (LOE) sector during their next simulator cycle.
- Updated their Flight Crew Operating Manual (FCOM) procedure of pre-takeoff engine run-ups.

- Updated their Operations Manual Part C (OM-C) for all Finnish Airports to include a requirement to report the intended direction of turn to the Flight Information Service Officer (FISO) before takeoff.

Boeing 737-8K5, G-FDZF
11 September 2021, Aberdeen Airport

Synopsis

A serious incident occurred to a Boeing 737-800, registration G-FDZF, during a go-around at Aberdeen Airport on 11 September 2021. During the manually flown go-around, which was initiated at 2,250 ft amsl, the aircraft initially climbed, but just before it reached the cleared altitude of 3,000 ft amsl it began to descend. It descended to 1,780 ft amsl (1,565 ft agl) with a peak rate of descent of 3,100 fpm and accelerated to an airspeed of 286 kt (the selected airspeed was 200 kt) before the crew corrected the flightpath. The aircraft descended for a total of 57 seconds before the climb was re-established. It is likely that the crew allowed the aircraft to descend unnoticed having become overloaded by the high workload during the go-around.



Flight data for the approach and subsequent unintended descent

As a result of this serious incident, Aberdeen ATC changed its procedures for aircraft being broken off from the approach, and the aircraft manufacturer issued guidance to pilots about the behaviour of the Autopilot and Flight Director System (AFDS) and autothrottle during go-arounds. The aircraft operator informed all its pilots about the event; included extensive go-around training in its training cycle; and completed a full review on pilot recency, which introduced additional restrictions to manage pilots through periods of reduced flying.

Safety actions

The aircraft operator completed an investigation into the serious incident, and took the following safety action:

- An extensive review of pilot recency related safety events was conducted, and additional company restrictions were introduced to safely manage pilots through a period of reduced flying.
- Pilots of the Boeing 737 were informed that above 2,000 ft radio altitude a push of the TO/GA switches will provide full go-around thrust.
- The operator's non-Boeing 737 pilot community was notified of the incident.
- Go-around training would be included in the next recurrent simulator cycle to address the issues raised in this serious incident. The training objectives would be to increase the knowledge of the AFDS system in GA mode, increase exposure to

two engine go-around events to reduce possible startle effects, and to encourage the use of appropriate pilot competences including threat and error management. The package would include a total of at least six go-around scenarios to be flown by the crew, including one above 2,000 ft radio altitude so crews would experience the thrust increasing to full go-around thrust.

- Details of the serious incident were shared with other operators through the CAA Flight Operations Liaison Group.

The airport ATC conducted an investigation into the serious incident and subsequently took the following safety action:

- Changes were introduced through a supplementary instruction to Manual of Air traffic Services (MATS) Part 2, which included introducing a procedure for aircraft being broken off an approach within the Final Approach Fix to only be instructed to conduct a standard missed approach (unless there are over-riding safety considerations, or the crew have already been issued with alternative instructions). Headings would only be allocated once the aircraft is level at the missed approach altitude.

The aircraft manufacturer took safety action in relation to the aircraft Flight Crew Operations Manual:

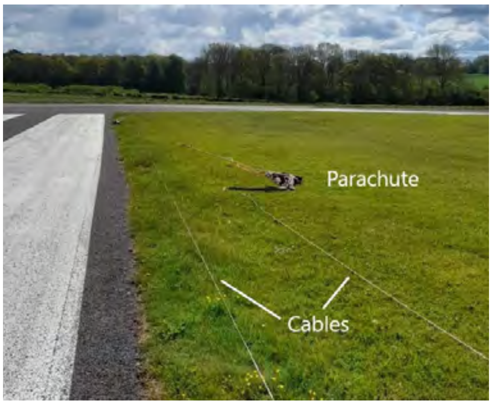
- Clarification was introduced relating to the first push of the TO/GA switches at or above 2,000 ft radio altitude, with the Flight Crew Operations Manual amended to read:

> *'If pushed at or above 2,000 ft RA (or below 15,500 ft if both RA's have failed) with glideslope engaged or the flaps down: [autothrottle] (if armed) engages in N1 mode and advances thrust towards the full go-around limit. The [autothrottle] Engaged Mode annunciation on the FMA indicates N1.'*

Airbus A319-111, G-EZAJ
26 May 2021, Lasham Airfield, Hampshire

Synopsis

An airliner landed on Runway 27 at Lasham Airfield while winch-launch cables were present on the grass abeam the southern edge. The gliding club and maintenance organisation have taken action to improve communication between relevant parties and to emphasise the importance of securing the runway area during heavy aircraft movements.



Winch cables with parachutes laid on the grass along southern side of Runway 27 abeam the landing threshold

Safety actions

The following safety actions have been taken:

The airfield owner stated that:

- Individuals are required to contact the Duty Instructor (DI) for a brief on relevant airfield information and any aircraft movements if there is a need to enter the operational area prior to the daily briefing.
- Planned winch maintenance will be notified the day before it is due to take place.
- Any winch maintenance should be conducted as far away from the main runway as the circumstances allow.

The Maintenance Repair Organisation (MRO) has:

- Issued an information bulletin to provide guidance on the importance of securing the runway during heavy aircraft movements and what constitutes a secure runway strip. This will be incorporated into the airfield fire service (AFS) manual which is currently undergoing revision.
- Briefed Fire Crew Commanders on the event and on the guidance about runway strips, the procedures to be used, and how to determine that a runway strip is secure. This will be incorporated into future Fire Crew Commander training.
- Briefed all members of the air-ground communication service (AGCS) on the incident and how the handover from Farnborough Radar controller (FRC) before the runway was available contributed to the incident.

Boeing 737-4Q8, G-JMCY
19 January 2021, Exeter Airport, Devon

Synopsis

Photograph looking aft showing distortion of the rear fuselage and rippling in the skin

During an ILS approach at Exeter Airport, the aircraft became unstable after the point where the crew had declared it stable and continued with the approach. During the final 500 ft the rate of descent exceeded the required 500 ft stable approach maximum on four occasions. All bar the first of these excursions were accompanied by GPWS "SINK RATE" alert. The subsequent hard landing resulted in extensive damage to the aircraft. There were no injuries.

The operator has taken safety action to reinforce its operating procedures with regards to the criteria for a stable approach.

Safety actions

Since the accident the following safety actions have been taken:

- The operator has instructed their crews that, until further notice, only the commander is to conduct the landing at Exeter Airport.
- The operator has added a note to Section 2.1.14 Stabilised Approach of OM B stating, 'An approach that becomes unstabilised below this point [1,000 ft above touchdown zone elevation (TDZE) in IMC or 500 ft above TDZE in VMC] requires an immediate go-around.'
- The operator recognised that there were no robust mechanisms to monitor trends in pilots' performance across recurrent checks. The operator has since introduced a number of new procedures to rectify this.

Safety Actions Overview

Boeing 737-4Y0F, EC-MIE
16 June 2021, East Midlands Airport

Synopsis

After an uneventful pushback, the towbar was left on the taxiway in front of the aircraft. Soon after the aircraft commenced taxiing, its left landing gear went over the towbar. The missing towbar was noticed when the ground crew returned the tug to the towbar parking area. The aircraft was subsequently stopped from taking off to allow an inspection to take place. Damage was found to two landing gear tyres, which were replaced before the aircraft departed.

Damage to one of the landing gear tyres

The investigation found that the ground crew did not complete some of their tasks or check the taxiway was clear before they left the area.

As a result of this incident the handing agent implemented several safety actions to make the ground crew's procedures more robust.

Safety actions

- The handling agent reviewed the headset operatives' and tug drivers' roles and responsibilities and added the following procedures:

  The chock is removed from the nosewheel by the headset operative.

  The chock is handed to the tug driver who stows it in a basket on the tug.

  The tug driver immediately vacates the taxiway with the tug and towbar.

  The tug driver parks in view of the aircraft and checks the area is clear in front of it.

  After the tug has departed, the headset operative checks that the area in front of the aircraft is clear of equipment and foreign object damage/debris (FOD), and that the pathway is clear.

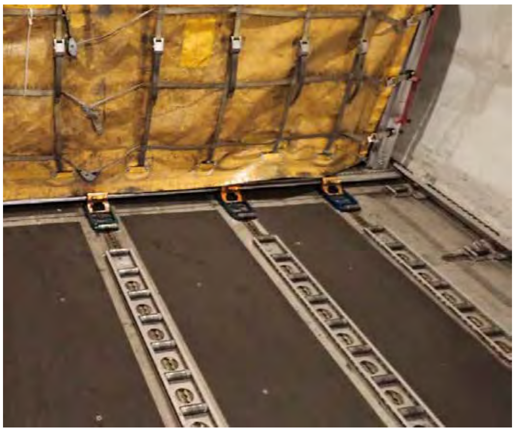
  The tug driver waits for the aircraft to taxi to ensure they are no longer required.

- The handling agent also reviewed and amended its training material, 'safe systems of work', and auditing processes to reflect these changes and to try to prevent recurrence. It also publicised the event and these changes to its staff in its 'Internal Operations Briefing'.

ATR 72-211, G-CLNK
16 April 2021, Guernsey Airport

Synopsis

As the cargo aircraft took off, a Unit Load Device (ULD) positioned in the centre of the aircraft slid rearwards into a vacant bay. After landing, as the aircraft braked, the ULD slid forward breaking through the forward locks and coming to rest in a vacant bay forward of its original position.


ULD rails and locking mechanisms

An investigation by the ground handling organisation found that the locks to the rear of the ULD had not been raised and that there were no independent checks during the loading to verify that the locks had been correctly raised.

To raise awareness of risks associated with void bays, such as the effects on trim if the aircraft is loaded incorrectly or the ULD moves into another bay, the operator has also taken safety action.

Safety actions

By the ground handling organisation,

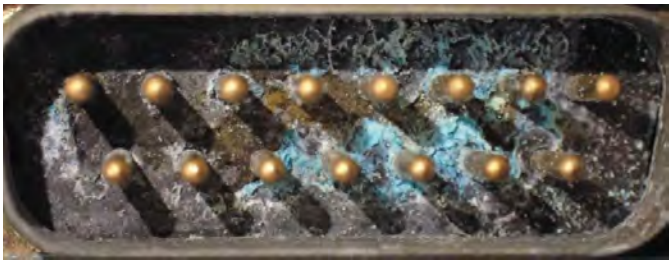
- The ground handling organisation has revised their loading procedures to introduce an independent check to verify that all locks are positioned in the correct position when the aircraft is loaded.

By the operator,

- The operator has introduced 'void bay awareness' training as part of their Operator Proficiency Check on all fleets to highlight the risks when operating with void bays.

BAe ATP, SE-LPS
9 April 2021, Ronaldsway Airport, Isle of Man

Synopsis


Contamination and corrosion on the audio warning unit connector

SE-LPS was on approach to Ronaldsway Airport, Isle of Man with the co-pilot as pilot flying (PF). As the aircraft approached the minimum descent altitude, the co-pilot attempted to disengage the autopilot. There was no audio tone to indicate the disengagement and the co-pilot felt there was resistance in the flying controls. Both pilots checked the cockpit indications which seemed to show that the autopilot had disengaged. The commander took control and also felt resistance in the flying controls. He pressed and held the synchronisation (SYN) button on the control column which he felt released the controls and was able to land the aircraft normally.

A definite cause could not be found for the autopilot not disengaging as designed. The manufacturer responsible for the design of the autopilot identified a possible scenario where the autopilot servomotors could remain engaged after the autopilot disengaged. This would result in higher-than-normal forces at the cockpit controls.

On 2 December 2021, another autopilot occurrence on an ATP, registration SE-MAJ, was reported to the AAIB. The results of this investigation are included in this report.

Safety action was taken by the CAA to include additional testing of the autopilot system as part of the continued airworthiness programme of the ATP. The operator took safety action to reconfigure their fleet so that either pilot could override either autopilot via the SYN button on their respective control wheel. The operator also initiated remedial action to try and prevent water ingress into the cockpit.

Two Safety Recommendations were made to the CAA regarding the use of magnetic tape recorders.

Safety actions

As a result of this serious incident the following safety actions were taken:

- The aircraft operator took the following safety actions:
  - Restored the original SYN button logic on all their ATP aircraft.
  - Included the use of the SYN button to overcome the autopilot for all crew in a simulator session in early 2022.

- Review the water ingress Service Bulletins (SB)s on all their ATP aircraft. The SBs will be incorporated and repaired as necessary.

- The CAA will consider the investigation findings as part of their ongoing review of the ATP continued airworthiness.

Britten Norman 2B-26 Islander, J8-VBI
29 September 2021, John A. Osborne Airport, Montserrat

Synopsis

On landing at John A Osborne Airport, Montserrat, the pilot was unable to maintain directional control of the aircraft, later reporting the left brake felt "spongy". The aircraft veered off the right side of the runway and came to rest in an adjacent drainage ditch.

An inspection of the aircraft's braking system revealed a slight brake fluid leak from one of the pistons in the left outboard brake calliper. This would have prevented full brake pressure being achieved on the left brakes, resulting in an asymmetric braking effect. Difficulty in maintaining directional control was compounded by the use of an incorrect braking technique on landing.

The investigation identified shortcomings with the operator's manuals, procedures and regulatory oversight.

A dust seal from one master cylinder showing degraded condition

Safety actions

- The operator has ensured it now complies with the requirements of Governor's Instruction MON 004.
- The airport regulator, Air safety Support International (ASSI) has reviewed its processes to ensure better compliance monitoring of commercial operators using John A Osborne Airport.

Piper PA-31, G-UKCS
23 July 2021, Doncaster Sheffield Airport

Synopsis

The aircraft's lower cabin door came open in flight when a screw forming part of the door's forward latching mechanism fractured. The aircraft landed safely and the investigation determined that the cabin door's rear latch was probably not locked when the cabin door was closed, allowing the door to open when the screw fractured. The screw had not been securely fastened and was loose, which contributed to a fatigue failure of the screw. The operator has taken a number of safety actions intended to detect unsafe conditions of the cabin doors on its PA-31 fleet.

Protruding state of the lower cabin door handle observed during testing (image courtesy of 2Excel)

Safety actions

The operator plans to conduct a fleet check on its PA-31 aircraft to ensure that the latch pin screws are not loose and are correctly mechanically fastened. It also plans to issue the following amplification statements:

- In its PA-31 Aircraft Maintenance Programme daily inspection instructions to ensure that the internal and external door handles are flush when the door is in the locked closed.
- In its PA-31 Check 1 (50-hour) inspection to include specific visual inspections for correct engagement of the cabin door latch pins and hook plates when the door is locked closed, and also that the latch pin screws are correctly mechanically fastened. Correct rigging of the internal and external cabin door handles is also to be highlighted in the Check 1 instructions.
- In its PA-31 Operations Manual pre-flight checklist to include a specific visual inspection to ensure that the cabin door internal handle is flush to the door inner skin when the door is locked closed.
- The operator also plans to disseminate its internal occurrence report for this event to its engineers and flight crews and will include related safety information in recurrent continuation training.

Commercial Air Transport (Rotary Wing)

Leonardo AW189, G-MCGT
30 July 2021, near Heads of Ayr, South Ayrshire

Synopsis

Autopilot Control Panel

During a pre-fight brief for a SAR training flight, the co-pilot highlighted an event on a previous flight which had resulted in unexpected pitch oscillations following the selection of the Transition Down mode of the Automatic Flight Control System (AFCS). On the conclusion of the other training priorities for the flight, the crew replicated the circumstances that had triggered the pitch oscillations previously; this resulted in similar unexpected flight path oscillations in the pitch axis. The crew reported this second event to the operator.

The event was caused by a shortcoming in the design of the Phase 5 version of the AFCS software SAR upper modes which also resulted in incorrect AFCS mode indications to the flight crew. To address this issue pending the correction of the AFCS software in the Phase 9 release, the helicopter manufacturer issued a Technical Information Letter detailing actions to be taken in the event of a re-occurrence and updated the Flight Management System (FMS) Pilot's Guide for Phase 5, Phase 6 and Phase 8 software. The manufacturer has corrected the design shortcoming in the Phase 9 release of the AFCS software.

Safety action has been implemented by the operator regarding automation management and incident reporting.

Safety actions

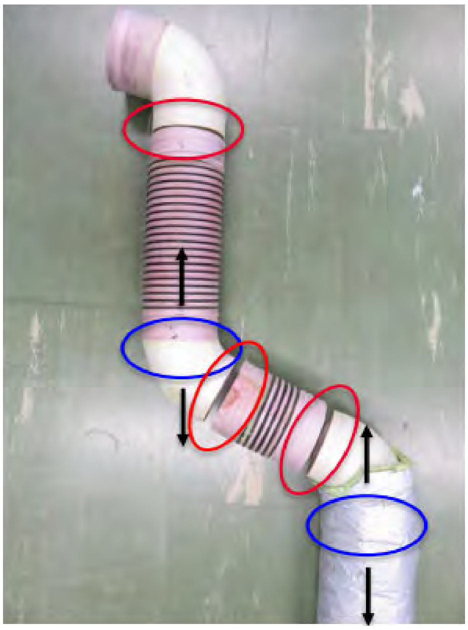
- The helicopter manufacturer has issued a Technical Information Letter advising operators of this behaviour and the actions that should be taken in the event of its occurrence. It also briefed the helicopter community on the issue during HAI Heli-Expo 2022 and has updated the FMS Pilot's Guide for Phase 5, Phase 6 and Phase 8.
- The design shortcoming in the AFCS software has been corrected in the Phase 9 release.
- The helicopter operator has restricted the use of autonomous ground speed (NGSPD) in conjunction with transition down (TD) by its flight crews and has reinforced the importance of reporting incidents to ensure that issues that could affect safety are dealt with appropriately.

- The operator also included information on this AFCS issue in the ground school training as part of its Operator Proficiency Check programme which all of its SAR AW189 crews have received.

[Leonardo AW189, G-MCGU](#)
4 March 2021, 3 nm south-east of Porthcawl, Wales

Synopsis

While returning from a Search and Rescue (SAR) training sortie, shortly after selecting the cabin and cockpit heating ON, a heating duct failed causing fragments of duct insulation material to be discharged through the heating vents. The heating system was turned OFF but the subsequent presence of smoke, and a smell of burning, prompted an emergency landing. Several weeks later, a similar heating duct failure occurred on another of the operator's AW189 helicopters. The occupants of both helicopters suffered respiratory irritation.



Failed heating duct from G-MCGU

The investigation determined that the heating ducts failed due to non-uniform adhesion at joints between rigid and flexible sections of duct. Interim safety action taken by the manufacturer includes the publication of a Service Bulletin to inspect and modify the installation of the heating duct. A further heating duct failure occurred on another AW189 following embodiment of the Service Bulletin and that event was reported separately by the AAIB. At the time of publication of the AAIB report, the investigation into the recent duct failure was ongoing and the aircraft manufacturer was continuing to work with the duct manufacturer to achieve a permanent design solution.

Safety action

- On 23 July 2021 the aircraft manufacturer published Service Bulletin 189-296, requiring operators to perform a one-off inspection of the heating duct and to modify the duct installation.

MBB-BK 117 C-2, G-MPSB
12 March 2021, North Weald Airfield, Essex

Synopsis

G-MPSB landing gear
(viewed from front looking rear)

This serious incident occurred during the demonstration of an engine failure after takeoff emergency procedure on a revalidation flight for the commander's type rating instructor qualification. The engine failure was simulated by the commander reducing Engine No 1's throttle to IDLE. Shortly afterwards the commander increased the throttle setting, but Engine No 1 did not respond. During attempts to resolve the problem, the throttle setting for Engine No 2 was inadvertently reduced, resulting in insufficient power being available for continued safe flight. The commander rejected the takeoff and executed a firm landing within the airfield boundary.

While the aircraft's skid assembly was deformed as a result of the landing, the touchdown forces did not exceed the manufacturer's threshold for it to be classified as a 'hard landing.' The subsequent engineering investigation did not find any evidence of malfunction in the engine control systems. Engine No 1 probably did not respond because the rotor rpm droop compensation had been inadvertently trimmed in the wrong direction.

Safety actions

The helicopter's operator has:

- Issued a temporary Flying Staff Instruction prohibiting engines being retarded to idle in flight during BK 117 C-2 training and checking.
- Raised a technical request with the manufacturer to clarify procedural elements of one engine inoperative (OEI) training with one engine retarded to idle.
- Initiated a review of workload at all management levels where change was occurring, including the Head of Flight Operations role.
- Introduced simulator training, including OEI serials, for BK 117 C-2 pilots.

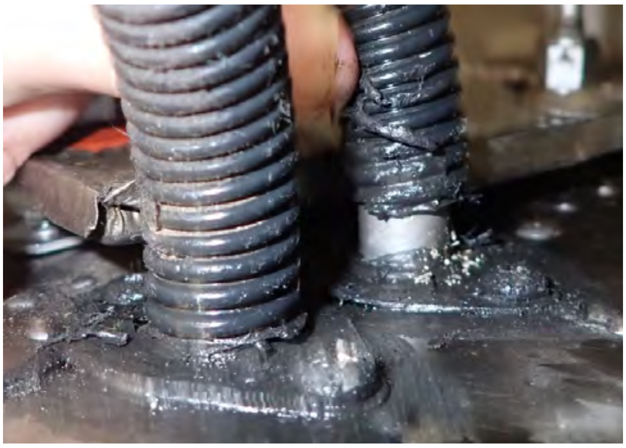
The helicopter manufacturer reported that it intended to:

- Develop formal guidance to pilots delivering simulated OEI training in the helicopter using the one engine at IDLE technique, and

- Review the appropriateness and scope of the Rotorcraft Flight Manual (RFM) limitation requiring the use of the manufacturer's training device when conducting OEI training at maximum training gross mass (MTGM).

MD 900, G-LNDN
25 July 2021, In flight between Royal London Hospital and RAF Northolt, Greater London

Synopsis



Right engine ignitor cable sheath easily moved away from deck

During a flight from the Royal London Hospital (RLH) to RAF Northolt, G-LNDN suffered a series of seemingly unconnected electrical system faults. The first faults related to the stability augmentation system (SAS) and the commander's flight instrument displays but did not materially affect the conduct of the flight. Later, when approximately 4 nm from their destination, the pilots were alerted to electronic engine control (EEC) system fault indications for both engines. A '*critical*' fault on the right engine required the pilots to manually control its throttle but the fault on the left engine was non-critical and the engine operated as expected in the NORMAL (automatic) control mode. The pilots were able to complete an uneventful approach and landing at RAF Northolt.

The electrical failures were the result of water ingress from the right engine bay onto electronic components located in the rear fuselage area.

Safety actions

The following safety actions were taken.

- The operator inspected its other aircraft to ensure that the sealant around the igniter leads was applied correctly.
- The operator introduced additional maintenance procedures to ensure the engine bays remained clear of debris and the drains remained serviceable.

Safety Actions Overview

[Airbus Helicopters AS355 F1, G-BOSN](#)
2 March 2021 Bourne End, Buckinghamshire

Synopsis

Whilst hovering at 20 ft agl smoke was observed coming from the engine exhaust. A member of the operational team on the ground informed the pilot, who then landed immediately. A fire warning subsequently illuminated, and the pilot activated the fire extinguishing system. The fire was determined to have been caused by the loss of retention of the right engine inboard exhaust nozzle, which was released because of the failure of its securing clamp. The released nozzle had blocked the overboard exhaust outlet and allowed hot exhaust gases to impinge on the engine cowlings leading to local overheating.

Paint blistering on engine cowling adjacent to right engine inboard exhuast tube

The clamp failure was attributed to a combination of an incorrect locking washer being fitted during maintenance and elevated engine vibration which caused the clamp to loosen. A crack then propagated in low-load high-cycle fatigue until final rupture of the clamp.

The helicopter manufacturer is taking safety action to amend the Aircraft Maintenance Manual (AMM) highlighting the correct installation of the clamp.

Safety actions

As a result of this investigation the helicopter manufacturer is taking Safety Actions to ensure the correct washer is fitted when installing the exhaust nozzles to the engines as follows:

The helicopter manufacturer is amending the AMM to clarify the engine exhaust nozzles installation working card to:

- Check the condition of the exhaust clamp (absence of cracks, etc.)
- Check if the serrated washer delivered with the clamp is replaced by the tab washer
- Introduce an installation drawing depicting the correct installation of the clamp and its tab washer

- Check if the tab washer is properly installed and bent according to the installation drawing
- After installation, complete a ground run and then re-adjust the tightening torque to ensure correct tightness.

General Aviation (Fixed Wing)

Piper PA-46-350P (Modified), G-HYZA
29 April 2021, near Cranfield Airport, Bedfordshire

Synopsis

The electrically powered aircraft was undertaking experimental flight tests, under E Conditions[1], when power to the electrical motors was lost. A forced landing was carried out close to Cranfield airfield during which the aircraft was severely damaged.

Parameters displayed on pilot's powertrain electric cockpit display

The loss of power occurred during an interruption of the power supply when, as part of the test procedure, the battery was selected OFF with the intention of leaving the electrical motors solely powered by the hydrogen fuel cell. During this interruption the windmilling propeller generated a voltage high enough to operate the inverter protection system, which locked out the power to the motors. The pilot and observer were unable to reset the system and restore electrical power.

Five Safety Recommendations were made regarding Civil Aviation Publication (CAP) 1220, *'Operation of experimental aircraft under E Conditions'*. The operator has also taken Safety Action to address a number of findings from this accident.

Safety actions

As a result of this accident the operator undertook the following safety actions:

- The design for the operator's future project would incorporate the learning in terms of handling back-EMF [voltage] due to windmilling.
- Future prototype testing would be limited to non-critical redundant situations until the powerplant design matures.
- The design and flight test of future programmes would follow CAA/EASA part 21J and aviation industry best practice.
- A safety management system based on a 'just' aviation culture would be established and include occurrence reporting, investigation, and corrective actions functions.

Footnote

[1] E Conditions, which were first published under CAP1220 in November 2015, enable a UK registered, commercially or amateur built, non-EASA aircraft with a Maximum Take off Mass (MTOM) of 2,000 kg or below to test a concept in the air without having to comply with the more stringent requirements of B Conditions.

- Commercial pressure would be actively managed to ensure that it does not compromise safety.

Piper PA-28R-200-2, G-EGVA
2 April 2022, approximately 20 nm west of Le Touquet, France

Synopsis

On 13 May 2022 the AAIB published Special Bulletin S1/2022, describing the accident involving G-EGVA on 2 April 2022. The Special Bulletin highlighted the danger of entering cloud without the necessary qualifications and experience and referred to guidance published by the CAA on the use of lifejackets.

Photograph taken at 0924 hrs showing cloud to the surface

Safety action

- The CAA has published an animation and podcast to reinforce the safety messages published in AAIB Special Bulletin S1/2022 concerning the accident involving G-EGVA.

Cessna 182B, G-OMAG and Boeing Stearman A75N1(PT17), N68427
20 August 2021, Dunkeswell Aerodrome, Devon

Synopsis

N68427 was completing a circuit at Dunkeswell Aerodrome when it landed on top of G-OMAG on the runway. G-OMAG had joined the circuit from the dead side and positioned ahead of N68427 on final for Runway 22. Neither pilot saw the other aircraft, nor were they alerted to the presence of the other by radio transmissions until late on the final approach.

Looking back to threshold of Runway 22 (image used with permission)

Following this accident, the CAA published a Supplementary Amendment to CAP 452 to improve the situational awareness of pilots operating at aerodromes providing an Air to Ground Communication Service.

The approved Aerodrome Manual contained no guidance on the delivery of the AGCS, and there had been no comments or indications of non-compliance in the most recent periodic audit by the CAA. The AAIB was informed by the CAA that work was currently in progress to review the scope of CAP 452 and the wider aspects of the AGCS, and this was expected to address the apparent gap between regulatory intention and practice. CAPs are subject to periodic revision to take account of changes to source regulatory material, feedback from industry, and recognised best practice.

Safety actions

To address the issues ahead of the revision to CAP 452, the CAA took the following Safety Action:

- On 4 August 2022, the CAA published Supplementary Amendment 2022/01 to CAP 452 Aeronautical Radio Station Operator's Guide providing an update to requirements for holders of a Radio Operator's Certificate of Competence (ROCC). The Amendment included the following provision:

  AGCS/OCS shall be provided to aircraft during the notified hours of operation. Notified hours are as published in the Air Information Publication (AIP) or promulgated via other means. Aerodrome operator's must be notified on occasions where AGCS/OCS cannot be provided during the hours of operation.

  If no answer received outside of these notified hours the use of blind transmissions is required.

  It is important that the radio operator should be free from distractions and keep additional admin tasks to an essential minimum.

Safety Actions Overview

Compulsory read-back of those ATS messages specified in the Radiotelephony Manual (CAP 413) paragraph 2.70 are required.

Information reported by pilots including position reports may only be used in a retransmission as an aid to assist other pilots in their lookout and safe operation of the aircraft. They are not to be assumed correct/incorrect or to be challenged by the AGCS/OCS operator.

Any information provided by the ROCC operator does not relieve the pilot-in-command of an aircraft of any responsibilities.

Piper PA-28-181, G-BFSY
25 June 2022, Chatteris Airfield, Cambridgeshire

Synopsis

The aircraft landed on a disused section of runway at Chatteris Airfield, due to a combination of insufficient airfield detail available during flight planning, and disused runway markers obscured by long grass. Safety actions have been taken by the flight planning tool provider and local flying club to update the airfield information. The airfield has also taken action to maintain the grass length.

Accident site

Safety actions

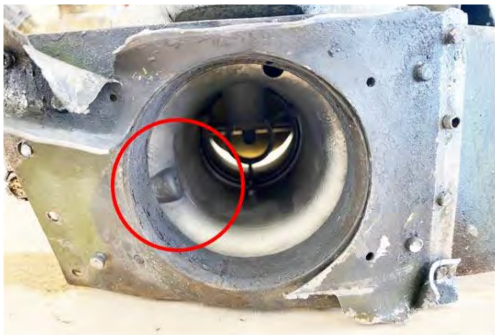
The following safety actions have been taken:

- The airfield management team have taken action to cut the grass of the disused section of Runway 05/23 so that the white crosses are more visible.
- The flight planning tool provider have updated their airfield plate to show the disused section of Runway 05/23.
- The flying club's website is updating their visiting pilot information to display the latest airfield plate showing the disused section of Runway 05/23.

Grumman AA-5, G-BBSA
25 September 2021, Teesside International Airport

Synopsis

The aircraft suffered a partial loss of engine power very shortly after takeoff from Runway 23 at Teesside International Airport. The pilot, believing the aircraft was outside the airport boundary, attempted a turnback to the airport to land. The aircraft stalled during the turn and struck the ground west of the runway near the Runway 05 threshold. The three occupants all sustained serious injuries.



Missing accelerator pump discharge tube from G-BBSA carburettor

The engine suffered a partial loss of power during takeoff due to a portion of the accelerator pump discharge tube having been released from the carburettor into the No 4 cylinder. Following this partial loss of power at low altitude the pilot decided to turn back to land, although post-accident analysis of the circumstances shows there was a sufficiently clear area ahead in which to effect a landing. During the turn, at a low airspeed, the aircraft stalled and struck the ground. All three occupants sustained serious injuries in the impact.

Management of a partial power loss event is not covered in the PPL syllabus and there is limited information provided for pilots conducting renewal or revalidation of licences. Three Safety Recommendations are made to address these topics. Safety action is also being taken by the CAA

Safety action

- The CAA has agreed to discuss the airworthiness concerns relating to discharge tube release events with the FAA, who are the regulator of the engine's Type Certificate holder.

Edge 540, G-EDGY
1 May 2021, overhead Tempsford Airfield (disused), Bedfordshire

Synopsis

During an aerobatic flight, as the pilot applied a full left aileron control input, the centre hinge attachment for the right aileron failed. This allowed the right aileron to bend up in the centre and fail before detaching from the aircraft; only a small inboard section of the aileron remained attached. The pilot had sufficient control remaining to make a safe landing.


Parts of the failed centre hinge attachment for the right aileron before removal from wing

The investigation found that the centre hinge attachment for the right aileron failed due to fatigue cracks developing to such an extent that the parts were no longer able to carry the required load. These fatigue cracks had multiple origins indicating that they were not due to a material feature or flaw. The aircraft manufacturer has issued a Service Letter to all known owners recommending regular detailed inspections of similar aileron centre hinge attachments. The LAA has contacted all affected owners in the UK to ensure they are aware of this mandatory Service Letter.

Safety actions

- The aircraft manufacturer has issued Service Letter, SB E540015 to all known owners of affected aircraft. This letter is annotated 'MANDATORY' and recommends removal of the centre aileron hinge attachment assemblies at each 100 hour or annual inspection to allow inspection for cracks using a dyepenetrant method.
- The LAA has contacted all affected owners in the UK to ensure they are aware of this mandatory Service Letter.

Safety Actions Overview

Supermarine Aircraft Spitfire Mk 26, G-CIEN
12 August 2021, Newtownards Airport, County Down

Synopsis

After landing, the aircraft suddenly veered to the right causing the left wingtip, propeller, and engine cowl to scrape the runway. Examination of the left landing gear leg revealed a failed weld that had allowed the lower part of the leg to rotate and consequently affect the wheel alignment. It is possible that the weld was damaged during a previous heavy landing, but due to the design of the leg it had not been possible to inspect the weld. The LAA has issued a warning to owners and is reviewing the design of the landing gear.

Landing gear damage
(photograph used with permission)

Safety actions

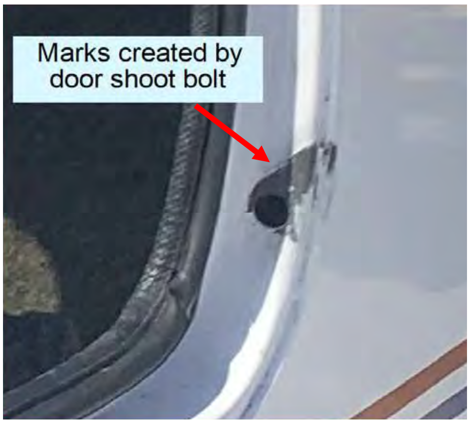
As a result of this accident the following safety actions have been taken:

- The LAA has issued a warning to all UK owners of Spitfire Mk 26 aircraft that there is potential for hidden damage to a weld following a heavy landing.
- The LAA is reviewing of the design of the Spitfire Mk 26 undercarriage leg, including the access restriction to inspect the weld that failed.

Europa, G-FLOR
23 June 2021, Brinkworth, Wiltshire

Synopsis

The pilot was on a local flight from Cotswold Airport with a passenger. The aircraft was flying at approximately 100 kt and 2,500 ft amsl when, without warning, the left cockpit door detached. After checking that the aircraft's control responses appeared normal, the pilot returned to Cotswold where the aircraft landed without further incident. Subsequent inspection of the left tailplane identified minor damage to the leading edge and upper surface consistent with it having been struck by the door.



Rear shoot bolt guide

This was the eighth event involving the inadvertent opening of cockpit doors fitted to Europa aircraft operated in the UK. The Light aircraft Association (LAA) have developed and issued a modification to the Europa to prevent the door latch lever reaching the closed position when the door is not properly latched.

Safety action

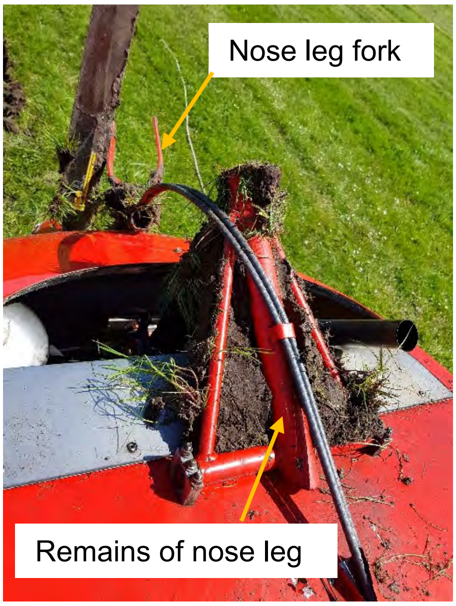
- On 1 November 2021, the LAA approved and issued a standard modification (mod number SM 15833) for fitment to Europa aircraft to prevent the door latch from closing when the door is not pulled home at the rear, and the rear pin is properly engaged. The requirement for this modification has been promulgated by LAA Airworthiness Information Leaflet MOD/247/012, which has been allocated mandatory status for all Europa aircraft operating under an LAA Permit to Fly and is required to be fitted within five flying hours after that date, or next permit revalidation, whichever comes first.

Eurofox 912(S), G-CGYG
29 May 2021, Highland Gliding Club, Easterton Airfield, Elgin, Moray

Synopsis

During the third landing following the replacement of the nosewheel tyre, the nosewheel detached from the aircraft and the nose leg fork dug into the soft ground. The nose leg broke and the aircraft flipped over onto its roof causing substantial damage. The investigation determined that the nosewheel had not been refitted correctly to the aircraft following the tyre change.

Three safety actions have been taken by the manufacturer and the LAA.



Snapped nose leg

Safety actions

The following safety actions have been taken by the manufacturer and the LAA:

- The manufacturer will amend Section 5 of the AMM to include the procedure to refit the nosewheel and to highlight the potential for clamping the wheel onto the nose leg without correctly routing the wheel axle through the nose leg fork.
- The LAA has produced an Engineering Matters article in their monthly Light Aviation magazine highlighting the potential to incorrectly fit the Eurofox 912(S) 3K nosewheel.
- The LAA has updated the aircraft's Type Acceptance Data Sheet, (TADS) 376, to include reference to an incorrectly fitted nosewheel in paragraph 3.4 – 'Special Inspection Points.'

Aeronca 65C, G-BTRG
21 October 2021, Birchwood Airfield, North Yorkshire

Synopsis

Shortly after takeoff the propeller departed the aircraft and then the engine over sped. All six propeller bolts failed in fatigue due to a lack of pre-load. It is possible that a misinterpretation of an engine manufacturer's requirement resulted in the incorrect bolt length being chosen. When the bolts were tightened to the correct torque they shanked, no pre-load was applied and failed due to normal propeller loads in fatigue. The aircraft was extensively damaged and the propeller was not recovered.

Close-up of propeller flange

Safety action

The engine manufacturer has taken the following safety action:

- To revise the propeller installation document to include a drawing to aid the correct length of propeller bolt to be selected.

General Aviation (Gliders)

Silent 2 Electro, G-CIRK
23 April 2021, Wormingford Airfield, Colchester, Essex

Synopsis

Damage to aircraft

During the ground roll for a self-launched takeoff, the motor glider suffered a propeller strike shortly before it got airborne. The eyewitness evidence and recorded data showed that the glider climbed steeply to about 100 ft before stalling and entering an incipient spin to the left. The glider struck the ground nose-first and the pilot suffered serious injuries, in part due to the lack of energy absorbing structure ahead of the pilot's seat. The pilot had no recollection of the accident flight. No mechanical fault or defect was found that would explain the aircraft pitching up excessively after takeoff. The steep climb was most likely the result of an excessive aft stick input that was not corrected.

While the investigation could not positively identify the cause of the aft stick input, it is likely that distraction, pilot workload or stress were factors in the accident. Additional contributory factors were the aircraft's characteristics of low stick forces with low sensory feedback, and poor stall warning indications.

As a result of the investigation findings the British Gliding Association (BGA) has published and sent a *'Safety Briefing'* to Silent 2 Electro owners in the UK which provides guidance on operating the motor gilder. This has also been provided to the European Gliding Union (EGU) for onward dissemination to other European gliding associations.

Safety actions

- The BGA has published and sent a 'Safety Briefing' to Silent 2 Electro owners in the UK and to the EGU which provides guidance on operating the Silent 2 Electro (Appendix A). It covers ways to address the aircraft's stick force characteristics, its stall characteristics, recommendations on takeoff handling, takeoff flap and takeoff speeds, as well as recommendations on mentally rehearsing aborted takeoffs.

- On 24 January 2022 the CAA updated G-INFO to show when an aircraft is fitted with an Emergency Ballistic Device, such as a Ballistic Parachute Recovery System (BPRS), an active ejector seat or canopy miniature detonating cord. The CAA undertook the task of identifying UK-registered aircraft fitted with such devices to support this change. To capture newly-registered aircraft with an Emergency Ballistic Device in the future, the CAA is updating the aircraft registration process to specifically require owners to declare the aircraft status with respect to an Emergency Ballistic Device.

- The CAA are planning to contact the registered owners of Single Seat Deregulated (SSDR) aircraft, which are fitted with a BPRS device, to inform them about Sky Wise article SW2021/91 which strongly recommends that owners of these aircraft comply with the requirements of British Civil Airworthiness Requirement (BCAR) Section S, Sub-Section K, to clearly identify the presence of the BPRS.

Unmanned Air Systems

Avy Aera 1.5
6 May 2022, Lamlash, Isle of Arran

Synopsis

The Unmanned Aircraft (UA) was hovering at between 50 m to 65 m agl during a demonstration flight, when a rhythmic, lower than normal sound was heard emanating from the UA. It then dipped and spiralled downwards during which control could not be re-established. The UA hit the ground and was severely damaged. A fatigue failure of a blade attachment bolt caused one of the lift propeller blades to detach in flight.

Avy Area 1.5 in flight
(image courtesy of manufacturer)

Safety actions

As a result of this accident the following safety actions have been taken:

- The manufacturer has introduced a 10-hour replacement schedule for the propellers and immediate propeller replacement if a Quadchute[1] event occurs.
- The manufacturer is carrying out a review of propeller designs for UAs under its development.

Footnote

[1] Quadchute: if fixed-wing mode fails (eg loss of altitude), multicopter mode takes over and brings the aircraft to a steady hovering position.

Evolve Dynamics Sky Mantis
1) 14 January 2021, Skegness, Lincolnshire
2) 17 February 2021, Skegness, Lincolnshire

Synopsis

A screw which attached the propeller blade of an unmanned aircraft (UA) to the motor hub adaptor failed during a training flight. A second screw failure was experienced by the same operator after the UA had been repaired and had been fitted with a different design of hub adaptor and screws.

Evolve Dynamics Sky Mantis

The first failure was caused by stress corrosion cracking possibly with the presence of hydrogen embrittlement. The second was a fatigue failure which may have been initiated and accelerated by hydrogen embrittlement. The hardness of both screws exceeded the specification which increased the susceptibility of the screws to hydrogen embrittlement.

The UA manufacturer has introduced several design changes to prevent reoccurrence.

Safety actions

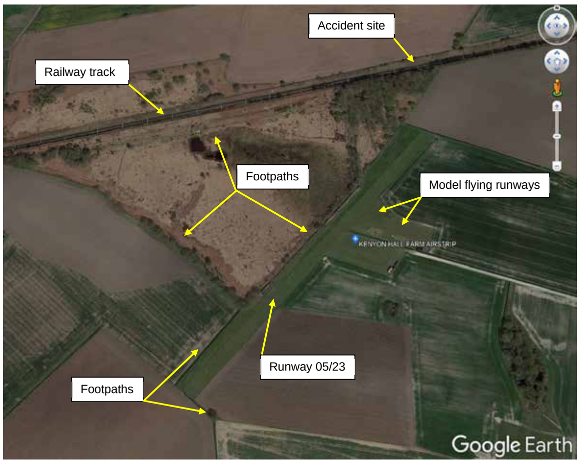
As a result of these two events the manufacturer has made several design changes to the motor hub adaptor.

- Introduced changes to the hub assembly by;
  - Increasing the screw diameter to M4
  - Using a serrated washer
  - Using a single use lock nut
  - Removal of the thread locking compound
  - Adding a brass spacer to the blade root
- Incorporated a stress test to ensure that bolts do not suffer from hydrogen embrittlement

MA Scale F4 Phantom
16 September 2021, near Kenyon Hall Farm Airfield, Warrington, Cheshire

Synopsis

A turbine powered model aircraft suffered a loss of control during its maiden test flight. It continued to fly beyond visual line of sight before crashing on a railway track and was subsequently run over by a passing train. Safety actions taken as a result of this accident include publication of enhanced guidance for members by the British Model Flying Association (BMFA). The model flying club also amended its procedures relating to flying turbine powered models.



Airfield overview

Safety actions

- Following the accident, collaboration was undertaken between the BMFA and Network Rail's Air Operations team. This resulted in the provision of tailored guidance for unmanned and model aircraft operators which will be incorporated in the BMFA's member's handbook. It included the provision of a 24-hour emergency contact telephone number for reporting railway safety threats, including the presence of people or objects on or near railway tracks.

- The BMFA also published an article about this accident, and operation in proximity to railways in general, in the July 2022 edition of its member magazine 'BMFA news'.

- In addition, the BMFA has updated its incident/accident reporting portal to specifically guide members to telephone Network Rail immediately in the event that an aircraft has come down on Network Rail property, in addition to the requirement to inform the AAIB.

- After the accident the club amended its procedures to require any turbine powered model to be approved by the club committee before it can be flown at the site, so that its suitability can be assessed. Following this investigation the club added a section to its procedures relating to retrieval of models that land outside the airfield boundary, which directly references the Network Rail 24hour emergency telephone number.

Appendix 1

Commercial Aviation Safety Team (CAST) / ICAO Common Taxonomy Team (CICTT) Occurrence Categories

CODE	DESCRIPTION
ARC	ABNORMAL RUNWAY CONTACT
AMAN	ABRUPT MANEUVER
ADRM	AERODROME
MAC	AIRPROX/TCAS ALERT/LOSS OF SEPARATION/NEAR MIDAIR COLLISIONS/ MIDAIR COLLISIONS
ATM/CNS	AIR TRAFFIC MANAGEMENT/COMMUNICATIONS NAVIGATION OR SURVEILLANCE
BIRD	BIRD
CABIN	CABIN SAFETY EVENTS
CTOL	COLLISION WITH OBSTACLE(S) DURING TAKEOFF AND LANDING
CFIT	CONTROLLED FLIGHT INTO OR TOWARD TERRAIN
EVAC	EVACUATION
EXTL	EXTERNAL LOAD RELATED OCCURRENCES
F–NI	FIRE/SMOKE (NON-IMPACT)
F–POST	FIRE/SMOKE (POST-IMPACT)
FUEL	FUEL RELATED
GTOW	GLIDER TOWING RELATED EVENTS
GCOL	GROUND COLLISION
RAMP	GROUND HANDLING
ICE	ICING
LOC–G	LOSS OF CONTROL – GROUND
LOC–I	LOSS OF CONTROL – INFLIGHT
LOLI	LOSS OF LIFTING CONDITIONS EN ROUTE
LALT	LOW ALTITUDE OPERATIONS
MED	MEDICAL
NAV	NAVIGATION ERRORS
OTHR	OTHER
RE	RUNWAY EXCURSION
RI	RUNWAY INCURSION
SEC	SECURITY RELATED
SCF–NP	SYSTEM/COMPONENT FAILURE OR MALFUNCTION (NON-POWERPLANT)
SCF–PP	SYSTEM/COMPONENT FAILURE OR MALFUNCTION (POWERPLANT)
TURB	TURBULENCE ENCOUNTER
USOS	UNDERSHOOT/OVERSHOOT
UIMC	UNINTENDED FLIGHT IN IMC
UNK	UNKNOWN OR UNDETERMINED
WILD	WILDLIFE
WSTRW	WIND SHEAR OR THUNDERSTORM

Glossary of Abbreviations used in AAIB Reports

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 Service
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
DME	Distance Measuring Equipment
EAS	equivalent airspeed
EASA	European Union 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)
FDR	Flight Data Recorder
FIR	Flight Information Region
FL	Flight Level
ft	feet
ft/min	feet per minute
g	acceleration due to Earth's gravity
GNSS	Global Navigation Satellite System GPS
GPWS	Ground Proximity Warning System 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

Glossary of Abbreviations used in AAIB Reports cont

km	kilometre(s)
kt	knot(s)
lb	pound(s)
LP	low pressure
LAA	Light Aircraft Association
LDA	Landing Distance Available
LPC	Licence Proficiency
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
PM	Pilot Monitoring
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
TODA	Takeoff Distance Available
UA	Unmanned Aircraft
UAS	Unmanned Aircraft System
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

Air Accidents Investigation Branch

Annual Safety Review
2022