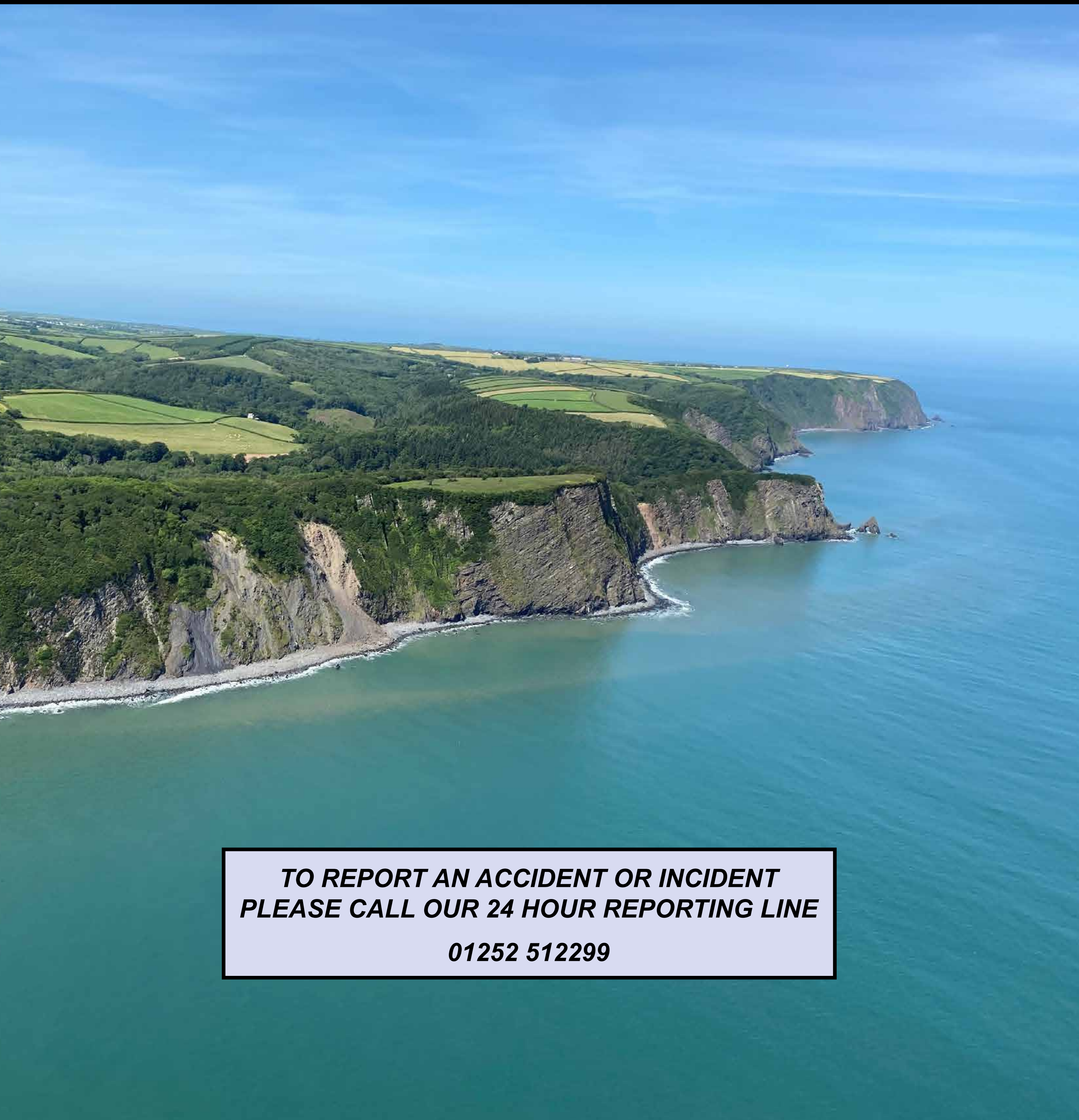
AAIB
Air Accidents Investigation Branch

AAIB Bulletin 12/2022



TO REPORT AN ACCIDENT OR INCIDENT PLEASE CALL OUR 24 HOUR REPORTING LINE

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The sole objective of the investigation of an accident or incident under these Regulations is the prevention of future accidents and incidents. It is not the purpose of such an investigation to apportion blame or liability.

Accordingly, it is inappropriate that AAIB reports should be used to assign fault or blame or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose.

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This bulletin contains facts which have been determined up to the time of compilation.

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None

(ALL TIMES IN THIS BULLETIN ARE UTC)

AAIB Field Investigation Reports

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

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

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

ACCIDENT

Aircraft Type and Registration:	Boeing 787-8, G-ZBJB
No & Type of Engines:	2 Rolls-Royce Trent 1000-AE3 turbofan engines
Year of Manufacture:	2013 (Serial no: 38610)
Date & Time (UTC):	18 June 2021 at 0651 hrs
Location:	London Heathrow Airport Stand 583
Type of Flight:	Commercial Air Transport (Cargo)
Persons on Board:	Crew - 2 Passengers - None Other - 6
Injuries:	Crew - 1 (Minor) Passengers - N/A Other -1 (Minor)
Nature of Damage:	Underside of forward fuselage, door 2L and forward lower engines cowlings damaged
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	47 years
Commander's Flying Experience:	8,364 hours (of which 587 were on type) Last 90 days - 26 hours Last 28 days - 0 hours
Information Source:	AAIB Field Investigation

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.

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 and Airworthiness Directive 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.

History of the flight

The aircraft was scheduled to operate a freighter flight from London Heathrow Airport to Frankfurt Airport. The aircraft was planned to be operated by two pilots accompanied by an Overseas Engineer (OSE) to provide technical support down route. The pilots arrived at the operator's Crew Reporting Centre at approximately 0520 hrs and collected the flight briefing pack. The pilots met the OSE prior to briefing but he had some engineering matters to attend to, so did not attend the flight crew briefing.

The briefing pack referred to an outstanding technical issue with the aircraft related to the NLG door solenoids. The pilots consulted the relevant Minimum Equipment List entry and confirmed that the defect caused no operational or aircraft performance issues. The rest of the briefing was routine and the crew went through security and reunited with the OSE at the crew bus gate at approximately 0620 hrs. The aircraft was parked on a remote stand and the crew arrived at the aircraft at approximately 0625 hrs.

Three ground engineering personnel were on the flight deck when the pilots and the OSE arrived. They informed the crew that they were attempting to resolve a number of Engine Indicating and Crew Alert System (EICAS) status messages related to the NLG door solenoids. The OSE offered his assistance to the ground personnel in dealing with the issues but was told he was not required. The OSE left the flight deck to perform his pre-departure checks of the cabin. The commander asked the Licensed Aircraft Engineer (LAE) for an estimated timeframe for rectification of the issues and was told it would take around 40 minutes. The commander then left to conduct the aircraft walk around checks. During the walk around checks the commander did not recall seeing any landing gear locking pins installed.

Two of the ground engineers left the flight deck and the LAE remained in the left seat working through the engineering procedures on a laptop. The co-pilot sat in the right seat and began his pre-departure checks. The co-pilot had limited interaction with the LAE as he was focused on his own task. He did recall that the engineer pressurised a hydraulic system. The co-pilot received the flight departure clearance by datalink at 0650 and very shortly after that recalled the LAE raising the gear lever to UP. The co-pilot recalled hearing the gear system actuate and then the aircraft nose struck the ground. Though the co-pilot sustained a minor injury the engineer was unhurt.

Following the NLG retraction, the co-pilot recalled that alternating current (AC) electrical power had been lost and that the Auxiliary Power Unit (APU) had shut down. The co-pilot then moved the APU selector to SHUT OFF but left the aircraft battery ON to facilitate RTF communications. He did not make a RTF call to inform ATC of the incident.

At the conclusion of their walk round checks the commander reboarded the aircraft and was in the galley adjacent to the R2 door, along with the OSE and the Turn Round Manager (TRM), when the NLG retracted. Although some hot drinks were spilled onto the TRM none of the personnel in the galley were injured. An engineer who was seated in the forward cabin was also uninjured. A member of the cargo loading crew who was standing on a Unit Load Device (ULD) Loader next to the forward cargo door was struck on the head by the cargo door as the aircraft fell to the ground. He suffered minor injuries and was taken to hospital for examination.

After checking there were no injuries in the cabin, the commander and the OSE went to the flight deck. The commander and co-pilot left the flight deck to check for safe egress routes from the aircraft. The OSE then turned off the inertial reference system and all electrical power.

The airport RFFS arrived and entered the aircraft through the L2 door which had been extensively damaged by contact with the access stairs when the NLG retracted. The RFFS suggested that all on board should vacate through the L2 door but due to safety concerns related to the escape slide in the damaged door, the commander suggested that R1 was used when additional steps arrived.

When the crew exited the aircraft, they were confronted by a large number of people who wished to gain information from them. The crew described the situation as “mayhem” and felt the pressures from ground staff impeded their conduct of post-incident duties.

History of ground maintenance actions

Assigning maintenance teams

The maintenance shift started at 0530 hrs and the ramp maintenance management team assigned an experienced LAE, a technician and two mechanics to prepare the aircraft for flight. The technician was known to the LAE but had not worked with the other team members before and was not experienced on B787 aircraft maintenance operations. Of the two mechanics, one was experienced (Mech 1) on the B787 aircraft and had worked extensively with the LAE before. The other (Mech 2) had been seconded from the Cabin Excellence Team (CET) to pass on knowledge and experience of cabin and seat maintenance to the rest of the team whilst unofficially gaining knowledge and experience of ramp maintenance himself. It was a two-way process. The cabin work undertaken by the CET was being subsumed into the ramp maintenance teams’ responsibilities because the CET role was to be discontinued.

The maintenance team reached the aircraft to carry out their routine external checks at 0605 hrs. Once complete, the two mechanics plus the technician made their way to the flight deck to switch the aircraft batteries on whilst the LAE applied external ground power to the aircraft. Mech 1 plugged in the maintenance laptop to review any EICAS status messages as various aircraft systems were brought online.

NLG solenoid error messages

Once on the flight deck the LAE found that the maintenance laptop showed three NLG solenoid faults as well as an existing Acceptable Deferred Defect (ADD) for a NLG door solenoid fault from 13 June 2021. The LAE accessed the information related to the fault in the Aircraft Maintenance Manual (AMM), the Dispatch Deviation Guide (DDG) and the Fault Isolation Manual (FIM) and judged that there would be insufficient time to rectify the faults before the aircraft's scheduled departure time at 0720 hrs. The LAE consulted the DDG which confirmed rectification of the three NLG solenoid faults could be deferred providing the NLG doors were recycled to determine that they functioned correctly. To recycle the NLG doors, the landing gear downlock safety pins would have to be fitted to prevent the landing gear from retracting on the ground, the hydraulics applied to the aircraft and the landing gear selector lever set to UP and then back to DN (Down).

Inserting landing gear downlock pins

During the LAE's assessment of the faults, the flight crew arrived, so the technician and both mechanics left the flight deck and moved to the galley area to await instructions. The LAE was sat in the left seat with the maintenance laptop and an electronic tablet on his lap whilst also consulting the aircraft tech log screen. The FO was sat in the right seat to begin crew preparations. The LAE asked Mech 2 to put the downlock pins in and Mech 2 relayed the message to Mech 1. Mech 1 asked Mech 2 if he had inserted downlock pins into the landing gear of a B787 before. Mech 2 stated he had not, so Mech 1 retrieved the five landing gear downlock pins from the flight deck stowage and exited the aircraft with Mech 2. The technician also left the aircraft to sit in the team's vehicle to stay out of the way of the now busy flight deck and galley area.

Mech 1 looked for a set of small steps which would enable him to reach the NLG lock link downlock pin hole but could not see any. However, as Mech 2 was tall enough to insert the pin without needing steps, Mech 1 decided to show Mech 2 where to insert the pin. As both mechanics crouched down to the left side of the NLG and looked up into the NLG bay, Mech 1 pointed to the downlock pin hole and asked Mech 2 to insert the pin. Mech 2 reached up and inserted the pin into the NLG while Mech 1 moved back to give him room. Mech 1 heard the pin "click" as it was inserted and, as Mech 2 moved out of the way, he looked up to see the pin was inserted, although he did not consciously check that it was inserted in the correct position. He pulled on the pin warning flag that was hanging down from the NLG downlock pin to confirm that the pin was held firmly in place.

Both mechanics left the NLG bay and, after locating a set of large steps, Mech 1 fitted the Main Landing Gear (MLG) downlock safety pins. The steps were moved a few feet from the inboard, left MLG door to avoid contact during the slight movement of the landing gear when hydraulics were applied.

Preparing for application of hydraulics

Both mechanics returned to the flight deck and informed the LAE that the downlock "pins were in." The mechanics then exited the aircraft and Mech 1 collected a headset from their vehicle to enable communication with the LAE on the flight deck. Once the headset was plugged in to the NLG bay connection, the LAE instructed Mech 1 to make sure the cargo loading team were clear of the aircraft because the "landing gear moves slightly" when hydraulic power is applied. There was a risk of damage if the cargo door or surrounding fuselage structure moved and hit the ULD Loader. In addition, loading team personnel standing on the ULD Loader's platform might be injured when the aircraft moved. As he was positioned to the left of the NLG bay, Mech 1 ducked under the fuselage to talk to the loader who was standing on the ULD Loader at the forward cargo door on the front right side of the aircraft. He asked the loader to lower the platform and move clear of the aircraft.

Mech 1 asked the LAE to switch on the aircraft's anti-collision lights to warn personnel working in the vicinity not to approach the aircraft. From his position left of the NLG bay he could see no feet visible on the ULD Loader and two loading personnel walking away from the aircraft. He informed the LAE that the loaders were clear of the aircraft. The LAE asked if they were "clear for hydraulics?". From his position near the NLG, Mech 1 quickly looked underneath the fuselage, and the right, rear and left sides of the aircraft. All areas appeared to be clear of personnel and equipment sufficiently far from the aircraft to avoid contact with the aircraft. He confirmed the area was clear and the LAE applied hydraulic power. The LAE then asked Mech 1 to confirm that the downlock pins were fitted and that the landing gear could be cycled.

Mech 1 completed a final visual check and observed that the landing gear ground lock pins warning flags were visible; one flag showing from the NLG bay and two each from the MLG bays. Mech 1 asked Mech 2 to step back from the aircraft and confirmed to the LAE that they were ready for the gear up selection. The LAE announced he was selecting "gear up", pressed LOCK OVRD (override) and moved the landing gear selection lever to UP.

The aircraft shuddered as the NLG retracted and the nose of the aircraft struck the ground.

Accident site

The aircraft was parked on Stand 583 in the Terminal 5 area of Heathrow when the event occurred, (Figure 1).

On the stand, the aircraft was resting on its nose with no NLG visible (Figure 2) but with both MLGs down and their down locks in place.

The front lower fuselage and both NLG doors were badly damaged, and the doors were partially detached from their hinges. Crushed underneath the nose was a metal articulated conduit containing the ground power supply cables (Figure 3).

On the left side of the aircraft, aft of the NLG bay, deep vertical scratches were scored into the fuselage skin where it had been in contact with the fixed power unit when the nose lowered to the ground. The fixed power unit was also deformed and damaged by the impact with the aircraft (Figure 4). There were signs of distressed rivet heads along the bulkhead rivet lines forward and aft of the NLG bay.

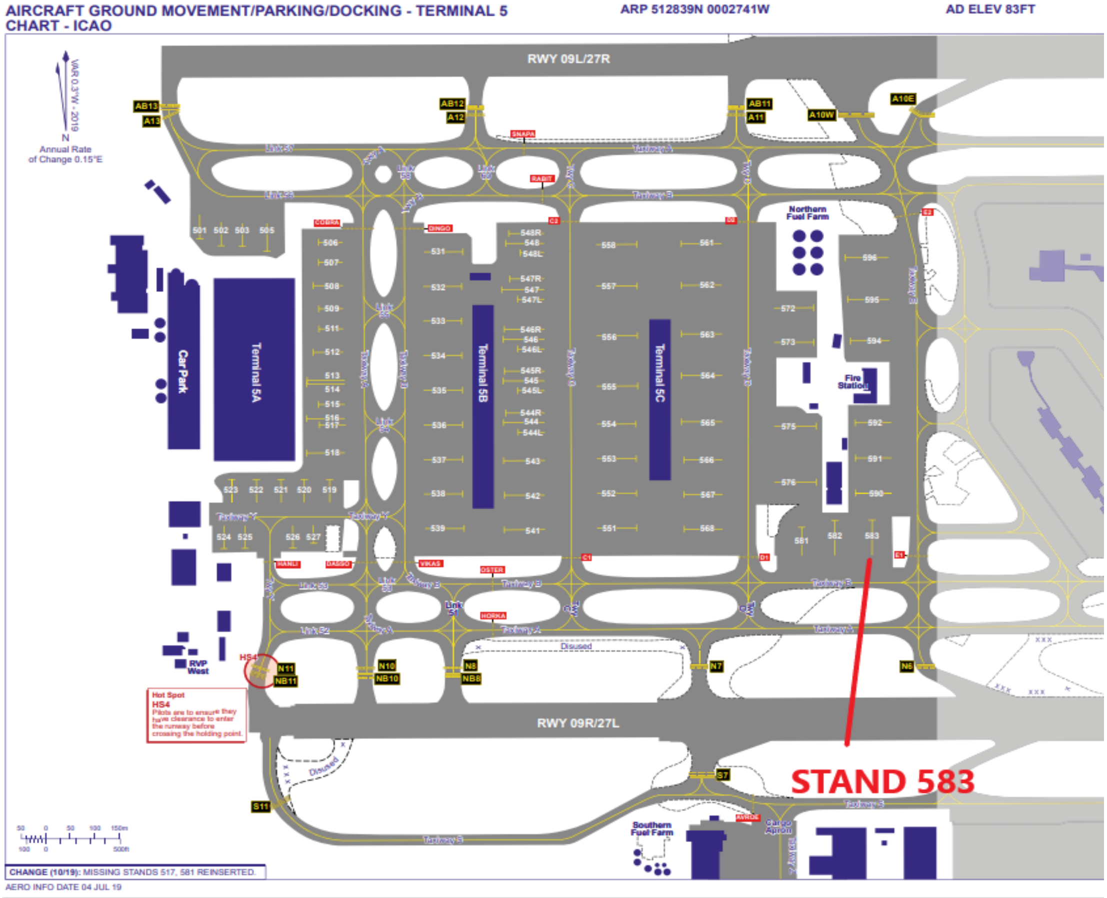

Figure 1

London Heathrow Terminal 5 parking stands

Figure 2

View of right and left side of the aircraft following NLG retraction

Figure 3

View of the damaged NLG doors and crushed ground power supply cables

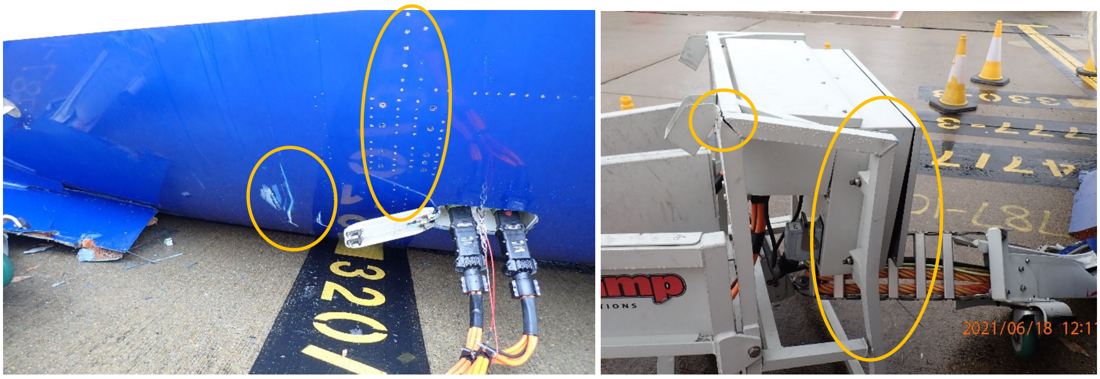

Figure 4

Score marks and distressed rivet heads (left) and damage to fixed power unit (right)

At door L2, motorised covered passenger stairs were still in place. The aircraft passenger door hinges had been disrupted during the accident sequence and the door was resting on the horizontal platform at the top of the stairs. The stairway's platform was approximately 2 feet higher than the lower door frame (Figure 5).

The aircraft's engine cowlings were resting on the ground and the inboard left MLG door had been damaged by contact with the large steps positioned nearby. The steps' safety handrail had bent slightly following contact with the MLG doors.

On the right side of the aircraft was an access stairway that had been positioned at door R2 to allow safe access to the aircraft after the accident. At the forward cargo door was the ULD Loader for raising cargo pallets to the height of the aircraft cargo hold and transferring them to the aircraft. There was slight damage to the aft vertical cargo door frame caused by contact with the ULD Loader when the aircraft nose lowered to the ground (Figure 6). The rear cargo door was also open but there was no ground support equipment at that location.

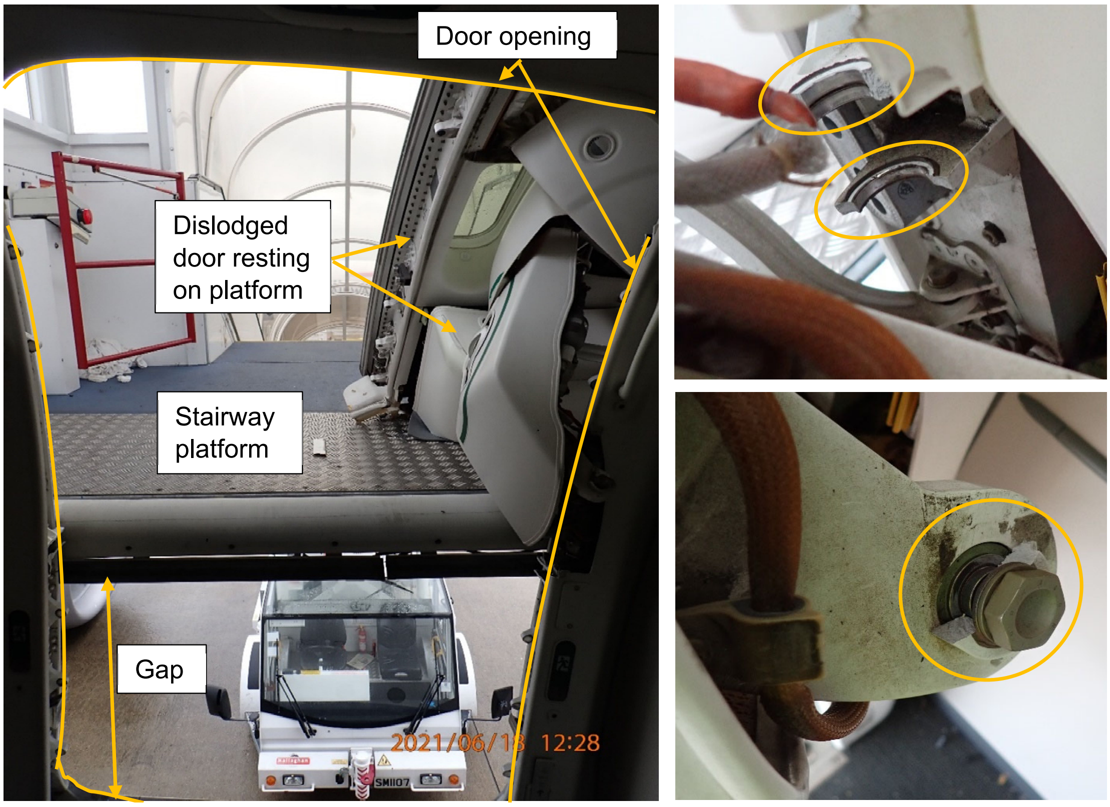

Figure 5

View from inside the aircraft showing the door resting on staircase and disrupted door hinges

Figure 6

ULD Loader (left) and impact damage to aft side of cargo door frame (right)

In the cabin, the force of the impact with the ground as the aircraft's nose lowered was sufficient to cause some of the passenger oxygen masks to drop down from their containers and some overhead baggage compartment doors to open.

On the flight deck, the landing gear selection lever remained in the UP position (Figure 7) but AC power had been lost when the nose of the aircraft crushed the ground power cables.

The aircraft batteries had been switched off by the OSE to make the aircraft safe following the accident. The CVR and FDRs were recovered and sent to the AAIB for data retrieval and analysis.

Figure 7

Landing gear selector lever in the UP position

Recovery action commenced by raising the aircraft nose using a system of pneumatically inflatable mats. As the nose was raised, the NLG lowered under gravity, (Figure 8), until it was in its down position.

Figure 8
Aircraft nose was lifted using pneumatic inflatable mats

NLG downlock pin location

When the NLG bay was accessed, the NLG downlock pin was found to be in the leg's apex bore hole rather than the downlock pin hole (Figure 9). The downlock pin was transferred to the correct position to lock the gear down and to allow the inflatable mats to be removed so the aircraft could be towed to a suitable quarantine hangar.

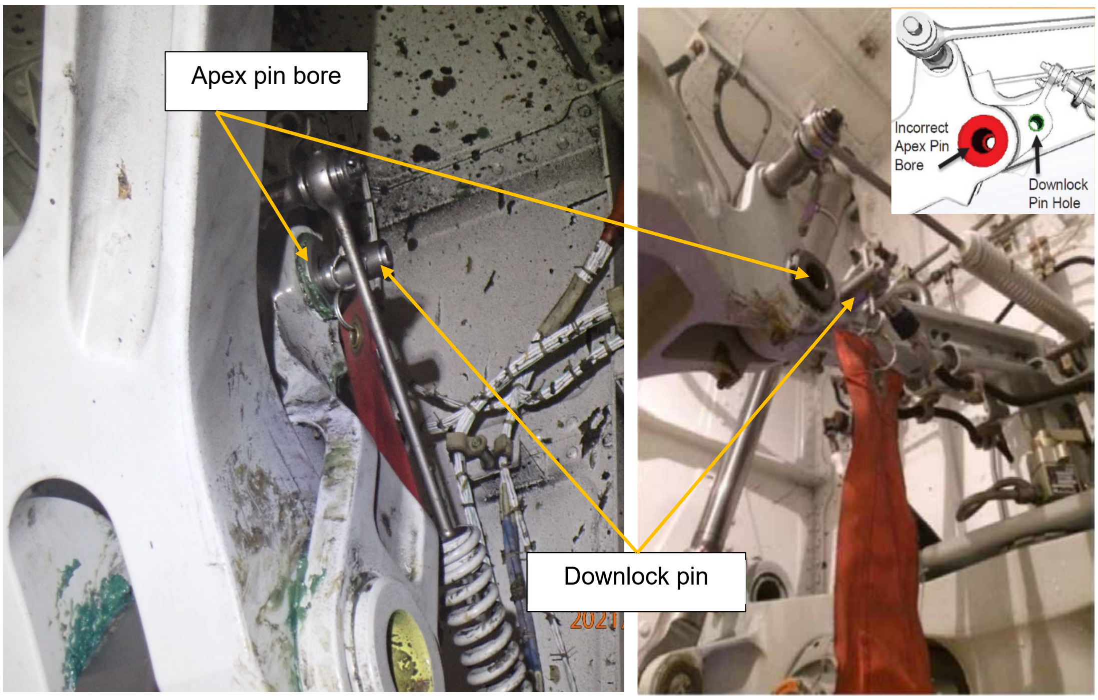

Figure 9
Downlock pin incorrectly fitted to the apex pin bore (left) and an example of the correct location of the pin for comparison (right)
Image used with permission

Post-Incident Response

Immediately following the event at 0651 hrs the operator's personnel on Stand 583 telephoned their Maintenance Office to inform them of the event. They then phoned the Airport Operations Centre (APOC) at 0653 hrs and 48 seconds, on 222, the internal emergency number, to alert the Emergency Services. The operator found the caller difficult to hear due to background and wind noise. The airport operator triaged the call and, in this case, passed the event to the Fire Desk at 0654 hrs and 39 secs. The Fire Desk officer also had difficulties with the audio on the call due to the background and wind noise and had to repeat questions to be sure of gathering the correct details. At 0655 hrs and 55 seconds the Fire Desk called Heathrow ATC[1] to request a deployment under the terms of Local Standby Ground (LSBYG).

LSBYG is a local definition for events where there is no visible fire or smoke and no reported injuries. It is used where an event is sufficiently serious to warrant an emergency response but below a threshold that would require support from agencies outside of Heathrow. The description of LSBYG from the airport Emergency Orders is at Figure 10.

Local Standby - Ground

G. LOCAL STANDBY - GROUND

General Information

Definition	An Aircraft on the ground is involved in an incident of a lesser nature than an AIRCRAFT GROUND INCIDENT. There are NO reports of smoke, fire, or injured persons from or on an aircraft. Non-exhaustive Examples: An aircraft on the ground: • Requires External Assistance (i.e. an inspection by the AFRS) • Hydraulic Leak • Fuel Leak / Spill • Vehicle / Ground Handling Equipment Hit Aircraft • Deployment of Aircraft Evacuation Chutes Known to be Accidental • A domestic fire where an aircraft is at risk.
Emergency Services Response	Police alerted and AFRS attend
Initiated by	ATC, using the EMERGENCY Line
Upgrade	Yes, by ATC to AIRCRAFT GROUND INCIDENT on the CRASH Line ATC to nominate the RVP THREAT TO AIRCRAFT (By Police only)
Downgrade	None
Cancellation	By ATC on the EMERGENCY Line following confirmation that the incident is over from the AFRS Incident Commander.
Overall Co-ordination	AFRS Incident Commander

Figure 10
Emergency Orders description of LSBYG

A LSBYG event is co-ordinated by the RFFS incident commander. When he arrived on scene, he observed there was no smoke or fire and no injuries were reported to him. He

Footnote

[1] All events at the airport are initiated under the authority of ATC.

was therefore content to retain the LSBYG classification. The Police Duty Inspector for the airport attended the scene and had a briefing with the RFFS incident commander at which the LSBYG classification was discussed. The Police Inspector did not agree with the categorisation, but as the RFFS commander considered no off airport resources were required, he decided to maintain the LSBYG status.

The next higher category of incident is an Aircraft Ground Incident (AGI). The description of AGI from the airport Emergency Orders is shown at Figure 11.

Aircraft Ground Incident

D. AIRCRAFT GROUND INCIDENT

General Information

Definition	An aircraft on the ground is involved in an incident of a lesser nature than an AIRCRAFT ACCIDENT, there **ARE** reports of smoke / fire or odours and / or there **ARE** reports of persons injured. It is not necessary for another aircraft or a vehicle to be involved in an AIRCRAFT GROUND INCIDENT. Non-exhaustive examples: • Smoke, Fire or Fumes on or within aircraft • Smoke or Fire on equipment attached to aircraft • Smoke or Fire on stand, whilst an aircraft is on stand • Emergency deployment of aircraft evacuation chutes (non-accidental) • Unknown reason for deployment of aircraft evacuation chutes • Injury of individual / multiple Injuries • Incapacitated Aircraft without smoke / fumes or fire
Emergency Services Response	Full
Initiated by	ATC, using the CRASH Line
Upgrade	Yes, to AIRCRAFT ACCIDENT, by ATC on the CRASH Line
Downgrade	Yes, to LOCAL STANDBY GROUND, by AFRS Incident Commander through the Heathrow Fire Desk to ATC, then broadcast by ATC on the EMERGENCY Line
Cancellation	By AFRS Incident Commander through the Heathrow Fire Desk to ATC, then by ATC on the EMERGENCY Line
Overall Co-ordination	A senior Police Officer is appointed as the Police Incident Commander and is responsible for taking charge of the overall co-ordination of activities at the incident site.

Figure 11

Emergency Orders description of AGI

The descriptions of LSBYG and AGI give examples of the types of event expected to be covered by the classifications. The examples in Figure 12. include an '*incapacitated aircraft without smoke/fumes or fire*'. Some personnel in the airport response organisation concluded from the incapacitated aircraft statement that the event should have been categorised as AGI.

The Police and the Ambulance Service initially deployed their predetermined response for an AGI but these resources were stood down.

The airport Emergency Orders are published and controlled by an Emergency Orders Group which draws representation from a wide range of stakeholders at the airport.

Due to the proximity to one of the operator's maintenance offices a large number of the operator's personnel were quickly at the scene of the event. While some of these personnel, such as the members of the operator's aircraft recovery team, had a legitimate reason for their presence the majority were not required. The Emergency Services had a limited number of personnel at Heathrow and they were focused on their operational role. They did not have the capacity to release personnel to conduct crowd or traffic control. In the airside environment it was not appropriate to use incident tape to cordon a scene due to the FOD risk presented by the tape. The RFFS commander considered that the large numbers of uncontrolled personnel in the vicinity caused a reduction in the safe conduct of the incident response.

When the flight crew left the aircraft, they were immediately met by a number of personnel from various organisations who began to question the crew on the event and their actions. The flight crew reported that this impeded the conduct of their duties in the time immediately following the incident. Some of the maintenance personnel involved were taken from the scene by one of the operators Quality engineers for their wellbeing. The airport Police were concerned that it may have represented an attempt to coach witnesses on their statements as it took a significant period of time before the location of the witnesses could be subsequently established. The operator stated that the personnel involved were taken off the ramp to facilitate their preparation of statements.

The airport Emergency Orders give predetermined actions for many individual agencies to create a rapid and cohesive response to events on the airport. For an AGI an automatic response for airport security to attend the scene and provide a cordon is included. This provision is not part of the automatic response to a LSBYG and so no personnel were deployed to cordon the event.

Also included in the AGI response is the creation of an Equipment Assembly Point on the airport. This is defined in the airport Emergency Orders as '*The Equipment Assembly Point (EAP) is a nominated stand where equipment and personnel assemble prior to being called forward to the scene of an accident or incident under Airport Escort Vehicle escort. The EAP is relayed to the Airline / Handling Agent, Airport Control (APOC) and other appropriate agencies by the Airfield Control Room following consultation with the Aircraft Operations Unit'.* The EAP provision is not part of the LSBYG actions.

If an AGI is declared the London Fire Brigade have a predetermined immediate response which consists of four pump appliances and some specialist units. This would require a deployment from at least two fire stations. While this is a significant response the Fire Brigade stated that it could be accommodated without disruption to other operations.

The London Ambulance Service predetermined response consists of two ambulances, two response vehicles with management personnel and a Hazardous Area Response Team with four vehicles. The Service views this as a significant response but it is manageable without serious impact on other operations.

The operator deployed a passenger coach to the site of the incident, and this was used to conduct on site operational briefings and some initial witness interviews. It also provided shelter from the inclement weather. The airport does not have a command post vehicle to fulfil such a role.

The Operator's emergency response system

The Operator has an internal incident response system to manage serious events. This is based around an escalation scale of four levels dependent on the severity of the event and its likely impact on the operation. The definitions of the four levels are shown in Figure 12.

Escalation levels

Normal Ops is the day-to-day management of global operations, airport and engineering operations, with regular coordination meetings, communication messages and interactions to deliver the planned schedule. Includes management of minor 'on-the-day' ad hoc adjustments to the schedule where there is no overall pattern or causal reason
Bronze command is established to coordinate the management of customer impact incidents within key operational teams and control centres – e.g. delays, diversions & cancellations of scheduled services where 'Normal Ops' processes would not provide adequate control and resolution of issues from both an operational and customer point of view. It also may be stood up to oversee the implementation of an Operations Planning Group (OPG) plan. It should also be stood up in anticipation of a deterioration of operational performance based on agreed triggers, led by the Accountable Manager Operations. To oversee recovery and de-escalation.
Silver command is established to coordinate the management of significant global disruption events causing large scale global regularity and punctuality impacts for prolonged periods. It also may be stood up to oversee the implementation of an OPG plan. Representation is from selected departments within and outside of 'operational' areas. It should also be stood up in anticipation of a deterioration of operational performance based on agreed triggers, led by the Crisis Management Team Leader. To oversee recovery and de-escalation.
Gold command is established to manage any corporate crisis such as serious aircraft incidents or threats to life and/or assets. A full 'corporate response' may be required which will be determined by the Crisis Management Team Leader. It also may be stood up to oversee the implementation of a Contingency Planning Group (CPG) plan.

Note: Silver and Gold can both be run at the same time. In this instance, Silver would manage the recovery of the global operation and Gold would manage the crisis

Figure 12

Operator's Incident Response Levels

The system is designed to facilitate the management of any crisis which affects the operator's network and therefore makes provision for dealing with weather, commercial, security and technical events as well as airfield emergencies. The response levels do not therefore correlate directly with those of the airport. At Silver and Gold levels the operator's response is led by the Crisis Management Team (CMT) Leader who reports to the Chief Operating Officer. At Silver level the CMT has representation from selected departments within the organisation. At Gold Level the operator's Crisis Management Centre (CMC) is activated and all departments of the company are represented. The operators orders allow for the CMC to be activated at Silver but this was not done for this event. Also at Gold, an Incident Site Leader is appointed by the operator to liaise with the Emergency Services and to feed information to the Safety and Security team in the CMC.

In this event Silver command was declared and so the CMC was not activated, and no Incident Site Leader was appointed.

The operator stated that in general Gold level events were generally declared for incidents that involved large numbers of passengers.

The operator has an Emergency Liaison Vehicle (ELV) at Heathrow which can be used to facilitate communications with the emergency services on scene. The airport Emergency Orders for LSBYG call for the operator to prepare to deploy equipment, but to only deploy to the EAP when an AGI or greater is declared. In this event the ELV was not deployed.

Engineering Aspects

Authorised maintenance personnel

Under the terms and within the scope of work of UK Part 145[2] Approval, the Operator's engineering organisation had been approved to issue maintenance certification authorisations to suitably qualified and competent staff for the purpose of performing and certifying maintenance activities on their aircraft.

The Operator's aircraft maintenance authorisations were designed to align with UK Part 66 licence categories as far as possible and incorporated multi-trade activities linked to aircraft types. Engineering training courses, which support maintenance authorisations, were aligned to these certification requirements and structured accordingly. Engineering maintenance authorisations, their UK Part 66 category and UK Part 145 certifications were related as follows (Table 1):

Engineering Authorisations	Part 66 Licence Category	Part 145 Certification of Maintenance
M7 – Mechanic identification stamp only M6 – signifies competence in cabin M5 – signifies competence on a specific type	None	None
A3/A4 – Technician must be trained on type to issue a Certificate of Release to Service (CRS)	Category A	Limited Line Maintenance Certifier
B1/B2 – Licensed Aircraft Engineer with type rating	Category B	Line Maintenance Certifier

Table 1

Authorisations and equivalent UK Part 66 and UK Part 145

Footnote

2 Part 145 Approval – Approval for maintenance of any Part 21 aircraft and engines or fitted components. Part 21 regulates the approval of aircraft design and production organisations and the certification of aircraft products, parts and appliances.

The LAE was a category B1 licensed engineer (aircraft structure, powerplant, mechanical and electrical systems and limited avionics systems) who was type rated on the Boeing 787 in October 2017. He had 11 years of experience as a B1 engineer. His authorisations were current, and he had received some team leader training.

The technician held an A3 Authorisation for the Boeing 777 from 2006 and an M6 (interiors) Authorisation for all the Operator's aircraft types. Other than the M6 (Interiors) no further authorisations for the Boeing 787 were held. The technician had joined the ramp shift in December 2020.

Mech 1 had worked for the Operator since 2012. He held M5 Authorisations for the Boeing 777-200 (including landing gear familiarisation) and M6 (interiors) on all aircraft. Both were valid at the time of the accident. He had completed a five-day B787-8/-9 General Familiarisation course in 2013 which included fitting landing gear downlock pins, and an A3 course in 2014. Although he held no specific B787 Authorisations, he was working on his basic license modules and experience log prior to the accident. His last competency assessment was July 2020 which was valid for 4 years.

Mech 2 held M6 (interiors) and M7 (greasing) Authorisations on the Airbus A380 and had received some familiarisation training on the A380 landing gear. No Boeing 787 Authorisations were held. The mechanic worked within the CET until seconded to the ramp maintenance teams in January 2021 to pass on accumulated knowledge of interiors maintenance. Mech 2 was eager to widen his experience and was undertaking informal on-the-job training by assisting with other ramp maintenance tasks where possible.

Access to electronic aircraft documentation

Chapter 32-00-30 of the AMM contains the instructions for fitting the landing gear downlock pins. The instructions are 12 pages long despite the task being regarded as relatively straightforward. Both the LAE and Mech 1 felt familiar enough with the instructions in the AMM to be able to complete the task without reference to it. The mechanics were issued with company iPads that had a 'Pinpoint' application installed for accessing aircraft maintenance data and manuals. However, the B787 (and Airbus A350) manuals were not installed, therefore, the Mechanics could not have used their iPads to view the task or for Mech 1 to step Mech 2 through the instructions to fit the pins. Whilst the AMM could have been accessed via the Maintenance Laptop, this was already in use by the LAE on the busy flight deck.

NLG mechanism and operation

The NLG consists of a shock strut, an extension and retraction mechanism, (Figure 13), two unbraked wheels, a torque link and a nosewheel steering system. The shock strut provides shock absorption to dissipate the vertical forces experienced during aircraft taxi, takeoff and landing. The strut uses a mixture of compressed air, which acts as a spring to absorb vertical shock loads, and hydraulic oil, which provides damping to reduce the harmonic bouncing effect of the compressed air spring.

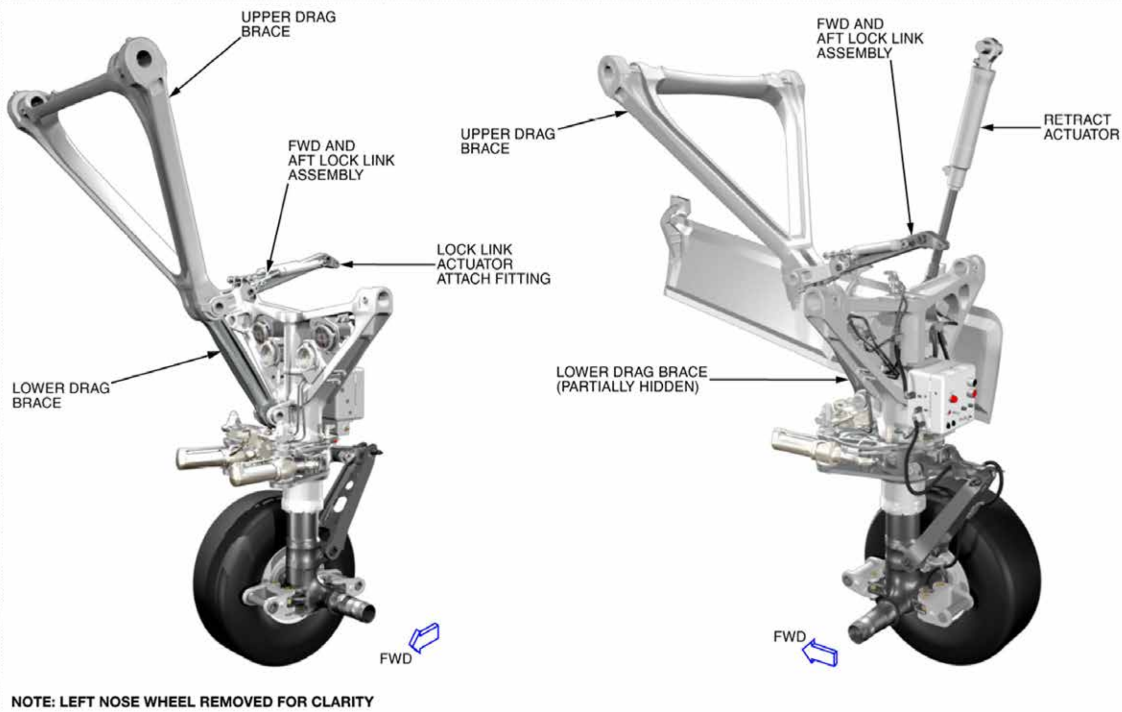

Figure 13

NLG showing the extension and retraction components
Copyright Boeing. Used with permission

The extension and retraction mechanism employs a hydraulic NLG lock actuator to lock and unlock a lock link assembly. The lock link assembly is designed to form a geometric lock when it is in an over-centre position which prevents the landing gear from retracting or extending. Lock link springs hold the over-centre position when there is no hydraulic pressure to the actuator. During the NLG retraction process, hydraulic pressure forces the lock link actuator piston to retract which in turn causes the lock link assembly to move away from the over-centre position, unlocking the NLG. Hydraulic power to the NLG retract actuator then forces the NLG to retract into the wheel bay. The lock link actuator piston moves the lock link assembly to the over-centre position again where the actuator and springs fix it in position, thereby locking the NLG in the up position (Figure 14).

During the NLG extension process, hydraulic pressure is supplied to the lock link actuator piston to remove the over-centre position of the lock link assembly and unlock the NLG.

The NLG pivots down under gravity. Once down, the lock link actuator drives the lock link assembly into the over-centre position where springs and the actuator hold the assembly in place. This locks the NLG in the down position (Figure 15).

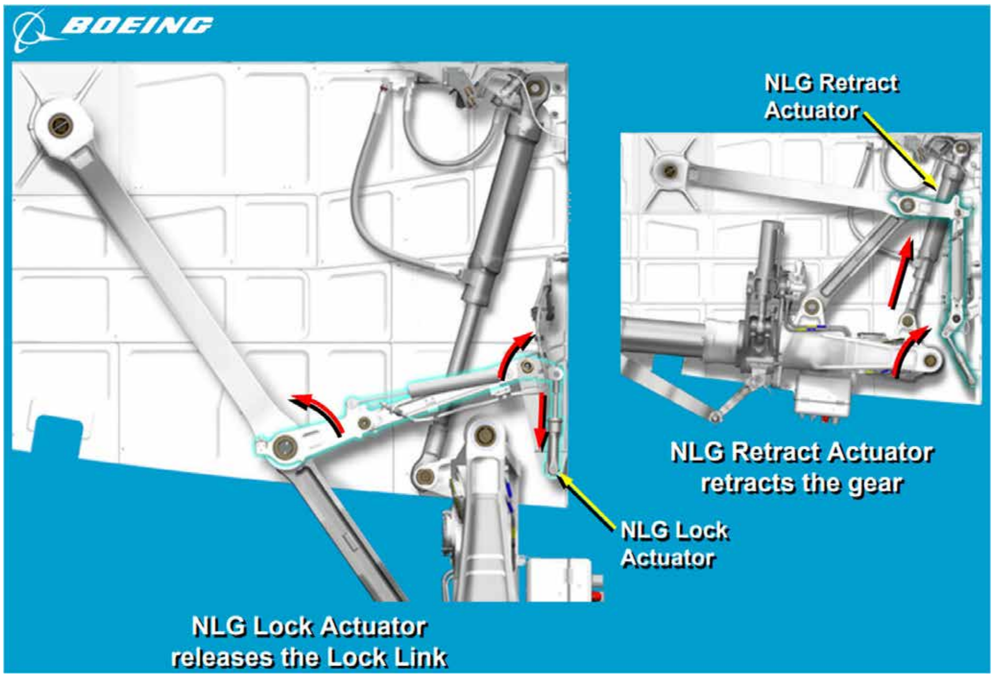

Figure 14

NLG lock link release from over-centre and gear retraction process
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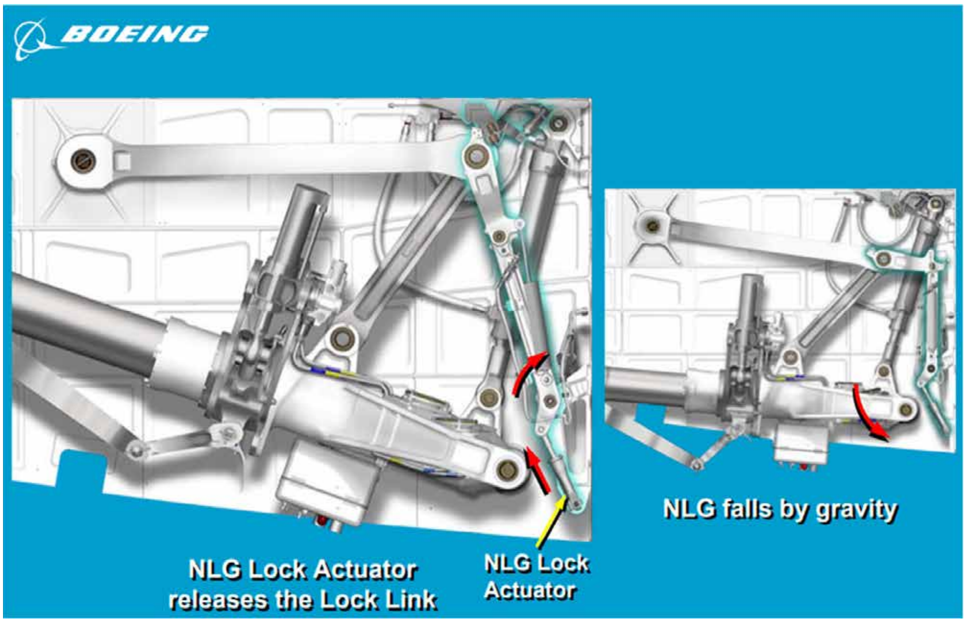

Figure 15

NLG lock link release from over-centre and gear extension process
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The lock link assembly can be prevented from moving away from the over-centre position with the aircraft on the ground and during maintenance procedures by using a downlock pin. The pin is inserted in the downlock hole, aft of the lock link assembly apex pin bore hole, to fix the lock link in position and prevent retraction of the NLG even with hydraulic power applied and the landing gear selected to UP (Figure 16).

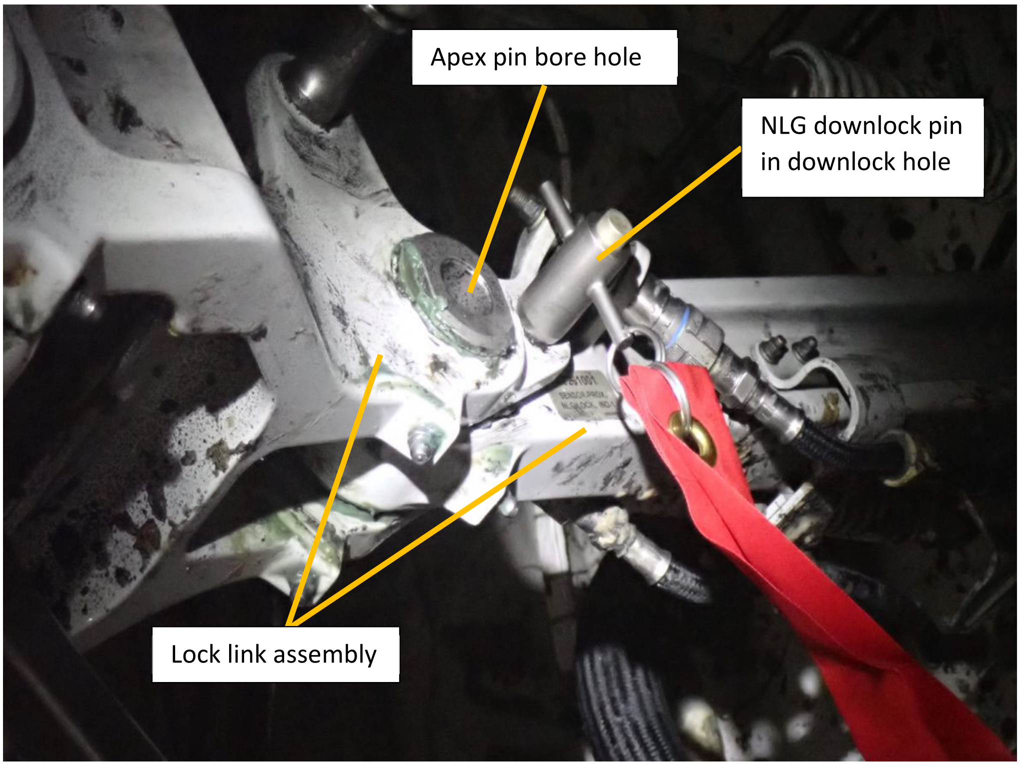


Figure 16

NLG downlock pin inserted into lock link assembly downlock hole

Assessment of the NLG pin insertion task

A specific small set of steps (not the same as those needed to fit the main landing gear pins) was required to fit the NLG downlock pin, unless the maintainer was tall enough to do this as an overhead task or chose to climb on the wheels to reach the downlock pin hole. The position of the NLG doors and the limited amount of space in the NLG bay did not allow two people to stand upright together and look at the area where the pin must be fitted. Even in daylight, light in the bay was limited and a torch was required to properly see the area. There were no distinguishing markings or labels to identify the downlock pin hole and the apex bore hole.

The design of the B787 NLG downlock is unique and significantly different from other Boeing aircraft. The downlock pin can be easily inserted into the apex pin bore hole. When it was fitted in this position it made a 'click' noise similar to the noise made when fitted into the correct downlock pin hole. The pin, when seated in the apex pin bore hole, had enough friction to stop it moving or coming out when the attached '*remove before flight*' flag was tugged.

History of incorrect insertion of the NLG downlock pins

By 2018 there had been two incidents reported to Boeing of B787 NLG retractions on the ground with weight on wheels because the NLG downlock pin had accidentally been fitted to the apex pin bore when landing gear UP was selected. The second occurrence was at the Boeing facility in March 2018. The manufacturer initially raised a Service Related Problem (SRP) to investigate the NLG downlock pin problem and to identify corrective action[3].

Notifying Operators

Boeing determined immediate interim corrective actions that would reduce the overall fleet risk. As a result, they released a Multi-Operator Message (MOM) on 21 March 2018 which described the NLG downlock pin location problem and included an illustration of the correct and incorrect positions of the pin.

MOMs are distributed to a pre-arranged list of recipients which includes Boeing Field Service Bases that support customer operations. Field service bases maintain communication with customers about MOMs to ensure they are aware of the content. Boeing's Heathrow field service base confirmed that they had received it and discussed the content with the airline at the operator's Fleet Team Conference on 23 October 2018. The option to fill the apex bore hole with silicone sealant to prevent the downlock pin from being incorrectly fitted, and a Fleet Team Digest (FTD)[4] article which would provide more detailed information, were also presented at the conference.

The MOM was followed by the publication of the Boeing FTD[5] article on 3 May 2018. The article described the NLG retraction incidents, the risk of inadvertent insertion of the downlock pin in the apex pin bore and provided a reference to AMM 32-00-30. The reference contained the procedure for fitting the NLG downlock pin and illustrations showing the correct location. The FTD also provided details on the option to fill the apex pin bore with PR1422 sealant in accordance with the Boeing Standard Overhaul Practices Manual (SOPM) 20-50-19. G-ZBJB's operator stated that they regarded the FTD publications as a good source of information and they proactively accessed FTDs issued by the manufacturer. No immediate action was mandated by the FTD although the publication was later referenced in an article in the operator's Technical News (explained later in the report) to inform maintenance personnel of the problem.

Development of the Service Bulletin and Airworthiness Directive

Boeing evaluated the two reports of prior inadvertent nose gear retractions on the 787 fleet and determined that a Service Bulletin (SB) should be generated to provide

Footnote

[3] An SRP is an internal document to Boeing and was not for release to aircraft operators.

[4] FTDs are intended to convey up-to-date technical information to operators at a working level on in-service issues. FTDs are published by Boeing on the 'My Boeing Fleet (MBF)' web portal and the content is searchable by operators who use the service. Operators can be alerted to new FTD articles using communications such as MOMs.

[5] 787-FTD-32-18003.

corrective action to operators. The FAA and Boeing worked independently to assess the task, collaborating during various stages, to consider the risks, evaluate the criticality to the fleet of any corrective actions, provide a priority rating, determine a compliance time and assess the complexity of any corrective actions. Following a period of evaluation, an Airworthiness Directive (AD) was raised by the FAA to mandate the SB. A 'sanity check' was also completed whilst evaluating the AD compliance times. If the corrective actions were relatively easy and materials readily available, the FAA reserved the right to adjust the compliance time to reduce the risk to the fleet sooner than indicated by the analysis.

Boeing released Issue 001 of SB B787-81205-SB320040-00 on 12 March 2019 as a 'Special Attention' category[6] bulletin with a three-year compliance time from the date of the SB. Although the SB only refers to a single event plus receipt of a safety report, the SB highlighted '*the risk of accidental NLG retraction due to easy installation of the NLG downlock pin into the lock link assembly apex pin'.* The SB provided instructions, including details of a kit of parts, to install an insert into the NLG lock link assembly apex pin inner bore to prevent inadvertent insertion of the downlock pin (Figure 17).

The FAA evaluated the SB using their risk analysis process to assess the statistical risk to safety. The process determined the Risk Outer Marker Time (ROM-T) which was divided into three event times: corrective action development time, rulemaking time and compliance time. The times were agreed between Boeing and the FAA with specific dates the FAA would receive the manufacturer's proposed corrective actions. The FAA's evaluation established that a Notice of Proposed Rulemaking (NPRM) with a priority rating[7] of 'normal' was appropriate. The NPRM was published in the Federal Register on 23 July 2019. Following a period of consultation with B787 operators, AD 2019-23-07 was issued on 12 December 2019 with a three-year compliance period beginning on 16 January 2020.

The compliance period was calculated jointly by Boeing and the FAA based on an assessment of risk encompassing all inadvertent landing gear retractions that had occurred to Boeing aircraft since the 1970s. Based on this data set, inadvertent gear retractions on in-service B787s had been reported at a rate of one event per million flight cycles with no reports of injuries. The statistical models at Boeing and the FAA indicated an exposure period greater than 20 years, therefore, the compliance time for the SB and AD was set to 36 months. The aircraft manufacturer confirmed that the location of the B787 NLG downlock pin hole, directly adjacent to the apex bore hole, was unique to the B787 series of aircraft which had been in service with the operator since 2013.

Footnote

6 The Special Attention category generally involves safety issues such as personal hazards that do not threaten immediate airplane airworthiness. It is also used to address issues which have a high economic impact if not incorporated.

7 Priority ratings determine if the FAA needs to generate a normal NPRM, a high priority NPRM or an immediate adoption rule. The FAA has legal standard rule making times associated with each type of rulemaking action.

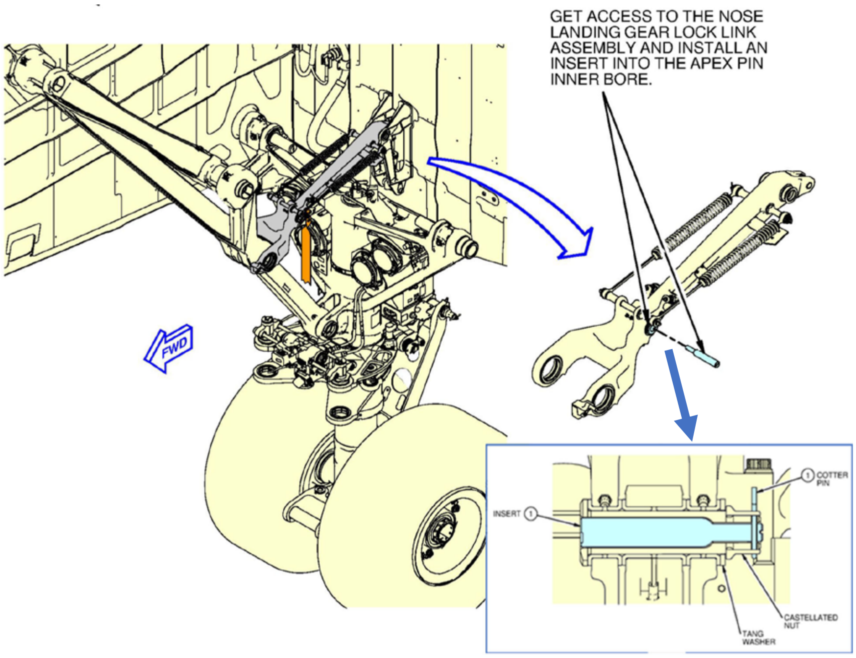


Figure 17

SB illustration of NLG lock link assembly and apex inner bore insert
Copyright Boeing. Used with permission

The operator's response to the SB and AD

Although SB Issue 001 was received by the Operator's Technical Information Management (TIM) team and a Technical Document Response (TDR) raised to review the SB within 30 days of receipt[8], no further actions were deemed necessary at that time. In addition, the apex pin insert modification kits were not made available until 25 June 2019. The Airworthiness Directive (AD) mandating the SB was received by the TIM team on 12 December 2019, one month prior to its effectivity date. It was reviewed within seven days of receipt and another TDR request raised to manage the progression of the AD.

To prepare for installation of the apex pin bore insert and to raise the appropriate modification paperwork, a Technical Order Modification (TOM) process was started in March 2020. However, progression of the SB was put on hold in April 2020 because of the disruption caused by COVID 19 measures. As a mitigation measure, a Technical News article (No ITI-10279007-000-00) was issued in April 2020 to inform engineering teams of the release of the SB and AD and to highlight the potential unsafe condition caused by inserting the NLG downlock pin in the apex bore pin hole.

A two-month review extension was applied to the TDRs to allow time for the modification to be presented to the maintenance organisation's Modifications Committee for embodiment during A and C maintenance checks. This would have achieved fleet implementation

Footnote

8 As required by the Operator's CAMO-Tech Document Evaluation BACOMPANYDOCS-CAMO-01-01-0020-00000-041A-D. Non mandatory documents to be reviewed within 30 days, mandatory documents within 7 days.

by December 2022 and within the three year compliance period of the AD. To defer spending because of the financial impact of COVID, a delay was granted in May 2020 and implementation of the modification replanned to begin between late 2021 and early 2022. However, the Modifications Committee did not meet after the COVID restrictions were imposed in March 2020, so the modification was never presented to the committee, and it remained a work in progress TDR. During this period, all such modifications were to be approved and signed-off by the appropriate stakeholder, in this case the maintenance organisation. Once the modification became free of charge, it was not necessary to seek the approval of the Modification Committee.

Technical News process

The Technical News process was the operator's engineering department's way to communicate important information to staff. It included technical, quality, health and safety and environmental bulletins.

The core content of the technical news was subject to a mandatory read and sign process for everyone in the operator's engineering organisation. Teams were also allocated additional relevant articles according to their role, such as those relating to a specific aircraft type.

Each time a staff member logged on to the technical news application they would be presented with all articles that had been published since the last time they completed the read and sign process. If there had been a long interval since logging on, many pages of information would be presented which would take a number of attempts over time to read and sign for. In 2020, there were 219 articles published of which up to 182 were applicable to the maintenance team.

The software used to present the technical news and record the signature offered little opportunity to filter or prioritise the articles. For the system to consider an article as read, it only needed to be opened. Read and sign compliance was monitored monthly and authorisation to work could be removed if compliance lapsed.

Whilst the read and sign process provided a mechanism for identifying who had read each article, there was no process to determine if the information provided in the articles was effective in raising the awareness of its intended audience.

Downlock pin - Technical News

The *787 NLG downlock pin installation* Technical News was initially issued in April 2020, then re-issued in December 2020 as the 6-month validity date of the original article had expired (Figure 18). It was due to be re-issued again in June 2021.

Technical News

787 NLG DOWNLOCK PIN INSTALLATION

This Tech News is being re-issued to highlight that it may be possible to install the NLG downlock pin in the incorrect position until a preventative modification can be actioned. 787-FTD-32-18003 refers.

BACKGROUND

Boeing has received reports of the NLG downlock pin being incorrectly installed in the inner bore of the apex pin on the NLG lock link assembly, adjacent to the correct hole. The correct location is shown in Fig 1 of AMM Task B787-A-32-00-30-00A-720A-A Landing Gear Downlock Pin Installation.

The FAA issued AD 2019-23-07 to address this issue, which could result in the NLG retracting on the ground, possibly causing serious injuries and substantial aircraft damage. The associated SB 320040 installs an insert into the apex pin bore to prevent incorrect installation of the downlock pin. The current 787-8 and -9 fleets will have this SB incorporated before the compliance end date (Jan '23). 787-10 G-ZBLA and all subsequent deliveries will have this change from production.

ACTION

Please ensure that the NLG downlock pins are always installed in the correct location IAW the AMM. The correct and incorrect locations are shown below for reference.

CORRECT

<Correct Installation>

INCORRECT

<Incorrect Installation>

Note:	1. 2.	This Technical News expires 6 months from the issue date above. Persons performing a supervisory function are responsible for informing their appropriate staff of the content of this document.
Authority:	3.	Head of Engineering Quality & Technical

Figure 18

Tech news article explaining correct/incorrect location of the downlock pin

Prior to the accident, all G-ZBJB's engineering team had signed to confirm they had read the article. None of the team recalled the article until reminded about it after the accident. Table 2 shows the date when each member of the team signed for the December 2020 issue of the technical news article and approximately[9] how many articles in total were required to be read and signed for in the same batch. This was a higher than usual number of articles for some team members due to an accumulation of articles during periods of COVID19 furlough.

Footnote

[9] The data are approximate due to limitations of the operator's historical recording system for tech news articles.

Team member	Date 787 NLG downlock pin article signed for	Total number of articles
LAE	02/01/2021	16
Technician	01/02/2021	36
Mech 1	08/12/2020	12
Mech 2	03/01/2021	40

Table 2

Read and sign dates for the Technical news article explaining correct/incorrect location of the downlock pin and number of articles required to be read in the same batch (including NLG article)

Reviewing the priority and potential safety risks of the SB and AD

The engineering fleet technical team believed that, when compiling the AD and the SB, the FAA and the manufacturer had assessed multiple risk types including Health and Safety, Flight Safety and Airworthiness. Whilst the primary risk analysis conducted by the manufacturer used the regulated airworthiness requirements, Boeing reported that both personal and aircraft level safety were considered during the compliance time evaluation. As a result, the wording in the SB included the following text:

> *'If this Service Bulletin is not done, the NLG can be retracted on the ground during maintenance or fault isolation if the NLG pin is accidentally installed in the apex pin inner bore, which can cause damage to the airplane and injuries to personnel.'*

Similarly, the AD also included the following safety statements:

> *'Summary*
>
> *The FAA is issuing this AD to address the unsafe condition of these products.*
>
> *(e) Unsafe Condition*
>
> *This AD was prompted by reports that the nose landing gear (NLG) retracted on the ground, with weight on the airplane's wheels, due to the incorrect installation of a NLG downlock pin in the apex pin inner bore of the NLG lock link assembly. The FAA issued this AD to address the NLG downlock pin being incorrectly installed in the apex pin inner bore of the NLG lock link assembly, which could result in the NLG retracting on the ground, possibly causing serious injuries to personnel and passengers and substantial damage to the airplane.'*

The SB had been categorised by the aircraft manufacturer as '*Special Attention*' which was a category used to specifically highlight safety issues such as personal hazards that do not immediately threaten airworthiness but can have a high economic impact if not incorporated.

The technical team reviewing the SB and AD consisted of a team leader and several technical engineers. The procedures the engineering organisation used to evaluate technical documentation[10] from manufacturers stated the following may be considered but not all decisions had to be documented:

'a. The actioning Technical Engineer conducts a high-level review of the document to understand its contents and technical intent. The following lists the subjects that may be considered:

i. It's applicability to aircraft or components for which the engineering department holds technical responsibility.

ii. Is the task mandatory?

iii. Compliance requirements - Mandatory or not?

Note: Alert, Special Attention and Alert Operator Transmissions technical documents are classed as mandatory by the Technical Safety Group (TSG).

All Alert and Special Attention Service Bulletins and Alert Operator Transmissions (Airbus), require adoption on the fleet, with sign-off by the Specialist Technical Engineer or Team Manager. By exception, the Alert, Special Attention Service Bulletin or Alert Operator Transmissions are to be brought to the TSG by the owning Team Manager for their agreement when embodiment action is not to be taken.

iv. It's effect in enhancing safety.

NOTE: Alerts and Special Attention documents are classed as mandatory by the TSG unless a safety case is presented to the TSG meeting for decline.

v. Whether it offers improvements to an existing task or product data can be gathered by reviewing our own fleet, world fleet, Original Equipment Manufacturer (OEM) and other operator experiences / data.

vi. Whether the beneficiary is to the Operator / Owner.

vii. Its ETOPS[11] implications.

Note: If the TDR is ETOPS significant then a detailed entry describing the implications, including any actions being taken to address or mitigate the implications, must be recorded in the long text of the TDR.

viii. Whether it is linked to other documents.'

Footnote

[10] CAMO-Tech Document Evaluation BACOMPANYDOCS-CAMO-01-01-0020-00000-041A-D.

[11] ETOPS - Extended Range Twin-engine Operational Performance Standards.

Whilst this procedure considers these items and others such as reviewing the Boeing FTD, cost and reliability, it does not require a documented risk assessment showing which risks have been considered.

The first stage of the review by the senior technical engineer concluded that the SB did not represent a safety issue despite its 'special attention' category status and the potential for serious injury of personnel and passengers warning in AD sub paragraph (e) 'Unsafe Condition.' Although the assessing personnel did consider the potential safety impact of an aircraft in an unmodified state, the assessment only focused on the potential impact on flight safety and airworthiness.

A subjective decision on the embodiment timeline was made by drawing on the experience of the personnel making the assessment.

Safety Management Systems (SMS)

A safety management system (SMS) in aviation refers to a collection of processes, tools and methodologies to formally manage a structured safety programme. Many aviation service providers have processes in place to mitigate for hazards and risks. Aviation SMS programmes are based on the ICAO standards or recommendations and guidelines for managing safety programmes at a state and individual operator level, found in ICAO Document 9859.

The operator had a mature SMS in place but it was only employed within their Operations and Management departments rather than their maintenance organisation. Their system had a structured risk assessment process which covered hazard analysis, risk assessment, perspective categorisation[12], risk ownership, mitigation activity and risk tolerability. The outcome of the SMS processes identified gaps in safety so the operator could produce strategies to reduce, manage or eliminate the identified safety risks.

Whilst the operator did have an SMS in place, the system had not been adopted by their maintenance organisation because there was no legislated requirement for them to do so in the CAA Part 145 regulations. The operator's TDR process to embody the AD considered flight safety, airworthiness and the AD's 'effect' in enhancing safety, but there was no documented evidence of any health and safety risks considered.

The CAA has proposed that the requirement for an SMS is introduced into the Part 145 regulations by the end of 2022. The operator has stated that they have already started implementing an SMS risk system within the maintenance organisation.

Footnote

[12] *'Risks can be categorized from two perspectives: Perspective 1 – Technical, programmatic or performance, supportability or environment: Such as people, equipment, reliability, maintainability etc. Perspective 2 - Cost: Such as sensitivity to technical risk, overhead, estimating errors etc. Schedule: Such as degree of concurrency, number of critical path items, sensitivity to cost etc.'* Abhilash Gopi '*Categorization of Risks in Project Risk Management*', 29 November 2008. Available at www.pmhut.com/categorization-of-risks-in-project-risk-management [accessed May 2022].

Organisational information

Maintenance organisation

The AAIB interviewed relevant maintenance personnel and their managers and conducted observations of ramp maintenance. The operator's internal investigation was also reviewed. The following relevant organisational features were found:

The impact of the COVID19 pandemic

The operator experienced a sudden and significant downturn in operations because of the pandemic. This resulted in operational changes within the maintenance organisation and an immediate need to minimise costs. The ramp maintenance team involved in the accident did not report that any of the changes had affected their individual performance.

Ramp maintenance team structure

Licenced aircraft engineers are expected to oversee the technicians and mechanics working within their team and have some leadership training to support this. Technicians and mechanics are not expected to oversee the work of their colleagues and have no leadership training. However, it is common for mechanics, technicians, and licenced engineers to observe each other and work together as a means of on-the-job training and to gain experience.

Workload

Overall, the workload within the engineering team where the accident occurred was considered by management and the engineers who were interviewed to be comfortably achievable. Maintenance staff were not working full days. Removal of pitot probe covers and cabin inspections had been added to the standard ramp maintenance schedule as additional duties. The removal of pitot covers was an unfamiliar task across all of the operator's aircraft fleet resulting from incidents of insects blocking the sensors whilst aircraft had been parked for long periods during COVID. This extra task included a detailed visual inspection by the LAE but also increased the time taken to complete ramp maintenance. Cabin inspections were necessary due to the revised structure of the CET. Most of the mechanics from the CET had been seconded to aircraft maintenance ramp teams to pass on their knowledge of interior maintenance. Although this was more work on each aircraft, it was considered by management that additional resource had been made available to cover it.

Analysis

The aircraft was undergoing a corrective maintenance task to allow the deferment of three NLG Solenoid faults in accordance with the DDG. The task required cycling of the landing system. Maintenance personnel inserted locking pins into all three undercarriage legs before the LAE in the flight deck selected the landing gear to UP. The locking pin for the NLG had been inserted in an incorrect position and therefore did not function as intended. When the LAE selected the landing gear to UP the NLG retracted as designed. The aircraft nose then fell to the ground.

Design of the aircraft NLG

The design of the aircraft nose landing gear created an opportunity for error with two holes located close together that the locking pin could be inserted into. When the pin was inserted into the wrong hole, it made a 'click' noise like the noise made when it was inserted into the correct hole, and it fitted with sufficient friction to remain seated even in response to tugging from below. This meant that there were powerful auditory and tactile cues that could easily mislead someone to believe the pin was correctly inserted even when it wasn't. There were no strong visual indications to distinguish between the correct and incorrect placements. A visual inspection would therefore be unlikely to reveal incorrect placement unless the person checking was specifically looking for it.

Performance of the ramp team

To select the landing gear to UP, the LAE needed to be on the flight deck. Time before the aircraft's scheduled departure was limited so he delegated the fitting and checking of the landing gear pins and the external check for hazards around the aircraft to Mech 1. Mech 1 was experienced, and the LAE trusted him based on their history of working together. The LAE supervised Mech 1 and Mech 2 remotely from the flight deck and communicated with Mech 1 via a headset. The LAE could be heard on the CVR leading the team through the checks in the procedure. However, there was no briefing for the team before leaving the aircraft establishing who would do what and what the hazards of the task were.

Mech 1 asked Mech 2 to fit the NLG pin because the smaller steps needed to access the NLG bay were not immediately available at the remote stand and Mech 2 was tall enough to do it without the steps. Mech 2 was also taking the opportunity of his secondment to the ramp maintenance team to further his experience, and this may have seemed to Mech 1 like an appropriate task for him to learn. Mech 1 pointed to the location to fit the pin, monitored the fitting of the pin and checked it by listening, looking and pulling the flag. The limited space available within the NLG bay and the location of the hole above their heads made it difficult to clearly indicate the correct pin location, especially without access to a picture such as that in the AMM. Mech 1 did not have in mind the hazard of incorrect placement, so he did not emphasise this to Mech 2 or consciously check for it.

The AMM was available to the maintenance team on a laptop, but this would have required time and is not a convenient device to use outside the aircraft and in the rain. The operator issued iPads with maintenance information included via an App, but they did not contain the necessary B787 manuals.

Mech 1 attempted to clear the outside of the aircraft of other personnel and check everyone was clear, but the visual check was ineffective due to the restricted view available from Mech 1's position by the NLG. It is also likely that he believed people only had to be clear enough for a small movement of the aircraft as hydraulic power was applied and did not consider the possibility the aircraft nose could drop.

The operator did not have any procedure or rule to prohibit or control the hazards of this type of task during loading or passenger boarding. The team tried to complete the task as quickly as possible while performing the required safety checks in the AMM but did not set up a safe system of work that effectively controlled the hazards. The resources available within the team were not used to best effect to assist Mech 1 during preparations for cycling the NLG doors. The NLG pin was fitted by Mech 2 who had no experience of the task and was not given an adequate explanation. The experienced technician and OSE who were available to help with the pin fitting and external visual checks for people working around the aircraft were not utilised.

Mitigation effectiveness using the technical news

The possibility of installing the NLG downlock pin in the incorrect position was a known hazard and a modification was available to eliminate the risk of it happening. Pending incorporation of the modification, the operator sought to mitigate the risk by raising awareness of the issue through a technical news article. However, the interim mitigation using the technical news read and sign process was not effective. Even though all members of the accident ramp maintenance team had signed to say they had read the article, none of them appeared to have in mind the risk of incorrect pin installation. This was probably because of the volume of information in the technical news, and the need for maintainers to remember the information between the time of reading and the next fitting of NLG pins on the B787. The accident occurred more than five months after the LAE and the two mechanics signed for the relevant technical news article. For Mech 2 there had been approximately 40 articles in the same batch. There was no process to monitor the effectiveness of the interim mitigation. The operator has introduced a new software application for technical news that has an improved interface and requires each page of every article to be displayed before it can be signed. The new software offers the capability to highlight documents that are mandatory or safety related. When this functionality is deployed, users will have to read and sign when they access the system. Additional functionality has also been added to allow engineers to bookmark documents of interest.

Access to aircraft documentation

Access to B787 maintenance data and manuals via the company iPads may have provided an opportunity for Mech 1 to step Mech 2 through the procedure for inserting the NLG downlock pin. The procedure contained illustrations showing the correct and incorrect locations for the pin which might also have jogged their respective memories regarding the warning notice in the Technical News article. The operator has now provided access to Boeing technical data, documents and manuals via the company iPads.

The manufacturer and regulator's response to the hazard of incorrect pin insertion

The NLG design issue was known to the manufacturer and the regulator because of previous incorrect ground lock installation events. When the manufacturer became aware, they acted, starting an internal investigation and then issuing a MOM followed by a Fleet Team Conference presentation that included a suggested temporary fix using sealant. This information was supplemented by the publication of a FTD article on the manufacturer's web portal six weeks after the MOM was issued which provided additional details.

It was roughly a year after the MOM was released before the manufacturer issued a SB with a permanent fix that required a kit of parts and had a three-year compliance time. The AD followed ten months later and reset the three-year compliance time so that compliance was required by 16 January 2023. The AD highlighted that the safety and economic risk '*could result in the NLG retracting on the ground, possibly causing serious injuries to personnel and passengers and substantial damage to the airplane*.' But the compliance time meant that it would be up to four years and nine months between the issue being recognised and all aircraft being modified to prevent incorrect installation of the NLG downlock pin.

The compliance date for the SB and AD was calculated using occurrence data from Boeing 787 models, however, the relative risk of personal injury was determined by considering data from all large Boeing aircraft types dating back to the 1970s. Boeing's safety review process considered statistical analysis methods that included the possibility of human error, because it is a common contributor to aviation accidents and incidents. The potential for human error during airplane maintenance formed the basis of the Safety Issue determination. The potential for a serious injury within the lifetime of the 787 fleet was also assessed in the compliance time determination.The operator's response to the SB and AD during COVID pandemic.

The SB and AD were assessed by engineers in the operator's engineering department and within the timescales prescribed. The SB only refers to a single incident of NLG retraction plus a safety report, so the Operator's assessment was based on a single event not the two events that had been reported to Boeing prior to the release of the SB. Their assessment concluded that the issue was not flight safety related or an airworthiness risk and embodiment towards the end of the compliance period was acceptable. Despite the warnings in the AD, the potential risk of serious injury to personnel working around the aircraft and boarding passengers was not given sufficient consideration. Nor was the design characteristics of the 787 NLG downlock pin and the adjacent apex pin holes. Had these risks been given greater significance, embodiment of the modification may have been given greater priority. Action to begin the embodiment process was initiated but was put on hold and repeatedly deferred due to the economic impact of the COVID19 pandemic. A further consequence of the restrictive COVID measures was the suspension of the Modifications Committee leaving the embodiment decision to stakeholders via a Sharepoint workflow. This modification remained a TDR work in progress prior to the accident and was never presented to stakeholders for sign off; although once the SB became free of charge, approval of the Modification Committee was not necessary. The SB was signed off by the Modifications Committee and incorporated soon after the accident as a matter of urgency.

As a result of this accident, the operator has reviewed the processes used to assess SBs and ADs and has developed appropriate organisational structures to identify and manage health and safety risks more effectively in the TDR process.

Emergency response

Although the co-pilot was in the cockpit when the event occurred, he did not make a PAN or MAYDAY call to ATC, instead relying on the phone calls made by the ground personnel. As a result, ATC were not initially aware of the incident. Had they been, then ATC could have issued an alert over the airport's dedicated crash system. This would have simultaneously informed the RFFS, the Police, airport ground operations and security and reduced the response time to the event. It is possible that ATC would have declared the incident an AGI and triggered the associated security response.

During the post incident response, the principal issue was the large number of uncontrolled personnel who converged on the site. As the incident had been declared a LSBYG, airport security were not directed to provide a cordon and so there was no control of personnel entering the scene. The request to declare the incident a LSBYG was made by the RFFS commander on receipt of information from the APOC Fire Desk and confirmed by ATC. Once on scene the RFFS commander considered that local resources were sufficient to manage the situation and discussed this with the police commander. Declaration of an AGI would have triggered a predetermined response from the London Fire Service and the London Ambulance Service, diverting resources that were not required on scene and the RFFS commander wished to avoid this. Both the LFB and LAS stated that the predetermined responses to an AGI, while significant, would not unduly disrupt their other operations.

The creation of an EAP would have possibly created a focus for personnel assembly away from the incident site and diverted unnecessary personnel.

The operator declared the incident as a Silver in their internal management process. At this level the CMC was not activated, and no Incident Site Leader was appointed. Therefore, there was no clear chain of command for company personnel at the event site. If an AGI had been declared the operators ELV would have automatically deployed to the EAP and would have been available to liaise with the Emergency services on scene. This may also have been of assistance in controlling the presence of the operator's personnel. In response to the event the operator has commenced a review of their incident management process.

Future SMS Policy

Whilst there was no requirement for SMS within maintenance organisations at the time of the accident, the AAIB wishes to highlight the safety benefit that future adoption of SMS in maintenance is expected to provide in a situation like this. There would be a systematic response to the safety intelligence received from the manufacturer and regulator and the risk holders would have visibility of that. Comprehensive risk assessments would be carried out and appropriate hazard mitigations would be identified and recorded. The hazards and the effectiveness of those mitigations would be monitored. Had the aircraft been boarding passengers when the NLG retracted, the consequences could have been much more severe.

The CAA have already taken measures to close the policy gap for maintenance organisations. Their aim is for Government approval of an SMS to be introduced into the Part 21 and Part 145 regulations by the end of 2022. The operator has stated that they have started implementing an SMS risk system within their maintenance organisation.

Safety actions taken

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 TDR 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

Conclusions

The aircraft NLG retracted on the ground when the landing gear selection lever was selected to UP as part of a maintenance procedure. The NLG downlock pin had inadvertently been inserted in the downlock link assembly apex pin bore instead of the downlock pin hole. When the nose of the aircraft struck the ground, significant damage was caused to the lower front section of the aircraft and minor injuries to the co-pilot and a member of the cargo load team.

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. There were powerful auditory and tactile cues that could easily mislead someone to believe the pin was correctly inserted even when it wasn't and there were no strong visual indications to distinguish between the correct and incorrect placements.

The determination of the risk of incorrect installation of the NLG downlock pin in the manufacturer's SB and the regulator's AD did take account of the design of the B787 NLG and the associated probability for error. The operator's process to embody ADs and SBs considered flight safety, airworthiness and the AD's 'effect' in enhancing safety, but there was no documented evidence that health and safety risks had been fully considered. Had these risks, that were clearly highlighted in the AD and SB, been given greater significance by the operator during the embodiment process, the priority of the modification may have been escalated and avoided the decision to defer implementation to the end of the compliance period.

Published: 3 November 2022.

ACCIDENT

Aircraft Type and Registration:	Boeing A75N1(PT17) Stearman, N707TJ
No & Type of Engines:	1 Pratt &Whitney R-985 engine
Year of Manufacture:	1940 (Serial no: 75-950)
Date & Time (UTC):	4 September 2021 at 1448 hrs
Location:	In the sea off Sandbanks, Poole, Dorset
Type of Flight:	Private
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	57 years
Commander's Flying Experience:	4,494 hours (of which 3,581 were on type) Last 90 days - 175 hours Last 28 days - 62 hours
Information Source:	AAIB Field Investigation

Synopsis

While performing an aerobatic wing walking display over the sea at Bournemouth Air Festival, the aircraft experienced a reduction in engine power. The pilot stopped the display routine and flew the aircraft west, along the coast, with the intention of returning to Bournemouth Airport. The wing walker returned to her seat in the front cockpit. Although the aircraft was initially able to maintain height, the engine subsequently experienced a complete loss of power and the pilot ditched in the entrance to Poole Harbour. The aircraft flipped over on contact with the water, but both occupants were able to exit the aircraft unaided.

The investigation determined that during the display the engine suffered a loss of engine power due to failure of the oil inlet pipe, most likely due to fatigue, which prevented oil being supplied to the engine. This was precipitated by a fatigue failure of the metal strap which supported the weight of the oil inlet pipe. The fatigue failure initiated at an area of mechanical damage on the surface of the support strap, which had been caused by over-tightening of the retaining nut.

History of the flight

The aircraft was part of a two aircraft display team performing at the Bournemouth Air Festival from 2 to 5 September 2021. The team consisted of four people, with one pilot and one wing walker in each aircraft. Following the flight on 3 September 2021, the pilot of N707TJ refuelled the aircraft and confirmed that the oil level was between 7 and 8 USG.

On the day of the accident the team met to discuss the planned display routine. This included a walk-through of the display sequence and discussion of actions to take in the event of various types of emergencies. The discussion included the technique required for ditching the aircraft and the actions for egress in the event of a ditching.

Prior to starting the engine, the pilot turned the propeller by hand to ensure there was no oil pooled in the lower cylinders. He reported that he did not see any sign of oil on the ground. He started and warmed-up the engine in accordance with the operator's checklist and completed the power checks, which were satisfactory.

The two aircraft took off from Bournemouth Airport at 1437 hrs with the wing walkers already on the wing and with N707TJ as the lead aircraft. They changed to the display radio frequency and when at 'Town Hold'[1] were cleared by the Flight Display Director (FDD) to proceed directly to the display area to begin their display. The pilot subsequently reported to the AAIB that the oil temperature and pressure were normal, and the engine was responding as expected. The key locations during the flight are shown in Figure 1.

Figure 1

Display area and key locations

(©Google Earth, map data SIO, NOAA, US Navy, NGA, GEBCO)

Footnote

[1] Town Hold was a holding point used to manage the aircraft flow to and from the display area situated to the east of the airport.

The team commenced the display at 1443 hrs and completed the first two manoeuvres during which the pilot reported that the engine rpm was approximately 2,000 rpm and the manifold pressure 32 inches. Positioning for the next manoeuvre, both aircraft flew away from the crowd line and, after increasing power, the pilot noticed that the aircraft was not climbing, and the rpm was lower than expected at around 1,800 rpm. The pilot checked and confirmed that the throttle lever was fully forward. He also checked the fuel, magnetos, and carburettor icing controls, which were all in the correct positions, and the engine temperature and pressure indicators which were normal.

As the engine was not delivering full power, the pilot turned to depart the display area to the west. He rocked the wings, which was the agreed signal to attract the attention of the wing walker and indicated by hand signal for her to dismount the wing. The wing walker dismounted, strapped into the front cockpit, and disconnected the wing walking safety restraint.

The pilot reported on the display frequency that he had an engine problem and advised that he planned to return to Bournemouth Airport. The pilot of the other aircraft followed N707TJ at a distance and instructed his wing walker to dismount. As N707TJ began to route west along the coast, at about 600 ft above mean seal level (amsl), the engine misfired. The pilot changed frequency to Bournemouth Tower, declared a PAN and was cleared to route direct for any runway.

While there was insufficient power available to climb, the aircraft was still able to maintain height. However, not wishing to cross a built-up area at 600 ft amsl and mindful that the engine might stop, the pilot continued to fly west parallel with the coast. His intent was to fly around the west of Bournemouth and Poole and return to the airport over the more open ground to the north. He then noticed oil streaming out of the engine cowling and coming past the cockpit.

Recognising that there was no opportunity to land on the beach, owing to the crowds and the available distance between the wooden groynes[2], the pilot asked Bournemouth Tower for a steer to an open field and was given a heading to Parkstone golf course. However, the pilot considered that the golf course would be occupied, and a safe emergency landing could not be assured. As he was now approaching the Sandbanks area, and losing height, he set the aircraft attitude to achieve the best glide speed of 70 mph and aimed for some open fields on the Studland side of Poole Harbour. Around this time, the engine produced a loud mechanical noise, vibrated violently, and suffered a significant loss of power.

The entrance to Poole Harbour was ahead and the pilot identified an area clear of boats in which to ditch, located between the breakwater and the shoreline, and separated from the channel by a line of poles. He reported that the water was 'choppy' and the wind was light from the west. The last speed he observed was 70 mph (stall speed was 55 mph) and that he pulled back on the control column to put the tail into the water first. Video recordings showed the aircraft in a stable descent, with the propeller turning, and it adopted a slightly

Footnote

2 A groyne is a barrier built out into the sea from a beach to stop erosion.

nose-high attitude as it neared the water (Figure 2). On contact with the water the aircraft rapidly flipped over onto its back and came to rest close to the chain ferry slipway on the Sandbanks side of the harbour entrance; the ferry was on the other side of the harbour. The pilot and wing walker exited their cockpits, which were submerged, and were picked up by a small leisure craft.

Figure 2

Stills taken from video just prior to ditching (Used with permission)

The time from the initial indications of an engine problem to the ditching was about four minutes. The ditching occurred 3 nm to the west of the display area.

The pilot of the other aircraft in the formation shadowed N707TJ to the point that it ditched and then orbited for a short time. He declared a MAYDAY to Bournemouth Tower who informed the Distress and Diversion Cell at the National Air Traffic Service Swanwick at 1450 hrs.

Emergency response

The police control room was informed of the accident at 1452 hrs. Although the accident occurred outside of the air display area, a multi-agency control centre (MACC) established for the Air Festival took control of the incident, with the police as the lead agency. The police coordinated the response with other agencies using local and air show resources. The MACC informed a RNLI vessel supporting the festival that the aircraft had a problem, which then followed the aircraft and arrived on scene shortly after the pilot and wing walker had been rescued by a leisure boat and transferred to a working boat operating in the area.

The wing walker, who had knocked her head during the accident, was examined by a paramedic on the RNLI vessel. Both the wing walker and pilot were taken by ambulance to hospital for medical checks and released later that day.

The FDD made the decision to cancel the remainder of the flying display for that day.

Recorded information

Photographs and videos taken during the accident flight on 4 September 2021 show heavy oil staining on the underside of N707TJ's fuselage aft of the engine cowling (Figure 3) and lighter oil staining on the upper fuselage, aft of the rear cockpit. Photographs taken the previous day during and at the end of the display showed no oil staining present.

Figure 3

Oil staining on underside of N707TJ (white aircraft) fuselage during accident flight

The oil staining was evenly distributed across the bottom of the fuselage and emanated rearwards from the bottom of the engine cowling, which eliminated the possibility that the oil came from the oil cooler or the engine exhaust.

The final part of the ditching was captured by CCTV from a nearby hotel which shows the aircraft flipping over very rapidly.

Aircraft information

The Boeing Stearman 75 (Stearman) is a two-seat tandem biplane, with a fixed landing gear and tailwheel configuration. The fuselage is of tubular welded steel construction with a secondary aluminium structure. The wings and centre section have wooden spars covered with aluminium compression struts and steel bracing wires. The fuselage and wings are fabric covered.

The accident aircraft, originally powered by a 220 hp Continental engine, was manufactured in 1940 for the United States Navy and remained in service until 1944. The aircraft subsequently transferred to civilian use and was re-registered several times.

Over the intervening years the aircraft underwent various modifications, embodied under FAA Supplemental Type Certificates, to increase aircraft performance and allow inverted aerobatic flight. The modifications included in 1974 the replacement of the original engine and propeller with a 450 hp radial Pratt & Whitney R-985-AN14B 'Junior Wasp' engine and a constant speed Hamilton Standard 2D30/6101A-12 propeller.

In 1988 the aircraft was rebuilt and re-registered as N707TJ. The rebuild included the installation of an overhauled R-985 engine, modification of the fuel and oil systems to allow inverted flight and various aerobatic modifications. The original oil tank was replaced with a larger tank of 8 USG capacity, and this was relocated from the engine bay to beneath the baggage compartment, with associated modifications to the oil system to re-route the supply and return lines. A wing walking rig on top of the upper wing centre section and an aerobatic display smoke system were also added. N707TJ was imported to the UK in 1990 when it entered service with the current operator.

The R-985 engine installed at the time of the accident was fitted in 2013 following the failure of the previous engine.

Aircraft maintenance

N707TJ was primarily maintained by the operator's engineer. The maintenance was inspected and certified by an external FAA licensed engineer.

The most recent annual inspection was completed on 21 January 2021. During this inspection a cylinder was replaced on the engine, a compression check was carried out and an engine ground run performed. Except for a 20-minute check flight flown in April 2021, the aircraft did not fly again until August 2021. In June 2021, the engine mounts and both carburettors were replaced and an engine ground run was carried out. The aircraft was subsequently flown for a total of 6 hours and 50 minutes, over 10 flights between 3 August 2021 and the accident flight. At the time of the accident, the aircraft had accumulated a total of 14,809 hours and the engine had accrued 475 hours since overhaul.

Accident site

The aircraft ditched in the sea in the entrance to Poole Harbour on the Sandbanks side, and subsequently sank. The AAIB did not attend the accident site and the aircraft was recovered from the water by marine contractors under the direction of the Poole Harbour Master.

Examination of wreckage

Aircraft

Photographs taken during and after the recovery of the aircraft from the water showed that the lower right wing had separated at the spar stub and both upper and lower right wings had collapsed on top of the forward cockpit. The aircraft had suffered substantial damage to the upper surface of the fuselage, consistent with it striking the water in an inverted orientation. The tailplane exhibited damage associated with water impact and the recovery.

The aircraft was examined by the AAIB several days after the accident, after it had been transported by road to the operator's facility. The wings had been removed to facilitate transportation. Both cockpits showed evidence of prolonged immersion in water but were otherwise free from damage and the integrity of the cockpit structure was maintained.

The engine cowlings were missing, but the engine and propeller were largely intact and free from impact damage. Oil residue was present on the fuselage sidewalls, upper and lower surfaces, and on the engine firewall. There was no evidence of oil in the oil tank.

Engine oil inlet pipe

Forward of the engine firewall, the oil inlet pipe comprises a flexible section and a rigid section, which is attached to a mounting boss on the bottom of the engine oil pump via a 90º threaded joint. Incorporated in the rigid section of the pipe is a port for the engine oil temperature probe. A metal strap supports the weight of the rigid section of the oil pipe. The strap is retained at its upper end on a mounting stud for one of the oil drain lines and is secured by a nut.

Visual examination of the engine revealed that the oil inlet pipe was broken at the point where it attached to the engine casing (Figures 4 and 5). The rigid section of pipe had fractured at the mounting boss and the support strap had fractured at a fastener hole. An area of damage was evident on the flexible section of pipe, but this was limited to a tear in the fire-retardant sleeve on the pipe and the inner pipe was intact at this location. This damage may have occurred during recovery of the aircraft from the water, as the engine cowlings which would normally protect this part of the engine bay were no longer present.

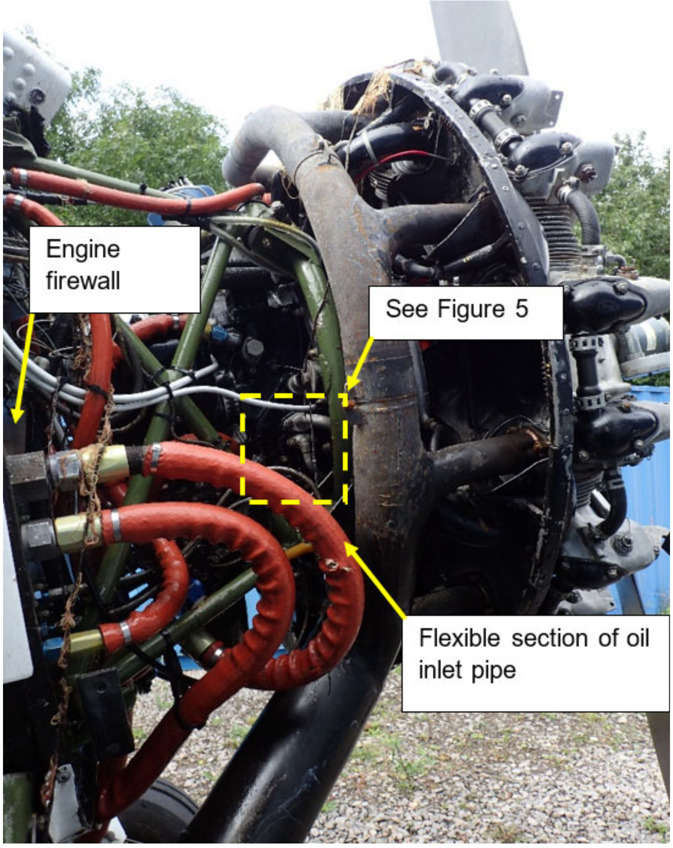


Figure 4

N707TJ's engine viewed from right side showing oil inlet pipe

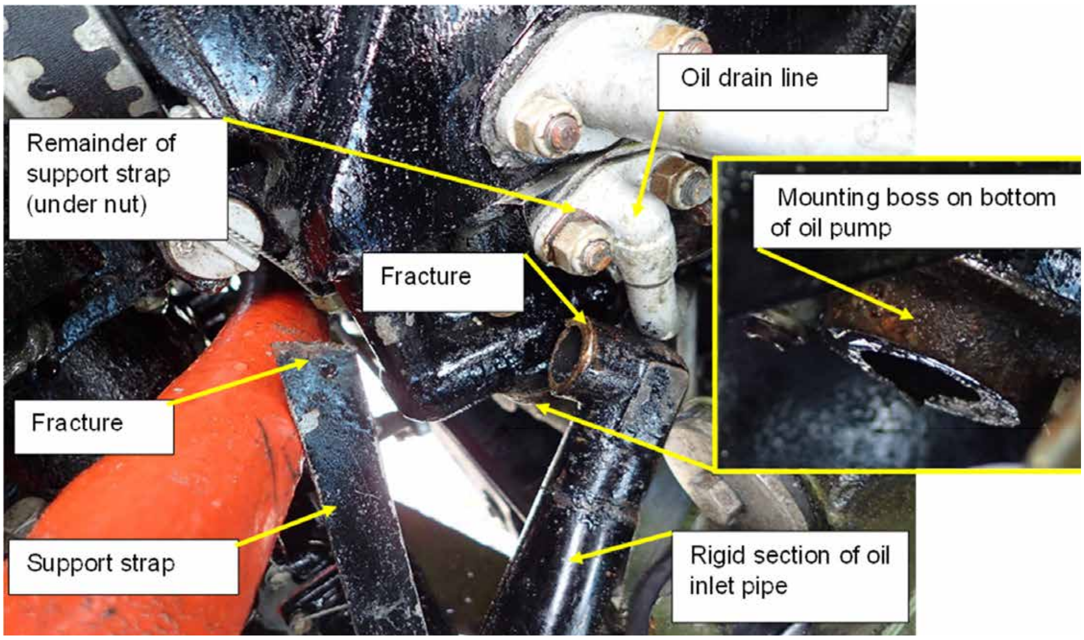


Figure 5

Fractured oil inlet pipe and support strap

Metallurgical examination of the oil inlet pipe and mounting boss

General

The oil inlet pipe, mounting boss and part of the support strap were subjected to a metallurgical examination.

Failure had occurred at a fastener hole in the support strap and on the threaded section of pipe that connected to the mounting boss. Part of the threaded joint remained inside the mounting boss (Figure 6). The support strap and main oil pipe were made from steel. The right-angled threaded end piece of the oil pipe which had fractured was made from a leaded gunmetal casting. It appeared that the gunmetal end fitting had been brazed to the steel pipe.

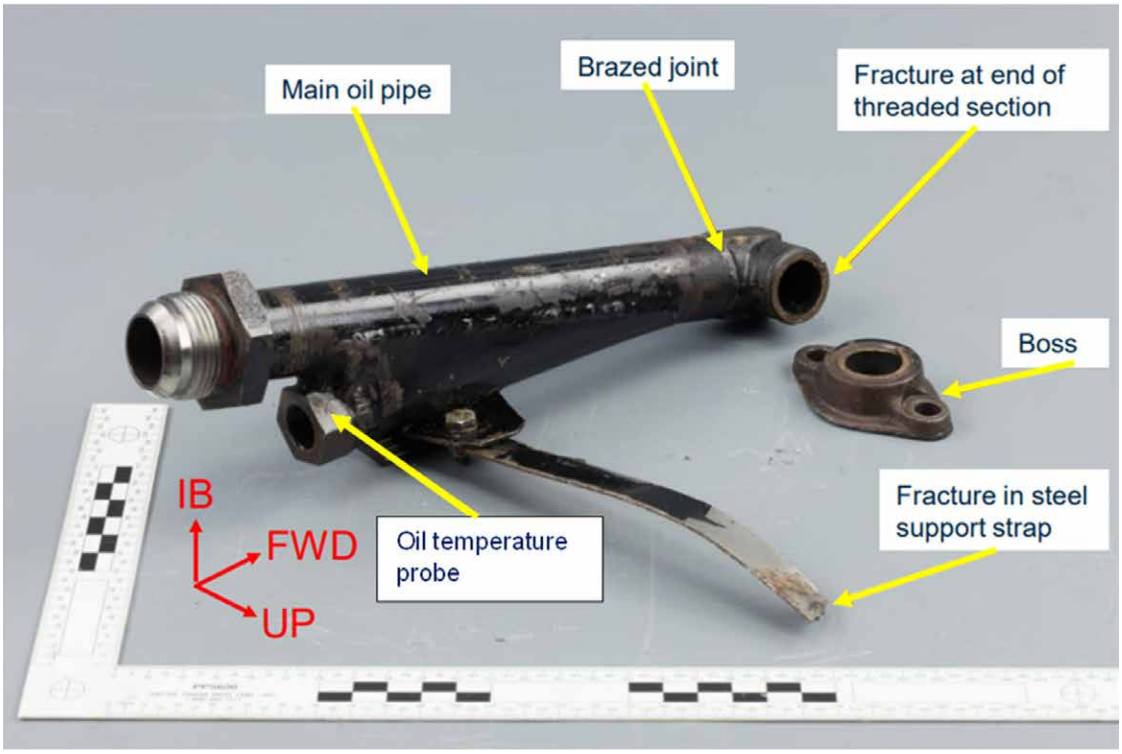


Figure 6

Rigid section of the oil inlet pipe

Support strap

Visual examination of the support strap at the fracture location showed evidence of mechanical damage (witness marks) around the fastener hole on both sides of the strap (Figure 7). The witness marks were circular in shape and consistent with a nut (possibly in combination with a washer) having been over-tightened. No washer was present when the aircraft was examined.

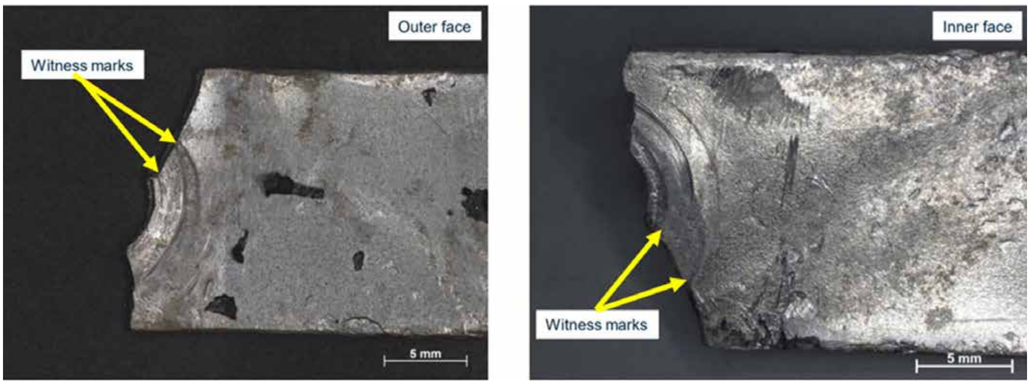


Figure 7

Witness marks around fastener hole on support strap outer face (left image) and inner face (right image)

Scanning electron microscope (SEM) examination of the fracture surface showed extensive corrosion. After cleaning to remove the corrosion, fatigue striations were observed across most of the fracture surface on both sides of the fastener hole. The fatigue initiated within the mechanical damage around the fastener hole on the outer face of the support strap and propagated towards the inner face. A small amount of overload was observed at the right edge of the fastener hole on the inner face. The end of the fatigue crack on the left side of the fastener hole had been destroyed by mechanical damage (Figure 8).

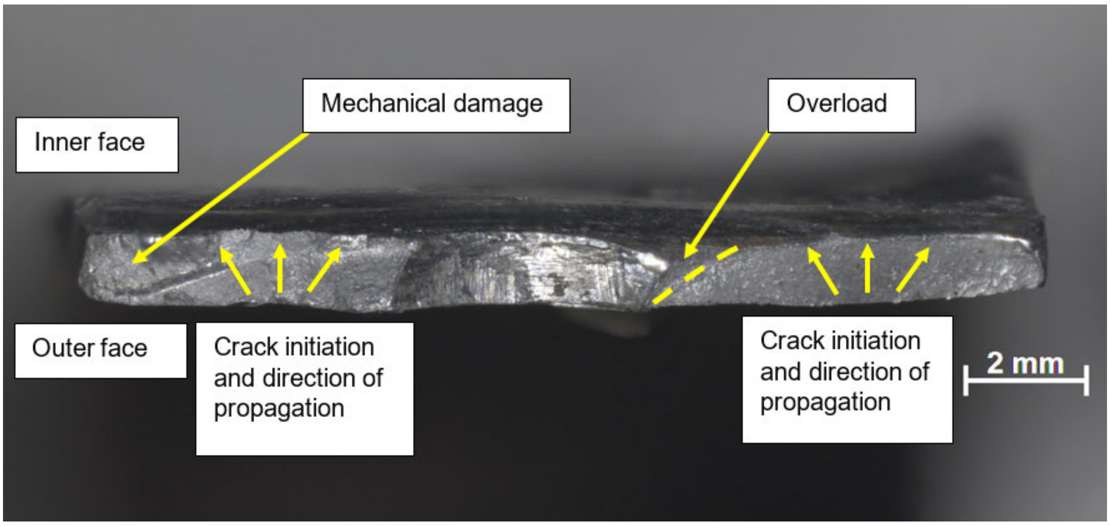


Figure 8

Key failure features identified on the fracture surface of the support strap (Fatigue striations not shown in this image)

Oil pipe threaded joint

The fracture surface of the part of the threaded joint of the oil pipe which remained inside the mounting boss was examined. Visual examination showed that the topography of the fracture surface was typical of overload failure, with no areas that appeared to be consistent with progressive crack growth. The fracture in the oil pipe occurred in the root of a thread.

A step was evident in the fracture surface at the 12 o'clock position (Figure 9). In threaded components, this usually occurs at the last part to fracture. This suggests that crack initiation is likely to have occurred opposite to this (around the 6 o'clock position), with the crack propagating clockwise and anticlockwise around the helical thread. At the 12 o'clock position the crack jumped between adjacent threads to form a continuous crack. An area of mechanical damage/smearing was also evident on the fracture surface. A corresponding area of damage on the opposing fracture face indicated that this likely occurred as a result of relative movement between the two fracture faces during or after the final failure.

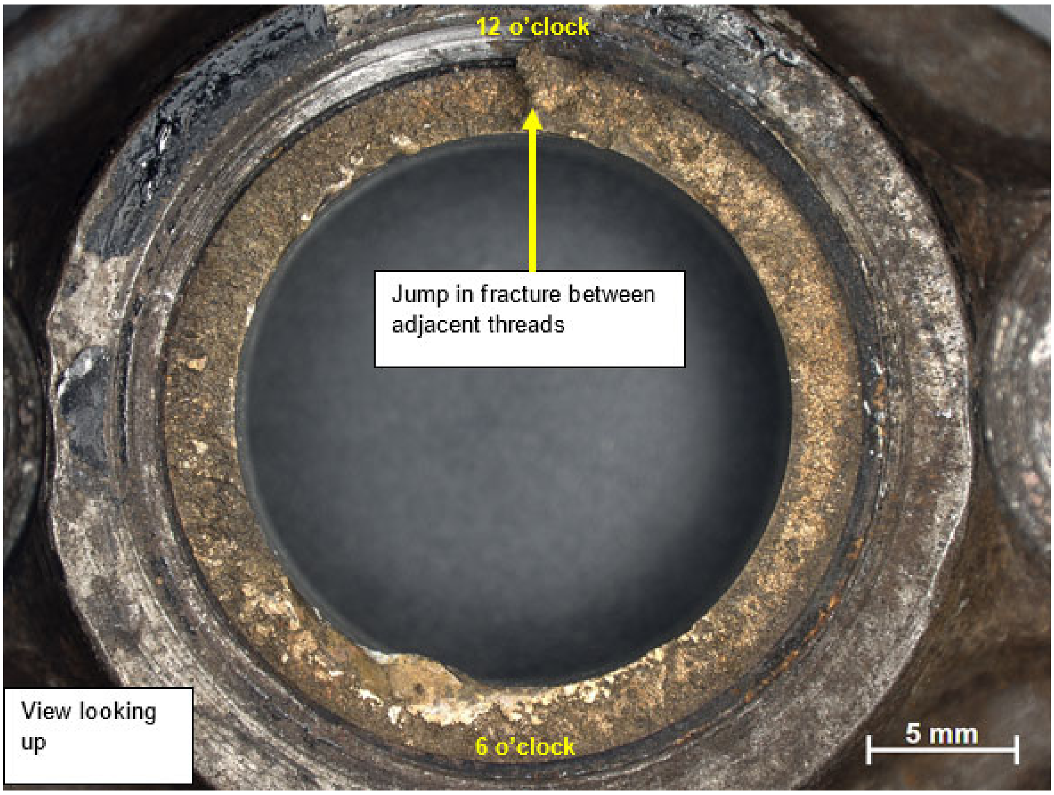


Figure 9

Fracture surface of the oil pipe at root of thread

SEM examination of the fracture surface showed extensive corrosion. Cleaning to remove the corrosion product only revealed a surface that had been attacked by corrosion and no real surface detail was visible. Shrinkage porosity was observed on the fracture surface. Shrinkage is a common defect found in cast materials, but without a specification for the casting, it was not possible to determine if the amount of shrinkage exceeded any specified limit. The presence of shrinkage porosity would reduce the load carrying capacity of the casting, and it is therefore possible that it contributed to the failure.

Between the 4 o'clock and 7 o'clock positions on the fracture surface, a band approximately 0.3 mm deep that contained ratchet marks was observed at the edge of the thread root. This band is identified by yellow dashed lines in Figure 10, and the ratchet marks as yellow arrows.

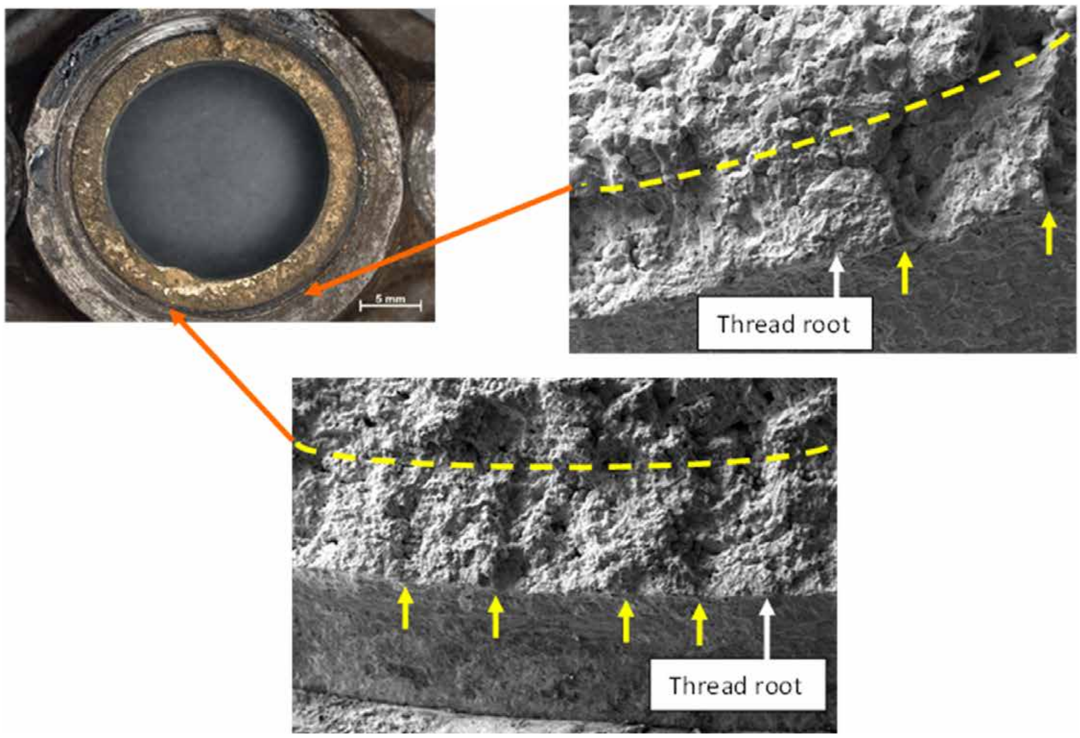


Figure 10

Fracture surface of the oil pipe at edge of thread root, showing ratchet marks in two example locations between the 4 o'clock and 7 o'clock positions

Ratchet marks are a characteristic of fatigue cracks and occur when cracks initiate at multiple points on different planes and then join to form a single crack front. Striation-like features were also observed within the 0.3 mm deep band. These features were consistent with fatigue striations and their orientation was consistent with fatigue initiating at the thread root. However, due to the extent of the corrosion it was difficult to positively attribute them to fatigue.

Aircraft maintenance

The operator's engineer considered that there was no reason for the oil inlet pipe connection to be disturbed, other than during an engine removal or installation, and he could not recall any maintenance in this area in recent years. Nor was anything relevant recorded in the engine or aircraft logbooks. He therefore considered that the oil pipe mounting boss and support strap would have last been disturbed in 2013, when the most recent engine replacement took place.

The aircraft was routinely disassembled, shipped by container and reassembled to fly at overseas air displays between 2014 and 2019. The oil and fuel were drained for shipping, but the oil system was not otherwise disturbed.

Although the area where the oil inlet pipe mounting boss and support strap connected to the engine casing had many pipes, accessories and engine bay structure present which may have obscured visibility, the engineer believed that he would have noticed the broken support strap had it been present on recent annual inspections. He advised that no torque limit was specified for the nut which held the support strap in place. During the aircraft examination, the torque to loosen the nut was noted as approximately 21 Nm.

The flexible and rigid sections of the oil inlet pipe were weighed, and the combined weight was found to be 1.54 kg.

Examination of other Stearman aircraft

There are five Stearman aircraft on the UK register equipped with the R-985 engine and at least one US-registered aircraft based in the UK. Of these six aircraft, three are known to have the modification for the larger oil tank in the baggage compartment, similar to N707TJ. Two are owned by N707TJ's operator, which, also owns a third R-985-engined Stearman that had retained the original 4 USG oil tank mounted on the firewall.

The oil system forward of the engine firewall was examined on the operator's three other R985-engined Stearman, to identify if there was potential for similar failures. The operator advised that when Stearman were historically retrofitted with the R-985 engine there was no standard manufacturer-approved modification, and the installation of the oil system could differ from aircraft to aircraft. Examination showed that the installation and support of the main oil inlet pipe was different on each of the operator's aircraft, and none had the exact same installation as N707TJ.

The oil inlet pipe on the first aircraft examined also comprised a flexible and rigid section of pipe. The rigid section, which also accommodated a port for the oil temperature probe and a 90º threaded joint, was similar in shape but much smaller and lighter than that on N707TJ. Two support straps supported the weight of the pipe (Figure 11).

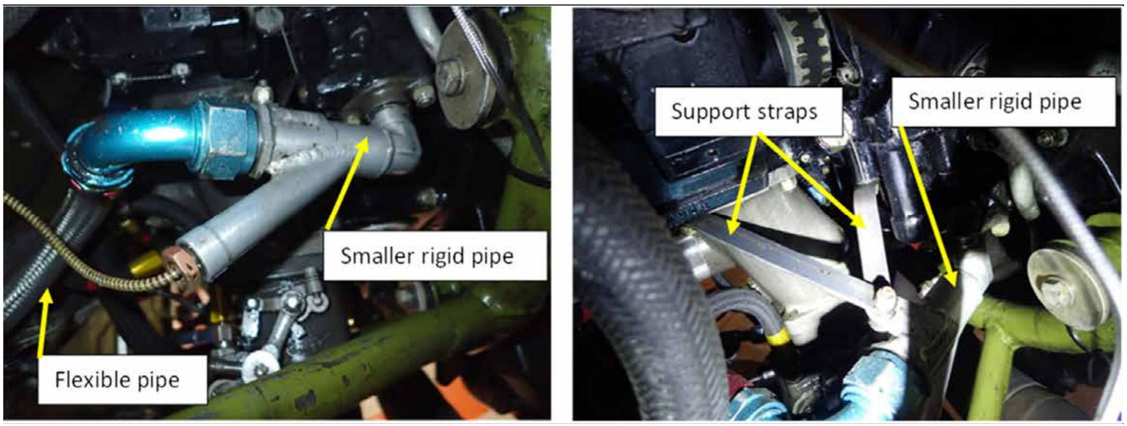


Figure 11

Alternative installation: smaller rigid pipe. Side view (left image), top view (right image)

The operator subsequently modified the installation on this aircraft to consist of a single flexible pipe and relocated the oil temperature probe.

The oil inlet pipe on the second aircraft was comprised only of a flexible pipe, which was shorter than that on N707TJ and a 90º threaded union (Figure 12). There were no supporting straps and the oil temperature probe was mounted separately.

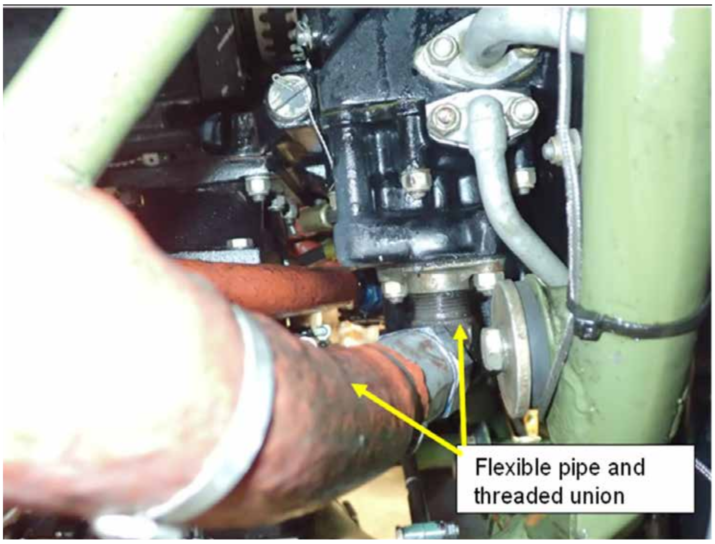


Figure 12

Alternative installation: flexible oil pipe and 90º threaded union, no support strap

The third aircraft, which had the original smaller oil tank mounted on the firewall had a flexible oil pipe which ran down from the oil tank, along the forward face of the firewall, into a Y-shaped union. From there a flexible pipe ran forward to the engine casing where it was attached to the mounting boss via a rigid 90º union. There were no support straps.

Safety and survivability aspects

Harnesses

Each seat in N707TJ was equipped with a 5-point seat harness connected to the seat and a secondary airline-style lap belt connected to the airframe. In addition, the wing walker wore a harness under her coverall, which attached to a safety restraint system and was used when the walker was outside the cockpit.

After the aircraft ditched, the pilot reported that he was able to unclip both his harnesses and escape without difficulty. The wing walker detached from the safety restraint system when she returned to the cockpit. She reported that although she struggled to exit the aircraft due to the shock of ditching, locating the seat harnesses was instinctive because of her training.

Head protection

There was no regulatory requirement for either of the occupants to wear a helmet. The operator informed the investigation that their standard practice was for both occupants to wear a helmet during transit flights. For display flights, the wing walkers would not wear a helmet as the operator considered that the weight and drag would place an extra strain on their body.

While there was padding around the sides of the cockpit, there was no padding on the coaming to provide head protection for the occupant (Figure 13). The operator explained that with the seat harnesses correctly tightened, it is not possible for the head to hit the coming or instrument panel.

Figure 13
Padding around the side of the front cockpit

Life jackets

Regarding this air display, the operator believed that wearing a life jacket could pose a potential hazard of becoming trapped in an inverted aircraft following a ditching and that there was less risk in not wearing a life jacket. This assessment was based on the time the aircraft would spend over the water during the display, and that it would be close to shore with safety vessels present to rescue the crew. It was also felt that wearing a life jacket would restrict the freedom of movement of the wing walker in climbing onto and off the wing.

Training

At the beginning of each season, training was undertaken by the wing walkers. This included familiarisation with the cockpit harnesses, the wing walker safety restraint system, and the brace position to be adopted during a crash or ditching.

Communication between pilot and wing walker

The aircraft was not fitted with any means for voice communication between the pilot and wing walker. Rocking the wings was the signal for the wing walker to look back to the pilot who would then communicate using pre-defined hand signals. The team reported that the moment either of the pilots deviated from the set display routine, the wing walker and the other pilot would recognise that there was something amiss.

The operator's 'Professional Wing Walker's Induction Guide' defined the hand signals to be used between the wing walker and the pilot but did not include any signals to be used in the case of an emergency. The wing walker reported that although she noticed when she returned to the cockpit that it was covered in oil, she had no means of informing the pilot.

As a result of this accident, the operator has introduced three new signals: expect a diversion; prepare for a forced landing / ditching and adopt the brace position; and for the walker to advise the pilot that there is fuel or oil in the cockpit.

Personnel

The pilot joined the operator in 2006. He was the lead pilot for the display team and had flown more than 900 displays. He held a UK Part-FCL PPL (A) with a valid SEP (land) class rating and a Display Authorisation (DA), which allowed him to act as formation leader and to carry out displays with an individual standing on the wing.

The wing walker had been with the team since 2018 and was the lead wing walker. This was her fourth display season with the team.

Ditching technique

The Pilot's Flight Operating Instructions for the Stearman provide no guidance on the technique for ditching. The pilot reported that prior to the flight he briefed the wing walker that in the event of a ditching he would fly as slowly as possible into wind just above the stall speed and 'pancake' the aircraft with the tailwheel touching first.

CAA Safety Sense Leaflet 21[3], extant at the time of the event, provided the following general advice to GA pilots on ditching and survival techniques:

> *'The force of impact can be high so ditch as slowly as possible whilst maintaining control…Hold the aircraft off the water so as to land tail down at the lowest possible forward speed, but do not stall into the water from a height of several feet…This main impact will usually result in considerable deceleration…'*

Following this accident, the CAA provided a routine update to Safety Sense Leaflet 21[4], which provides additional guidance on the technique to be used for ditching.

Analysis

Introduction

The loss of engine power, and subsequent ditching, was the result of a loss of oil supply to the engine. This occurred following a failure of the engine oil inlet pipe.

Footnote

[3] CAA Safety Sense Leaflet 21D '*Ditching*', dated January 2013, extant at the time of the accident.
[4] CAA Safety Sense SS21 '*Ditching Light Aircraft on Water*', dated July 2022. Available at https://publicapps.caa.co.uk/docs/33/SafetySense_21-Ditching.pdf [accessed August 2022].

Failure of the support strap

The steel support strap on the oil inlet pipe failed as a result of fatigue, which initiated at mechanical damage on the outer surface of the strap and propagated towards the inner surface. Normal engine vibration could have provided the cyclic loading mechanism to propagate the crack once formed. The function of the strap was to support the weight of the oil pipe. Once the strap had failed, the load would have transferred to the threaded joint on the pipe.

The size and shape of the witness marks associated with the mechanical damage on the support strap were consistent with its retaining nut having been over-tightened. It was not determined when this occurred, but there was no indication in the aircraft logbook that the oil pipe had been disturbed since the engine was replaced in 2013. It was not determined how long the aircraft may have flown with the support strap fractured, but nothing was noted during the recent annual inspection carried out several months before the accident.

Failure of the oil pipe

Examination of the fracture surface of the oil pipe threaded joint was less conclusive due to the extent of the corrosion, which likely occurred due to the aircraft's immersion in salt water. However, several features observed on the fracture surface, and the location of these features, were consistent with fatigue.

After the support strap failed, the weight of the oil pipe would have been taken solely by the threaded joint, leading to a stress concentration at the point of maximum tensile load. The final failure point, (at the 12 o'clock position), indicated by the crack jumping between adjacent threads, suggests that the crack initiated at or close to the 6 o'clock position (Figure 9). Examination around the 6 o'clock position, identified ratchet marks between the 4 o'clock and 7 o'clock positions.

The presence of ratchet marks, and their location at the edge of the thread root, combined with the striation-like features in the area where a fatigue crack would most likely initiate (around the 6 o'clock position), suggest that fatigue was the most likely cause of failure of the oil pipe. The presence of shrinkage porosity in the cast material of the threaded portion, would have reduced its load carrying capacity and may also have contributed to the failure.

No unusual oil leaks were noted on the engine prior to the accident. Photographs taken as the aircraft was landing after the previous day's flying display show no evidence of an oil leak, and no oil was noted on the ground during the pilot's pre-flight inspection on the day of the accident. It is therefore concluded that the final failure of the oil pipe occurred during the accident flight, although the crack may have been propagating for some time.

Other aircraft

The particular arrangement of the oil inlet pipe on N707TJ most likely arose from the need to re-route the oil supply when the larger oil tank was installed in the baggage compartment. Examination of the operator's other three R-985-engined Stearman aircraft (including two with a relocated oil tank) showed that there were a variety of possible installations for the oil inlet pipe. The installations on the other aircraft were different to each other and smaller/lighter than that on N707TJ, which made them less likely to suffer a similar failure. Nonetheless, the operator inspected the oil pipe installation on the other aircraft to satisfy itself that they were adequately supported.

Management of the emergency

The initial symptoms were that the aircraft was not climbing and the engine power was lower than expected. Consequently, the pilot abandoned the display with the intention of returning to the airfield without overflying populated areas and endangering third parties. As the emergency developed, the pilot declared a PAN and communicated his changing intentions. The involvement of the second aircraft in observing the event and declaring a MAYDAY, after N707TJ ditched, enhanced the overall understanding of the situation and ensured a rapid response from the emergency services.

With the FDD and representatives from the emergency services collocated in the MACC there was a joint understanding of the developing situation, which allowed a coordinated response. This included the tasking of the RNLI rescue boat, and paramedic, to shadow N707TJ and the subsequent transfer by ambulance to hospital.

The decision by the FDD to cancel the remainder of the flying display prevented subsequent aircraft from displaying before the fuel supply at Bournemouth Airport could be checked for contamination. It is also not unusual following an accident for other pilots and staff involved in the event to become unsettled and for safety resources to be out of position. Therefore, the cancellation of the flying allowed individuals to reconcile what had happened and provided the necessary time to reset the programme and ensure that the safety boats were in position.

Ditching

The crew had prepared for a ditching by briefing the technique to be used prior to the flight and by the wing walker rehearsing the brace position and the release of both seat harnesses during the preseason training. The video of the final stages of the flight showed the aircraft in a stable descent with the aircraft adopting a slightly nose raised attitude towards the end of the flight, followed by a controlled impact with the water. A ditching will result in a rapid deceleration and given the fixed landing gear it was almost inevitable that the aircraft would flip over.

While the wing walker banged her head during the ditching there were no medical reports of either crew sustaining an injury. A helmet would offer the wing walker additional protection, but the operator believed that this would be at the risk of possible injury due to the additional strain a helmet would place on the body while standing on the wing. The risk of a head injury was somewhat mitigated by padding down the edges of the cockpit, correctly fitted harness and the use of the brace position.

The operator considered that life jackets might impede the release of the seat harnesses and the escape from a submerged cockpit. It would also make it more difficult for the wing walker to get on and off the wing. Consequently, they were not worn. While not wearing a life jacket would have advantages during the evacuation, it would leave the occupants unprotected once in the water. The mitigation during the display was that organisers had several safety vessels situated around the display area who could quickly offer assistance; however, in this case the ditching occurred 3 nm from the display area.

Conclusion

The reduction in engine power occurred due to the failure of the oil inlet pipe, which resulted in the loss of the oil supply to the engine. The pilot was quick to respond to the situation and initially intended to return to the airfield avoiding high ground and populated areas. As the situation deteriorated, he continually revaluated his options and positioned the aircraft for a ditching that would reduce the risk to third parties. The pilot and wing walker were well rehearsed in handling emergencies and a successful ditching was carried out.

Following this accident, the operator introduced additional hand signals to enable the wing walker to inform the pilot of any oil or fuel leaks, and for the pilot to inform the walker that he intended to ditch.

Published: 20 October 2022.

ACCIDENT

Aircraft Type and Registration:	Piper PA-28R-200-2, G-EGVA
No & Type of Engines:	1 Lycoming IO-360-C1C piston engine
Year of Manufacture:	1976 (Serial no: 28R-76-35229)
Date & Time (UTC):	2 April 2022 at 0920 hrs
Location:	Approximately 20 nm west of Le Touquet
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers -1
Injuries:	Crew - 1 (missing) Passengers - 1 (missing)
Nature of Damage:	Aircraft missing
Commander's Licence:	Private Pilot's Licence
Commander's Age:	69 years
Commander's Flying Experience:	200 hours (of which 4.7 were on type) Last 90 days - 1.3 hours Last 28 days - 0.7 hours
Information Source:	AAIB Field Investigation

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. Further investigation did not reveal additional evidence having any different effect. This report includes information already published and confirms the initial findings presented in the Special Bulletin.

Synopsis

G-EGVA was one of seven aircraft taking part in a club 'fly-out' from Wellesbourne Mountford to Le Touquet in France. A line of highly convective cloud was forecast on the intended route in the English Channel. As G-EGVA approached the middle of the Channel, one of its two occupants, who were both pilots, reported to London Information that they were in cloud. The aircraft was operating under visual flight rules and neither of the pilots was qualified to fly in cloud. Shortly after this transmission the aircraft disappeared from radar. An extensive search of the area was coordinated by the UK and French Aeronautical Rescue Coordination Centres but neither the aircraft nor its occupants were found.

It is likely control of the aircraft was lost when the aircraft entered the convective cloud.

The CAA has published an animation and podcast reinforcing the safety messages highlighted in AAIB Special Bulletin S1/2022.

History of the flight

On Saturday 2 April the two pilots[1] of G-EGVA were taking part in a flying club 'fly-out' from Wellesbourne in Warwickshire to Le Touquet in France. Six other aircraft took part in the fly-out. One of the aircraft flew under IFR[2]. The other aircraft, including G-EGVA, planned to fly under VFR, each flying a similar route from Wellesbourne towards Newbury and Goodwood then east towards Le Touquet. One of the occupants of G-EGVA had filed a flight plan using a flight planning and navigation app. The route, shown in Figure 1, was planned at 5,000 ft and the flight plan gave an estimated flight time of 1 hour 38 minutes.

Whilst the fly-out was arranged by the flying club there was no coordination or joint pre-flight planning. Each of the pilots reported that they had completed their own planning and made their own assessment of the weather conditions. The six VFR aircraft took off from Wellesbourne between 0750 hrs and 0830 hrs and proceeded separately. G-EGVA was the second of the VFR aircraft to take off, at approximately 0754 hrs but, being faster, overtook the first aircraft near Basingstoke.

Figure 1

Filed flight plan route via waypoints 'NUBRI', 'HAZEL', 'GWC' and 'ALESO'

Footnote

1 Although G-EGVA was a single pilot aircraft, both occupants were qualified pilots and may both have been involved in the management and decision making during the flight. Witnesses and video evidence suggest the left seat pilot was flying the aircraft during the accident flight, but it is possible that the right seat pilot also undertook some tasks.

2 The aircraft flying IFR, G-BJNZ, was involved in a separate accident on the same day and is the subject of a separate AAIB investigation.

At 0759 hrs G-EGVA contacted London Information and requested that their flight plan be activated[3]. At 0816 hrs they transferred to Farnborough Radar before returning to London Information at 0839 hrs. When they returned to London Information, they reported they were at 5,000 ft and 1 nm west of Littlehampton.

At 0846 hrs a video was posted online by the right seat pilot of G-EGVA. Extracts from the video are shown in Figure 2. The video showed the aircraft in flight passing abeam Shoreham with the flight appearing to proceed normally. The aircraft's altimeter showed 5,000 ft, the heading was approximately 090° and the airspeed indicator showed approximately 115 kt. The autopilot did not appear to be engaged and the engine and fuel indications, which were visible, appeared normal. Cumulus cloud could be seen in the distance ahead of the aircraft. Both occupants were wearing lifejackets with their shoulder harnesses worn under their lifejackets.

Figure 2

Extract from the video posted at 0846 hrs showing the instrument panel and the cloud ahead of G-EGVA

Footnote

[3] The flight departed before Wellesbourne AFIS was open so they activated their flight plan once airborne.

The next radio exchange with G-EGVA occurred when London Information contacted them to confirm their position, as the FISO[4] estimated they would be approaching the boundary with French airspace and intended to transfer them to Lille Radar. The radio exchange is shown in Table 1.

Time	Station	Message
0915:51	London Information	"G-EGVA WHAT IS YOUR POSITION AND ALTITUDE"
0916:08	London Information	"G-EGVA LONDON INFORMATION"
0916:10	G-EGVA	"G-VA WE'RE CURRENTLY IN CLOUD"

Table 1

Last radio exchange between London Information and G-EGVA

London Information tried to contact the aircraft several times and asked other aircraft to try to relay a message without success. At 0920 hrs the London Information FISO informed Distress and Diversion Cell (D&D) that they had lost contact with G-EGVA. The FISO also contacted Le Touquet and Lille Information to determine if they were in contact with G-EGVA; they both stated they had no contact with the aircraft. D&D replayed the radar recording, in which G-EGVA was last visible on radar at 0916:31 hrs at a position 20 nm west of Le Touquet and descending rapidly. Lille Information also replayed its radar, which gave similar indications.

The UK and French Aeronautical Rescue Coordination Centres were informed, and a search was launched involving both French and UK vessels and aircraft. The search continued until the following evening but, initially, nothing was found of the aircraft or its occupants. Subsequently, some items were found washed up on the French Coast.

Reports from other aircraft

The pilots and passengers of the other aircraft participating in the fly-out were interviewed after the accident. All the pilots reported encountering a line of cumulus cloud in the middle of the Channel. Four of the five other aircraft flying a VFR route had been able to descend and find a gap to fly around the cloud. Figures 3 and 4 were taken at 0918 hrs and 0924 hrs by one of the other aircraft and show the cloud conditions. Waterspouts can be seen descending from the base of the cloud in Figure 3. Having flown past this weather, the four aircraft continued normally to Le Touquet, returning to Wellesbourne later the same day.

Those onboard the last aircraft in the group initially tried to descend and fly around the weather, but decided they could not find a safe route and diverted to Shoreham Airport.

Footnote

[4] FISO - Flight Information Service Officer.

Figure 3

Photograph taken at 0918 hrs showing the cloud mid Channel (waterspout circled in red)

Figure 4

Photograph taken at 0924 hrs showing cloud to the surface

The pilot of the aircraft which flew under IFR to Le Touquet reported that he estimated the cloud tops to be at least 8,000 ft when he flew past the line of cumulus cloud at approximately 0825 hrs.

A passenger flying in another aircraft, unconnected to the Wellesbourne fly-out, which was flying from Elstree to Le Touquet took a video of the mid-channel weather. The image in Figure 5 is an extract from that video and shows one of the waterspouts.

Figure 5

Image from a video filmed from an aircraft which was also flying to Le Touquet

Found items

In the days after the accident several items were found on the French coastline which had come from the aircraft. On 5 April 2022 a bag belonging to the left seat pilot was found at Plage d'Equihen, containing his flying licence, logbook and other flight documents. On 7 April 2022 a kneeboard belonging to the right seat pilot was found at Plage de Wimereux and on 8 April 2022 a seat from G-EGVA was found on Plage de Sante-Cecile. Figure 6 shows the approximate location of each item found and the final known position of G-EGVA.

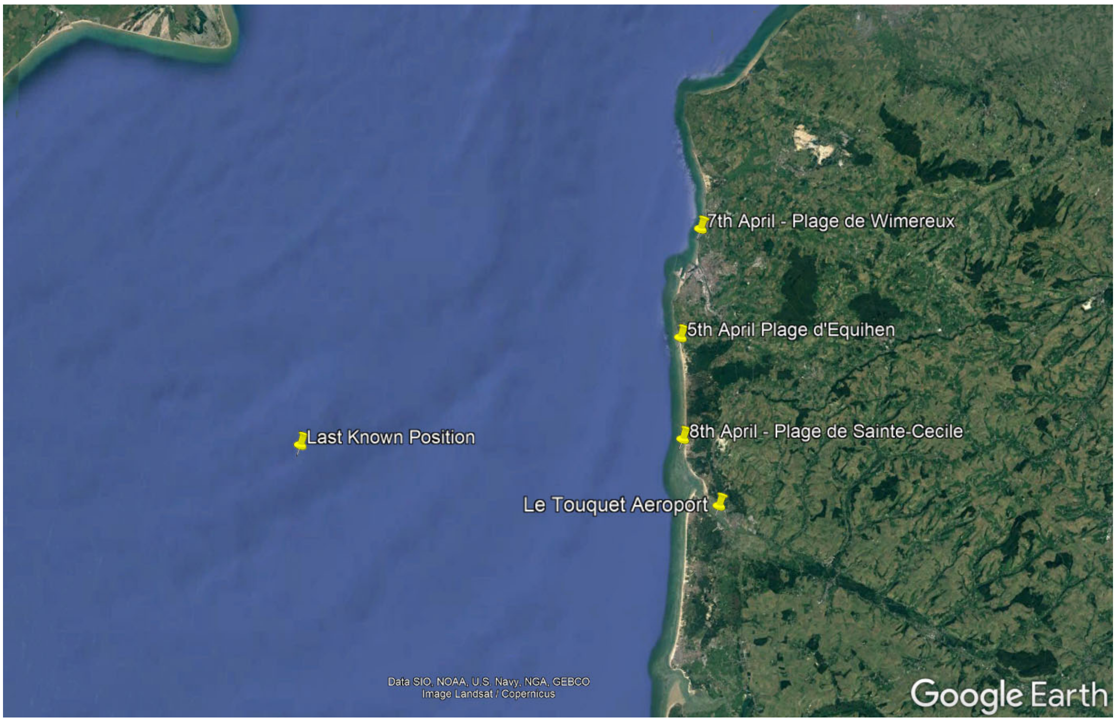


Figure 6

Location of items found on the French coastline

Recorded information

Secondary surveillance radar data for G-EGVA and the nearest two aircraft of the fly-out is shown in Figures 7 and 8. Figure 7 shows part of the ground track of these aircraft to the point when radar contact was lost with G-EGVA at 0916:31 hrs. Figure 8 shows the reported altitudes for these aircraft, corrected for the QNH of 1022 hPA. Indicated on both these figures is the point at which G-EGVA descended from its cruise altitude of about 5,000 ft amsl, and on Figure 8 the corresponding time when the two following aircraft were abeam this point.

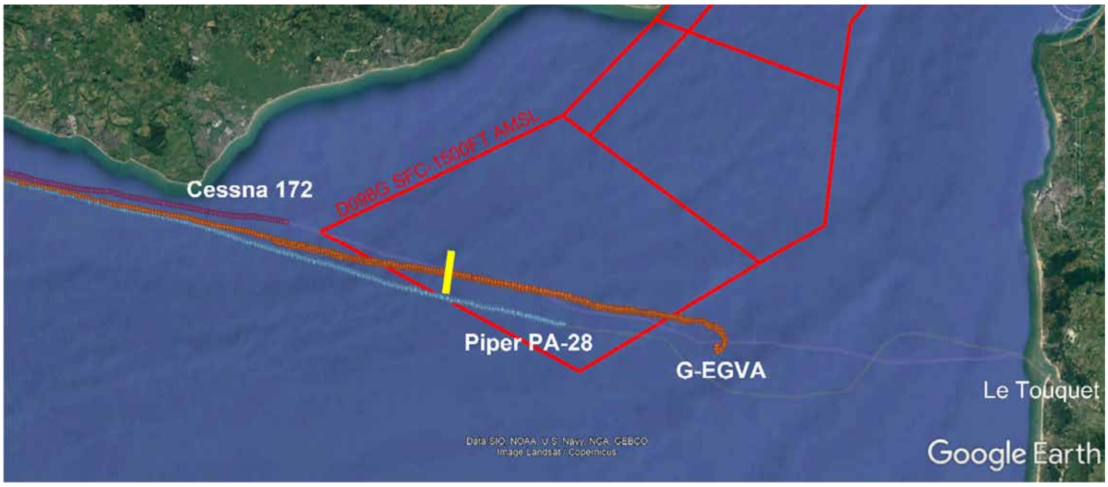


Figure 7

Radar track of G-EGVA up to the last know position at 0916 hrs with the location of two of the following aircraft shown. The yellow line on G-EGVA's track is the point at which G-EGVA descended from its cruise altitude.

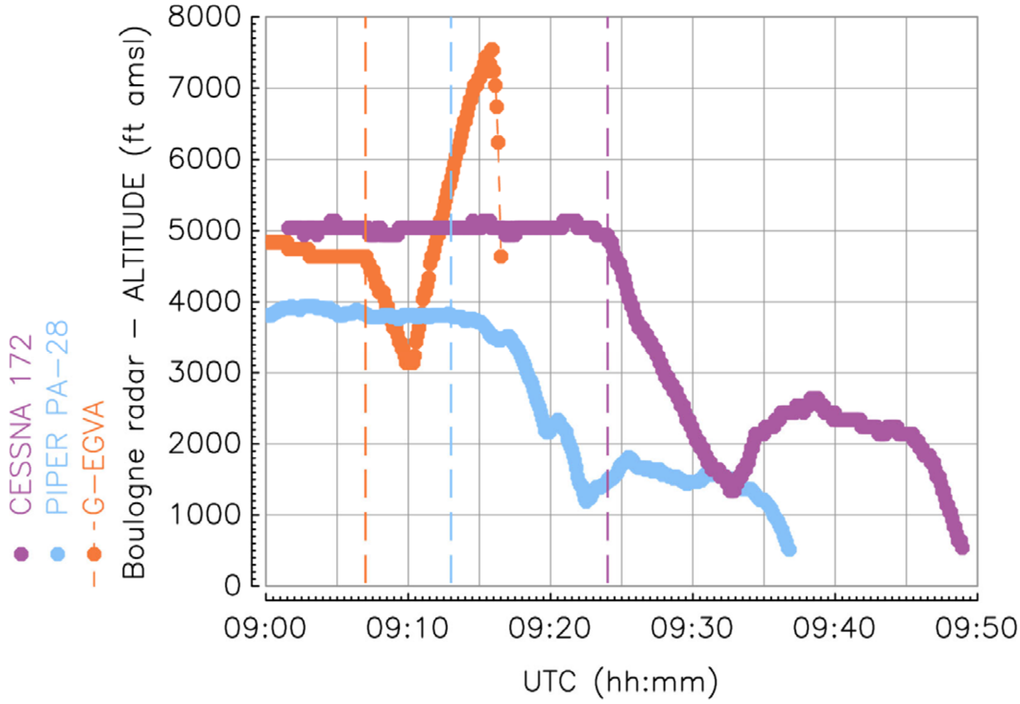


Figure 8

Altitude trace of G-EGVA and the following aircraft from 0900 hrs. The orange dashed line shows when G-EGVA descended from its cruise altitude – the corresponding dashed lines for the other aircraft show when they were abeam this point

Figure 9 is a plot of the altitude and radar-derived data for G-EGVA starting just before the descent from the cruise altitude. The plot shows that the aircraft descended to about 3,000 ft at approximately 500 fpm, where it remained for 30 seconds before climbing to over 7,000 ft at about 1,000 fpm, while maintaining an easterly track. Over the next 50 seconds the aircraft climbed 400 ft, descended 200 ft, and then climbed 300 ft, and at the same time turned right, left, and right again through a total of 50°. The aircraft then continued to turn to the right in a descent. Radar contact was lost 40 seconds later as the aircraft descended through 4,600 ft with a calculated descent rate of just under 10,000 fpm. The last recorded position was 50°34’23.49” N 001°04’11.23” E at 0916:31 hrs.

Figure 9 also shows when the last radio transmissions between London Information and G-EGVA were made. G-EGVA was descending through 7,000 ft at about 3,000 fpm and accelerating during its final transmission.

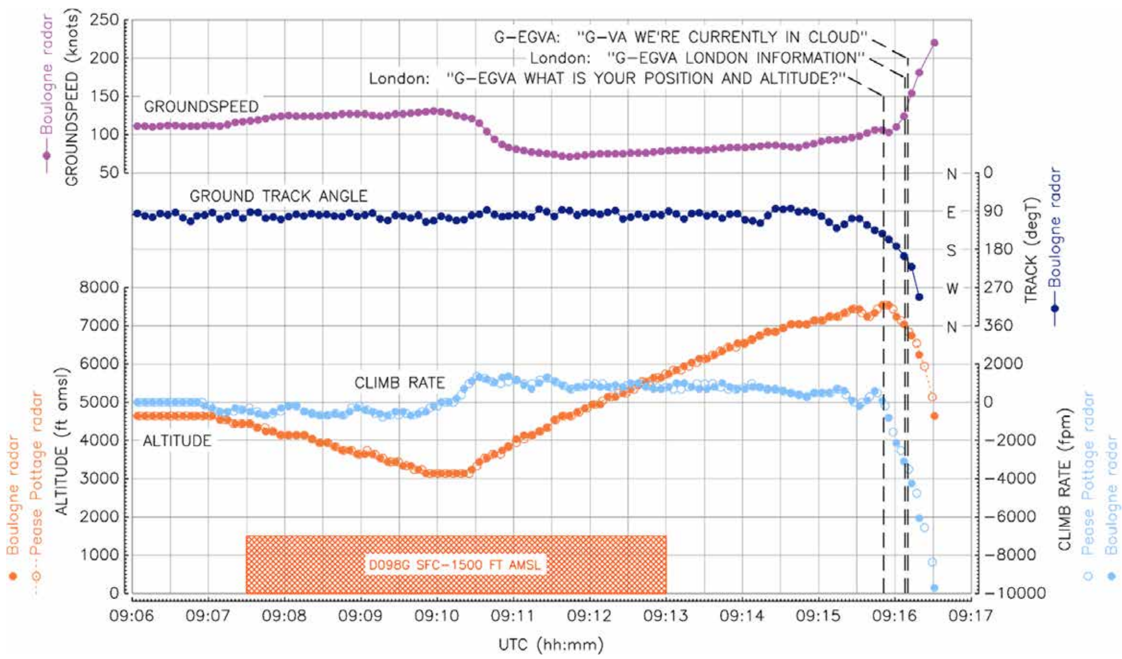


Figure 9

Altitude and radar-derived data for G-EGVA

Aircraft information

The PA-28R-200-2 Cherokee Arrow II is a four-seat, single engine aircraft of metallic construction with retractable landing gear. G-EGVA was equipped with a Lycoming IO-360-C1C four cylinder, horizontally opposed, fuel-injected engine.

G-EVGA’s Airworthiness Review Certificate was valid until 21 March 2023. The most recent maintenance was an annual inspection carried out between 14 February 2022 and 23 March 2022. Since then, it had flown 6 hours over ten flights. Prior to the accident flight the aircraft had accumulated 2,886 flying hours. There were no open or deferred defects recorded in the aircraft’s technical log.

The aircraft was fitted with an active carbon monoxide detector. Maintenance records indicate that during the recent annual inspection the function and condition of the detector and its batteries were checked, and the aircraft was inspected for evidence of carbon monoxide contamination; none was noted.

G-EGVA's seat covers, and cushions had been replaced during previous maintenance in October 2021. The front seats were equipped with a three-point harness comprising a lap strap and a diagonal shoulder harness.

Aircraft seat examination

The seat recovered from the French Coast (Figure 10) was examined at the AAIB. No part number or serial numbers were evident on the seat, but the style and branding of the seat covers matched those of the new leather seat covers that had recently been fitted to G-EGVA. It was identified as being one of the rear seats.

The seat cover exhibited minor scuffing and several small tears but was otherwise in good condition. The lower seat frame was severely distorted, and the forward left mounting point had separated from the frame.

Figure 10
Seat recovered from G-EGVA

Survivability

The video posted on social media showed that both occupants were wearing lifejackets. It appears to show that both occupants were wearing their shoulder harnesses under their lifejackets. This suggests that they secured their seatbelts before donning their lifejackets. When donning a lifejacket after securing a seatbelt there is a risk of becoming entangled in the belt when trying to rapidly exit the aircraft. The CAA Safety Sense Leaflet – Ditching[5] contains guidance on the use of lifejackets.

Fuel

Airfield and flying club records suggest that G-EGVA had approximately 38 USG of fuel onboard when it took off from Wellesbourne. The aircraft normally used approximately 11 USG per hour so it would have contained approximately 23 USG when the accident occurred.

Airspace

On the 2 April 2022 a Danger Area was active in the English Channel within which flight below 1,500 ft amsl was prohibited. The Danger Area is shown in Figures 7 and 15. In the same area Class A controlled airspace exists above FL75. Therefore, as G-EGVA crossed the Channel, the aircraft was restricted to flight between 1,500 ft amsl and FL75.

Meteorology

Forecast weather

On the 2 April 2022 a generally slack pressure pattern existed across the UK in association with high pressure. A convergence line lay from the Dover Strait to Le Mans, France. The convergence line was shown on the surface analysis chart valid at 0600 hrs (Figure 11).

An extract from the Met Office UK low-level forecast chart (F215) issued on the morning of the 2 April 2022 is shown in Figure 12. The forecast was valid between 0200 hrs and 1100 hrs. Initially the flight would have been in Area D. The conditions were forecast to be generally 40 km visibility with scattered or broken (SCT/BKN) cloud with a base between 2,000 and 5,000 ft amsl. However, there would be isolated (ISOL) patches of mist (BR) reducing visibility to 3,000 m at times, with a further risk of visibilities reducing to 200 m in freezing fog (FZFG) until 1000 hrs. Associated with this there would be scattered or broken (SCT/BKN) cloud with a base between 500 and 1000 ft, lowering to the surface at times in fog.

On reaching the South Coast and the English Channel, the flight moved into Area C. Again, general conditions were expected to be 40 km visibility, with few or scattered, occasionally broken (FEW/SCT (OCNL BKN)) cloud with a base between 2000 ft and 4000 ft. Due to the convergence line occasional (OCNL) showers of rain and snow (SHRASN) were forecast to reduce visibility to 5,000 m in places. This would reduce further in isolated (ISOL) heavy rain and snow showers or thunderstorms with small hail or snow pellets (+SHRASN/+TSRAGS)

Footnote

5 Available at https://publicapps.caa.co.uk/docs/33/20130121SSL21.pdf (accessed 6 May 2022).

and be associated with severe icing and turbulence. The heavier showers were expected to be generated by cumulonimbus (CB) cloud with a base between 1,500 ft and 3,000 ft. The convergence line was not depicted on the F215.

The 0°C isotherm was forecast to be between 1,000 ft and 2,000 ft.

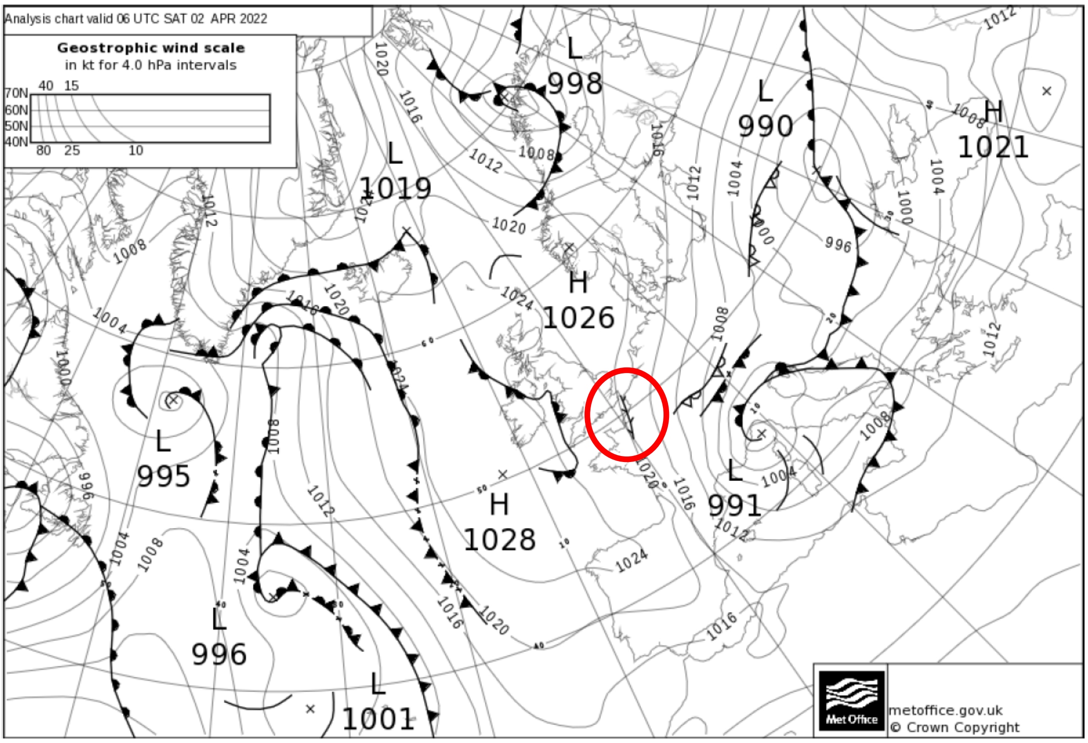


Figure 11

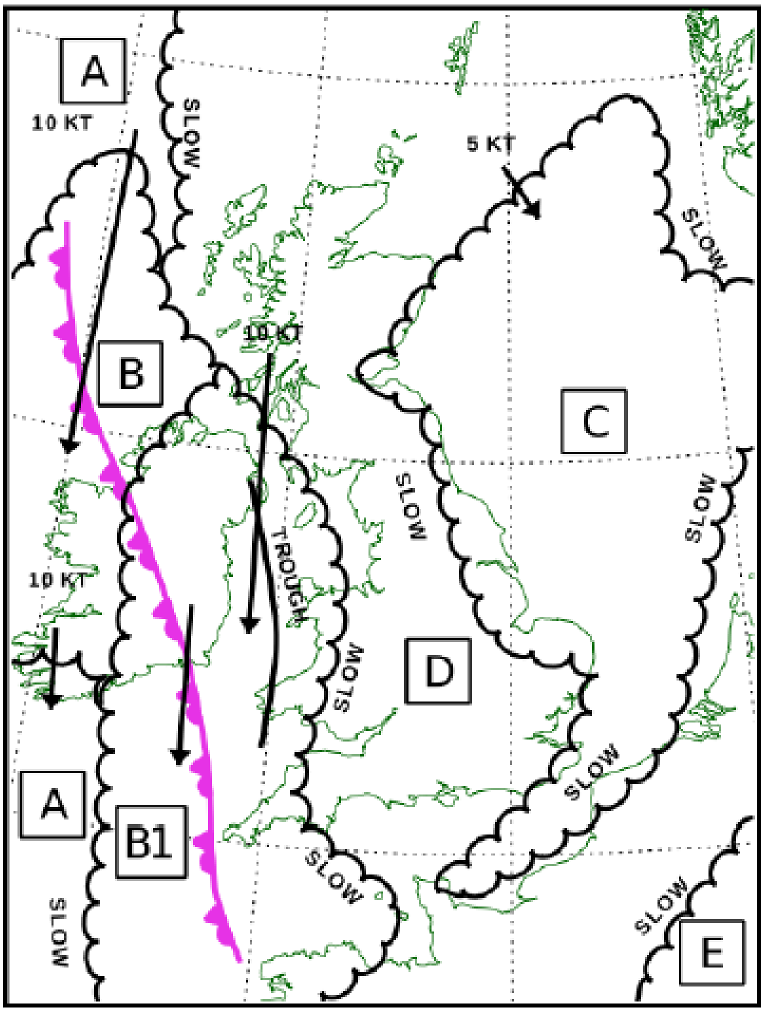
Surface analysis chart valid at 0600 hrs 2 April 2022
(convergence line highlighted in red)

Actual weather

Satellite images taken at half hour intervals between 0800 hrs and 0930 hrs on 2 April 2022 are shown in Figure 13. The images show small amounts of cloud across mainland southern England, with clearer skies across the south-east. A band of cloud lay through the Dover Strait into northern France at 0800 hrs, moving slightly westwards through this time period. The white colour of the cloud in the imagery indicates higher cloud tops which, along with the shape of the cloud structure, suggests showery activity.

Figure 14 shows four radar images between 0800 hrs and 0930 hrs on 2 April 2022. These show dry conditions across central and southern England. A band of showers is shown lying through the Dover Strait, which ties in with the cloud structure observed in satellite imagery. The colouring of the radar returns suggests some heavy precipitation to the west of Le Touquet around 0900 hrs.

Figure 15 shows the radar track of G-EGVA and the two following aircraft overlaid on the 0900 hrs weather radar image.



AREA	SURFACE VIS AND WX	CLOUD	0 C
C	40 KM NIL OCNL 5000 M SHRASN ISOL 2000 M +SHRASN/+TSRAGS ISOL 400 M +SHSN MON ISOL HILL FG	FEW/SCT (OCNL BKN) CU SC Ψ ⋀ ... ... 020-040 / 070-XXX ISOL CB 015-030 / XXX ISOL SCT/BKN ST 005-010 / 015	015-020
D	40 KM NIL ISOL 4000 M SHRASN MAINLY SEA COT ISOL 3000 M BR LAN TL 10 Z ISOL 1500 M SHSN NE AND MON ISOL 200 M FZFG LAN TL 09 Z ISOL HILL FG	ISOL SCT/BKN CU SC Ψ ⋀ ... ... 020-050 / 060-080 ISOL SCT/BKN ST 005-010 / 015 ... ... (BASE 000 FZFG)	010-020

Figure 12

Extracts from the Met Office F215 valid 2 April 2022 between 0200 – 1100 hrs

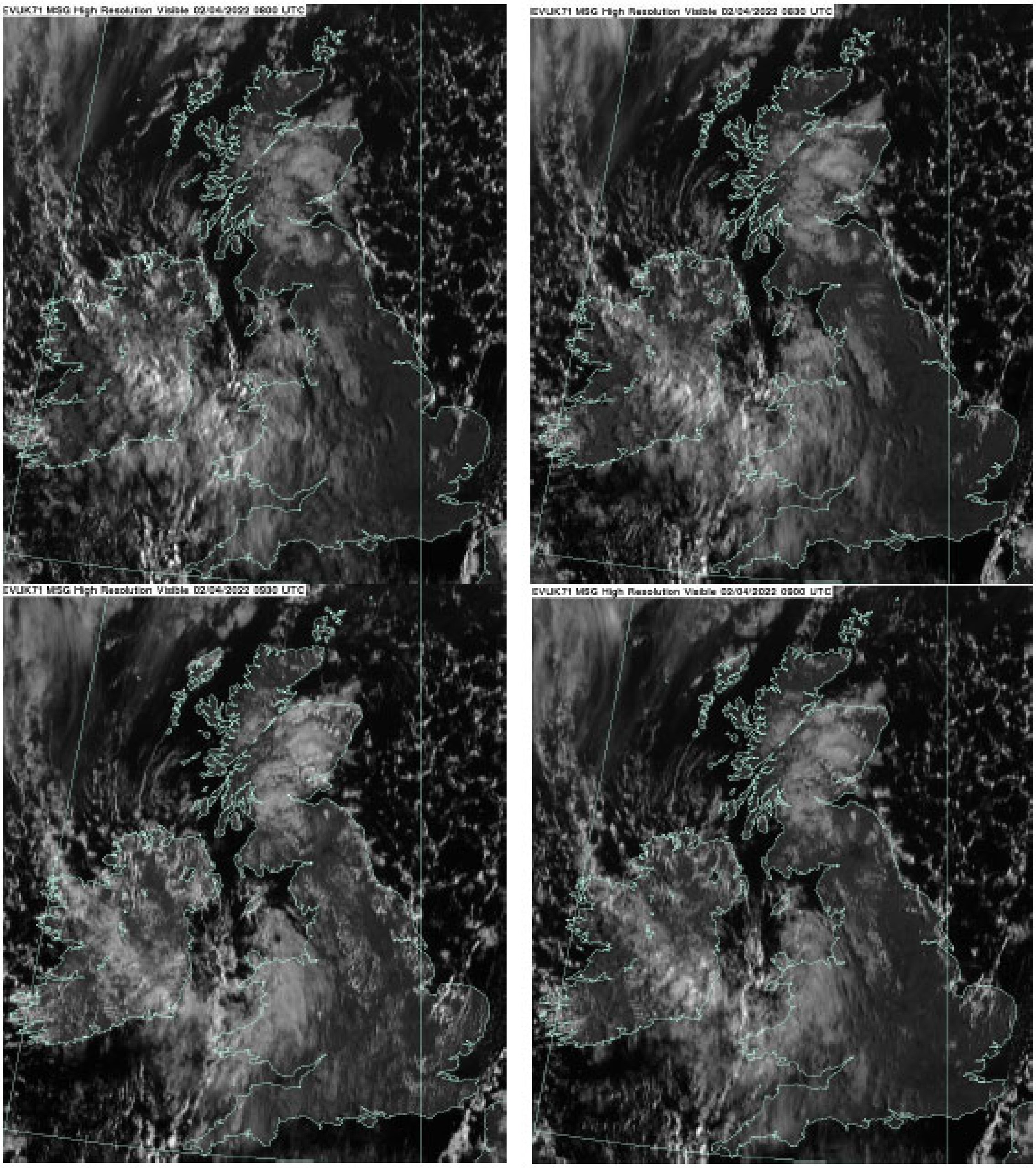


Figure 13

Satellite Imagery between 0800 hrs and 0930 hrs on 2 April 2022

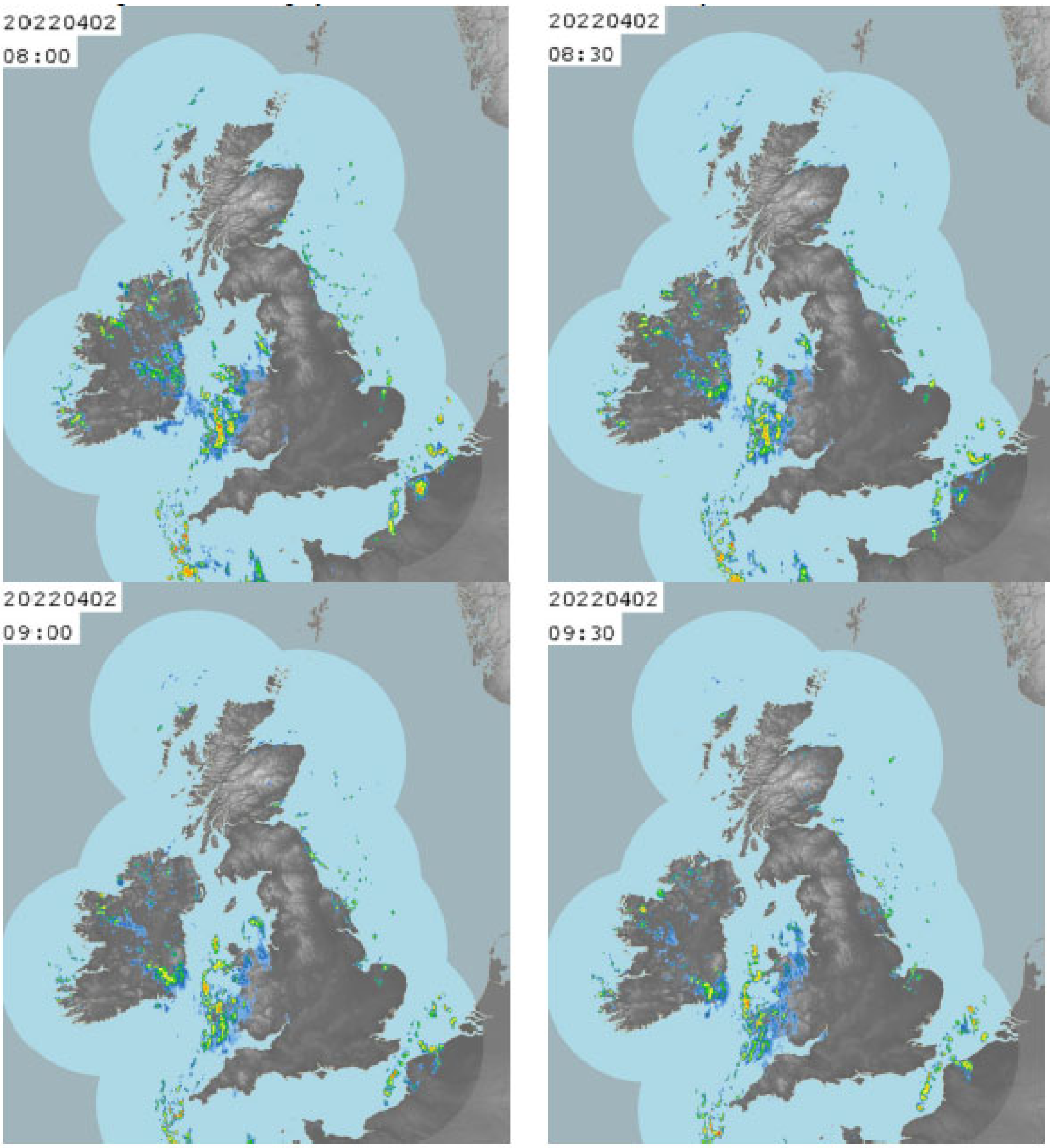


Figure 14

Radar imagery between 0800 hrs and 0930 hrs on 2 April 2022

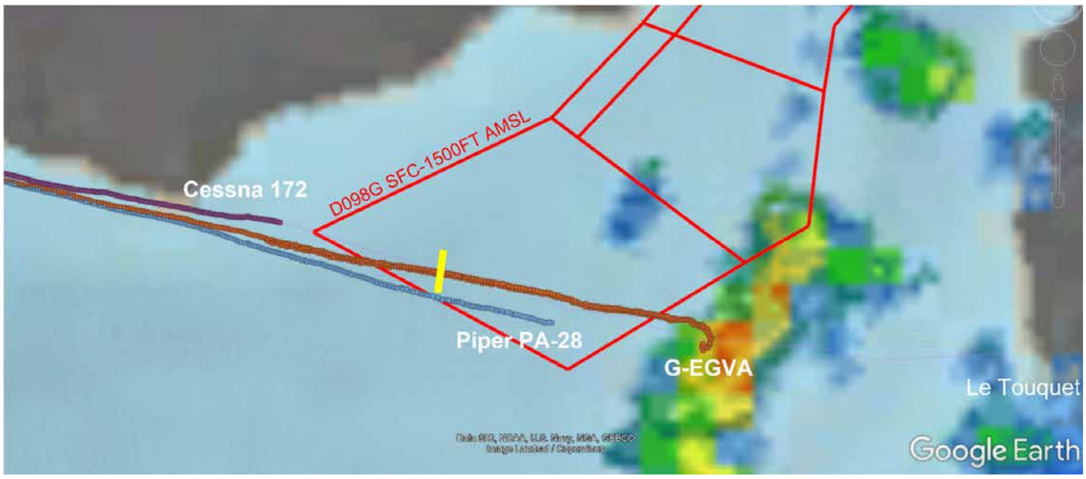


Figure 15

Aircraft tracks at 0916 hrs overlaid on the 0900 hrs weather radar image (the Danger Area described in the NOTAM is shown in red outline). The yellow line on G-EGVA's track is the point at which G-EGVA descended from its cruise altitude

Pilot information

Both pilots aboard G-EGVA held a Private Pilot's Licence (PPL) with a valid Single Engine Piston rating and had completed the complex aircraft training required to fly G-EGVA. Both learnt to fly at the same Wellesbourne flying club in 2010 and since qualifying had flown together often. They had taken part in club fly-outs together before, including to Le Touquet, when typically one of them would fly the outbound leg and the other would fly the return.

Neither pilot held an instrument rating or IMC qualification. The right seat pilot held a night rating.

The left seat pilot's logbook showed a total of 200.4 flying hours. He had flown two previous flights in 2022; one on 23 March (0.7 hours) which was in G-EGVA and included three takeoffs and landings, and one on 11 February (0.6 hours) in a Cessna 152. He had flown 4 flights in 2021, totalling 3.6 hours, including a recency flight with an instructor. He held a valid Class 2 medical.

The flying club's records indicated the right seat pilot had 167.2 flying hours. He had also flown two previous flights in 2022, totalling 1.4 hours, both flights were in a Cessna 152. He had flown a total of 14.1 hours in 2021. He held a valid Class 2 medical.

The families of both the pilots reported that they were fit and well prior to the flight and were well rested.

Passengers who had flown with the pilots on a previous trip to Le Touquet reported that they had briefly entered cloud during that flight, but on that occasion the flight had continued without incident.

Instrument meteorological conditions

It is very dangerous to enter cloud when not suitably qualified or when not in current practice in instrument flying. The AAIB has investigated numerous accidents when control of an aircraft was lost after intentionally or inadvertently entering cloud in these circumstances[6].

The PPL syllabus teaches pilots some basic instrument flying skills. However, this is often conducted using foggles (partially obscured spectacles) or a hood rather than in real cloud and is usually pre-planned so the student is expecting to fly the exercise. Whilst this is useful training it may not equip the pilot for the quick transition to instrument flying following an inadvertent entry into cloud or give a full understanding of how easy it can be to become disorientated. Instrument flying in a turbulent cumulous cloud is likely to be different from what is experienced in this basic training. Instrument flying is also a perishable skill which requires regular practice to maintain. There is no requirement for PPL pilots to practice instrument flying after they pass their initial skills test. The training does not usually include recovery from unusual attitudes on instruments, so once an aircraft has departed from stable flight, pilots with this training are unlikely to have the skills to recover the aircraft.

Weather decision making

The CAA's Safety Sense leaflet – *'Pilots - it's your decision!'*[7] contains the following comment about loss of control in IMC:

> *'More than three quarters of the pilots killed when they lost control in IMC were flying in instrument conditions without an instrument qualification. Disorientation can affect anyone, particularly those who have not been adequately trained to fly on instruments and kept in practice. It is important to be able to see and recognise cloud ahead early enough to avoid it safely. Even an IMC rating does not impart sufficient skill for prolonged, intentional flight in instrument conditions. Unless you are in regular instrument flying practice it should only be regarded as a minimum skill to 'get out of trouble' if an unintentional excursion into IMC occurs.'*

The CAA Skyway Code (CAP 1535[8]) contains further guidance on pre-flight weather decision making, including the following guidance for avoiding loss of control caused by inadvertently flying into cloud:

> *'When there is either frontal convective or foggy weather around, it can be hard to predict exactly what conditions at a certain point will be. Study the weather carefully and consider options in different scenarios should the weather be*

Footnote

6 Recent AAIB reports include G-CCPV (https://www.gov.uk/aaib-reports/aaib-investigation-to-jabiru-j400-g-ccpv), G-BHFI (https://www.gov.uk/aaib-reports/aaib-investigation-to-reims-cessna-f152-g-bhfi), G-OPEN (https://www.gov.uk/aaib-reports/aaib-investigation-to-bell-206b3-jet-ranger-iii-g-open) and G-WAVS (https://www.gov.uk/aaib-reports/aaib-investigation-to-piper-pa-28-161-cherokee-warrior-iii-g-wavs) [accessed October 2022].

7 Available at https://publicapps.caa.co.uk/docs/33/20130121SSL23.pdf (accessed 6 May 2022).

8 Available at http://www.caa.co.uk (accessed 6 May 2022).

worse than anticipated – calculate altitudes that if forced below by weather, you will turn back or divert.

Do not succumb to the belief that the 'weather is never as bad as forecast' – while that is sometimes the case, it is very often the exception that breaks the rule and causes the accident.

Decision making is generally easier on the ground away from the additional pressure of flying the aircraft – it is tempting to get airborne to 'have a look', but this could suck you into commencing a flight when it is not safe to do so.

If faced with a decision to be made in the air, do so within the parameters you set for yourself at the start of the flight – it is no good calculating a safety altitude if once in flight you think 'oh I'm sure descending a few hundred feet further will be OK'.'

It is not known what pre-flight planning was completed by the pilots before the accident flight. It was reported that the pilots of each aircraft in the fly-out completed separate planning and made their own weather decisions. Whilst there was no coordination between the aircraft it is possible that they inadvertently influenced each other. In a group, if an individual is concerned about a hazard but no one else has mentioned it, it is easy to think that everyone else is not concerned and dismiss one's own concerns. However, it is possible that others are thinking the same thing without raising it. Individuals are often reluctant to challenge the decision of the group. This effect, known as 'group think', is described in the section of the CAA flight-crew human factors handbook (CAP 737)[9] – *'group decision making'*. The families of the pilot's onboard G-EGVA did not think they had any concerns about the weather prior to the flight.

It is not known how the two occupants of the accident aircraft made decisions during the flight. It is possible their decision making was affected by 'risky-shift' which is similar to group think. This effect is described in CAP 737 as:

'The tendency for group decisions to err towards extremely high-risk strategies […]*, rather than moderate risk strategies which individuals are more likely to make alone.* […] *This occurs because an individual's doubts about a strategy can disappear as others show agreement. Confidence in the decision grows as agreement is perceived.* […] *This effect is accompanied by a diffusion of responsibility, meaning that each group member feels only partly responsible for the decision and is therefore able to accept an overall higher level of decision risk than they would alone.'*

Analysis

On the day of the accident an area of convective cloud associated with a convergence line was forecast in the English Channel, crossing the route planned by G-EGVA. The

Footnote

9 Available at http://www.caa.co.uk (accessed 6 May 2022).

forecast suggested that isolated heavy rain and snow showers or thunderstorms were to be expected with a cloud base between 1,500 ft and 3,000 ft and associated with severe icing and turbulence. It is not known what pre-flight weather information was reviewed by the pilots of G-EGVA and if they were aware of the forecast convergence line in the channel before they started the flight.

The convergence line was shown on the synoptic chart. Convergence lines are not currently shown on the F215. The Met Office is reviewing with the CAA whether it would be beneficial to include them.

Met Office weather radar data from the time of the accident showed heavy precipitation in the Channel, suggesting a highly active convective area. Photographs taken by other aircraft in the area at the time showed waterspouts descending from the cloud, and cloud down to the surface, also indicating a highly active convective area.

The video posted on social media by the right seat pilot of G-EGVA showed the aircraft at 5,000 ft with cumulus cloud visible ahead. Radar recordings show that after this time the aircraft descended to approximately 3,000 ft then climbed to above 7,000 ft whilst continuing on a constant heading towards the cloud. It is not possible to know the pilots' intentions but these changes in altitude might have been an attempt to avoid cloud vertically. Climb above 7,000 ft was restricted due to the controlled airspace above.

Shortly after reaching 7,000 ft the radio transmission from the aircraft indicated it had entered cloud. Neither occupant was qualified to fly in cloud. It is not known if they entered cloud inadvertently. The video recording from G-EGVA and the photographs from other aircraft show the cloud was clearly defined and visible from several miles away. There should have been sufficient time to turn around if they were unable to route around the cloud. It is possible that the occupants' previous experience of flying through cloud without incident encouraged them to try to fly through it on this occasion. It is also possible that their decision-making was affected by risky-shift.

It is not known exactly when the aircraft entered cloud. However, in the minutes before the aircraft was lost from radar its heading and altitude varied before it descended in a steepening right turn. The forecast severe turbulence and icing in cloud may have exacerbated the challenge of maintaining controlled flight. When the last radio transmission was made, the aircraft was descending through 7,000 ft at approximately 3,000 fpm. At the last radar point the aircraft was passing 4,600 ft and descending at just under 10,000 fpm. Basic PPL training is unlikely to have prepared the pilots for flight through a turbulent cumulus cloud. Once no longer in stable flight it is unlikely they would have had the experience to recover control of the aircraft.

The radar evidence suggests the aircraft struck the water with a high rate of descent. The damage to the retrieved seat suggests the aircraft was subjected to considerable forces and substantial disruption. It is therefore unlikely that the occupants had any opportunity to escape from the aircraft.

Following publication in May 2022 of AAIB Special Bulletin S1/2022 concerning this accident, the CAA published an animation and a podcast to reinforce its safety messages. These can be accessed at https://www.caa.co.uk/general-aviation/safety-topics/flying-in-cloud/ (accessed 15 August 2022).

Conclusion

Control of the aircraft was lost when it entered a highly active cumulus cloud, which had been forecast. Neither occupant was qualified to fly in IMC. It is likely the aircraft was substantially damaged on impact with the sea.

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.

Published: 17 November 2022.

AAIB Correspondence Reports

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

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

The accuracy of the information provided cannot be assured.

ACCIDENT

Aircraft Type and Registration:	Cassutt Racer IIIM, G-BPVO
No & Type of Engines:	1 Continental Motors Corp O-200-A piston engine
Year of Manufacture:	1973 (Serial no: DG1)
Date & Time (UTC):	1 July 2022 at 1042 hrs
Location:	Near Henstridge Airfield, Somerset
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Substantial
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	69 years
Commander's Flying Experience:	12,632 hours (of which 26 were on type) Last 90 days - 18 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

After a normal takeoff and initial climb to approximately 200 ft agl, the engine lost all power and the propeller started to windmill. The pilot quickly lowered the nose, to maintain best glide speed, and declared a MAYDAY. He rapidly tried to find the fault, but was not able to diagnose the loss of power. As the pre-briefed landing field was too far away, he sideslipped the aircraft to land in a small rough pasture. The aircraft touched down firmly and came to rest after a short distance, facing the opposite direction. It was substantially damaged, but the pilot was uninjured and able to vacate the aircraft unaided.

Later examination by a local aircraft engineer, identified the possible cause of the power loss was a disconnected throttle cable, the reason for this was not established.

The pilot provided a detailed report to the AAIB and highlighted the following safety points which contributed to a successful outcome:

- Self-briefing the 'Engine Failure After Take Off' drill before every takeoff enabled appropriate actions to be taken.
- Flying all the way to the ground ensured control of the aircraft was maintained.
- The harness straps were tightly fastened, which secured the pilot and minimised injury.
- A protective leather helmet provided some head protection.

ACCIDENT

Aircraft Type and Registration:	Luscombe 8E, G-BSYF
No & Type of Engines:	1 Continental Motors Corp C85-12 piston engine
Year of Manufacture:	1946 (Serial no: 3455)
Date & Time (UTC):	23 July 2022 at 1200 hrs
Location:	Near East Winch, Kings Lynn, Norfolk
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Extensive damage to the airframe and shock loading to the engine
Commander's Licence:	Light Aircraft Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	1,051 hours (of which 142 were on type) Last 90 days - 2 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

After a precautionary field landing earlier that day, the pilot was attempting to take off in G-BSYF. Despite a long takeoff run the aircraft was not able to accelerate to a speed sufficient to lift off the main wheels. The pilot shut the throttle and begun to brake; the aircraft then veered to the left. The main wheels caught in a crop, the tail lifted up and the aircraft nosed into the ground. The aircraft came to rest inverted and was extensively damaged.

History of the flight

The pilot was flying between Coldharbour Farm Airfield, Cambridgeshire to Fenland Airfield, Lincolnshire, via Hunstanton. When approaching south of Kings Lynn, the engine began to run roughly. Although the pilot applied carburettor heat, this made no perceptible difference. With the engine at full throttle, and the aircraft descending through 1,000 ft agl, the pilot decided to make a precautionary landing. Having chosen the only field without a tall crop, the pilot made a successful landing with no damage to the aircraft.

Having checked under the cowls, and with the propeller turning with normal compression, the pilot decided to try and start the engine. The engine started immediately and ran smoothly and without issue. Having cleaned the fuel filter and run fuel through the gascolater, the pilot concluded that carburettor icing had been the cause of the power loss.

Having examined the field, the pilot decided that he could fly the aircraft out to avoid the risk of damage from dismantling the aircraft for transport. The crop was low growing sugar beet and the end of the field had only a sparse covering of growth. There were hard soil tracks along the field made by the wheels of the farm machinery which the pilot felt he could use for the main wheels of G-BSYF to run along. Having removed the spats, the plane was pulled back so it had around 600 m of these tracks in front of it and, after several full power checks, the pilot started his takeoff run. Although the tail lifted as the speed increased, the aircraft did not reach sufficient speed to lift the main wheels off due to the surface conditions and the slight crosswind. The pilot closed the throttle and began to brake.

Once the tail settled back onto the ground, it was difficult for the pilot to see exactly where he was going. The aircraft is also fitted with heel brakes that can be challenging to apply evenly, especially at higher speeds. The pilot felt that he had probably applied slightly more left brake, which caused the aircraft to veer to the left and leave the narrow tracks. The left wheel then caught the crops, dragging the aircraft further left. The combination of braking and the resistance of the crops on the main wheels caused the tail of the aircraft to lift, and the nose struck the ground. The aircraft came to rest inverted. The pilot was able to release his seat belt and kick the door open to escape the aircraft. He was not injured in the accident.

The aircraft suffered extensive damage to the lower cowl, engine firewall, windscreen, and tail and wing surfaces, and the engine was shock loaded.

Figure 1

Accident field showing the tracks used by the pilot and the sugar beet crop (used with permission)

Available guidance material

Civil Air Publication (CAP) 793[1] offers guidance for pilots who operate from unlicensed aerodromes and sites. The recommended runway dimensions for light aircraft (MTOW > 2,730 kg) are:

> *Length – The greater length of 1.25 x Take-Off Distance Required or 1.43 x Landing Distance Required, as detailed in Pilot's Operating Handbook*
>
> *Width – 18 m*
>
> *Obstacles – No vertical obstacles within 25 m either side of centre line. Runway end obstacles (hedges etc.) not above 2 m high*

Whilst there are no regulations on the minimum width of a strip to be used for takeoff, the guidance suggested a minimum width of 18 m to allow for the pilot to make directional control adjustments during the takeoff or landing without leaving the designated runway. The two tracks used by the pilot in the field were each less than one metre wide with almost no margin for error or correction.

The CAA also provide Safety Sense Leaflet 12: '*Strip Flying*'[2], which is intended to assist pilots in thinking about safety in flying to and from strips. It states that grass height should be not more than 30% of the diameter of the aircraft's main wheels and ideally shorter. The height of the sugar beet crop was not measured by the pilot, but pictures of the accident site showed that parts of the crop were probably around the same diameter as the main wheels.

Decision making

The pilot was concerned that dismantling the aircraft could risk damaging it, and the length of the road journey to recover the aircraft was significant. The pilot was also assisted by another pilot who flew the same aircraft type and considered that the proposed takeoff was feasible.

The CAA Skyway Code (CAP 1535)[3] is intended to provide General Aviation pilots with practical guidance on the operational, safety and regulatory issues relevant to their flying. It states that,

> *'Good decision making is one of the first lines of defence against risk since it allows for risks to be avoided or mitigated, rather than relying purely on skill or luck to manage them.'*

Footnote

1 CAP 793: Safe Operating Practices at Unlicensed Aerodromes (caa.co.uk) [accessed 1 November 2022]
2 https://www.caa.co.uk/media/zrwcxzv0/caa8230_safetysense_12-strip-flying_v12.pdf [accessed 1 November 2022]
3 https://publicapps.caa.co.uk/modalapplication.aspx?appid=11&mode=detail&id=7920 [accessed 1 November 2022]

Additionally, it offers the following guidance on decision making:

- *'Adopt a cautious attitude to decision making, always checking information and carefully considering the different factors.*
- *Adopt a risk-based approach – identify risks such as weather or lack of currency. If you identify a number of risks on a particular flight, question whether it is sensible to proceed. Consider modifying your plans to reduce some of the risk factors.*
- *Always ask the 'what if?' question.*
- *Avoid exposing yourself to pressure to complete a flight.'*

Analysis

The area used by the pilot in attempting to take off was significantly narrower than the recommended 18 m runway width from CAP793. The wheel tracks were less than one metre wide and did not allow for any margin in directional control. The pilot was unable to remain within the very narrow takeoff tracks in the field during the aborted takeoff. A combination of braking and leaving those tracks resulted in the aircraft nosing over and coming to rest inverted.

The CAA provides considerable guidance for GA pilots to assist in good decision making. The pilot made a sound decision in making a precautionary landing when the aircraft suffered from a partial loss of power. The landing was successful with the aircraft undamaged. However, when faced with an aircraft now stuck in a field of sugar beet, and what the pilot felt to be a normally running engine, a takeoff was attempted from the field. Both the risk of damage during dismantling and the length of journey to recover the aircraft may have contributed to the pilot deciding that attempting to fly the aircraft out of the field was a suitable option.

Conclusion

Having previously made a successful precautionary landing in the field due to a partial loss of engine power, the pilot attempted a takeoff from a sugar beet field. Despite a long takeoff run, the aircraft did not achieve sufficient speed for flight and the takeoff was aborted. The pilot was unable to maintain directional control and the aircraft nosed over and came to rest inverted. The pilot was uninjured and able to extract himself from the wreckage.

Influences on the pilot such as the risk of damage to the aircraft during dismantling and the length of the road journey for recovery may have influenced the pilot's decision making to consider that attempting a takeoff was a suitable option.

ACCIDENT

Aircraft Type and Registration:	Pioneer 300, G-LEAH
No & Type of Engines:	1 Rotax 912 ULS piston engine
Year of Manufacture:	2007 (Serial no: PFA 330-14497)
Date & Time (UTC):	19 June 2022 at 0954 hrs
Location:	Ludham Airfield, Norfolk
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Twisted wing box, damaged engine mounting, propeller, landing gear and left wing
Commander's Licence:	Private Pilot's Licence
Commander's Age:	64 years
Commander's Flying Experience:	1,846 hours (of which 7 were on type) Last 90 days - 7 hours Last 28 days - 7 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

Shortly after takeoff the aircraft developed a rough running engine and suffered a reduction in engine power. The aircraft was unable to maintain height to allow a return to the airfield and the pilot landed in a field during which the aircraft was extensively damaged. The pilot had recently refuelled the aircraft with E10 Mogas, which the LAA does not approve for use on their Permit to Fly aircraft.

History of the flight

After a normal takeoff, at a height of 300 ft, the engine started to run rough with a reduction in engine power. The pilot turned left directly downwind with the intention of landing back at the airfield. He adjusted the throttle and applied carburettor heat but there was no discernible effect on the engine. After selecting landing gear down and first stage of flap, the pilot commenced a turn onto final. The pilot realised that he would not be able to complete the turn and landed the aircraft in a field approximately 30 m short of the runway threshold.

While the aircraft was extensively damaged, the pilot and passenger were uninjured.

Use of E10 Mogas

The Aircraft Flight Manual approves the use of unleaded Mogas (98[1] Octane or greater) and 100LL Avgas. The pilot last refuelled the aircraft with E10 Mogas[2] which had been purchased from a local garage forecourt a week before the accident.

The introduction of E10 Mogas prompted the LAA to issue the following warning on their website: '*E10 unleaded fuel - Not approved for LAA aircraft use*[3]*.'* The LAA have also produced Technical Leaflet (TL) 2.26 – *'Procedures for use of E5 unleaded and E5 super unleaded Mogas*', which provides more details of the range of problems related to the increase in ethanol content in Mogas.

The LAA states that carburettor icing is more likely with Mogas and requires a placard to be fitted on the instrument panel to warn the pilot. Ethanol is a powerful chemical solvent which can attack components such as rubberised gaskets, fuel pipes, old-lacquered carburettor floats and composite or plastic components. The doubling of ethanol concentration from 5% (E5) to 10% (E10) in Mogas increases the risk of problems for parts not designed to be ethanol proof. Ethanol also tends to absorb water which, over time, can become acidic and corrode metal components in fuel and engine systems.

TL 2.26 also states that Mogas has a much higher vapour pressure than Avgas 100LL, with the initial boiling point of the fuel only slightly above ambient temperature. It only takes a slight raise in temperature or drop in pressure to make it vaporise. This makes vaporisation more likely for an aircraft fitted with an engine-driven mechanical fuel pump bolted to the engine crankcase, where heat from the engine will raise the temperature of the pump body considerably. Open vented tanks, with the fuel-pump several feet away from the tank and the fuel routed through a convoluted pipe system, filter and fuel selector encourages vapour lock. There is a requirement to check that full engine power is available before committing to takeoff to ensure that vapour lock is not present.

Although some manufacturers state their engines may be able to use E10, the aircraft's fuel system may not be compatible with this fuel, particularly with vintage aircraft types.

Comment

The pilot commented that vapour lock or carburettor icing may have been factors in the aircraft's rough running engine. He was aware of the LAA limitation on the use of E10 Mogas, but decided to mitigate the effects of E10 Mogas by mixing it with Avgas which he believed was an acceptable practice.

Footnote

1 E10 is 95 octane and E5 is 97 + octane. Reference www.gov.uk/guidance/e-10-petrol-explained accessed 21 October 2022

2 E10 Mogas is a reference to motor gasoline with a 10% ethanol content, which was introduced in the UK on 1 September 2021.

3 http://www.lightaircraftassociation.co.uk/engineering/Mogas/e10mogas.html [accessed July 2022].

Accident

Aircraft Type and Registration:	Jabiru UL-430, G-RUFS
No & Type of Engines:	1 Jabiru 2200A piston engine
Year of Manufacture:	1999 (Serial no: PFA 274A-13359)
Date & Time (UTC):	13 August 2022 at 1350 hrs
Location:	Lower Upham Airfield, Hampshire
Type of Flight:	Private
Persons on Board:	Crew – 1 Passengers - 1
Injuries:	Crew - 1 (Serious) Passengers - 1 (Serious)
Nature of Damage:	Aircraft substantially damaged
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	55 years
Commander's Flying Experience:	1,449 hours (of which 824 were on type) Last 90 days - 21 hours Last 28 days - 9 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

During a go-around, the aircraft collided with trees at the upwind end of the runway. It is likely that the aircraft was unable to climb above the trees due to the reduced performance in the high temperature and rising ground.

History of the flight

The pilot and passenger were flying back from Bakersfield Airfield (near Corby) to Lower Upham Airfield (near Swindon). On arriving overhead at 1,800 ft agl, the pilot estimated the windsock was showing an easterly wind at approximately 6 kt, so elected to land on the easterly runway. He descended into the circuit and flew a normal approach with full flap and an airspeed of approximately 55 kt. He recalled that as the aircraft approached the threshold the airspeed was "a little fast" and on touchdown the aircraft bounced, so he decided to go around. He applied full power and attempted to climb ahead. The airspeed had dropped to 45 kt so he lowered the nose slightly to regain airspeed. He recalled seeing 55 kt on the airspeed indicator and retracting the first stage of flap but the aircraft was not climbing as expected. He felt the engine was operating normally but the aircraft was not climbing. He recalled that with rising ground and trees ahead he attempted to make a right turn and also remembered the aircraft hitting the ground.

The passenger, who was also a qualified pilot, had a similar recollection. He recalled the pilot applying full power on the go-around but the aircraft not achieving a good climb. He remembered looking to his left and seeing trees at the same height. He then recalled a loud bang and the aircraft hitting the ground.

Figure 1

G-RUFS after the accident with the runway in the distance ahead of the aircraft.
The aircraft is facing in the opposite direction to its flightpath before impact

A witness who was parked in a lay-by approximately 100 m from the runway saw the aircraft making its approach then trying to climb. He thought he saw the left wing hit the trees. He saw the aircraft spin round to its right and descend into the field, and alerted the emergency services in a call timed at 1350 hrs.

Both occupants sustained serious injuries.

Accident site

Figure 1 shows the aircraft after the accident, facing in the opposite direction to its flightpath before impact. The runway can be seen in the distance with the trees the aircraft collided with shown in the right of the image.

The police who attended the scene reported there were ground impact marks approximately 10 m from where the aircraft came to rest.

Aerodrome information

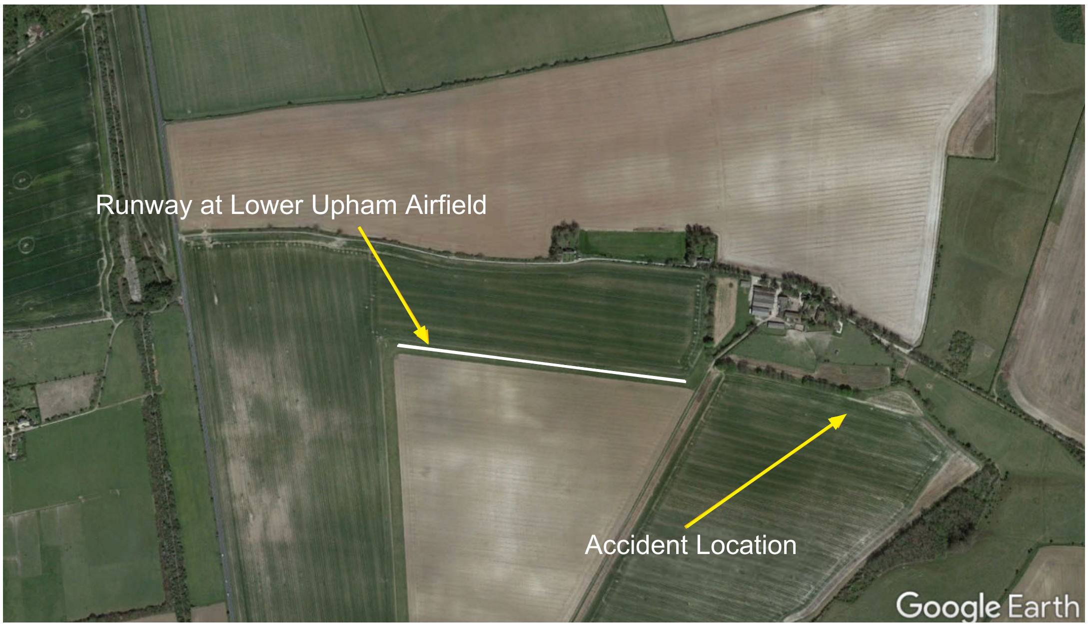


Figure 2

Aerial View of Lower Upham Airfield (runway highlighted with a white line)

The grass runway at Lower Upham is approximately 550 m long and is 560 ft above mean sea level (Figure 2). The runway is orientated roughly east west and slopes up from the west to the east. The accident location elevation is 80 ft higher than the threshold of the easterly runway.

Meteorology

The day of the accident was warm. The pilot reported the weather on landing to be a clear and sunny with a surface wind from 090° at 6 kt, visibility 20 km and a temperature of 33°C.

Gloucestershire Airport (approximately 30 nm from the accident site) reported a surface wind from 130° at 3 kt, CAVOK, temperature 33°C and sea level pressure of 1013 hPa.

Aircraft information

The Jabiru UL-430 is a high-wing two-seat microlight of simple composite construction, fitted with the four-cylinder, four-stroke Jabiru 2200A engine and wooden fixed pitch propeller.

Aircraft performance

The pilot estimated the aircraft's weight was 407 kg when the accident occurred.

The aircraft's rate of climb and baulked landing performance is assessed during the annual 'Permit to Fly' check flight. The pilot had reported the baulked landing performance was 'satisfactory' on the previous three check flights. Table 1 shows the climb performance reported during these flights.

Year	Temperature (°C)	Airspeed (kt)	Rate of Climb (fpm)
2021	+19	75	895
2020	+18	75	857
2019	+16	70	923

Table 1

Rate of Climb recorded during previous check flights

Density altitude

Density altitude is defined as pressure altitude corrected for nonstandard temperature variations. It gives the altitude in the standard atmosphere equivalent to the conditions on the day.

The density altitude at Lower Upham at 1350 hrs on 13 August would have been 2,720 ft. This means the performance of the aircraft at the airfield would have been equivalent to the performance at 2,720 ft on a standard day.

The FAA has published a safety leaflet[1] which describes the effects of density altitude on takeoff and landing performance and on rate of climb. The chart at the end of the leaflet suggests G-RUFS would have experienced a 25% reduction in climb performance in the conditions on the day of the accident.

Analysis

The aircraft was not examined by the AAIB so the possibility of an engine problem could not be eliminated but both occupants reported they thought the engine was operating normally.

It is not known exactly where on the runway the go-around was initiated or what airspeed the aircraft was achieving, so it is not possible to calculate the rate of climb that would have been required to clear the trees. However, it is likely that the reduced performance due to the high ambient temperature combined with the rising ground meant the aircraft was not able to climb at a sufficient rate.

The CAA has published Safety Sense Leaflet 12, - *'Strip Flying'*, which gives guidance on flying from small airstrips and includes a section about climb performance[2].

Conclusion

It is likely that the reduced climb performance due to the high ambient temperature meant the aircraft was unable to climb sufficiently to clear the trees at the end of the runway.

Footnote

1 FAA Safety Leaflet – '*Density Altitude*' available at https://www.faasafety.gov/files/gslac/library/documents/2011/Aug/56396/FAA%20P-8740-02%20DensityAltitude%5bhi-res%5d%20branded.pdf (accessed 27 September 2022).

2 CAA Safety Sense Leaflet – '*Strip Flying*' available at https://publicapps.caa.co.uk/docs/33/CAA8230_SafetySense_12-Strip-Flying.pdf (accessed 27 September 2022).

ACCIDENT

Aircraft Type and Registration:	Zenair CH 601UL, G-CDAL
No & Type of Engines:	1 Rotax 912-S piston engine
Year of Manufacture:	2004 (Serial no: PFA 162A-14195)
Date & Time (UTC):	1 August 2022 at 1050 hrs
Location:	Field northwest of Kinglassie, near Fife Airport
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Significant damage to fuselage, wings, propeller, canopy, and undercarriage
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	70 years
Commander's Flying Experience:	828 hours (of which 45 were on type) Last 90 days - 18 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft's canopy came open unexpectedly shortly after takeoff, causing significant handing difficulties for the pilot who elected to carry out an immediate forced landing ahead. During the landing ground roll the aircraft suffered significant damage due to a rapid deceleration caused by crops catching on the wings and undercarriage.

The pilot concluded that the most likely cause of the canopy opening in flight was an object fouling the right canopy latch mechanism when the canopy was closed for flight, thus leaving it insecure.

History of the flight

The accident occurred shortly after takeoff from Runway 24 at Fife Airport. Reflecting on the flight, the pilot recalled carrying out his normal routine of checking that both right ('passenger') and left ('pilot') sides of the canopy "were fully down and secure" immediately after it had been lowered. He also remembered checking canopy security during the pre-and after-start checks as well as immediately prior to lining up on the runway before starting his takeoff roll.

The takeoff proceeded normally until, as the aircraft climbed through approximately 100 - 150 ft, the right side of the canopy lifted up. Shortly afterwards, the pilot heard "an almighty bang" and a blast of air struck him, blowing off his headset. At the time, he attributed the noise and increased airflow to the canopy having subsequently lifted on his side of the cockpit. The insecure canopy generated a significant amount of extra drag and the pilot had difficulty controlling the aircraft. He reduced power and landed ahead in a field of barley. The fully-grown crop caught the wings and undercarriage, causing a rapid deceleration and loss of directional control which resulted in significant damage to the aircraft (Figure 1).

Figure 1

G-CDAL after the accident, damage evident to wings, fuselage, and canopy

While the right side of the canopy transparency was largely intact, the left side was broken and a large section of it was missing (Figure 2).

In the aftermath of the landing, the pilot could not remember if he needed to unlock the left canopy latch before exiting the aircraft, or if it had been released during the accident sequence.

Figure 2

G-CDAL's broken canopy

Aircraft information

G-CDAL has a one-piece canopy, hinged at the front of the canopy frame. Independent latching mechanisms to secure the canopy for flight are located toward the rear of the canopy frame on each side of the cockpit. These latches engage automatically in corresponding spigots on the cockpit sills when the canopy is closed (Figure 3).

Figure 3
Latch components on canopy frame and cockpit sill

Handles located on each side of the canopy frame are connected to their respective latch mechanism and are used when exiting the aircraft to release the latches, thereby allowing the canopy to be opened (Figure 4).

Figure 4
Left side of canopy frame showing latch mechanism and operating handle

The pilot reported that, due to the spigot bracket design and the position of the seat back, it was not possible to visually check that the passenger side latch had correctly engaged around the spigot after closing the canopy on the accident flight. Nonetheless, he had physically checked that the canopy felt secure before departure.

Aircraft examination

A post-accident examination did not reveal faults with either latch mechanism but the left cockpit sill was distorted near the latch spigot bracket, as highlighted in Figure 5.

Figure 5
Left cockpit sill

During his post-accident inspection of the canopy mechanism, the pilot found that pushing up on the latch operating linkage (Figure 6) would release the catch independent of the canopy latch operating handle. He also determined that if the linkage was fouled while the canopy was being closed it could prevent the latch jaws from closing correctly around the spigot.

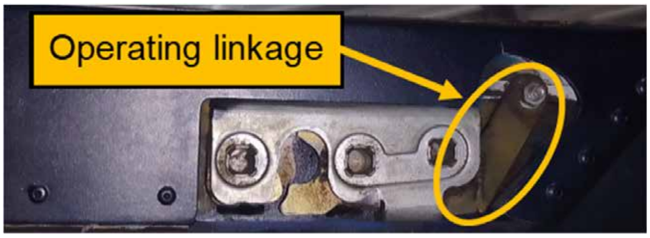


Figure 6
Latch operating linkage

Analysis

Having found no fault with the canopy latching mechanisms, the pilot concluded that the most likely cause of the accident was the right canopy latch not being fully engaged around its corresponding spigot thereby allowing the canopy to lift up as air loads increased. He surmised that the latch operating linkage had probably been fouled when the canopy was initially lowered, thus preventing the latch's jaws from closing correctly around the spigot.

Given the damage to the left cockpit sill, the pilot considered it possible that the loud bang and inrush of air could have resulted from the canopy fragmenting due to torsion as the right side of its frame lifted while the left latch remained engaged.

The pilot reflected that, if one had been available, a secondary canopy locking mechanism might have prevented the uncommanded canopy opening and subsequent accident.

ACCIDENT

Aircraft Type and Registration:	Avy Aera 1.5
No & Type of Engines:	5 Electric motors
Year of Manufacture:	2021 (Serial no: 007)
Date & Time (UTC):	6 May 2022 at 1225 hrs
Location:	Lamlash, Isle of Arran
Type of Flight:	Private
Persons on Board:	Crew - N/A Passengers - N/A
Injuries:	Crew - N/A Passengers - N/A
Nature of Damage:	Damage to lift motor boom, fuselage and landing gear
Commander's Licence:	Other
Commander's Age:	34 years
Commander's Flying Experience:	1,784 hours (of which 75 were on type) Last 90 days - 12 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries made by the AAIB

Synopsis

The 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 UAS. 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.

History of the flight

The UA was hovering during a demonstration flight and was being flown in various manual modes. After about three minutes in the hover, at between 50 m to 65 m agl, a rhythmic lower than normal sound was heard emanating from the UA. A few seconds later it dipped to the left and slowly spiralled downwards. Despite attempts to regain control and fly the UA back to the launch site, the UA was unresponsive and eventually hit the ground. The UA was severely damaged by the impact.

UAS description

The Avy Aera 1.5 is a fixed-wing, payload-carrying UAS which launches and lands vertically. Four electric lift motors mounted on twin booms, drive propellors that enable the vertical takeoff, hover and landing capability. A single electrically driven pusher propeller creates the thrust for horizontal flight. When the correct airspeed during launch for wing-borne flight is attained, the lift propellers cease to rotate and they remain stationary until the aircraft is commanded to slow and transition back to the hover. The UA is capable of beyond visual line of site operations. See Figure 1 for an image of the UA hovering.

Figure 1

Avy Aera 1.5 in flight
(image courtesy of manufacturer)

The lift propellers consist of two blades held between upper and bottom plates which form an articulated propellor hub. Each blade is held in place by a single M3 bolt and a stiff nut and are designed to pivot around the bolt in the horizontal plane. A small stop pin protrudes from the underside of the blade boss which engages with a groove in the bottom plate. This is designed to prevent the blade from 'overshooting' ie travelling too far and folding back on itself. Figure 2 shows the propeller hub assembly components.

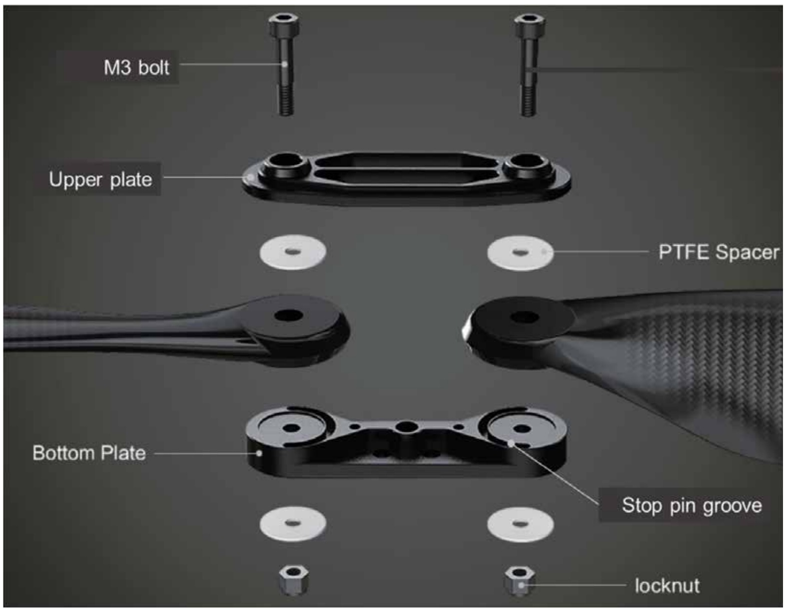


Figure 2

Propeller hub components
(image courtesy of the manufacturer)

The blades are fixed pitch, and the thrust is varied by increasing or decreasing the speed of the motor. Figure 3 shows a lift propeller (there is slight damage apparent on this example, but it is not the propeller that failed).

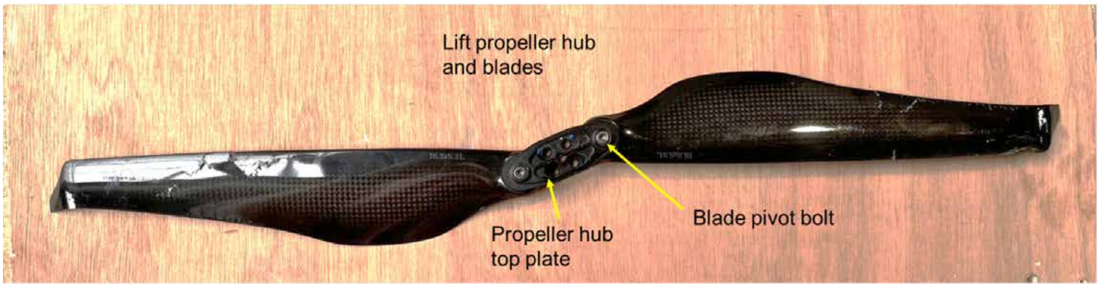


Figure 3

Example lift propeller
(image courtesy of the manufacturer)

Examination

Examination of the UA after the accident found that a blade of one of the lift propellers had detached from its hub in flight. The nut and bolt which held the blade in position had failed near the interface of the plain shank and threaded portion of the bolt. The threaded portion had remained within the stiff nut. The failure of the bolt had allowed the upper and bottom hub plates to separate and open out releasing the blade. Figure 4 shows the failed bolt with its nut and separated hub plates.

Figure 4

Separated hub plates and failed bolt. (The hub is shown inverted)
(image courtesy of the manufacturer)

Manufacturer's investigation

The manufacturer carried out a metallurgical examination of the M3 bolt and concluded that it had failed due to fatigue within the threaded portion under the nut. Further investigation, which included test running of example propellers, identified the probable causes of the fatigue failure of the bolt to lie with the design of the propeller and the loads they encounter in flight.

It was found that design features of the hub plates and blades could lead to a backlash between the blade boss and the bolt. This in turn can result in vibrations when the propeller is rotating. Results of the testing suggested that these vibrations lead to cyclical loads which manifest themselves as shear and bending loads in the bolt. In addition, it was also found that the failed propeller hub assembly stop pin groove was damaged and showed evidence of fretting on the underside of the blade boss (Figure 5).

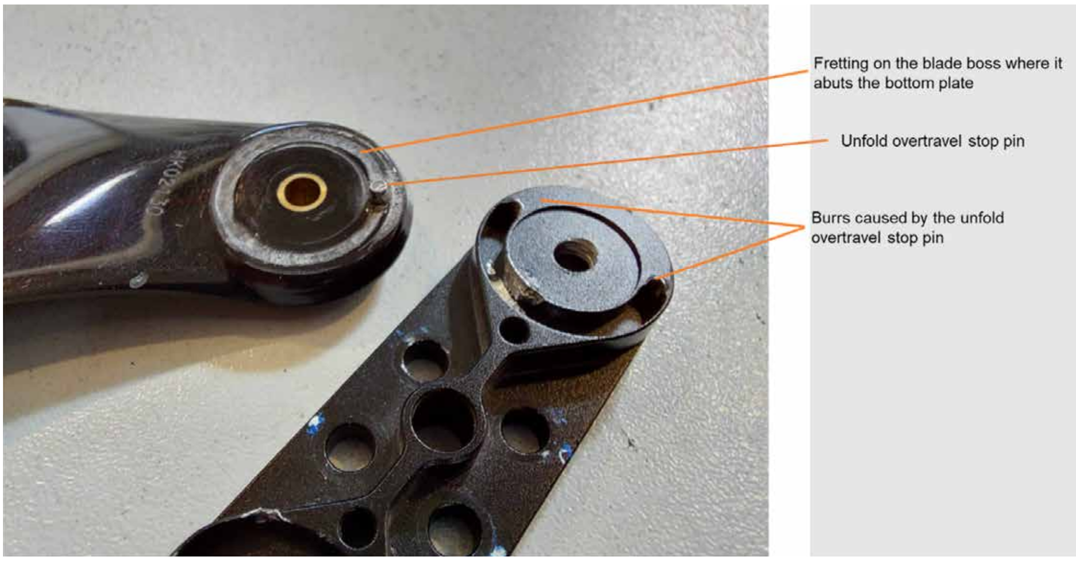


Figure 5

Fretting on the blade boss and damage to the ends of the stop pin groove
(image courtesy of the manufacturer)

It is possible that the damage to the stop pin and groove increased the risk of backlash within the assembly, thereby exacerbating the cyclical loads on the bolt.

The manufacturer also considered the tightness of the bolt. The nature of the design means that any wear or backlash between the blades and the hub is taken up by tightening the nut during assembly and maintenance. There is no specified torque setting and hence any inconsistency of torque within the nut and bolt could also lead to a fatigue failure of the bolt.

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.

AAIB Record-Only Investigations

This section provides details of accidents and incidents which were not subject to a Field or full Correspondence Investigation.

They are wholly, or largely, based on information provided by the aircraft commander at the time of reporting and in some cases additional information from other sources.

The accuracy of the information provided cannot be assured.

Record-only investigations reviewed: September - October 2022

17 Apr 2022 **Jabiru UL-450** **G-JABZ** Eshott Airfield, Northumberland

The aircraft became low and to the right of the intended flight path during approach to Runway 19 at Eshott Airport and it subsequently struck a tree. The pilot described the aircraft losing airspeed and bouncing on the runway. Video footage showed the aircraft become airborne again with excessive bank angle, followed by the sound of impact and the absence of engine noise.

28 Jul 2022 **Morane Saulnier Rallye 150SV** **G-KHRE** Leicester Airport

During flight, it was noticed that the nose wheel had detached from the nose landing gear. The pilot was able to land the aircraft safely.

6 Aug 2022 **Piper PA-28-161** **G-JASE** Popham Airfield, Hampshire

At approximately 200 ft agl after takeoff, the engine lost power and could not be recovered. The pilot selected a field for landing but, after touchdown, was unable to stop before hitting a hedge.

6 Aug 2022 **Pitts S-1C** **G-BPRD** Eastfield Farm, Louth, Lincolnshire

Shortly after a normal touch down, the left main landing gear collapsed and the aircraft nosed over into an inverted position. The pilot reported that the landing gear had fractured, possibly due to fatigue. The pilot believed that his lack of injury was due to his wearing a five-point harness and helmet.

13 Aug 2022 **Nipper T.66 RA45 Series 3** **G-NIPP** Breighton Aerodrome, East Riding of Yorkshire

The pilot was alone and secured the aircraft with chocks and handbrake before hand-swinging the propeller. His initial start attempts from behind the propeller, in reach of the cockpit controls, were unsuccessful so he repositioned to the front and tried again. The engine started immediately but G-NIPP “jumped the chocks”. The pilot managed to grab the left wingtip, G-NIPP swung around, its propeller dug into the ground and the aircraft “flipped over”. The pilot reflected he had too much confidence in the chocks’ and the parking brake’s effectiveness and would never attempt to hand swing a propeller without assistance in the future.

21 Aug 2022 **Eurofly Minifox** **G-CKYZ** Chalfont St Giles, Buckinghamshire

Following an engine failure, the aircraft struck a tree. The aircraft sustained damage and the pilot was uninjured.

Record-only investigations reviewed: September - October 2022 cont

26 Aug 2022 **Cessna F150L** **G-MABE** Doncaster Sheffield Airport, South Yorkshire

The aircraft was landing with a slight tailwind when the pilot's attention was distracted by "lots of black birds" on the runway. The pilot elected to continue the approach but noted on short final that the airspeed was 10 kt above target. The aircraft landed long and bounced twice. During the second bounce the pilot applied power to go around but the aircraft's wheels caught on bushes at the end of the runway causing it to "dive" into the ground, ending up inverted.

30 Aug 2022 **Tecnam P2002-EA Sierra** **G-NFLY** Eastbach Airfield, Gloucestershire

The aircraft was stable during approach as it came over the runway numbers. It suddenly encountered turbulence and lost lift. It landed heavily and the nose gear collapsed.

3 Sep 2022 **MCR-01 Club** **G-CCPN** Popham Airfield, Hampshire

During the takeoff run, the aircraft became airborne prematurely due to the undulating surface of the runway, and it then bounced before touching down heavily. The nose gear collapsed, and the aircraft came to a stop on the runway.

5 Sep 2022 **Druine D.31A Turbulent** **G-ARLZ** Little Gransden Airfield, Cambridgeshire

The aircraft suffered an engine failure shortly after takeoff which resulted in the aircraft making a heavy landing in a stubble field.

13 Sep 2022 **CEA DR360** **G-AYCO** Llanbedr Airport, Gwynedd

The pilot reported that the aircraft encountered a crosswind during landing and it bounced heavily on touchdown. The aircraft veered to the left and came to rest partially off the side of the runway in soft ground. The nose gear collapsed and the propeller and nose leg were damaged.

17 Sep 2022 **Aeroprakt A32 Vixxen** **G-VIXI** North of Atherton, Manchester

Having successfully carried out a precautionary landing in a field after experiencing a rough running engine, the pilot took off again using full power. The engine subsequently failed to respond to control inputs. The pilot carried out another precautionary landing, but during the landing the left wing struck a building.

All times are UTC

Record-only investigations reviewed: September - October 2022 cont

17 Sep 2022 **Piper PA-28-180** **G-AXZD** Teesside Airport

The student pilot made a normal approach with a 12 knot crosswind and with two stages of flaps selected. The aircraft bounced on landing and on the second touchdown the nose leg collapsed and the aircraft came to a halt on the runway.

20 Sep 2022 **Pegasus Quantum 15-912** **G-CDVH** Eccles Newton Airfield, Roxburghshire

The aircraft bounced on landing and then veered to the left. The student pilot applied full power and attempted to fly a go-around. The aircraft hit a hedge to the left side of the grass runway.

24 Sep 2022 **DH82A Tiger Moth** **G-ADJJ** Clench Common Airfield, Wiltshire

The aircraft landed on the left side of Runway 33. As it reached the runway intersection, at a speed of approximately 20 kt, the left wing struck an umarked wooden fence post that had been obscured by a clump of weeds. The pilot stated that he landed too far to the left on the narrow runway.

8 Oct 2022 **Jet Provost T Mk 5** **G-BWSG** North Weald Airfield, Essex

The aircraft touched down firm and fast, causing the tyre on the left landing gear to burst. The aircraft veered off the runway into the grass, crossing two disused taxiways before coming to rest. The pilot reported that the tyres were in good condition and properly inflated prior to the flight.

Miscellaneous

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

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

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

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

Published July 2015.

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

Published August 2015.

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

Published October 2015.

1/2016 AS332 L2 Super Puma, G-WNSB
on approach to Sumburgh Airport
on 23 August 2013.

Published March 2016.

2/2016 Saab 2000, G-LGNO
approximately 7 nm east of Sumburgh Airport, Shetland
on 15 December 2014.

Published September 2016.

1/2017 Hawker Hunter T7, G-BXFI
near Shoreham Airport
on 22 August 2015.

Published March 2017.

1/2018 Sikorsky S-92A, G-WNSR
West Franklin wellhead platform, North Sea
on 28 December 2016.

Published March 2018.

2/2018 Boeing 737-86J, C-FWGH
Belfast International Airport
on 21 July 2017.

Published November 2018.

1/2020 Piper PA-46-310P Malibu, N264DB
22 nm north-north-west of Guernsey
on 21 January 2019.

Published March 2020.

1/2021 Airbus A321-211, G-POWN
London Gatwick Airport
on 26 February 2020.

Published May 2021.

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

http://www.aaib.gov.uk

GLOSSARY OF ABBREVIATIONS

aal	above airfield level
ACAS	Airborne Collision Avoidance System
ACARS	Automatic Communications And Reporting System
ADF	Automatic Direction Finding equipment
AFIS(O)	Aerodrome Flight Information Service (Officer)
agl	above ground level
AIC	Aeronautical Information Circular
amsl	above mean sea level
AOM	Aerodrome Operating Minima
APU	Auxiliary Power Unit
ASI	airspeed indicator
ATC(C)(O)	Air Traffic Control (Centre)(Officer)
ATIS	Automatic Terminal Information 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	Global Positioning System
GPWS	Ground Proximity Warning System
hrs	hours (clock time as in 1200 hrs)
HP	high pressure
hPa	hectopascal (equivalent unit to mb)
IAS	indicated airspeed
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
IP	Intermediate Pressure
IR	Instrument Rating
ISA	International Standard Atmosphere
kg	kilogram(s)
KCAS	knots calibrated airspeed
KIAS	knots indicated airspeed
KTAS	knots true airspeed
km	kilometre(s)

kt	knot(s)
lb	pound(s)
LP	low pressure
LAA	Light Aircraft Association
LDA	Landing Distance Available
LPC	Licence Proficiency Check
m	metre(s)
mb	millibar(s)
MDA	Minimum Descent Altitude
METAR	a timed aerodrome meteorological report
min	minutes
mm	millimetre(s)
mph	miles per hour
MTWA	Maximum Total Weight Authorised
N	Newtons
N_R	Main rotor rotation speed (rotorcraft)
N_g	Gas generator rotation speed (rotorcraft)
N_1	engine fan or LP compressor speed
NDB	Non-Directional radio Beacon
nm	nautical mile(s)
NOTAM	Notice to Airmen
OAT	Outside Air Temperature
OPC	Operator Proficiency Check
PAPI	Precision Approach Path Indicator
PF	Pilot Flying
PIC	Pilot in Command
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

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